



Digital National Framework (DNF) – Overview

**Introduction to the DNF technical
architecture and supporting
documentation and services**



Document Ownership

Les Rackham as Chair of the DNF Technical Group is responsible for the content of this document.

Change record of this document

Version	Date	Summary of change
1	Sept 2006	Publication following review by DNF Expert Group
2	Dec 2006	Publication of updated text

Content

This document consists of 46 pages

Location of this document

<http://www.dnf.org/Pages/technical%20guidance/technicalguides.asp>

Approval for issue

This document has been approved by the DNF Expert Group

This publication

Copyright: This publication may be reproduced free of charge in any format or medium provided that it is reproduced accurately and not used in any misleading context or in a derogatory manner. The material must be acknowledged as a DNF publication and the publication cited when being reproduced as part of another publication or service.

Disclaimer: The information contained in this publication has been compiled from sources believed to be proven in practice and reliable but no warranty, expressed or implied, is given that the information is complete or accurate nor that it is fit for any particular purpose. All such warranties are expressly disclaimed and excluded and users are therefore recommended to seek professional advice before committing to investments that incorporate processes described in this document.

For more information see www.dnf.org/disclaimer.shtml



Contents

Section	Page no
Foreword	5
Executive Summary	7
1. Introduction	9
1.1 Purpose of the document	9
1.2 Document structure	9
2 Scope	9
3 Definitions	11
3.1 Terms	11
3.2 Abbreviations.....	16
4 Introduction to the architecture of DNF	17
4.1 Basic concepts	17
4.2 Main components of the DNF architecture	20
4.3 Service architecture.....	30
5 Defining DNF.....	31
6 Meeting DNF requirements	33
6.1 The need to set requirements.....	33
6.2 Basic requirements.....	34
6.3 Recommended requirements	37
7 Guide to documentation and services	37
7.1 Preamble	37
7.2 Models and Technical Guides for data	39
7.3 Guidelines and best practice for data	41
7.4 DNF Services	42
8 Bibliography/References	43
Appendix A: UML Modelling Conventions	44





Foreword

The Digital National Framework (DNF) is an industry standard for integrating and sharing business and geographic information from multiple sources. It is being developed for use within the United Kingdom although concepts and principles could be applied elsewhere. It aims to be: (i) definitive by using a detailed and maintained topographic reference base, (ii) inclusive by being open and adopting industry best practice, (iii) structured and formalised to the extent that data once created can be shared and used many times, (iv) reliable through the delivery of data integrity, (v) cost-effective through reduction in the costs of data from multiple sources and (vi) flexible by enabling information exchange.

The basic principles at the core of DNF are as follows:

- ~ The concept and methods shall be driven by the strategic needs of the wider geographic information (GI) community and the needs of the information industry;
- ~ Data should be collected only once and then re-used;
- ~ Base reference data should be captured at the highest resolution whenever economically possible;
- ~ Information following capture may, where appropriate, be used to meet analysis and multi-resolution publishing requirements;
- ~ DNF will incorporate and adopt existing *de facto* and *de jure* standards, wherever they are proven and robust.

DNF is being developed and promoted by an industry body with membership drawn from data providers, system vendors and integrators and users. Both the commercial and government sectors within Great Britain are represented. All members have a common interest in the integration, sharing and utilisation of geographic information. Direction and strategy comes from an Expert Group. This in turn oversees and approves the work of a Technical Group responsible for the development of all technical documentation including this document.

This document is one of a series of technical documents being developed in support of DNF. Included in the series are data models, technical guides, guidelines, best practice, examples and case studies. Web-based services such as identifier registration are also being developed in support of this documentation.



Of increasing significance to DNF is INSPIRE the European Union (EU) initiative for the creation of a European spatial information infrastructure. This will lead to the provision of integrated spatial information services and will allow users to identify and access spatial or geographical information from a wide range of sources from local to European-wide. There is much commonality between the objectives of DNF and those needed by UK to support INSPIRE. DNF has registered as a Spatial Data Interest Community (SDIC) and is participating fully in the review of INSPIRE documents. Conversely, DNF is ensuring that there is harmonisation between its documents and those of INSPIRE.

For more information on the Digital National Framework visit <http://www.dnf.org> .

If you have any comments or suggestions on this document, please e-mail contact@dnf.org , your response will be acknowledged.



Executive Summary

This document provides an overview to the technical architecture of the Digital National Framework (DNF) and a guide to the documentation and services being developed in support of the technical architecture. It is aimed at business readers wishing to gain a general understanding of the technical aspects of DNF and also other new adopters who need to understand the broader technical picture and seek guidance on where to look for more detailed information required for any implementation.

General concepts and principles underlying DNF are described and illustrated. The architecture which builds on the concepts is defined in terms of the main components and their relationships. A formal model in Unified Modelling Language (UML) is presented. This is followed by a description of the way in which the technical aspects of DNF are being defined and a summary of the basic requirements for adopting DNF. The document concludes with a guide to documentation and supporting services.





1. Introduction

1.1 Purpose of the document

This document provides an overview of the technical architecture of the Digital National Framework (DNF) and a guide to the documentation and services being developed in support of the technical architecture. Its purpose is to (i) equip the reader with a general technical understanding of the nature of DNF, (ii) enable the reader to appreciate whether this is applicable to their business or processes, (iii) indicate what may be required to adopt general DNF principles and (iv) act as a guide to how and where further technical information and services may be obtained.

The principles of DNF are applicable to a wide range of geographic or geospatial data; that is data that carries references or relates to locations on the earth's surface. Although many of the principles are generic, they currently apply to data which references locations in United Kingdom.

The detailed documentation and supporting services are still being developed. Thus, this overview is an evolving document. Certain sections are incomplete or interim in nature. This is made clear in the text.

1.2 Document structure

Document scope and terms used are presented first. The general concepts and principles underlying DNF are then described and illustrated. The architecture which builds on the concepts is then defined in terms of the main components and their relationships. A formal model in Unified Modelling Language (UML) is presented. This is followed by a description of the way in which the technical aspects of DNF are being defined and a summary of the basic requirements for adopting DNF. The document concludes with a guide to documentation and supporting services.

2 Scope

This document forms the top-level of a hierarchy of DNF documentation describing the technical architecture which includes:

- Models or schemas;
- Technical guides to DNF date and time referencing, positioning, reference objects, association and metadata;
- Examples and supplementary documentation supporting the technical guides.



- Guidelines and best practice for data maintenance, quality and classification.

The above are described in summary in this document which provides links to further more detailed information.

This document is particularly applicable to business readers wishing to gain a general understanding of the technical aspects of DNF. It is also applicable to other new adopters who want to understand the broader technical picture and need guidance on where to look for more detailed information required for any implementation.

Those seeking to construct business cases for the adoption of DNF principles should also consult the various case studies available at <http://www.dnf.org/Pages/case%20studies%20%26%20benefits/>.

Figure 1 shows the DNF Roadmap which sets out the main technical deliverables. These are described in summary form in this overview.

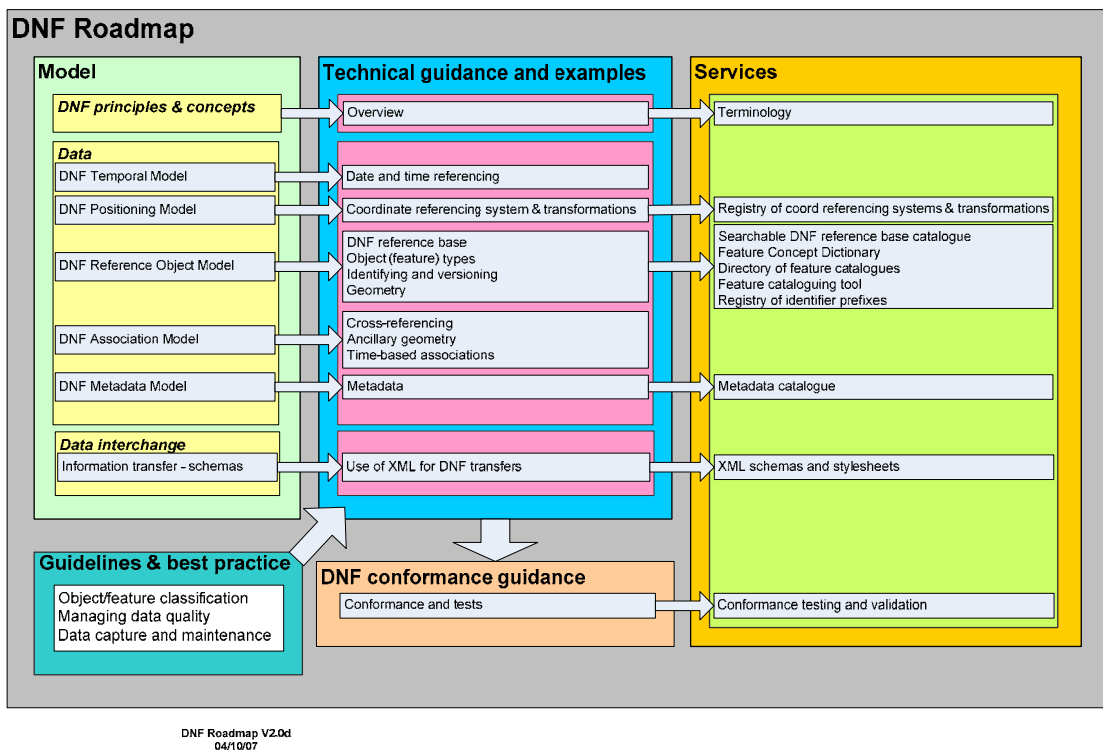


Figure 1: DNF Roadmap



3 Definitions

3.1 Terms

The following terms, arranged in alphabetical order, are used in this document. Where definitions include terms defined elsewhere then these terms are shown in *italics*.

See <http://www.dnf.org/Pages/technical%20guidance/terminology.asp> for a full and up-to-date list of terms used in the Digital National Framework.

3.1.1 Abstraction

Process of selecting only those *Real World Objects* and the *Attributes* and behaviours of those objects which are relevant to a particular application

3.1.2 Application Reference Layer

Aggregation of *Application Reference Objects* forming a partial or complete coverage of an area and which can be associated in some way to the *DNF Reference Base*

NOTE This need not exhaust space nor have national coverage

EXAMPLES Land title dataset; protected sites (SSSI) dataset, planning zones, Land & Property Gazetteer; Street Gazetteer.

3.1.3 Application Reference Object

Geographic Object which is referenced by a *Business Object* in an application. The Application Reference Object can refer to one to many *DNF Reference Objects*

NOTE Class or instance depends on the context, assume class unless otherwise stated

EXAMPLE An area of designated access land, the extent of a National Trust property, Basic Land and Property Unit (BLPU) in a land & property gazetteer; a street in a highways maintenance application; an Output Area used in census analysis; a land title extent in a Land Registry database.

3.1.4 Association

Any relationship between things or objects

NOTE In a DNF context it usually refers to a spatial relationship of some type. Associations can be simple and between two objects (e.g. this *Business Object* is related to that *Geographic Object*) or more complex and involve a number of associated *Geographic Objects*. There can be a number of different types of association between the same types of objects e.g. a person lives at one location and works at another

3.1.5 Attribute

Property of a class of objects



NOTE By convention attributes are named. An instance within a class can hold a value within a defined range of values. In the case of a *Geographic Object*, attributes may describe, for example, the geometrical, topological, or thematic characteristics

3.1.6 Business Object

Object which is processed by an application and needs to be located relative to a *Geographic Object*

NOTE Business is used a wide sense here to relate to any data and objects which are non-geographic. It is not specific to commercial data and can relate to any data such as environmental data that needs to be located

EXAMPLE Planning application referenced to a land parcel, census record referenced to a house, ecological record referenced to a Site of Special Scientific Interest

3.1.7 Ancillary Geometry

Lines or areas used to qualify the relationship between an *Application Reference Object* and a *DNF Reference Object* where the spatial relationship is not coterminous

NOTE The geometry i.e. the spatial properties in terms of points, lines and areas defined by coordinate positions must be consistent with that of the *DNF Reference Base* and fit to it.

EXAMPLE Additional line geometry created where a title extends beyond the physical boundary of a land parcel as represented by the DNF Reference Object

3.1.8 Coordinate Reference

Position of a *Geographic Object* given using coordinates

EXAMPLE National Grid Eastings and Northings)

3.1.9 Cross-Referencing

Mechanism of holding links between objects which may be expressed through the use of identifiers

EXAMPLE Unique Property Reference Number (UPRN) of a Basic Land and Property Unit (BLPU) cross-referenced to an OS MasterMap Topographic Area

3.1.10 Data Quality Element

Component of the information used in documenting the quality of a dataset

EXAMPLE Positional accuracy

3.1.11 Data Quality Schema

Model used to define and relate the *Data Quality Elements*



3.1.12 Digital National Framework

Industry standard for integrating and sharing business and geographic information from multiple sources

3.1.13 DNF Association

Relationship between an *Application Reference Object* and one-to-many *DNF Reference Objects*

NOTE This is a spatial relationship which can be simply expressed through cross-referencing or with more complexity. It may be qualified by the addition of other attributes and metadata and may include DNF Ancillary Geometry

3.1.14 DNF Coordinate Position

Point on the Earth's surface defined by a coordinate value derived using a *Spatial Referencing System Using Coordinates* and used to in the context of DNF

NOTE May be a two or three dimensional coordinate

3.1.15 DNF Positioning System

System for referencing position in time and space in the *DNF Reference Base*

3.1.16 DNF Reference Base

Base framework of reference made up of *DNF Reference Objects* to which *Application Reference Objects* are associated

NOTE Over land the DNF Reference Objects would normally provide complete coverage

3.1.17 DNF Reference Framework

Aggregation of *DNF Reference Base* and *Application Reference Layer*

NOTE Collective term used for all the DNF architectural components and the associations between the components

3.1.18 DNF Reference Object

Geographic Object that forms part of the *DNF Reference Base* which may be referenced by other objects

NOTE Currently, DNF Reference Objects are derived from a subset of OS MasterMap Topography Layer feature types on land but as DNF usage expands they will also be derived from other authoritative sources

3.1.19 DNF Reference Object Geometry

Representation of a *DNF Reference Object* as *Geometric Primitives* (points, lines and areas) defined by coordinates based on a recognised spatial referencing system



NOTE If the DNF Reference Object is derived from OS MasterMap then the spatial referencing system will be based on the National Grid

3.1.20 DNF Topographic Identification Scheme

Scheme for identifying *Geographic Objects* used in a DNF context

3.1.21 DNF Unique Identifier

Means of uniquely identifying *Geographic Objects* using a registered prefix and a local identifier which can be used in a DNF context

3.1.22 Feature

Abstraction of real world phenomena

NOTE 1 A feature may occur as a type or an instance. Similar instances of particular phenomena can be classified together as a type

NOTE2 *Geographic Object* is used in preference to feature in DNF except in reference to data classification and feature cataloguing where the term "feature" is widely adopted

EXAMPLE The phenomenon named "Acacia Avenue" may be classified with other similar phenomena into a feature type "street"

3.1.23 Feature Catalogue

Catalogue containing definitions and descriptions of classes of geographic objects or *Feature* types

NOTE Feature and object regarded as synonymous in this context

3.1.24 Geographic Object

Abstraction or application view of a real world object which has a fixed and identifiable location on the Earth's surface

NOTE 1 Typically represented in data by points, lines or areas

NOTE 2 Geographic Object is used in preference to *Feature* in DNF except in reference to data classification and feature cataloguing where the term "feature" is widely adopted

NOTE 3 Geographic Object is equivalent to "Spatial Object" in INSPIRE. However, "Spatial Object" in the ISO standards refers to an "object used for representing a spatial characteristic of a feature" e.g. a geometric or topological object.

EXAMPLE Building, street, land parcel

3.1.25 Geometry Primitive

Geometric object representing a single, connected part of space e.g. point, line or polygon



3.1.26 Location

Identifiable geographic place
(BS 7666-0: 2006)

3.1.27 Metadata Element

Component of information used in documenting the metadata of a dataset, *Feature* or object

3.1.28 Metadata Schema

Model used to define and relate the *Metadata Elements* used to document data resources

3.1.29 OSMM Topographic Object

Geographic Object that is derived from a subset of *Feature* class instances in OS MasterMap Topography Layer where these are abstractions of real world objects

NOTE Not all instances of all feature classes in OS MasterMap Topography are candidate objects

3.1.30 Position

Point fixed in relation to the Earth's surface which is defined by coordinates

NOTE Coordinates may describe the position in two or three dimensions

3.1.31 Real World Object

Something which has existence, whether concrete or otherwise, and is definable in some way through its attributes and behaviour

NOTE In the context of DNF real world objects will usually refer to *Geographic Objects* or *Business Objects*. Whereas the former will have a concrete existence, the latter may not be tangible objects e.g. a planning decision

3.1.32 Reference

Relating of business information to defined *Geographic Objects* which can be uniquely identified by address, set of characters or position

NOTE This is a specialisation of a general term when used in a DNF context

3.1.33 Reference Object

General term for any *Geographic Object* which is referenced by *Business Objects* or other *Geographic Objects*

3.1.34 Representation

In the context of DNF, the depiction of a *Geographic Object* using *Geometric Primitives* defined by coordinates based on a *Spatial Referencing System Using Coordinates*



NOTE Other forms of representation are possible such as images but these are currently not within scope of DNF

3.1.35 Spatial Referencing System Using Coordinates

Means of locating objects on the earth's surface using coordinates

3.1.36 Temporal Reference System

Means of date and time referencing

3.2 Abbreviations

AL2	OS MasterMap Address Layer 2
BLPU	Basic Land and Property Unit
DNF	Digital National Framework
GI	geographic information
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
ETRS89	European Terrestrial Reference System 1989
LLPG	Local Land and Property Gazetteer
INSPIRE	INfrastructure for SPatial InfoRmation in the European Community (INSPIRE)
ITM	Irish Transverse Mercator
ITN	OS MasterMap Integrated Transport Network
OS	Ordnance Survey
OSGB36	Ordnance Survey Great Britain 1936 (datum)
SMART	Specific, Measurable, Achievable, Realistic, Testable
TOID	Topographic Identifier
UPRN	Unique Property Reference Number



4 Introduction to the architecture of DNF

4.1 Basic concepts

Much data is related to locations on the earth’s surface. These locations are usually specific geographic or spatial objects in the real world (e.g. buildings, land parcels, streets). Applications, which are designed to process and analyse data which needs to be spatially referenced, model a particular view of the world. The geographic objects are abstracted and represented in the application in many different ways. Spatial aspects are often represented by geometric primitives such as points, lines, and areas. Position is related to a spatial referencing system such as the National Grid or latitude and longitude. The properties of the objects are reflected in attribute values. Other data is also usually included such as identifier, date of capture, date of last change and so on. These basic concepts are shown in a much simplified form in Figure 2. The “business objects” shown in the diagram can be any real world objects that need to be located; they are not restricted to those associated with human activity.

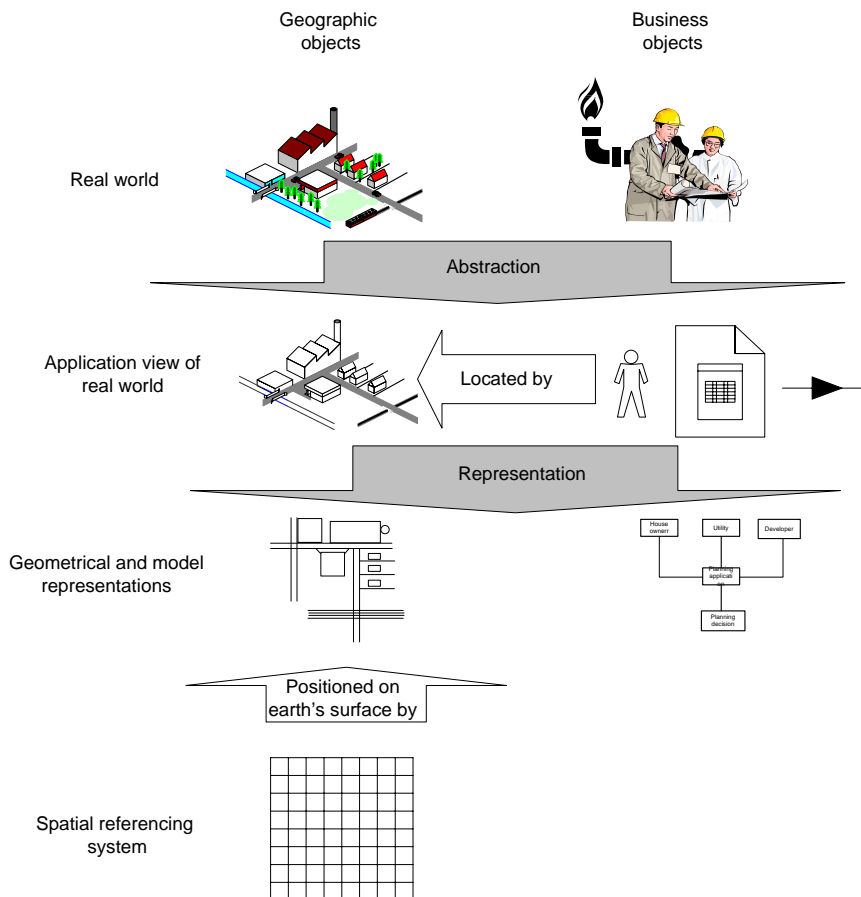


Figure 2: Abstraction and representation of geographic and business objects in an application for processing geographic information



The geometrical aspects and position of geographic objects is often derived in some way from a reference base, traditionally this has been some sort of topographic map such as OS Land-Line®. Increasingly this is from sources using object-based models of the real-world such as OS MasterMap® which is rich in maintained and uniquely identified topographic objects. See Figure 3.

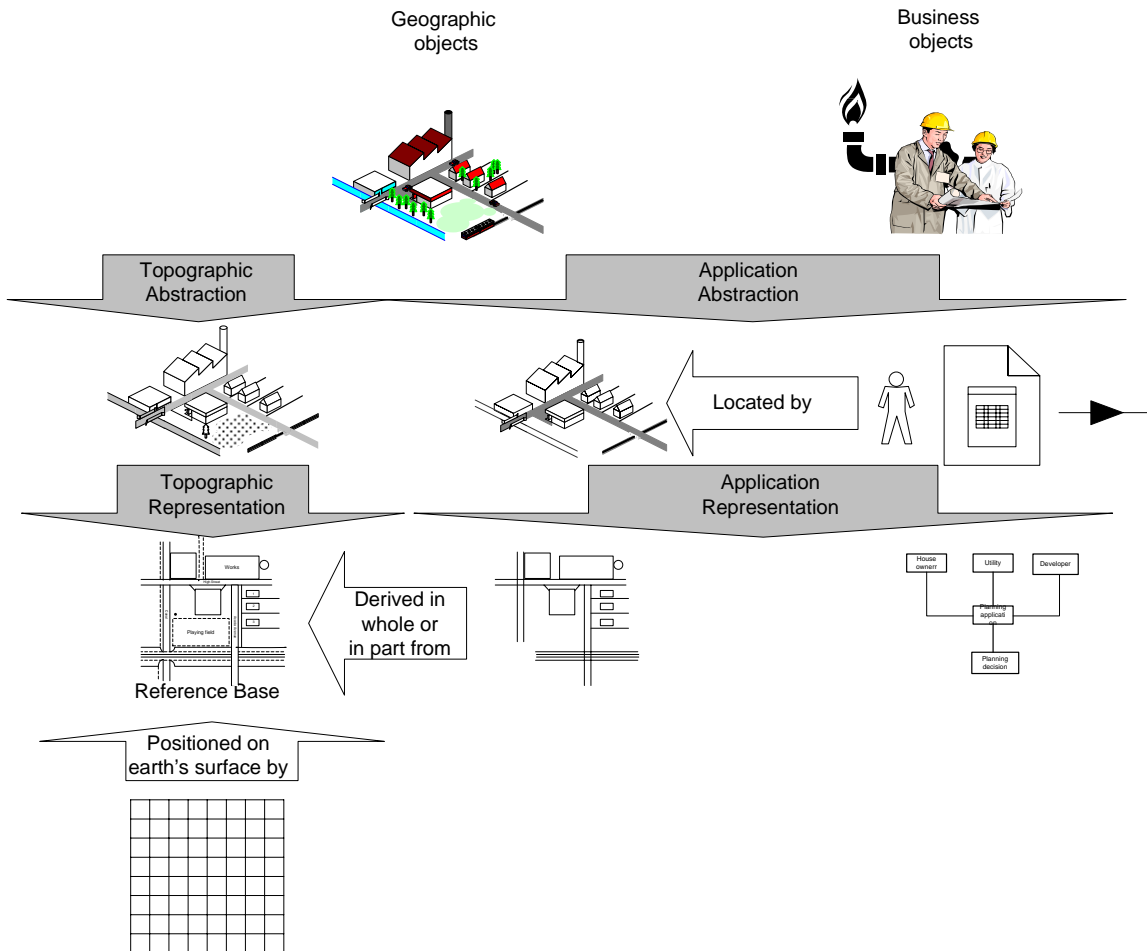


Figure 3: Abstraction and representation of geographic objects using a reference base

This opens up the possibility of creating and maintaining permanent associations between the geographic objects used in the application (application reference objects) and objects in the reference base (base reference objects). The advantages in doing this can be manifold:

- ~ it may be possible to relate the business objects directly to the geographic objects present in the reference base thus obviating the need to maintain separate geographic objects in the application;



- ~ changes to geographic objects reflected in changes to the reference base can be used to trigger a review of those geographic objects and business objects modelled in the application;
- ~ conversely, the objects modelled in the application can be immune to minor changes to objects in the reference base
- ~ deriving and then maintaining the geometry of the geographic objects represented in the application from a reliable, accurate and maintained reference base can lead to greater consistency and improved data integrity in the application;
- ~ by maintaining an association with a reference base which is also used by other applications a means is provided of associating the geographic objects from different applications:
- ~ by maintaining an association with a common reference base and doing this in a consistent way, according to agreed practice, opens up the possibility of data sharing and interoperability.

These latter concepts are shown below in Figure 4.

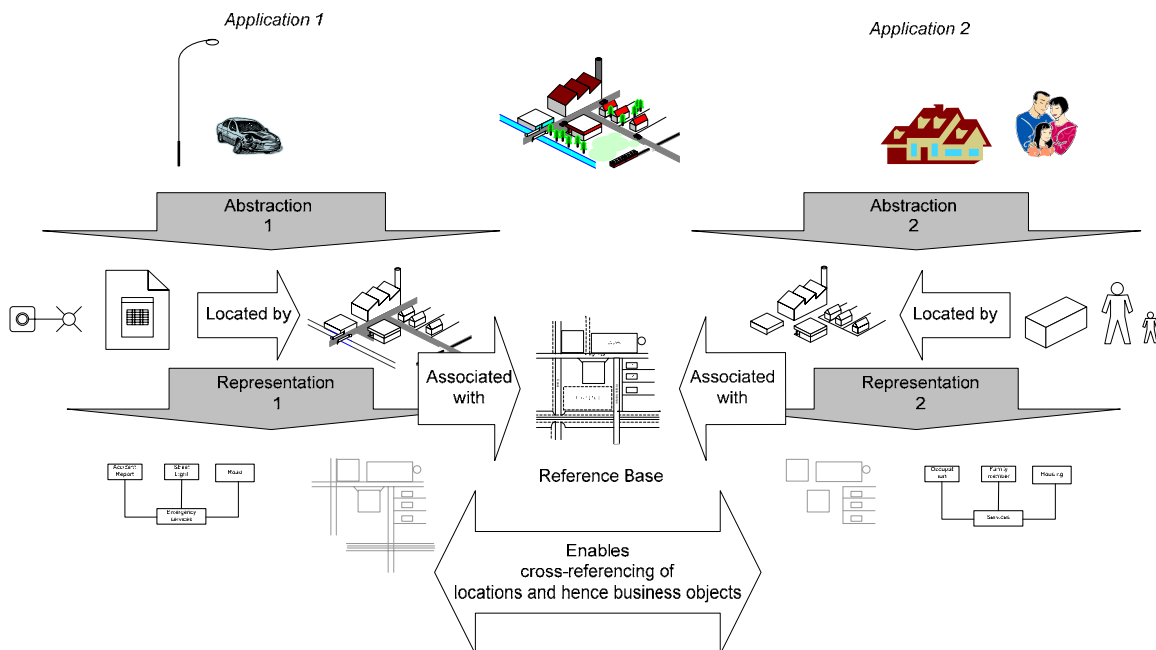


Figure 4: Diagram showing how applications can be associated with a reference base to enable cross-referencing

The nature of the association between the application reference objects and the base reference objects making up a common reference base will depend on a number of factors:



- ~ the closeness in views of the real world between the application reference objects and reference base – how similar or how dissimilar is the abstraction in terms of real world objects included or excluded;
- ~ the similarity of the abstraction in terms of attribution and geometric representation (e.g. as points, lines and areas) - this is about their degree of semantic similarity as well as their spatial “footprint”;
- ~ the classification of the application objects into different types
- ~ the granularity in terms of spatial detail and attribution between the application objects and the reference base
- ~ the life-cycles and maintenance regimes of the application objects and the objects making up the reference base.

There is unlikely to be a complete geometrical, temporal and semantic “fit” between the application reference objects and the base reference objects, therefore any association may need to be qualified in some way through some additional geometry and other attribution applied to the association itself. However, this depends on how close a spatial association is required. For many applications, a simpler association unqualified by additional geometry may be quite sufficient.

The concepts described above are core to DNF. In essence DNF is about how you can associate geographic objects used in different applications to a common reference base and, by so doing, provide a means of relating different business objects used in the applications where they are referenced to the same, or a very similar, location. As more applications use this approach so the range of business objects that can be cross-referenced increases.

4.2 Main components of the DNF architecture

4.2.1 Components of the DNF Reference Framework

The Digital National Framework takes the basic concepts set out above and builds a coherent technical architecture on these. The core architectural components¹ specific to DNF are:

- ~ *DNF Reference Objects* – the classes and instances of topographic objects which are the fundamental reference objects which together make up the *DNF Reference Base*. They form a common reference for any application objects;

¹ Components of the architecture are given in italics for ease of reference. Definitions are given under 3.1 Terms.



- ~ *DNF Reference Object Geometry* – this represents the *DNF Reference Object* as geometric primitives – points, lines or areas - which are defined by coordinates based on the *DNF Positioning System*;
- ~ *DNF Coordinate Position* - this is used in the positioning of *DNF Reference Objects* in space and is based on a recognised spatial referencing system. The positions of *Application Reference Objects* (see below) can also be related either directly or by transformation to the *DNF Coordinate Position*;
- ~ *DNF Reference Base* – the topographic base formed by an aggregation of *DNF Reference Objects*. This aggregation should cover all the land² area within scope of DNF³;
- ~ *DNF Association* – is the association between the *Application Reference Objects* and the *DNF Reference Objects*. It has its own properties or attributes.

For application data to be used in a DNF context the application needs to model not just business objects but defined and identified geographic objects. The latter locate the business objects and can be associated in some way with the *DNF Reference Objects*. In the simplest case, the geographic objects used by the business objects are the *DNF Reference Objects* i.e. the business objects reference the *DNF Reference Base* directly.

- ~ *Business Objects* – in a DNF context any business object which needs to be related or referenced to locations in the real world. Examples of *Business Objects* are planning applications, census records and highway maintenance records.

Where the *Business Objects* do not reference the *DNF Reference Objects* directly, then the geographic objects which provide the location for the *Business Objects* are referred to as:

- ~ *Application Reference Objects* – these are for example, Basic Land and Property Unit (BLPU), street, building, land title which are used to locate *Business Objects*. Beyond the fulfilment of certain basic requirements, DNF does not mandate the form of the *Application Reference Object*, this is an application issue;

The *Application Reference Object* is part of the:

² This may be modified when DNF is extended to include sea areas.

³ “Cover” in the sense of providing complete ground coverage if viewed from vertically above.



- ~ *Application Reference Layer* – this is made up of an aggregation of instances of the *Application Reference Objects* (for example, a Local Land and Property Gazetteer - LLPG) but it may not provide complete coverage of an area. An application may have several such layers where for example, *Business Objects* are referenced to geographic objects which are, in turn, referenced to BLPUs in an LLPG;

All the spatial components together form the *DNF Reference Framework*.

The parameters of the *DNF Coordinate Position* are defined by the *DNF Positioning System* which also includes the temporal⁴ as well as the spatial positioning.

The relationship between these components within the overall framework is illustrated in the following diagram at Figure 5.

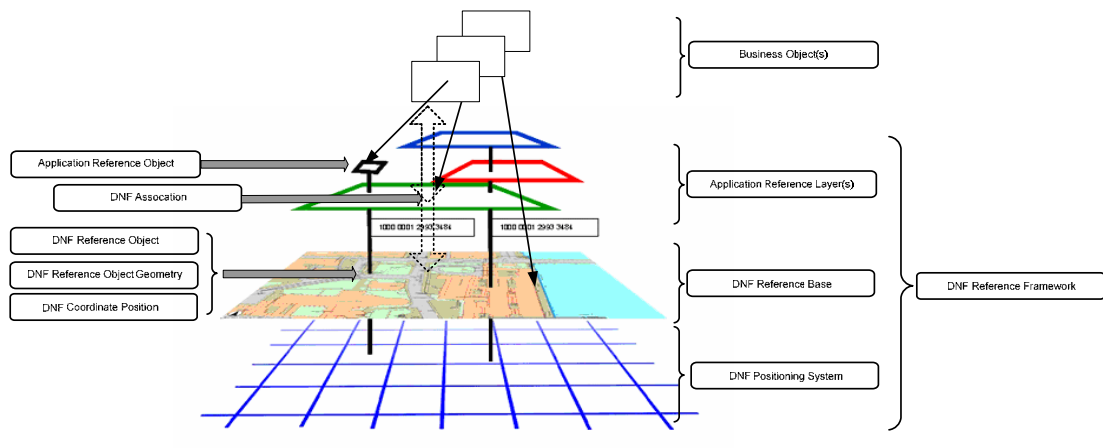


Figure 5: Diagram to illustrate how the main components of the architecture fit together

The relationship between these objects is expressed more formally in the following Unified Modelling Language (UML) class diagram. The conventions used in these models are given in Appendix A. The DNF Reference Framework and DNF Positioning System are omitted. This presents the simplest case, not all possible relationships are modelled.

⁴ Temporal positioning refers to dates related to particular events.

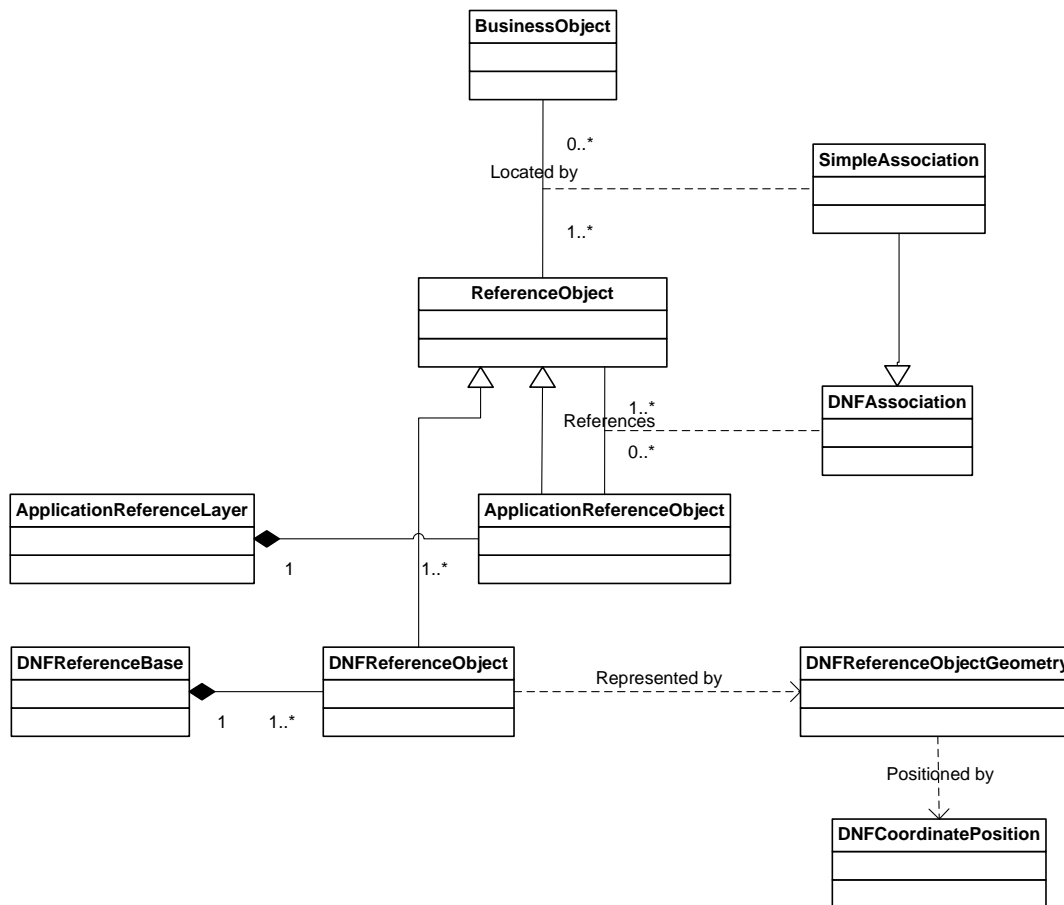


Figure 6: Simplified UML class diagram showing the relationships between the main components of DNF

The model expresses the following - starting from the top:

- ~ A *Business Object* is located by a *Simple Association* to one or more *Reference Objects*;
- ~ A *Simple Association* is a type of *DNF Association*.
- ~ A *Reference Object* may be referenced by any number of *Business Objects* or none;
- ~ There are two kinds of *Reference Object*: *Application Reference Object* and *DNF Reference Object*. Each instance of *Reference Object* must be either an *Application Reference Object* or a *DNF Reference Object*;



- ~ An *Application Reference Object* references one or more *Reference Objects* (each of which may be either a *DNF Reference Object* or an *Application Reference Object*⁵);
- ~ An *Reference Object* is referenced by any number of *Application Reference Objects* or none;
- ~ The *Application Reference Objects* aggregate into an *Application Reference Layer* which may or may not provide complete surface coverage and may be only local in extent;
- ~ The *DNF Reference Objects* aggregate into a *DNF Reference Base*;
- ~ A *DNF Reference Object* has a dependency on a *DNF Reference Object Geometry* which represents its spatial properties in terms of points lines and areas defined by coordinate positions;
- ~ The position (or positions) of the *DNF Reference Object Geometry* and hence the *DNF Reference Object* is given by coordinates that relate to a recognised coordinate referencing system - here shown as an object, the *DNF Coordinate Position* on which the *DNF Reference Object Geometry* is dependent.

Each of the classes represented in the model is described in more detail below.

4.2.2 DNF Reference Object

A *DNF Reference Object* is a geographic object resulting from abstraction from the real-world. It is represented geometrically by a point, line or area. A *DNF Reference Object* can only be represented by one defined collection of geometry not multiple geometries e.g. a road object can only be represented by an area or polygon indicating (say) the limits of the road metalling and not also by a line indicating the course of the road centre-line.

For *DNF Reference Objects* to be useful, their representations need to cover the complete surface of the area of interest, as far as is practical - at least over land. All instances of the classes of objects which form the *DNF Reference Base* and which are current must be present. Further they need to be maintained over time with unique identifiers and versions that are retained throughout the life-cycle of the object which is defined and documented.

DNF Reference Objects are abstractions of objects that are widely recognised in the real world. They must be capable of being related to, or associated with, other reference objects used in a large number of applications. This means that they need to be clearly defined and of a fine granularity and attribute rich.

⁵ In a DNF context, an *Application Reference Object* must reference at least one other *Reference Object*. A consequence of this is that ultimately the chain of references must lead to a *DNF Reference Object*. This means that it is not possible to have an *Application Reference Layer* which is not linked to a *DNF Reference Layer*. Any candidate to be an *Application Reference Layer* within DNF must be linked, either directly or indirectly, to a *DNF Reference Layer*.



Pragmatically, on land in Great Britain, the main candidates as *DNF Reference Objects* are OS MasterMap Topography Feature Types⁶. However not all OS MasterMap Feature Types are suitable as *DNF Reference Objects*. The OS MasterMap Topography Layer still carries a large cartographic baggage in the form of symbols, cartographic text and also the representations of objects that are not usually thought of as real-world objects such as boundary lines. Further, in order to close off areas or polygons and create usable reference objects where there is no physical boundary in the real world, the limits of some topographic objects are inferred using pragmatic rules e.g. on open-plan estates or between streets. Thus there is a need to be selective in the choice of OS MasterMap objects as *DNF Reference Objects* and also to be aware of the derivation of some geometry where this is inferred.

This does not preclude the use of other reference objects as *DNF Reference Objects* in the future so long as this is done in a controlled way. Potentially, the DNF concept is extensible to the whole of UK and beyond⁷. To be considered as *DNF Reference Objects* they need to conform to the principles set out above which implies that they have to be part of a maintained and detailed coverage to a consistent national specification which is either based on the National Grid or can be readily and consistently transformed to it. Also implied is widespread and accepted adoption and also ease of access to these objects by other users.

4.2.3 The DNF Reference Object Geometry

The *DNF Reference Object Geometry* is the representation of the *DNF Reference Object* as geometric primitives defined by coordinates based on the *DNF Positioning System*.

In a scale-free world all reference objects would be represented by areas. However, for practical and economic reasons the representation of objects in the real world has to be generalised may be captured as an aggregation or represented by points or lines.

⁶ 'Feature Type' is the term used by Ordnance Survey for classes of objects which can be represented by respectively, points, lines, symbols, boundary lines and areas.

⁷ The intention is to include marine objects in the DNF Reference Base, different principles may need to be adopted in their case.



4.2.4 DNF Coordinate Position

The *DNF Reference Object Geometry* is based on coordinate referencing systems specified by the *DNF Positioning System*. It follows that if the *DNF Reference Objects* are derived from OS MasterMap then currently this is OSGB36 National Grid in Great Britain. For the equivalent in Northern Ireland this would have to be the Irish Transverse Mercator (ITM)⁸.

Accurate transformations can be made to relate GNSS positions based on the European Terrestrial Reference System 1989 (ETRS89) to OSGB36 National Grid⁹.

4.2.5 DNF Reference Base

The *DNF Reference Base* is an aggregation of *DNF Reference Objects* such that the land surface is covered within the defined area. In simple terms, the *DNF Reference Base* is an abstraction of the topography of the area expressed as topographic objects and represented by geometric primitives. The primitives together form a coherent geometry covering the whole area. All lines “snap” and areas with boundaries in common share common coordinate values.

It follows from 4.2.2, that the reference base is currently a subset of topographic objects derived from the OS MasterMap Topography Layer selected such there is as near complete coverage of the land area of Great Britain as is feasible. It also follows that other data could be incorporated into the reference base subsequently albeit as separate but related layers subject to certain conditions being fulfilled. Digital Terrain Models (DTMs) and imagery could also be included in the future although the principles to be used have still to be worked out.

⁸ When the *DNF Reference Base* is extended over the sea then there will be transformations between OSGB36 National Grid and ITM and the coordinate referencing system for the sea areas.

⁹ Further information and a free transformation service are available on the Ordnance Survey website at <http://www.ordnancesurvey.co.uk/oswebsite/gps>. This is to be replaced by a DNF service shortly



4.2.6 DNF Association

The *DNF Association* encompasses the way that *Business Objects* and *Application Reference Objects* are related or associated with the *DNF Reference Objects* in a DNF context. In UML terms it forms an association class which carries attributes quite separate from those describing the reference objects. There are many types of association at the object and geometry levels. Of principal concern in a DNF context are spatial associations, that is associations relating to location, and the ways that the association can be established, for example through addresses¹⁰ or by position.

A *DNF Association* can be either:

- ~ Direct – *Business Objects* are directly associated with DNF Reference Objects without the involvement of any Application Reference Objects;
- ~ Indirect – the association between the *Business Object* and the *DNF Reference Object* is through one or more *Application Reference Objects* which may be in one or more *Application Reference Layers*.

An instance of a *DNF Association* can be of one of two types:

- ~ Simple – the *Business Object* is associated with one or more *DNF Reference Objects* without needing to qualify the association in way. This is because there is either (i) a good geometrical fit between the *Application Reference Objects* and the *DNF Reference Objects* or (ii) no requirement to provide a precise geometrical relationship;
- ~ Qualified - the association between the *Business Object* and one or more *DNF Reference Objects* requires the creation of additional geometry to make the relationship between the *Application Reference Objects* and the *DNF Reference Objects* more precise. In other words the relationship needs to be qualified by *DNF Ancillary Geometry*.

A simple association can be either direct or indirect but a qualified association can only be indirect because it must involve *Application Reference Objects*.

The association may be maintained through cross-referencing of identifiers. The minimum set of attributes and metadata needed to qualify this association has to be defined (e.g. dates, versions). Where a specific point along, or within, the *DNF Reference Object* needs to be indicated e.g. chainage along a street, then this will also be an attribute of the *DNF Association*.

¹⁰ A way of referencing a geographic object for identification and location, it does not have to be a postal address. It could be a street name and locality for example



Other spatial and temporal issues (e.g. imperfect spatial match, differing maintenance and life-cycle regimes between the *DNF Reference* and *Associated Objects*) also need to be resolved.

The geometry primitives (points, lines, areas) representing the *Application Reference Object* must have a defined relationship with the geometry of the *DNF Reference Base*. Pragmatically, it needs to be based on the same coordinate referencing system. In many cases the geometry may have been derived from the geometry of the *DNF Reference Base* in the first place.

The spatial match (or fit) may need to be refined by some additional or ancillary geometry where the geometry of the reference object is not coterminous with that of the *DNF Reference Object*. Any ancillary geometry must fit to the geometry of the *DNF Reference base*.

4.2.7 Business Object

In a DNF context *Business Objects* are abstractions of real world objects which are not themselves geographic objects but which need to be referenced to specific locations on the earth's surface. As the term "business objects" would suggest, they are modelled by an application because they are involved in processes within scope of that application. As discussed early, this is not just human activity but can be natural processes. Typical examples of business objects are planning applications, land titles, census returns for an address, highway maintenance records for a street, traffic flow counts, water quality in a river reach, record of consultation for delimiting access land and utility plant.

4.2.8 Application Reference Object

As previously discussed an *Application Reference Object* is a geographic object to which business data or *Business Objects* are related or referenced (e.g. to a BLPU or a land title extent) for the purposes of location. Some classes of *Application Reference Objects* may not be what most regard as real-world objects (e.g. title extents, or post code areas) and their representations do not need to exhaust space. They must have some sort of spatial or geographic expression, be capable of consistent definition, have a defined life-cycle (however simple) and be uniquely identifiable. They must be capable of being represented by points, lines or areas based on a coordinate referencing system transformable to that specified by the *DNF Positioning System* i.e. OSGB36 National Grid.

In some types of application several layers of reference objects may be used. The *Business Objects* may be referenced directly to certain application-specific geographic objects. These objects may themselves reference geographic objects in another reference layer. The commonest example of this is where geographic objects defined in a particular application are cross-referenced to a land and property or street gazetteer. The BLPUs or Streets are then associated with the *DNF Reference Base*.

In the context of DNF, OS MasterMap Integrated Transport Network™ (ITN) and Address Layer 2 are regarded as being made up of *Application Reference Objects* not



DNF Reference Objects albeit that these objects are cross-referenced to the OS MasterMap topographic objects. They represent alternative reference layers which already carry a DNF association.

4.2.9 Application Reference Layer

The *Application Reference Layer*¹¹ is formed of an aggregation of *Application Reference Object* instances. These may form a complete coverage of an area but do not have to – it depends on the nature of the abstraction from the real world.

Where the *Application Reference Layer* is represented by areas and lines then these should be defined by coordinates that are based on a recognised coordinate referencing system capable of being transformed to that used by the *DNF Positioning System* i.e. OSGB National Grid.

An application may have a number of *Application Reference Layers* where a number of classes of geographic objects are needed to locate different classes of *Business Objects*. For example in a local authority with a corporate application which integrates information from a number of departments, then each department may have its own classes of business and geographic objects. The latter may, in turn, all be referenced to a common set of geographic objects such as BLPUs.

4.2.10 A more complete architecture

We can now extend the model presented at Figure 6 to include the additional concepts described above. The main additions to the model are:

- ~ The *DNF Association* is shown with the *Qualified Association* in addition to the *Simple Association*.
- ~ The *Qualified Association* uses *DNF Ancillary Geometry*, that is geometry which needs to be created to qualify the relationship between the *Application Reference Object* and the *DNF Reference Object* where the geometries are not coterminous (e.g. where an OS MasterMap land parcel has to be divided because of differences with the geometry of the *Application Reference Object*);
- ~ The *DNF Ancillary Geometry* must fit to the *DNF Reference Object Geometry* thus it is shown as having a dependency on the latter;
- ~ The *Application Reference Object* must relate to the *DNF Reference Object Geometry* where the association is qualified. Not modelled explicitly is the geometry of an *Application Reference Object*. This may or may not be derived from a standard reference base (e.g. OS MasterMap Topography or the marine equivalent) but it needs to have definable relationship to it.

¹¹ This could be an INSPIRE theme for example

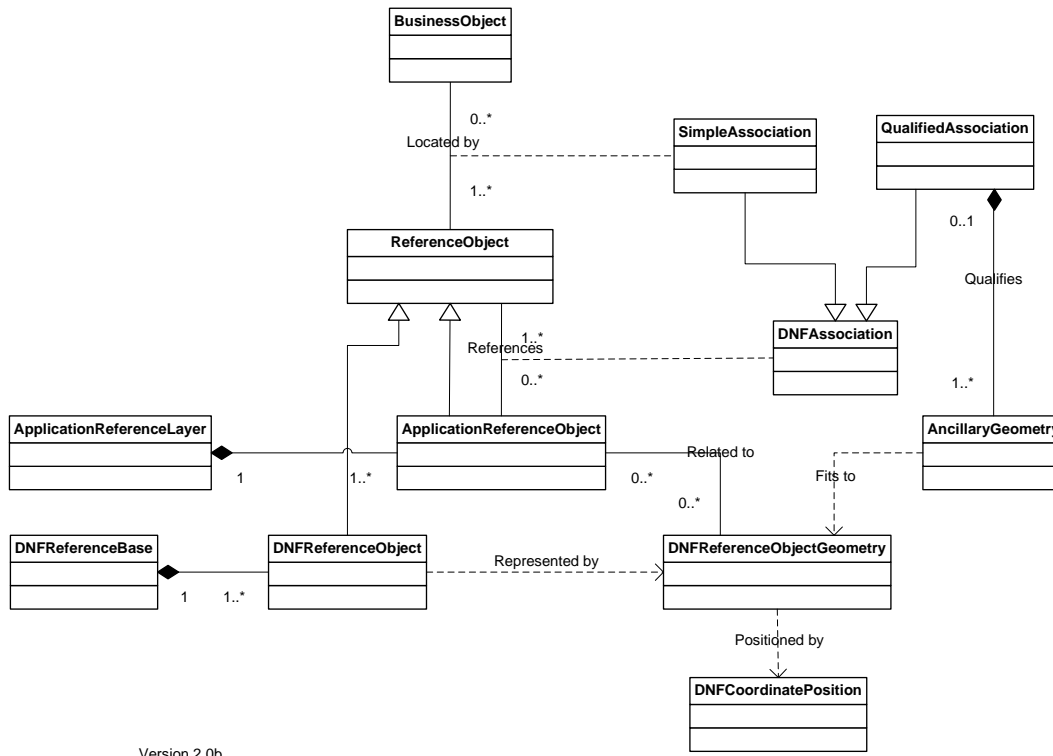


Figure 7: UML class diagram showing all the main components of DNF including the Qualified Association and DNF Ancillary Geometry

4.3 Service architecture

Although there is the potential to develop a complete service architecture around DNF, this is not currently envisaged. However there are a number of enablers that are being developed or planned:

- ~ Metadata and an associated catalogue service for discovery of datasets conforming to DNF;
- ~ Directory of feature catalogues;
- ~ Data interchange mechanisms principally in the form of XML schema.



5 Defining DNF

We can think of DNF in two ways:

- ~ as a definition or a “standard” for developing a national framework within which data can be shared and applications can interoperate – this is referred to here as the “DNF definition level”
- ~ data conforming to DNF and which over time could constitute a national framework of data. This in time would lead to definitive datasets universally adopted and used without modification e.g. land ownership parcels, river network, and protected sites. This is the vision and is referred to here as the “data level”. The “data level” has been described above at 4.2.

Thus for every component of DNF at the data level we have to have define that component in the DNF definition level. In practice and as a minimum, the “standard” needs to be:

- ~ a set of basic models for DNF Temporal Referencing, Positioning, Reference Object, Association and Metadata together with a summary or reference model;
- ~ a minimum set of basic DNF requirements together with technical guidance for implementing the models;
- ~ guidelines and best practice on wider issues such as a data quality, data maintenance and data classification which are required for successful implementation.

The above is illustrated superimposed on the architecture in Figure 8.

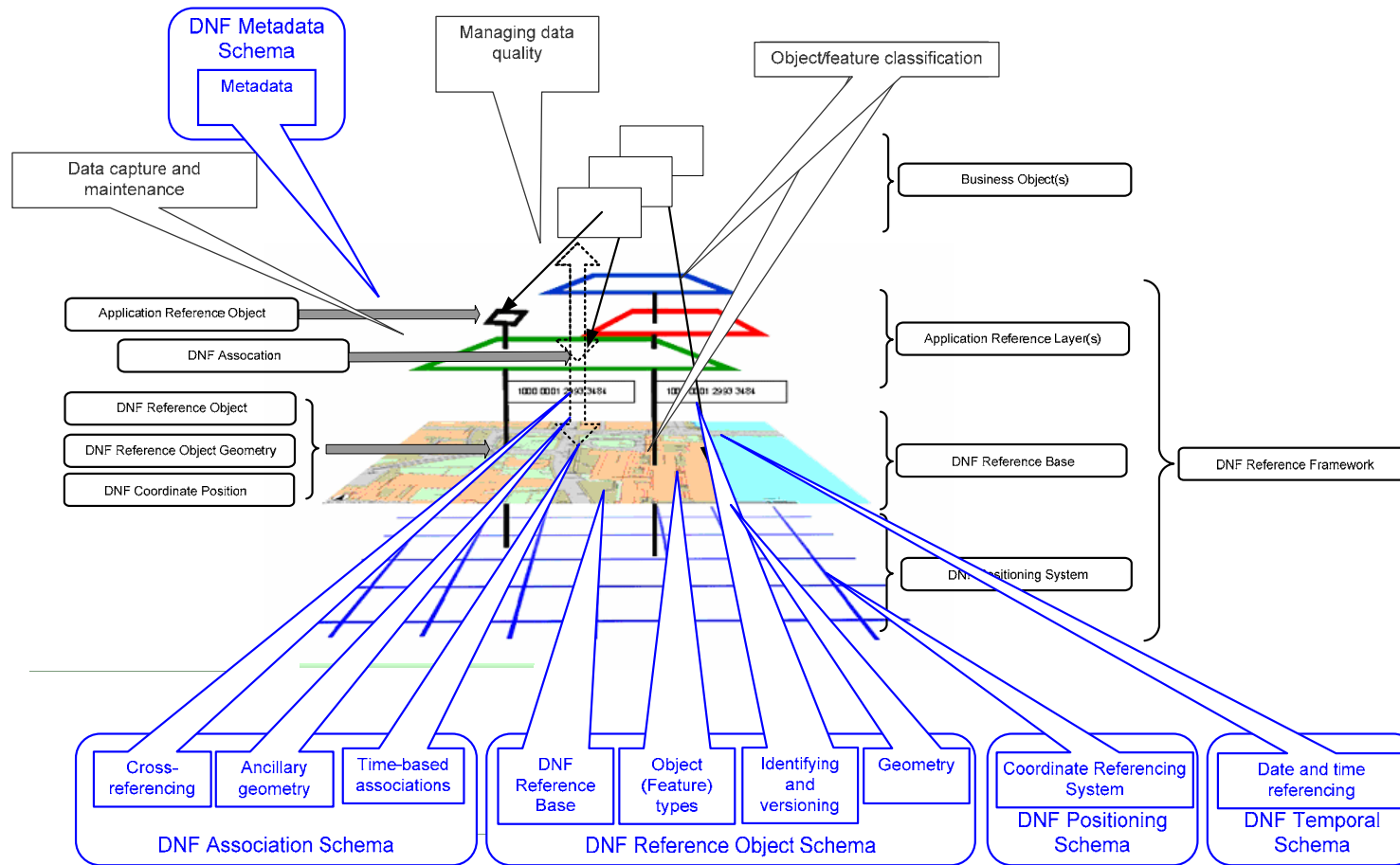


Figure 8: DNF architecture with the requirement for definitions superimposed (models, requirements and technical guidance in blue, guidelines and best practice in grey)

6 Meeting DNF requirements

6.1 The need to set requirements

Although DNF is defined as an “industrial standard”, the intention is to encourage good practice in data association and to enable data sharing and information exchange not to mandate and enforce rigid standards.

Nevertheless, a certain minimum set of basic principles will have to be followed and requirements met if being able to claim adoption of DNF is to mean anything.

In the world of formal standards, these might be referred to as “conformance clauses” i.e. requirements that must be met to claim conformance to a standard. These are currently under development but there will be a minimum set of requirements to be able to claim DNF conformance. They will need to be SMART:

- ~ Specific – clear and unambiguous requirements
- ~ Measurable – objective requirements that can be measured
- ~ Achievable – requirements that it is feasible to meet
- ~ Realistic – level of conformance that it is cost-effective to meet
- ~ Testable – able to prove conformance with objective tests

The areas for conformance are illustrated here and mapped against the Reference Model at Figure 9 and briefly described below. Not all of these will be mandatory – some will be recommended

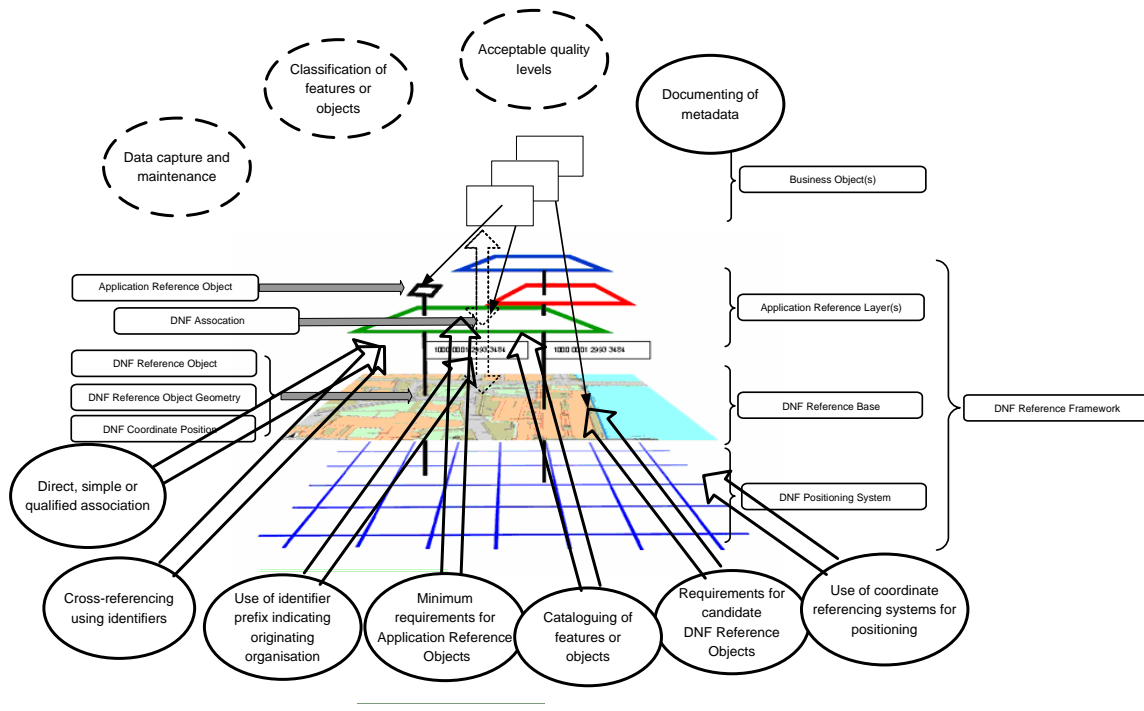


Figure 9: Conformance to DNF – ovals with solid lines indicate where requirements should be met to claim DNF conformance, ovals with dashed lines indicate recommended conformance

6.2 Basic requirements

The proposed basic requirements are as follows. Not all of these can be regarded as SMART and all are to be confirmed. Full details will appear in the detailed DNF documentation. Many of the requirements outlined below are being covered in the INSPIRE Implementing Rules¹², DNF will ensure that there is alignment with these.

~ **Requirements for candidate DNF Reference Objects** – these include:

1. For the dataset that contains the objects:
 - being captured and maintained in conformance with a published data specification accessible to users;
 - using a consistent approach to the classification of object or feature types and their documentation using a feature catalogue meeting DNF requirements (i.e. conforming to ISO 19110);

¹² For full details of these and other information about INSPIRE go to <http://www.ec-gis.org/inspire/home.html>



- over land, providing for complete coverage of the earth's surface of the area in scope by the objects or their representations (object instances may overlap each other e.g. roads under bridges);
- using vector geometry and a recognised coordinate referencing system to represent objects;
- being freely available to all users (if not available free);
- meeting published quality levels;

2. For the reference object:

- being an abstraction (view) of a real-world (geographic) object;
- being discernible – i.e. generally visible and identified or perceived as geographic objects in the real world i.e. things with a physical presence;
- being based on a clear definition – i.e. a lack of ambiguity in the definition of the object such that its consistent recognition and representation is assured be
- having fine granularity - more atomic units should be favoured over the less atomic - the finer the granularity and homogeneity the better.
- being complete - where an object type is defined as being present in a dataset, then all object instances within scope should be reasonably complete in the dataset.
- having a defined life-cycle - the life cycle of objects should be documented and maintained.
- being uniquely identified and versioned - object instances should carry a unique identifier and a version number.
- being represented geometrically by an area (polygon), point or line with a high degree of positional accuracy;

~ **Use of coordinate referencing systems for positioning** – these include:

- the *DNF Reference Base* being based on OSGB36 National Grid (there will be additional requirements if DNF is extended to sea areas or the rest of the United Kingdom);



- all *Application Reference Objects* being positioned by a standard spatial referencing system using coordinates which is either the same as that used for the *DNF Reference Base* or which can be accurately transformed to that of the *DNF Reference Base*.

~ **Minimum requirements for Application Reference Objects** – these include:

- having some sort of spatial or geographic expression;
- capable of consistent definition;
- having a defined life-cycle (however simple);
- being uniquely identifiable;
- capable of being represented by points, lines or areas;
- geometric primitives (points, lines, areas) representing the *Application Reference Object* having a definable relationship with the geometry of the *DNF Reference Base*.

~ **Use of identifier prefix to indicate originating organisation** – the requirements include:

- the form of the unique identifier;
- the organisation prefix;
- registration of the prefix.

~ **Cataloguing of feature or objects** – the requirements include:

- the creation of feature catalogue conforming to ISO 19110

~ **Direct, simple or qualified association**

<to be added when Technical Guides for Association drafted>

~ **Cross-referencing using identifiers**

<to be added when Technical Guides for Association drafted>

~ **Metadata**

<to be added when Technical Guide for Metadata drafted>



6.3 Recommended requirements

<These relate to classification of features or objects, data capture and maintenance and acceptable quality levels. Work has still to be done in this area. These will be based largely on ISO 191nn standards>

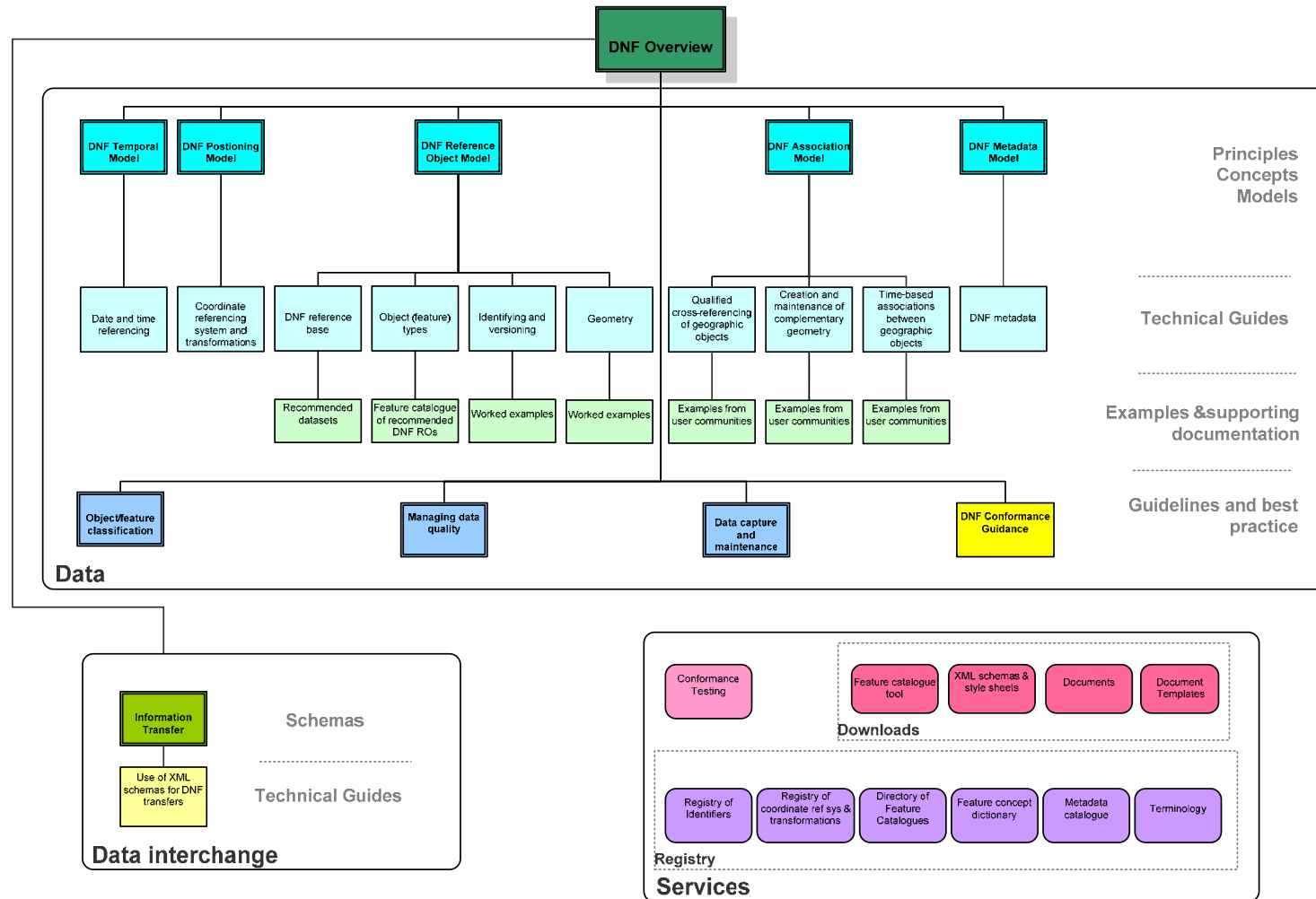
7 Guide to documentation and services

7.1 Preamble

A series of documents is being developed to provide users with a complete technical guide to DNF. Examples relating to particular types of application will also be provided. A registry is also being developed on the DNF website to provide documentation services and support related operations such as the registration of identifier prefixes.

The purpose of this section is to provide a guide to where further technical information can be found and how it can be used. A document hierarchy is being populated progressively. The hierarchy is at Figure 10. This is provisional and likely to change as documentation is developed and issued.

Figure 10: DNF Documentation structure and supporting services (overleaf)



DNF Documentation and Services Structure
Version 0.7 04/10/07

To aid users, a brief summary of each document is provided below, together with a link to the documents where these have been published.

7.2 Models and Technical Guides for data

The purpose of these documents is to provide a definitive description of the DNF principles and concepts – the models and practical guidance on their implementation – the Technical Guides.

7.2.1 DNF Temporal

Model

Not available.

Date and time referencing

Technical guide not available.

7.2.2 DNF Positioning

Model

Not available

Coordinate referencing systems and transformations

Technical Guide DNF 0020 explains the different coordinate referencing systems in common use in Great Britain, the transformations between these systems and how they support DNF. Links to authoritative and detailed sources of information are provided. Satellite positioning, map projection systems on land and offshore systems are in scope.

This document is intended to provide the general reader with an overview. The professional reader is provided with sources of definitive information for the execution of projects and the development of applications.

To access this document go to:

<http://www.dnf.org/Pages/technical%20guidance/technicalguides.asp>

7.2.3 DNF Reference Object

Model

Not available.



DNF Reference Base

This Technical Guide is not available yet. It will describe how the DNF Reference Base is constructed and its main characteristics at the dataset level.

Object (Feature) Types

This Technical Guide which is in preparation will describe the principles to be used in the selection of DNF Reference Objects and how they should be defined. It will draw on the ISO 19110, the standard for feature cataloguing methodology.

The Technical Guide will be supported by a feature catalogue giving recommended DNF Reference Objects.

Unique object identifiers

Technical Guide DNF 0011 outlines the fundamentals of dealing with nationally unique identifiers within DNF and provides rules and recommendations for their use, storage and allocation. It will be developed into a more general guide to identifying and versioning DNF Reference Objects.

The current guide is applicable to those organisations creating maintaining or owning geographic data which they wish to the use in the context of DNF.

To access this document go to:

<http://www.dnf.org/Pages/technical%20guidance/technicalguides.asp>

Geometry

This Technical Guide is not available yet. It will describe how the DNF Reference Objects are represented by geometry and topology.

7.2.4 DNF Association

Model

Association Model DNF 0004 presents the principles and concepts used within the Digital National Framework (DNF) for associating geographic objects used in applications and DNF Reference Objects which comprise the DNF Reference Base. The principles and concepts are expressed in words illustrated by diagrams as well as in a formal model in a recognised modelling language (UML – Unified Modelling Language). A logical view, not an implementation view is presented.



The geographic objects in scope are those used to provide a location for the business information within an application. Predominantly these are objects such as land parcels, property, streets and river reaches but they can also be larger units such as census and administrative areas. The DNF Reference Base is described in relation to OS MasterMap topographic objects but could be related to objects in other standard bases meeting DNF principles.

This document is intended to be read by data suppliers, application programmers and data users.

To access this document go to:

<http://www.dnf.org/Pages/technical%20guidance/technicalguides.asp>

Cross-referencing of geographic objects

This Technical Guide is in preparation. It will describe simple and qualified cross-referencing between Application Reference Objects and DNF Reference Objects.

Creation and maintenance of ancillary geometry

This Technical Guide is not available yet.

Time-based relationships between geographic objects

Not available

DNF metadata

This Technical Guide will build on existing metadata standards for the documenting of metadata in a DNF context.

7.3 Guidelines and best practice for data

The purpose of these documents is to provide general guidance and best practice in object classification, data quality and DNF conformance.

7.3.1 Object/feature classification

Guidelines on feature cataloguing are in preparation.

7.3.2 Managing data quality

Not available.



7.3.3 Data capture and maintenance

Not available

7.3.4 Conformance Guide

Not available.

7.4 DNF Services

The DNF documentation is support by a number of services available on the DNF website. These include a registry service and downloads.

7.4.1 Registry

Registry of identifiers

This provides for the registration of organisation prefixes. It allows organisations to register 4-character codes that are unique to them. On publication of DNF-compliant datasets, identifiers can be prefixed with these codes in order to guarantee uniqueness within the Digital National Framework.

To access this service go to: <http://www.dnf.org/Pages/registry/identities.asp>

Directory of feature catalogues

A feature catalogue of OS MasterMap objects which can be used as DNF Reference Objects will be available on the website shortly. This will be viewable and searchable and will include inset maps and photographs to illustrate the different objects. All the objects will be defined and their attributes given. The catalogue conforms to ISO 19110, the International Standard for feature cataloguing methodology.

This service is intended to be used by all those who wish to cross-reference their Application Reference Layer to the DNF Reference Base. Over time it is the intention to add other feature catalogues or make them viewable.

Registry of coordinate reference systems and transformations

This service which is in preparation will complement the technical guide. It will provide access to definitive sources of information and services for coordinate referencing.

Terminology

Terms, their definitions and some examples and notes are given for those specialist term used within DNF. There is a search facility to enable the user to look up any terms.



This service is at: <http://www.dnf.org/Pages/technical%20guidance/terminology.asp>

Bibliography

Not available.

7.4.2 Downloads

Feature catalogue tool

This tool which is based on Microsoft® Access has been developed to facilitate the creation of feature catalogues conforming to ISO 19110. It is capable of exporting the catalogue in XML. The tool will be available as a download shortly.

XML schemas

Not available.

Documents

All documents described as available above are downloadable from the DNF website.

Document templates

Available on request.

7.4.3 Conformance testing

Not available.

8 Bibliography/References

2006	British Standards Institution	BS 7666-0, Spatial datasets for geographical referencing. Part 0: General model for gazetteers and spatial referencing
2007	INSPIRE	D2.5: Generic Conceptual Model
2005	International Organization for Standardization (ISO)	ISO 19110, Geographic information – Methodology for feature cataloguing

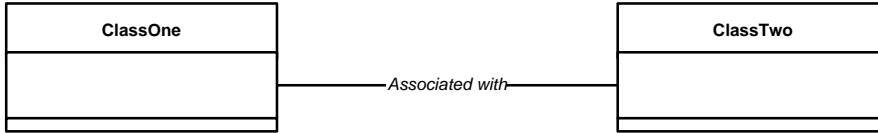
Appendix A: UML Modelling Conventions

The following diagrams show the conventions used in the UML models presented in this document.

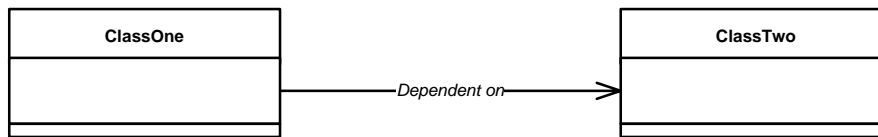
For a full explanation of UML please consult a suitable text.



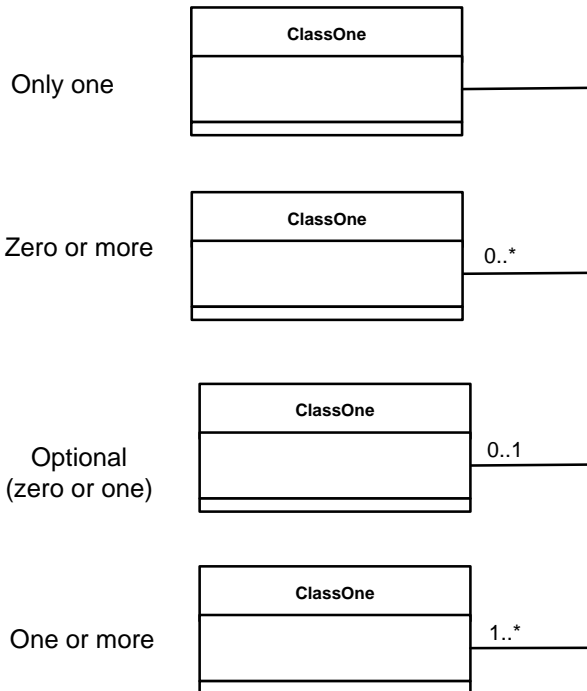
Association between classes with association name in *italics* read left to right and top to bottom



Dependency of an association

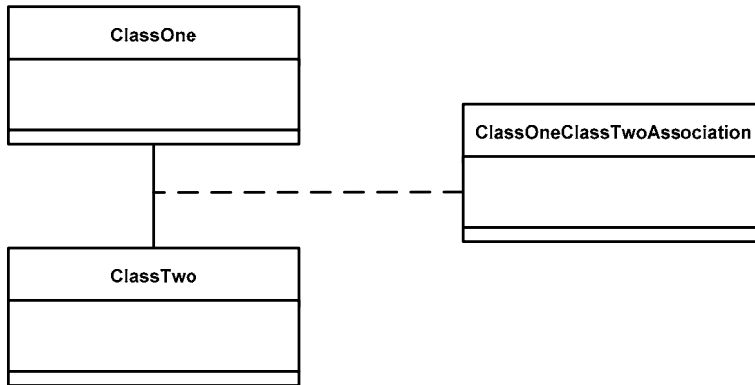


Cardinality of an association

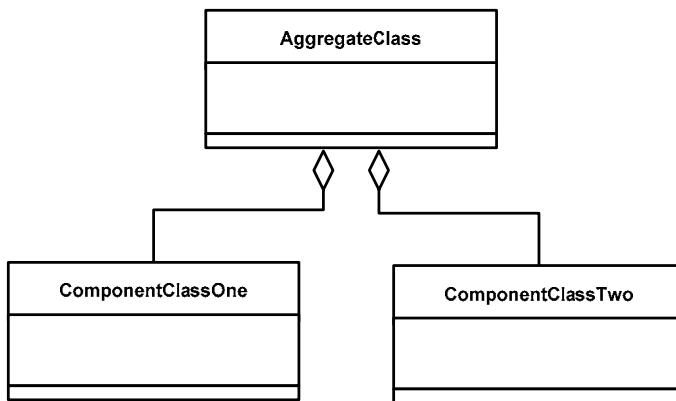




Association Class



Aggregation of classes



Filled diamond in arrowhead indicates a composite i.e component can only belong to just one whole

Class inheritance

