

# NATIONAL STANDARDS FOR THE TRANSFER OF DIGITAL MAP DATA

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## ABSTRACT

A Working Party was set up in February 1985 to formulate a set of standards for the transfer of digital map data. The Working Party was two tiered, with a Steering Group and a Working Group. A number of important issues in the transfer of data were identified, and these were covered by five main topics of interest. The most important is the Data Format itself, but this would be of reduced value unless supported by documentation in the form of a Glossary of Terms, a Data Classification, and an assessment of Data Quality. Of fundamental importance is the means by which this information is conveyed to users. A method of Standards Administration has also been considered.

## INTRODUCTION

In Great Britain the issue of a transfer standard for digital map data has been addressed by Ordnance Survey (OS) as the main investigator and supplier of such data. It was recognised as early as 1969 that in order to transfer map data to customers it would be essential to create a format that would allow the internal formats used in the OS digital system to be converted to a simple transfer format universally understood and accepted by customers for OS digital data. This remarkably simple format DMC has been fully documented and is in widespread use in Great Britain.

In 1984 DMC was modified to allow the transfer of more sophisticated data and the new transfer format called OSTF has been introduced for all data of this type. Independently the National Joint Utilities Group (NJUG) adopted this transfer format with some enhancements for the transfer of data between utilities and OS made some changes to the header to allow greater flexibility.

However not all customers are able to use the new format specification and both DMC and OSTF are available depending on the wishes of customers. For some time OS has required a transfer format for the transfer of data between its own systems and DMC followed by OSTF have been used for this purpose. All contractors digitising data for OS are now required to use OSTF.

It was the anomaly of having two transfer formats for large scale data and a different format for small scale data with a probable requirement for topologically structured data in the near future that impressed the urgency on OS to expedite discussions about a national transfer format.

## HISTORY

OS has a number of consultative committees, and one of these is the Royal Society OS Scientific Committee which has a sub-committee on Digital Cartography (Chairman Professor D W Rhind). This sub-committee created a working group which Professor Rhind also chaired to consider among other things the issues involved in defining standards for digital mapping. Some progress was made largely through modelling proposals on the OS transfer standards until in 1984 a trial was carried out to test OS digital map data using the Data Interchange at the Application Level (DIAL) format from the British Standards Institution (BSI). This was not a particularly successful test due mainly to the very different nature of map data from the commercial data on which DIAL is normally used. (Smith 1985).

In 1983 the House of Lords Select Committee on Science and Technology made the following recommendation (House of Lords 1983):

"Recommendation 25. Standards for the exchange of digital map data should now be established and consultation to that end should be pressed forward between the British Standards Institution, the OS and other interested bodies, under the aegis of the Royal Society (5.9.2-4)."

Following the publication of the report Professor Rhind made a proposal to the Royal Society (RS) that a task force should be established to study the issue of a national transfer standard for digital data. He proposed that a research student at Birkbeck College, funded through contributions from the main interested Government agencies, should prepare draft proposals for consideration by the task force.

At the same time the Government mapping agencies - OS, Military Survey and the Hydrographic Department - together with the Natural Environment Research Council (NERC) reviewed the situation and it was agreed that a National Working Party under the direction of OS, the main supplier of digital map data, should be established. OS agreed to provide a secretariat and researchers to service the Working Party and an inaugural meeting was held at OS Southampton in February 1985 to consider terms of reference, modus operandi and levels of participation. It was emphasised at the outset that anyone with expertise and a willingness to participate would be welcome either as a correspondent or a direct collaborator.

Thus although the House of Lords Select Committee recommended that the national standard should be created under the aegis of the Royal Society, the Government agencies concerned felt that the most effective way to support the initiative of the Royal Society would be through the creation of a National Working Party led by OS.

## THE NATIONAL WORKING PARTY

### Composition

At the first meeting it was decided that the actual work which had to be done would be most effectively and easily performed by a small working group reporting to a steering group. OS has chaired both groups throughout with the chairman of the steering group shared between the authors of this paper and the working group being chaired by Mr Haywood. The working party has had a participating membership as follows:

Steering Group. G Yarrow (NJUG), Prof T Coppock (RS), Prof D Rhind (RS), Dr P Dale (RICS), J Lankester (Mil Svy), D Dixey (Hydro Dept), P Thorpe (LAOSC), R Nitze (NJUG), Maj G Kennedy-Smith (Mil Svy) N Gooding (Hydro Dept), Dr G Robinson (NERC), M Sowton (OS), P Haywood (OS).

Working Group. T Waugh (RS), P Bibby (LAOSC), M Bosworth (LAOSC), B Lyons (Mil Svy) Dr G Robinson (NERC), N Smith (OS), P Haywood (OS), D Hughes (LAMSAC).

Note: LAOSC Local Authorities OS Committee  
LAMSAC Local Authorities Management Services and Computers

### Title

After some discussion the title of the Working Party was changed from Topographic through Cartographic until finally it was decided that digital map data could be safely defined as "The digital data required to represent a map" and interpreted to mean both topographic and cartographic data together with the attributes which relate the features on the map into an informative whole. The title "Working Party to Produce National Standards for the Transfer of Digital Map Data" was adopted.

### Terms of Reference

The Terms of Reference were kept simple as possible:

To create a national standard for the interchange of digital map data.

### Funding

Funding for the Working Party and the demand it would make on members' time were recognised as problems from the start. For such an important issue, Government funding would not be

inappropriate, but it would have been impossible to arrange this within a reasonable timescale. The agencies involved agreed to pay the expenses of their representatives, and to release them from other duties to contribute a "reasonable" amount of time to the standards. In addition, the Director General of the OS assigned staff to assist the Working Group and agreed that the paper work would be handled at the OS. This contribution was established as a project within one of the Research and Development Divisions.

#### Timetable

In acknowledgement of the work already carried out by its predecessor - the Working Group of the Royal Society - an ambitious timetable was adopted. This decision was fostered by the proposal that an Auto Carto conference would take place in London in 1986 and it was agreed that draft standards would be available for consideration at that event which, after amendment in the light of comment, would be adopted in early 1987. In order to do this the initial draft had to be prepared early in 1986 and this objective has been achieved. At the time of writing comments are being received and there is little doubt that the timetable will be met.

#### PHILOSOPHY OF A TRANSFER STANDARD

In order to define the work which had to be tackled the Working Party established rules which would govern the success or failure of the project.

1. The transfer format must be able to handle all of the data generated by any cartographic system. This rule can be checked by forward and back transfer of data after which no change in information content should have occurred.
2. The techniques used for the transfer format must be capable of being adapted easily for any computer on the market.
3. The structure of the transfer format should be such that development costs are minimised and maintenance is made easy.

From the above it should be clear that the Working Party are endeavouring to create a standard that is extremely flexible and versatile within practical limits imposed by computer hardware and cost. It was recognised at the start that not only were there costs of development and maintenance but also costs of implementation. If the latter became too high there would be limited acceptance of the standard and even if great flexibility and efficiency were to be achieved the benefits might possibly be swallowed up in higher operating costs with little hope of widespread implementation.

One particular aspect of the success of the resulting standard will be the way in which it is able to handle attributes of the digital map data, and topological relationships.

#### THE NEED FOR STANDARDS

The transfer of data between computer systems requires that the recipient computer "knows" what it is getting. This knowledge usually resides in a program which can read and interpret the data, and such a program can only be written if the supplier has documented his data and the transfer format. Many datasets have been successfully transferred during the past fifteen years or so, but often the receiver has been involved in considerable effort. Even when the documentation is good, which can never be taken for granted, the data user has to write another program each time there is a new supplier. As the use of digital data increases the number of transfers will also increase, and the current situation will become intolerable. Some would argue it already is.

The underlying reason for national standards is to improve the efficiency of data transfer, and this can be achieved if three conditions are met.

Firstly, if there is a set of rules for documentation with which every producer and user can become familiar. Secondly, if there is a common method of presentation of data, accepting that some variation will always be necessary. Thirdly, if data can be written and read by the same programs, irrespective of its detailed specification. (Haywood 1986)

#### PARTICIPATION BY USERS

At the outset there was criticism that producers of digital data were predominant on the Working Party and there could develop a situation where the suppliers could impose a standard on the users which, although efficiently transferring their product, was not effective when transferring other map data between users. The members of the Working Party were sensitive to this problem and invited a wide spectrum of people to contribute to the Working Group either directly, by correspondence, or through comment on the various drafts circulated on a wide basis. It is this informed comment upon which a great part of the standard has been built and the Working Party is very grateful to those who have participated. It will be no good complaining after the event when it has been possible to influence the result. Even the final draft presented at this conference will not be put forward for implementation without the opportunity to propose improvements.

## WHY DO IT AGAIN - THE CASE FOR A NATIONAL STANDARD

As stated earlier there is a cast iron need for a transfer standard, but why a national standard when so much work has been done in other countries which should allow the creation of an international standard in the very near future? The Working Party felt that the delay involved and the likely complexity of the result would not be in the best interests of digital mapping in Great Britain bearing in mind the unique nature of the large scale mapping which is the predominant type of data to be transferred. Having seen much of the work done in other countries, in particular the extremely detailed feature classification systems it was decided that a system for Great Britain would be created taking account of the best features of the work carried out in other countries. This plagiarism should be taken as a compliment and if the Working Party had not done so it would have been open to criticism for endeavouring to rediscover the wheel. However the result is British and as far as possible a British interpretation has been used particularly when it came to the creation of a Glossary of Terms.

We therefore acknowledge the help and reliance we have placed on the work of those who started before us - USA, Canada, Australia and Germany amongst others - and hope that ultimately some day an international standard will evolve which is not too complex and allows national variations. Meanwhile we hope someone will do us the compliment of some modest plagiarism.

### STRATEGY

#### The main tasks.

After establishing the principles and identifying the features of the transfer standards the Working Group decided to sub-divide the overall task. Central to the whole exercise is the definition of the data transfer format itself. This is concerned with the physical nature of the transfer medium, the method of encoding data on it, and the structure of the data. Tape specifications, character coding, block sizes, record lengths, and the descriptions of records are a few examples of the elements involved.

A data format is of little practical use without supporting documentation and some rules or guidelines as to how it should be used. This is obvious with reference to the format itself, but an understanding of the subject of the transfer, the map data, is an integral part of a successful transfer method.

A Glossary of Terms is required which will describe terms associated with transfer and data. What is meant by a "block", "record", or "feature"? A feature classification scheme is essential if there is to be a mutual understanding

of map data. What, for example is a farm: a building, group of buildings, or a parcel of land; or is it practically anything we wish to call a farm? Such a question appears trivial and irrelevant until data is to be loaded into a database, when it becomes crucial. When data is received, it is helpful and sometimes necessary to know something of its pedigree: but describing data quality is notoriously difficult. Is it accurate, and if so, is it as accurate as the data already held in a database? Is it current? Can it be relied upon to serve the purpose for which it is bought?

So standards are needed for terms, classification and quality. In addition, a method of standards administration must be developed if they are to become widely accepted.

#### The method.

The method for formulating each standard has followed a similar route, although there have been minor variations. The basic technique has been:

1. The OS research staff have examined other transfer standards. These have been summarised in a report, which also contained a list of objectives for our own national standard.
2. The Working Group commented on the objectives, which were revised if necessary. The report was then circulated.
3. OS staff wrote a draft proposal, which was circulated with a request for comment.
4. The Working Group discussed the proposal, taking account of any comments received.
5. A further draft was circulated, again with a request for comment.

Stages 4 and 5 were iterative, the number of iterations being dependent upon the response received. Eventually, the draft will become the Final Draft for publication at Auto Carto London in September 1986.

The circulation list contains about forty names, and has been compiled as a result of the publicity given to the standards. These are people who have expressed an interest and willingness to critically examine the proposals. It should be pointed out that the audience is much wider than a list of forty would suggest: agencies such as NJUG, NERC and LAOSC represent groups of data users.

One exception to the basic method was the Glossary. The Digital Data Working Group of the Royal Institution of Chartered Surveyors (RICS) had started work on a glossary

before the standards Working Party got underway. This was developed at the OS and circulated at Survey and Mapping in March 1985. It had already been "recycled" once before the Working Group was able to consider it.

Another variation concerns the data transfer format. The OS has concentrated on the requirements for vector data transfers, and this has followed the route described earlier. Recognising that the expertise in the handling of raster data lay elsewhere, the Working Group asked Gary Robinson of NUTIS (Reading) to formulate the first proposals. Michael McCullagh of the University of Nottingham was asked to define the main requirements of DTM transfer.

The role of the Steering Group is to monitor all this activity. It will place the "seal of approval" on the Final Drafts, and approve a policy for implementation.

#### THE COMPONENTS

##### The Glossary of Terms.

The Glossary has reached the Final Draft stage, though one or two comments on it remain to be discussed by the Working Group. The response to the early drafts was encouraging, but unfortunately the same level of enthusiasm has not been generated by the other aspects of the standards. It is interesting that there are two distinct groups of data users with quite different opinions as to the meaning of certain terms. One group consists of the surveyors and traditional map makers, who prefer long established definitions (where these are available) and want to use these, perhaps with some modification, in the digital environment. The second consists of the digital data users of mixed backgrounds but without the discipline of survey and map making, who more readily accept computer jargon. Unfortunately, the computer industry has a reputation for stealing terms from other activities and shamelessly abusing them! It is also noted, despite being closely involved with preciseness, for its loose and often ambiguous definitions.

The Working Group hopes that, with tact and diplomacy, it has managed to resolve the differences of opinion.

The Working Group adopted some guidelines governing the content of the Glossary. These appear in its foreword, but are repeated here for the benefit of those who have not seen that document.

"The terms to be included are those commonly used within Great Britain. Terms which are used in other countries, but are infrequently used in this country, are excluded wherever possible. This particularly applies to those terms which have a more commonly used British equivalent.



The terms are restricted to those considered necessary to promote a common understanding of the method of data transfer and the data being transferred. The glossary is not a "glossary of cartography" nor a "glossary of computing", although some overlap is to be expected with works of this nature. Within this guideline, the following categories of terms can be identified:

Those terms necessary for a definition of the data being transferred. For example, polygon, feature code, raster data.

Those necessary to describe the origin or quality of the data being transferred. For example, edge match, point digitising, accuracy.

Those necessary to describe the transfer method or format. For example, byte, run length encoding, header label.

When a term is used in digital mapping in a different way than in the more general field of computing, then the definition applicable to digital mapping is the one to be given.

When a term is in general use in computing, and there is no conflict with digital mapping usage, then the "Penguin Dictionary of Microprocessors" definition is to be given, and acknowledgement given to this effect. If the dictionary version is likely to prove ambiguous or unclear to the non-specialist, then it will be reworded or additional information given. References to other sources will also be given where applicable.

When a term has more than one meaning in common usage, every attempt will be made to produce one definition only, in the hope that this will become a nationally recognised definition. When this proves to be impractical, more than one definition and the context within which each is applicable will be given.

Definitions will be based on British usage, and not on usage in other countries."

#### Feature Classification.

This is the most difficult aspect of the standards, and it could probably keep a national committee fully occupied for the next ten years. In the meantime, it is our intention to produce one in less than twelve months. The second draft is now available.

Designing a classification scheme for cartographic data is difficult for two main reasons, both of which arise because of the wide range of uses for the data. Firstly, the level

of detail required varies enormously. To some people a road is simply a road, particularly when producing maps at 1:5M scale; to others, a road consists of white lines, drainage-grids, cats-eyes, and asphalt. Secondly, the most appropriate method of classification and the places features occupy within the scheme is application dependent. A hydrologist will consider a canal to be a drainage feature, while to an industrialist it is a transport feature. The Working Group accepted at an early stage that no classification scheme could be acceptable to all users, and to strive for such a goal was pointless.

The proposal now in circulation is for a classification scheme specifically for data transfer, into which users will map their own classifications. The OS topographic database study team is in the process of classifying all the topographic data normally handled by the OS, across the full range of scales. This scheme has the following objectives:

To provide a structured series of feature codes.

To provide a scheme which will allow expansion in the future without forcing a restructuring of the entire scheme.

To make feature codes easy to recognise and handle by using abbreviations (essentially, characters instead of numbers).

To provide flexibility in classifying features by allowing multiple feature coding (essentially, unlimited attribute coding).

To make the classification independent of scale.

The Working Group has agreed that the OS scheme should also be the basis of the proposed transfer scheme, until such time as a better one emerges.

The main weakness with the OS scheme is that it does not allow for the data used by the specialists, such as the Utilities or Geological Survey. Only they can classify their data, and there are two things to consider:

If a new classification category is identified for a specialism, say geology, is the structure of the OS scheme appropriate?

Where the specialism demands that further coding is added to the topographic features, can this be done within the OS scheme?

#### Data Quality.

This is another difficult aspect of the standards. The problem is somewhat different to that of classification.

A classification scheme which succinctly describes features can be developed, even though it is not easy to fully satisfy all applications at the same time. The difficulty with some aspects of data quality is identifying a meaningful way of expressing them. How can one producer say his data is better than others? The data quality proposal is now in its second draft.

The objectives for the assessment of data quality are as follows:

Information about data quality should cover positional accuracy, attribute accuracy, currency and validity, and completeness.

The information should be easily accessible; it should be in printed form or within the data being transferred.

The methods of presenting quality information should be flexible, but they should be clear and understandable; the information should be presented for various levels as appropriate eg, at database and feature levels.

Data quality should be stated as numerical values wherever possible, ie, it should be quantified to allow comparison with other datasets.

The information should be scale-independent, eg, positional accuracy should be stated in terms of ground coordinates.

The philosophy behind the proposal is that the user of data should know as much about the history of it as the producer. The implication of this is that producers must make their data self-documenting. Date of survey, method used, algorithms applied, assessment of expected change, the results of accuracy tests, digitising scale, and so on should all be recorded and transferred in digital form. Where appropriate, such information will be applied at feature level, or even to individual coordinates.

#### Data Transfer Format

The data transfer format is, of course, partially dependent upon the proposals for classification and quality. The format for vector data has reached second draft, while the raster format is only at first draft. The intention is to merge these into one standard for the Final Draft.

The objectives for the transfer format are as follows:

The volume of data transferred in the format should be kept to the minimum required.

There should be sufficient internal documentation within the transfer format, to enable the recipient to read the dataset and determine the basic logical structure and physical organisation of the data without having to read external documentation.

Transfer formats for vector and raster data should have the same framework, for example, common headers and trailers, although the actual formats will differ.

The transfer format should allow for the inclusion of all necessary data such as feature information, data quality, spatial and other data types, locational definitions, spatial and other relationships and ancillary data.

The standard should include a data dictionary.

Industry standards, where applicable, should be adopted to handle the various types of data.

The transfer format should be media-independent.

The transfer format should be computer-independent.

Entities and concepts must be transferable and the format must be flexible enough to allow for the transfer of new concepts without modifying existing ones.

There must be the capability for transferring "change-only" information to update databases.

The format should allow for the transfer of logically different datasets on one physical medium.

The format should include methods for error detection and data validation.

The proposal establishes a set of rules for formatting data on a magnetic tape or other medium, while at the same time offering flexibility. It will be possible to transfer the simplest of datasets in an efficient way, or a whole database containing a tangled web of relationships. What is offered is a structure and a default option, so that the option can be redefined within the structure to accommodate the unusual. The default option is a predefined sequence of data and record formats, but everything - records and data fields - is self-identifying. The data dictionary is a most important aspect. Here, the sender can establish his own classification scheme, record formats, and relationships. No doubt producers and users who regularly exchange the same type of data will quickly establish an appropriate subset of the total transfer package.

## STANDARDS ADMINISTRATION

The Working Party would like to see the transfer standards accepted and maintained by BSI, but there are obstacles to this. BSI has to deal with a multitude of standards and is, by its own admission, struggling to cope. It tends to follow the line that only where the absence of standards causes a problem, such as when standards are difficult to define and unlikely to receive widespread acceptance, usually because of intransigent self-interest, does it become involved. The transfer of digital map data would fall within this category but by showing willingness to cooperate and work towards a definitive answer, the Working Party are indicating to BSI that assistance is not necessary. However, BSI is quite prepared to adopt the standards once they have been completed, but here lies another problem. Notwithstanding the amount of effort put into the preparation of the standards, it will be necessary to make some modifications after their introduction, particularly during their early life. It may be necessary to make these changes quickly, particularly if users are not to become disillusioned, and for this the response time of BSI may be too slow.

The OS has agreed to publish the standards in early 1987, and to support them for 12 months. A secretariat at the OS will deal with proposals for change, and with the approval of the steering group (which is to continue in existence), make appropriate additions or modifications to the documentation. A circulation list of all users will be maintained so that regular bulletins can be issued. The secretariat will also be available to offer advice and assistance to users.

At the end of the 12 months, the standards may have "stabilised". The steering group will be considering alternative ways by which the standards can be maintained, one of which may be a formal approach to BSI to have the standards adopted.

## CONCLUSION

The draft "National Standard for the Interchange of Digital Map Data" is to be published at Auto Carto London. Thereafter it will be open to comment and amendment through the National Working Party until late 1986 when the draft will be finalised for implementation in early 1987. Amendment thereafter will be possible but more difficult because all users of the transfer format will have to be consulted.

The success of this venture depends on contributions by the users. Up to now there has been a limited response from

outside the Working Party. Does it mean that the draft will meet the bulk of users' requirements or will comment be delayed until users are faced with data in the National Transfer Format?

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