Developing a Location Database for the UK Radio Data System – Traffic Messaging Channel Service

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This paper deals with the development of a location database compatible for use with the proposed Radio Data System – Traffic Messaging Channel for Great Britain. It looks at the needs for such a database and the technical difficulties that have been overcome in developing a cost-effective, automatic, production system that provides the most detailed roads location database in Great Britain.

1. INTRODUCTION. The volume of traffic on Britain's road network is growing rapidly; the number of cars has grown from 16 million in 1984 to over 21 million[1] today. Not only has the volume of traffic increased, but so has the distance travelled. In 1984, 244 billion kilometres were travelled which has risen to over 345 billion[2] today. This 41 percent increase in travel has been accommodated on a road network that currently comprises 364967 kilometres and which has grown by only 5 percent[3] over the same period. Some forecasts[4] now suggest that, by 2005, one third of the motorway and trunk road network will be gridlocked, with all-day congestion, at levels equivalent to today's peak period jams, on all approaches to London, the Midlands and key strategic routes. Even rural lanes in the most densely populated areas will suffer peak time congestion. The chaos caused by terrorist bomb threats to the motorway network in early 1997 illustrated the vulnerability of the transport infrastructure and how close it is running to full capacity.

Over the last decade, the solution to this problem has been to build new motorways, bypasses or to widen existing carriageways around the bottlenecks in towns and cities. The growing realisation that this solution increases rather than decreases traffic volumes has resulted in disquiet and protest over the entire road building programme.

2. EFFICIENT USE OF EXISTING ROAD NETWORKS. A more effective solution to the traffic congestion problem is to utilise the existing roads more efficiently; using public transport where possible, encouraging cycling and walking and ensuring that when private cars and lorries must be used, the journey is as short and quick as possible. The RAC has long campaigned on behalf of the

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motorist and now acknowledges that road building is not the answer to traffic congestion. Instead, the RAC is assisting further discussion on the best methods for improving traffic flow and is investing heavily in systems to provide better information to the traveller, whether they be a motorist, cyclist, train user or even pedestrian.

In the autumn of 1996, the RAC approached Ordnance Survey with details of the European Community and European Broadcasting Union initiative to develop a Traffic Message Channel (TMC) to be broadcast on the Radio Data System (RDS) of the FM radio network. A working partnership was soon formed that brought together the unique skills and knowledge of Ordnance Survey and the RAC to develop a location code database for positioning areas, and relaying causes, of traffic congestion.

3. RDS-TMC. Motorists will be familiar with RDS as most cars are now factory fitted with an RDS radio. With RDS, the broadcaster can code information on the side band of the FM transmission. This broadcast contains details of alternative station frequencies, alerts the user to the imminent broadcast of traffic news bulletins and even the station name. RDS radios have the facility to scan these transmissions and to re-tune automatically to the frequency that provides the best reception as the car moves from area to area, display the station name or switch stations to one broadcasting a traffic update before reverting back to the original station. TMC is an extension of this service which allows RDS-TMC radios to display information broadcast on accidents, congestion, road works and other factors that affect the ease and speed of road travel.

RDS-TMC is based upon the ALERT C protocol[5] which has 5 basic fields:

(i) Event or incident description (11 bits).
(ii) Location (16 bits).
(iii) Direction and extension (4 bits).
(iv) Duration (3 bits).
(v) Diversion advice (1 bit).

RDS-TMC relies heavily on two factors: firstly that there is a large information-gathering network to collate information regarding traffic congestion; and secondly that there is an accurate map and location database on which to plot and then code the location and duration of the traffic incident. The RAC, as one of Britain's premier suppliers of traffic and travel news is already well placed to capture information on congestion; what has been lacking is the location database to convert this information from map co-ordinates into RDS-TMC compatible locations.

4. DEVELOPING THE RDS-TMC LOCATION DATABASE. In most other European countries, the development of a location database has required a considerable investment of both money and resources manually to digitise paper mapping. This results in a sparsely populated database with its accuracy limited to that of the paper map from which it was derived, often 1:50000, 1:100000 or smaller. Manual digitising also creates potential errors and limits the ability of the creator to produce updates as the road network changes.

The system developed for Great Britain has the advantage that the Ordnance

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Fig. 1. Ordnance Survey OSCAR data

Survey already has a highly detailed digital road network – OSCAR – which is continually updated and refined. As a result, Ordnance Survey has been able to derive the RDS-TMC location table automatically, without the need for any costly and time-consuming manual procedures and with the subsequent ability to update as and when changes to the road network require.

The OSCAR database (Fig. 1) is a road centreline product derived from Ordnance Survey's large-scale data. It contains every publicly accessible motorable road in Great Britain, whether private or public, and uses node points to represent road intersections, which are accurate to within 1 m. Each node in OSCAR is uniquely numbered and each stretch of road between nodes (a link) also carries a unique identifier.

Using OSCAR, Ordnance Survey has developed an RDS-compatible location database with over 3 million location codes, one RDS location code for every OSCAR link in the national road network. This larger, more complete database will be useful for digital audio broadcasting (DAB) and for the general standard for mobile communications (GSM) networks. However the band width of RDS-TMC allows room for only 64 000 codes and for this reason, the RDS-TMC database relates only to Department of the Environment, Transport and the Regions (DETR) classified roads (i.e. Motorways, A and B roads), and defines an RDS-TMC segment as a length of road between two *significant* junctions or locations. Each segment has a unique location number, and contains a reference to those segments before and after it, a description of the location of the start and end of that segment and the county in which that segment predominantly falls. It is this information, combined with the transmitted message, that is used to provide the driver with the necessary traffic information. The production of the RDS-TMC location database consisted of a two-stage process.

5. STAGE ONE. The RDS-TMC location referencing standard[6] defines the content of the fields in the location table, and the rules for the representation of the road network for RDS-TMC systems. This called for Ordnance Survey and RAC to agree rules defining the way that OSCAR data would be converted to conform to the standard. These rules involved minor changes to the representation of roundabouts and road junctions. For instance, staggered junctions where two classified roads crossed at an offset, had to be rationalised, as did roundabouts at the junction of two or more classified roads. In the instance of staggered junctions, the junction only takes the classification and road number of one of the roads at the junction. If no action were taken, this would result in a break in the sequencing of the other road's junction (see Fig. 2). In addition, roundabouts

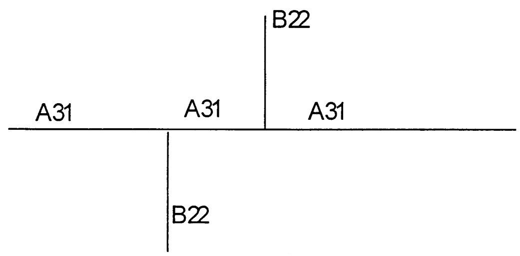

Fig. 2. Staggered junctions

which shared the road number of the dual-carriageway which passed through them (either at an actual junction, or at an overpass), also caused problems with the sequencing of road links. As a result, such junctions had to be simplified, either by the removal of those links which would otherwise upset the sequencing of the main road links, by duplicating the shared links, or else by representing the complete junction, including any associated slip roads, as a single point. This junction point could later be positioned at the relevant position on the road.

Once all such junctions had been amended, the locations of strategic journey decision points (major junctions), based on information supplied by the RAC, were integrated with the OSCAR network. Each link was then allocated to a particular county, using the county definitions held in Ordnance Survey's Meridian mapping database. Finally, using information from the RAC, Ordnance Survey's Small Scales settlement names, and Meridian urban area definitions name, each strategic decision point was then allocated a location name.

6. STAGE TWO. The second stage of the process involved processing each road in turn, ordered by its DETR road number. The processing consisted of establishing a sequenced list of OSCAR links for each road running from South to North or East to West, as most appropriate. This enabled the allocation of information in the RDS-TMC location table regarding the previous and next segments of a road.

This stage was fraught with difficulties, not only establishing a sensible

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sequence of links, but also dealing with situations where there were gaps in the sequence of a particular road number or where one road with the same DETR road number branches out in different directions. (Fig. 3). In this example, the

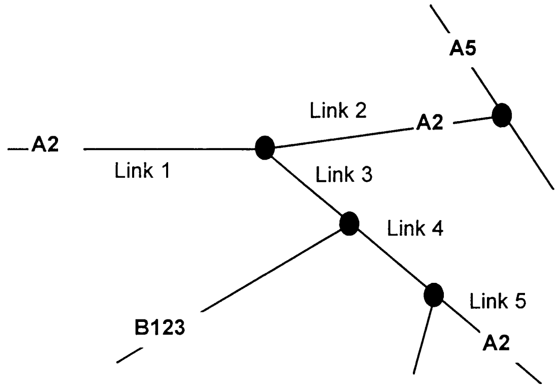

Fig. 3. Branching roads with same DETR road number

road A2 branches creating difficulty regarding the ordering of the links on each branch. One branch terminates quickly, allowing a fairly straightforward resolution to the problem. Once this process was completed, an ordered sequence of links was established for each road. This formed the basis of the RDS-TMC location table.

7. THE LOCATION TABLE. Each location in the database (Table 1) contains a unique identifying number, the RDS location code (Column 1), as well as information on the type of location (Column 2), road numbers and names (Columns 3 and 4), the location names of the start and end of the segments (Columns 5 and 6), references to the area and road in which the segment is located (Columns 7 and 8) and references to previous and next (Column 10 and 11) segments on the road. Within the database, there are 114 area location codes, which define 10 regional areas, and all the counties in Great Britain. The road network is split into segments which define the full extent of a road and segments of that road within a county, and between significant junctions or locations.

In total, the database contains 38325 total road segments, comprised of:

(i) 1825 motorway segments.
(ii) 25654 'A' road segments.
(iii) 10846 'B' road segments.

In addition to these standard RDS-TMC segments, the Ordnance Survey/RAC database contains additional information (including positions and unique identifiers) on every segment, and also information on every link on the classified road network (almost 500,000).This point is important for the future development of RDS, as it provides the capability to expand the database quickly and easily to provide RDS type location codes for every one of over 3 million links in Great Britain. This capability will ensure that the database can be used with

TABLE 1. RDS-TMC LOCATION DATABASE

RDS location code	Location type	Road no.	Road name	First name	Second name	Area ref.	Linear ref.	−ve offset	+ve offset
1	Continent			Europe		0	0	0	0
2	Country group			British Isles		1	0	0	0
3	Country			United Kingdom		2	0	0	0
11	Order 2 area			South east England		3	0	0	0
93	Order 3 area			Greater London		11	0	0	0
1505	Motorway	M41	West Cross route	Holland Park roundabout	Paddington	93	0	0	0
1506	Order 2 segment	M41	West Cross route	Holland Park roundabout	Paddington	93	1505	0	0
1507	Order 2 segment	M41	West Cross route	Holland Park roundabout	Paddington	93	1505	0	0
2600	Order 1 segment	A3		Hook	Tolworth	93	2597	2599	0
2697	Order 2 segment	A3	North side Wandsworth Common	Wandsworth	Battersea	93	2600	2696	2698
2698	Order 2 segment	A3	Battersea Rise	Battersea	Battersea	93	2600	2697	2699
2699	Order 2 segment	A3	Clapham Common North side	Battersea	Battersea	93	2600	2698	2700
12958	1st class road	A302		Hyde Park Corner	London	93	0	0	0
12959	Order 2 segment	A302	Grosvenor Place	Hyde Park Corner	Westminster	93	12958	0	12960
13044	1st class road	A304		Fulham	Chelsea	93	0	0	0
13045	Order 2 segment	A304	Fulham Road	Fulham	Fulham	93	13044	0	13046

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DAB or the GSM networks and makes it the most complete and accurate RDS location database in Europe.

8. THE BENEFITS OF THE ORDNANCE SURVEY/RAC RDS-TMC LOCATION DATABASE. Until now, the vital areas of journey planning, mapping and travel information have been separated by the inability to locate quickly and accurately the source of the congestion and then to broadcast this information to the road user. The production of an RDS-TMC database from OSCAR and its subsequent compatibility, and the depth and coverage of the RAC's traffic news service, bridges that gap.

The RAC, who use OSCAR in their command and control systems, can now easily identify incidents on a computer display and automatically generate RDS-TMC messages. When the system goes live, travellers equipped with RDS-TMC receivers will receive warnings and updates of congestion on the road network, as they happen, allowing alternative routes or alternative methods of transport to be taken or even to reschedule meetings altogether. The RDS-TMC system will save travellers time and fuel costs, reduce the number of hours lost sitting in traffic jams and ease general traffic congestion.

Command and control or logistics scheduling systems will also benefit by taking into account congestion, so optimising routeing and journey efficiency and increasing savings by lower fuel consumption and decreasing overtime payments to drivers stuck in traffic jams. Those systems that currently utilise OSCAR data as the base map could be the first to benefit owing to the compatibility between the RDS-TMC database and the OSCAR mapping.

Ordnance Survey is already helping in this area by providing its digital road mapping data product, OSCAR, to the major providers of in-car navigation systems. OSCAR is the only national, large-scale digital roads database and is one of the key elements to ensure accurate routing and direction information is provided by these navigation systems. In the near future, it is foreseen that this traffic information will be used directly by in-vehicle navigation systems to re-route automatically vehicles avoiding congested roads.

REFERENCES

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[3] DETR, Annual Abstract of Statistics, Table 10.3, HMSO, 1996.
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KEY WORDS

1. Traffic Information. 2. Communications. 3. Road. 4. Radio.