NETWORK MANAGEMENT NOTES

GEOGRAPHIC INFORMATION SYSTEMS

Example of various GIS Layers at different scales. Based on Ordnance Survey mapping ©Crown Copyright. All rights reserved. MEDIA/251/00.

Introduction

The use of Geographic Information Systems (GIS) has grown rapidly in the last 10 years, as a result of rapidly declining computer hardware costs, technology advancements and wider availability of digital mapping. It is now common place for business, government and utility companies to use GIS for many diverse applications.

A GIS has the ability to display large amounts of data in new and meaningful ways, and can be merged with existing systems to provide improved operator interfaces and analysis tools.

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(This Network Management Note is one of a series to be published.)

Early GIS systems were very expensive in that they required high–powered hardware and specialist users. Modern day GIS systems now run on standard desktop Personal Computers and can be driven by someone with basic computer skills.

What is GIS?

A GIS is a computer–based tool for mapping and analysing things that exist and events that happen on earth. Map making and geographic analysis are not new, but a GIS can perform these tasks better and faster than old manual methods.

A GIS is, however, not simply digital mapping which just stores a fixed geographic representation, but in addition stores data from which a new view or views to suit a particular purpose can be constructed.

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Definition

A standard definition of a GIS states that it is a system for the: COLLECTION
STORAGE
MANIPULATION
ANALYSIS
and PRESENTATION
of Geographic Information

Put simply several components constitute a GIS:

- **A computer held map;**
- **A link between objects on a map and computer database records, and**
- **The ability to analyse and manipulate information according to its geography.**

GIS can display any data which is directly or indirectly spatially referenced to the earth. Virtually all highway information is geographically referenced in one way or another, and by use of a GIS, data from different sources and of different types can be merged and displayed together.

For instance the centreline that represents a road on a map does not tell you much about the road other than its location. Using data stored in the database a new representation colouring roads by type and depicting their width by thickness of line can be created.

What are its features and how does it work?

GIS systems generally comprise a tool box of facilities and functions to manipulate and display data. All GIS systems are map based and allow data to be linked or related to geographically based features such as: roads, land parcels or specific co–ordinated points.

The mapping can be in two fundamental formats: raster/photographic image(pixel format) or vector mapping(points and lines). Modern GIS's are able to handle both formats. Raster and vector mapping can be used separately for different purposes, but are frequently used together such as a highway network with associated asset data shown over a raster map backdrop.

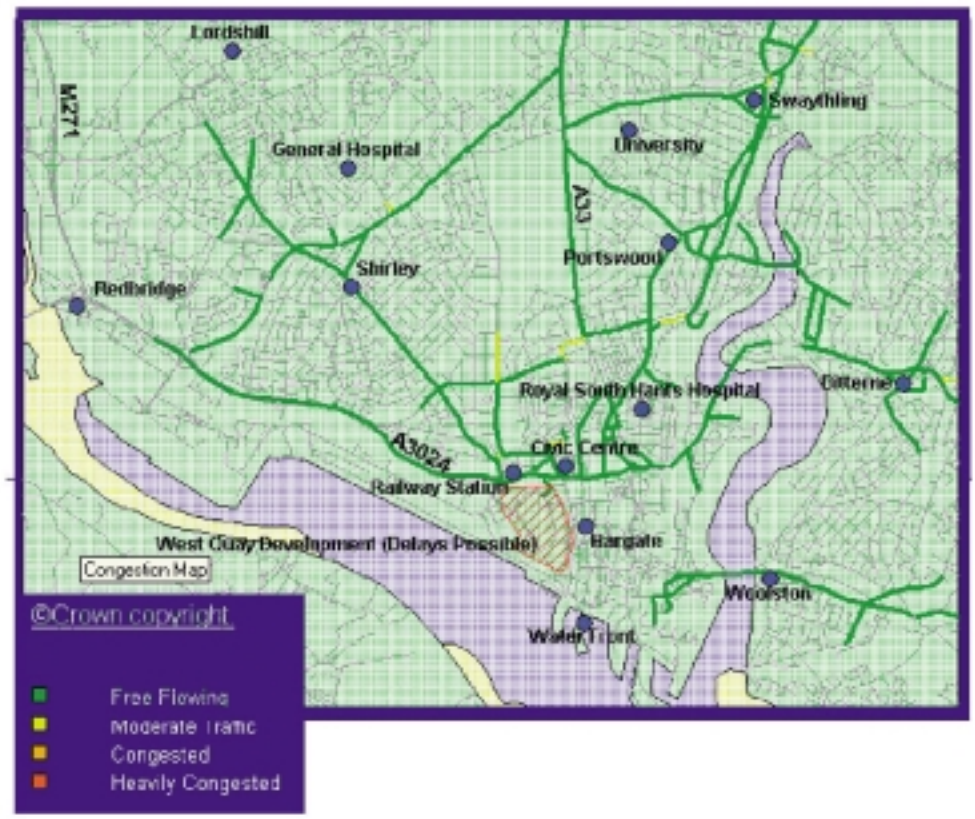
Digital copies of traditional map sheets can be stored within the GIS system, to provide a seamless coverage, thus eliminating the need to cut and paste sheets.

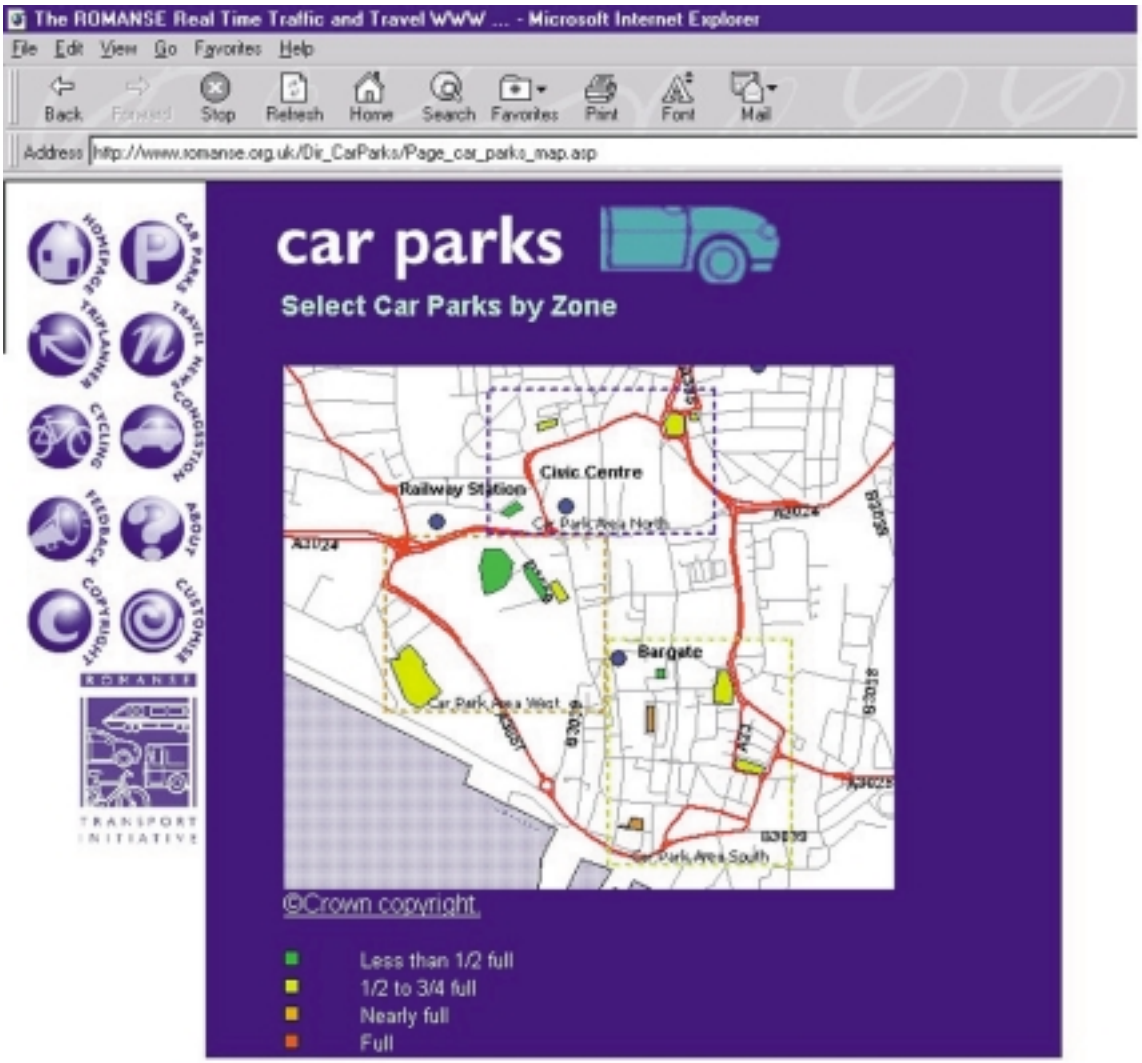
Once a link between data items and their geographic position on the map have been established, data layers or themes can overlay the base mapping to provide an integrated geographic display.

Typical highway network or highway management applications

- Highway Inventory/Asset Management – display where items are located, their current condition and/or inspections history;
- Highway Maintenance – display highway condition, residual life, road repair location and maintenance plans;
- Traffic counts and flows – display traffic flows and counts, showing history and increase/decrease over period of time;
- Accident information – display location of accidents, colour coded by severity and type of vehicles involved;
- Vehicle routing – maintain and display routing information for public transport, heavy vehicles, salting routes etc;
- Bridge Register – display location and maintenance/inspection history of structures;
- Street Works – display location and duration of openings;
- Land Charges and Searches – display background mapping superimposed with road schemes, rights of way, planning applications etc;
- Realtime display of traffic and travel information such as, traffic flows, speeds, congestion, car park occupancies and traffic incidents, and
- Realtime display of vehicle locations.

Example of realtime Traffic Congestion display. Based on Ordnance Survey mapping ©Crown Copyright. All rights reserved. MEDIA/251/00.





Car Park information via the Internet. Based on Ordnance Survey mapping ©Crown Copyright. All rights reserved. MEDIA/251/00.

Data is probably the most important component of a GIS, and can prove to be the most expensive part of the GIS system to maintain. Geographic data can be collected in–house or obtained from commercial data providers. A GIS will integrate this spatial data with other data sources which can be directly held in the GIS system or in external proprietary databases such as: ORACLE, INGRES, INFORMIX, DBASE, ACCESS etc. The merging of previously unrelated data offers many new opportunities both in the analysis of data and geographic display interfaces to existing systems.

A GIS allows large amounts of data to be presented in a clear and straightforward manner a picture truly being worth a thousand words…

What are its uses?

GIS distinguishes itself from other text based database systems by being able to answer questions like:

"What is at a particular location, place name or post code?"

"Where is a particular item or where do certain features exist?"

"What has changed in a particular area over a period of time?"

"What if a new road is added to the network?"

"Who is affected by a break in cable x or a failure of pipe y?"

Provision of geographically based displays for Web sites

As a further development, many GIS suppliers have built Internet Map servers that allow any of the above applications and display facilities to be made available as map based displays via Web sites. The opportunities here to provide accurate information to a wide audience simply and cheaply have yet to be generally realised. There a few developing examples providing the public with realtime traffic and travel information, and this could begin to have a real effect on when and how people travel.

Managerial considerations

It could be argued that as the cost of hardware falls so the cost of managing the data becomes ever more onerous. This is one of the penalties of success ie because something is possible, demand for it to be used to improve a level of service becomes formidable(such as hip replacement therapy). Hence it is vital that before embarking on the introduction of GIS those responsible for Network Management should endeavour to have a clear idea as to what the organisation wishes to achieve over a given timescale.

Some would argue that this stifles development and it is better to implement a system and let users see what it can do, then develop accordingly. There is much merit in this argument but, if it is adopted as a strategy, be prepared for some unforeseen escalation in the cost of service provision, as to what is a more cost–effective provision of an existing service level, becomes an enhanced level of service. In order to overcome this it is perhaps sensible to start with a pilot to explore the uses and potential of GIS, before embarking on a full scale development.

There is also an inherent danger where there is inadequate professional interpretation of data presented by a system. The danger arises when data is related via the GIS (say accident data and maintenance information) and decisions based upon a superficial interpretation of the data that appear as a

result of spatial connection. The consequences are usually unexpected and sometime hideously expensive. Therefore from a management point of view, it is vital that there are sufficient human resources of the right calibre available to interpret correctly the data presented by any system. In order to overcome this limitation there has been some attempt to introduce "expert systems" to run in parallel with GIS, however real life situations are often difficult to model accurately. Therefore Network Managers would be well advised to utilise GIS as a superb tool for helping their staff to make a much more thorough job of assembling, collating and presenting data than was possible hitherto. The temptation to use it as a means, purely of saving money, should be resisted.

What kind of products, applications and data are available?

❖ GIS software is available from many suppliers such as: ESRI, MapInfo, DataMap, SmallWorld, Integraph etc;

❖ Some developed software packages are available from GIS suppliers and specialist highway application suppliers. Most users have a combination of commercially supplied packages and in–house developments.

❖ In addition recent PC based software allows GIS systems to be merged with existing applications.

❖ Data requirements:

Digital mapping at various scales 1250/2500, 10k and 50k;

Road network such as OS OSCAR, and

Geo–referenced data located by grid reference or relationship to a feature.

❖ GIS Standards – there are no real architectures or GIS standards that are generally accepted, although Graphics Data Format(GDF) is an emerging geographic data exchange format within Europe.

The Ordnance Survey provides digital mapping in National Transfer Format (NTF) in the UK, and other mapping suppliers such as: The AA, Bartholowmews, ETAK etc. can provide digital mapping in a variety of CAD formats.

What does it cost?

The real cost is likely to be obtaining suitable mapping and base data. Specialist data may need to be re–collected and geo–referenced to make it suitable for use with a GIS. This is of course a one off exercise, but can prove to be very expensive when one takes into account the collection, loading and future maintenance of this data. With this also comes high user expectation of data accuracy, which can lead to further escalation of cost.

A typical desktop GIS system costs around £1,000, with additional cost for modules like network analysis, digital terrain modelling and 3D visualisation. There are now a number of cheaper products allowing data stored in a GIS system to be simply viewed, indeed some suppliers are making basic geographic viewers available free of charge.

These current GIS desktop systems now run on standard office PC's, so specialist hardware need not be purchased. What this brings is the opportunity to make GIS readily available in the workplace.

The benefit derived from having co–ordinated data, that can be merged with other datasets and used by different users for a variety of different purposes can be immense. Integrating the GIS system with operational front ends, can replace lengthy textual database queries with simple map based pointing or selection operations.

The future

It is apparent that GIS will have a profound effect on a whole range of service delivery systems and that we have barely scratched the surface of what will become feasible in the first years of the next century. There are three elements to this service delivery and they each interact with each other: GIS, Global Positioning Systems (GPS) and Internet/Intranets.

As increasing network bandwidth becomes available, coupled with digital broadcast, satellite communications and positioning, remote sensing etc. real–time interactive decision making against live video and map projection will become an everyday occurrence. Indeed it is already in partial use, and being built into control room front–ends of many command and control systems. It will bring great benefit provided that management guard against information overload and staff are adequately trained.

In the UK many of the developments will depend upon the ability of the Ordnance Survey to fund and implement the re–engineering of the national spatial data which is now held in digital form. The IHT has responded regularly to Government Consultation papers associated with this arena. Whenever possible much of this information is displayed on the IHT web site (www.iht.org.uk) together with useful links to other sites that will aid members in keeping up–to–date with developments in this fast moving technology.

Other useful sites in the GIS arena are:

Ordnance Survey	www.ordsvy.gov.uk
Association of Geographic Information	www.agi.org.uk
Royal Geographic Society	www.rgs.org
University consortium for GIS	www.ucgis.org

Conclusion

GIS should now been seen as just another tool to be made available in the workplace and used by non–specialist users. GIS technology is now relatively inexpensive and has the capability to deliver real benefits by displaying large amounts of data in new and meaningful ways to a wide variety of users.

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