On the g-track

Here's a look at how the largest civil engineering project in Europe is incorporating geospatial technologies in its processes

Crossrail is the largest civil engineering project in Europe and the largest single addition to the London transport network in over 50 years. It has been designed to provide a new railway network for London and the South East and carry 200 million passengers a year. From 2018, Crossrail will travel from Maidenhead and Heathrow in the west to Shenfield and Abbey Wood in the east, via 23 km of new twin tunnels under central London and 90 km of upgraded surface railways. It will link major employment centres of Heathrow Airport, the West End, the City of London and Canary Wharf.

THE GIS CHALLENGES

Crossrail is extensively using (and plans to use) GIS within the entire lifecycle of the project, including design, construction and maintenance. Currently, there are over 500 layers of information including mapping, environmental and the latest project design.

These vary in size from a few objects to large datasets such as the Ordnance Survey Mastermap, currently at over 90 million records. The Crossrail GIS department decided not to use the British National Grid as its standard coordinate system. Instead, it is adopting a more accurate survey grid (London Survey Grid), creating issues of data transformation. All this information had to be made available seamlessly to the CAD departments in 3D format to help create a unique 3D asset model.

OVERCOMING CURRENT CHALLENGES

To overcome these challenges, Crossrail has adopted Oracle 11g spatial database to help manage and process the vast amounts of data utilised within the project.

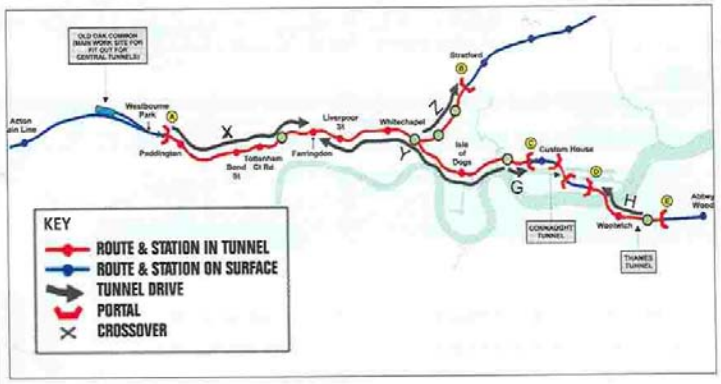
This is the singular master repository for all geospatial data. It has recently been extended to 300 GB to allow for addition of further project information. This is made possible due to the scalability of the solution. Specialised PL/SQL stored procedures have been developed to re-project data into London Survey Grid without the need for user intervention. With Oracle Spatial's neutral data format, the project got freedom in its choice of GIS. This facilitated the use of right tools for the right jobs. For example, the bored tunnels team selected Esri's ArcMap as it served as a powerful tool to fit the following requirements:

- Ground behaviour
- Settlement and assessment of potential damage
- Geotechnical services
- Instrumentation and monitoring
- Noise and vibration analysis
- Flood protection and drainage
- Interface management
- Alignment design
- Planning and environment
- Provision of the ITT scope document packages for potential contractors

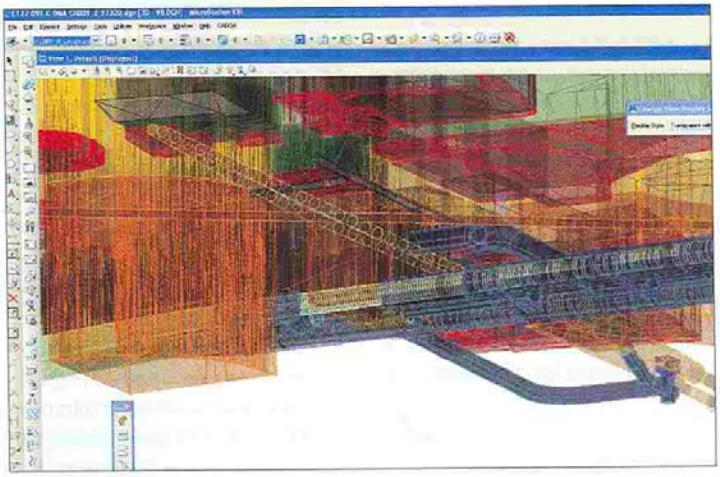
However, the planning department preferred Bentley Map due to the following capabilities:

- Topology tools
- 3D capabilities
- Data capture tools
- Simple development environment
- Integration with CAD
- Integration with Oracle Spatial

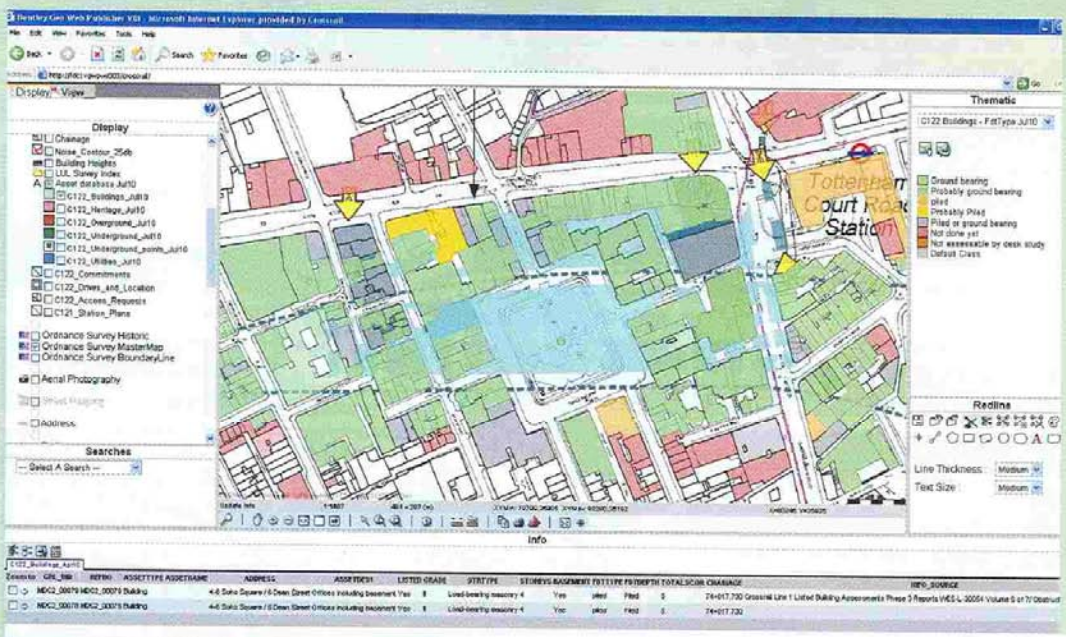
As the project has grown, so has the data to be accessed, including utility data, survey data, environmental studies and parliamentary information. This wealth of information was, and is, required to be distributed to the entire project on demand. Crossrail decided to have a tool which required little or no training, was intuitive to use and which delivered information in a timely fashion. It was also important that the tool provides data security, allowing the viewing of data based on user access rights. The solution was Bentley Geo Web Publisher, known as Crossrail Maps. It is a single mapping portal providing both mapping and metadata on the users'



Route map



Sub-surface CAD view



Crossrail Maps

desktop, filtering the information delivered by active directory group membership.

This implies that only one mapping interface has been created, reducing maintenance tasks and simplifying the training requirements. However, Oracle 11g Spatial database is only one part of the overall Crossrail GIS data requirements. Two other distinct data servers are being utilised to help distribute geospatial information - Bentley Systems ProjectWise and eB. ProjectWise, is an engineering document management solution and is primarily used to manage CAD-based engineering drawings. eB is the management and asset register application.

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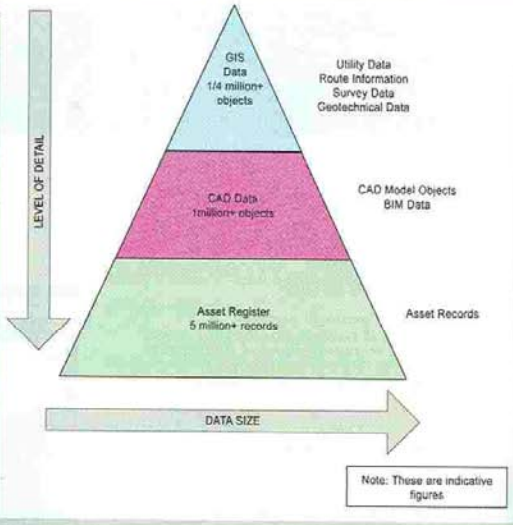
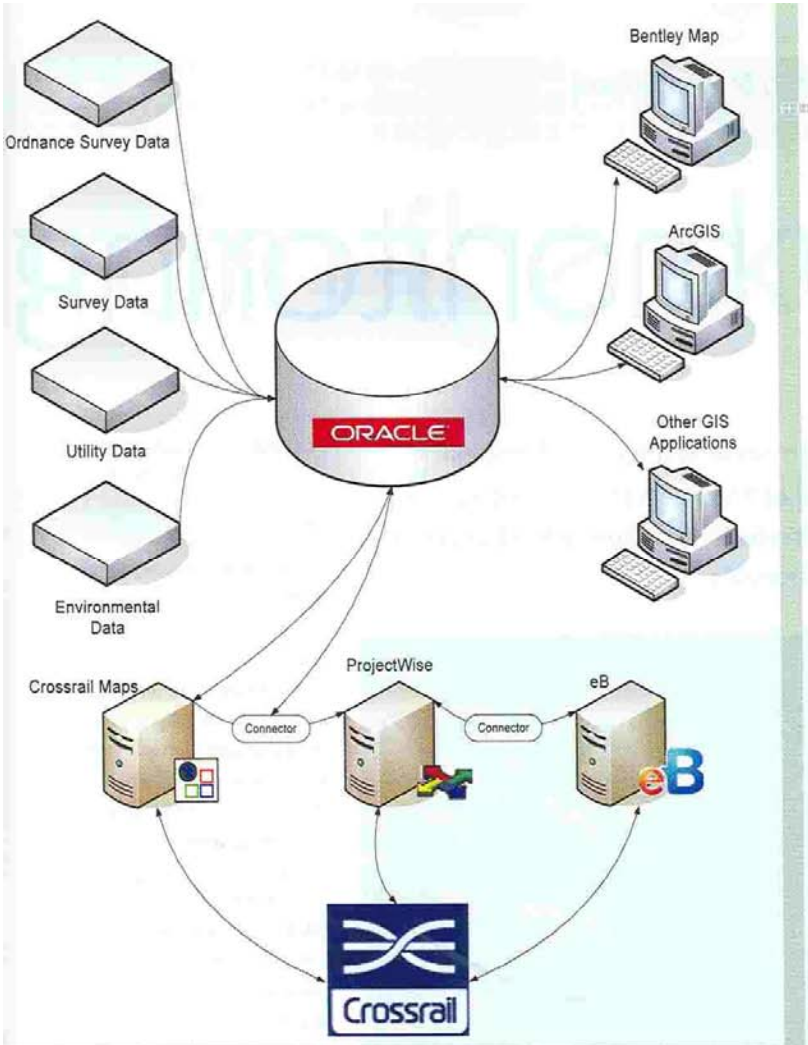


Asset structure

These solutions deliver information either through standard desktop clients or intranet. However, they also communicate with each other through connectors. These connectors link different applications together, allowing data to be transferred between each server. This allows GIS data held within the Oracle Spatial database to be communicated to the engineers



Architecture

using ProjectWise. Subsequently, this information can be passed to the asset management team using eB. The technology removes duplications, retains the live data in its original location and eliminates the potential of out-of-date information being delivered to any of its users.

FUTURE GIS DEVELOPMENTS

The Crossrail project is still evolving through the design and construction stages and into operation and maintenance. The geospatial data aspects within these stages will also change from data gathering and data provision to asset capturing and asset maintenance. Thus the spatial data models of Crossrail project had to incorporate the future requirements of asset capture and maintenance. From the beginning, the project management decided that all data will be captured in 3D, from both CAD and GIS perspectives. Within CAD, all data is being captured using BIM techniques. In GIS, where applicable, the data has its correct Z value associated to it. Thus a wealth of 3D intelligent data is being collated. In the future, Crossrail is planning to use automated extraction techniques to link CAD and GIS data with asset registry held with eB. In the process, asset information will be made available at differing levels of detail, similar to that described within the CityGML data structure.

This information will then be used for asset maintenance tasks based on either positional information or linear referencing techniques built within the GIS. Ultimately, Crossrail envisages a system where, through a simple singular interface, users can move from GIS data into BIM data to asset information.

This single system will also be linked to asset maintenance systems for tasks such as on-site inspection, providing not only asset information but spatial location within the Crossrail infrastructure.

The Crossrail GIS approach involves collaboration and cooperation across multiple disciplines and companies. It demonstrates how GIS and related procedures have been implemented on a substantial and complex civil engineering project, providing useful evidence of cost and time saving, as well as demonstrating risk mitigation by ensuring appropriate use of data and information. Crossrail hopes that the qualitative and the quantitative benefits of implementing GIS will increase as the project progresses.

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