



## Project Summary

**Organization:**  
Network Rail

**Solution:**  
Rail

**Location:**  
United Kingdom

**Project Objective:**

- Design overhead line equipment for 1,000 kilometers of single-track railway in western United Kingdom
- Create a 3D model of the entire project by combining survey data and design models
- Use the model to provide context to assess designs provided by engineering contractors, support signal sighting and driver training, create 4D simulations for construction for vegetation management, and lastly as a live asset management model

**Products used:**

Bentley Descartes  
Bentley Navigator  
Bentley Rail Track  
Bentley i-model Composition Server  
MicroStation  
ProjectWise

## Fast Facts

- Network Rail used Bentley Descartes to create a hybrid 3D model of the entire project by combining survey and engineering data.
- Survey data includes 950 route-wide point clouds (+/-50 millimeter accuracy, 60 points per meter density), and close to 30,000 images (5 centimeter resolution). Images stored in ECW format and managed with ProjectWise.

## ROI

- A scalable terrain model 250 miles in extent was created in one week, as opposed to 25 miles of traditional digital terrain model that would usually be created in the same time. Bentley Descartes allowed the scalable terrain model to be created 10 times faster.
- Tunnel modeling was improved by a factor of three with a tunnel 1 mile and 152 yards long being modeled in one to two days with Bentley Descartes against one week with a standard CAD tool.

# Point Clouds and Scalable Terrain Models Support Network Rail's Great Western Rail Electrification Programme

Bentley Descartes Enables Project Teams to Comply with BS 1192, and Provides Cost-saving Tools to Leverage Point-cloud Data in Engineering Projects

## Scalable 3D Model Allows Collaborative Designs and Live Asset Management

The Great Western Electrification Programme represents an investment of GBP 1.5 billion that will allow faster, quieter travel, with increased seating capacity, and improved reliability on one of the United Kingdom's oldest and busiest railways. This program will enhance the railway line between London and Oxford, Newbury, Bristol and Cardiff.

With a project of such scope, owner-operator Network Rail needed a way to incorporate enormous amounts of survey data with design models from multiple consultants, to aid efficient project collaboration and streamline interactions between designers and contractors. In addition, to encourage efficient data collaboration and increase productivity, Network Rail followed the BS 1192 code of practice for the collaborative production of architectural, engineering and construction information. Network Rail used Bentley Descartes to merge point clouds, scalable digital terrain models, and raster files with the consultants' design models to create a scalable 3D model. Using Bentley Descartes provided Network Rail with a complete view of the entire project, enabled efficient design review and effective team collaboration, and allowed the organization to meet BIM criteria included in BS 1192. When construction is complete, Network Rail will then be able to use the 3D model to support its asset management program.

## Bentley Descartes Combines Scalable Terrain Models, Point Clouds, and CAD files

Among this project's many requirements is the need to assess, retrofit, or construct significant amounts of infrastructure, including 1,000 kilometers of single-track, 12,000 steel piles and 4,000 reinforced concrete foundations, and 164 structures that require gauge clearance analysis – including bridge interventions, lowering of track, canopy cuts, and more. Managing such a project requires efficient collaboration between Network Rail and the organization's many business partners and subcontractors. Using Bentley Descartes, Network Rail has established a scalable 3D model as the geo-coordination platform to aggregate the

as-constructed and design information, including scalable terrain models, orthoimages, Bentley i-models (containers for open infrastructure information exchange), and DGN files. The model is used to streamline the interaction between design consultants and contractors by enabling the coordination in a 3D environment of all the designs from design consultants.

This scalable 3D model also supports design review by providing efficient 3D visualization of the designs, including all engineering intelligence. The individual design models created in industry-specific design applications, including Bentley Rail Track, are available when reviewing and navigating the entire 3D model in Bentley Descartes.

By combining a large terrain model draped with thousands of orthoimages, point clouds acquired by helicopter, and designs provided in the DGN format and i-models – which Bentley Descartes supports natively – the scalable 3D model provides a unique environment to enable collaborative review, condition assessment, and construction simulation together with 4D animations.

But the value of the 3D model goes beyond the design and construction phases, to support Network Rail's longer-term asset management program by providing a live 3D map that indexes and references asset documentation. As a long-time user of Bentley software, Network Rail uses ProjectWise as its engineering information management platform to enable team collaboration and data exchange in a secure environment among all partners and stakeholders.

John Nolan, CAD manager at Network Rail explained: "We have been early adopters of Bentley Descartes V8i (SELECTseries 4) and this new release provided us with exactly what we needed. The software's ability to create scalable terrain models now allows us to create and manage terrain models with hundreds of millions of points. With its fast scalable terrain model manipulation and very powerful modeling tools, Bentley Descartes allows us to integrate point clouds and engineering data into intelligent hybrid models."

*"We have been early adopters of Bentley Descartes V8i (SELECTseries 4) and this new release provided us with exactly what we were looking for. Scalable terrain models now allow us to create and manage terrain models with hundreds of millions of points and the section modeling capability addresses tunnel modeling perfectly."*

— John Nolan, CAD Manager,  
Network Rail

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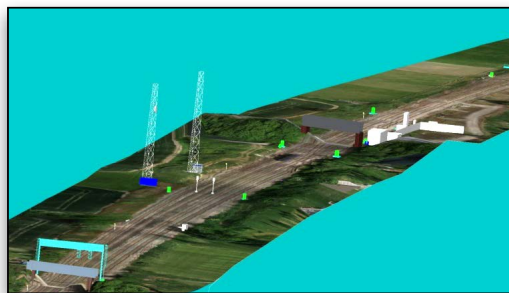
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## Hybrid Models Used to Assess New Designs

Some of the challenges of this project included the lack of up-to-date information on existing assets and potential inaccuracies in existing documentation. To provide surveys of the existing track conditions, data acquisition was outsourced, with aerial LiDAR used for open areas and laser scanning technology for tunnels. High resolution orthoimages were also acquired. The point clouds were colorized and classified initially as ground and non-ground classes.

Bentley Descartes was used to create a scalable terrain model directly from the classified point clouds by processing only the ground points. The scalable terrain model was then draped with high resolution images and the vector geometry engineering information referenced directly into the scene. The model was tiled to cover separate areas of tens of kilometers.

In order to assess vegetation for clearance, the non-ground point-cloud data was also merged into the 3D model. By integrating the colored point cloud of the vegetation into the model, Network Rail was able to identify vegetation areas that needed to be reduced to meet the necessary clearance for the new overhead electrical infrastructure.



*Network Rail created a scalable 3D model of the Great Western line, by combining terrain, draped images and i-models.*

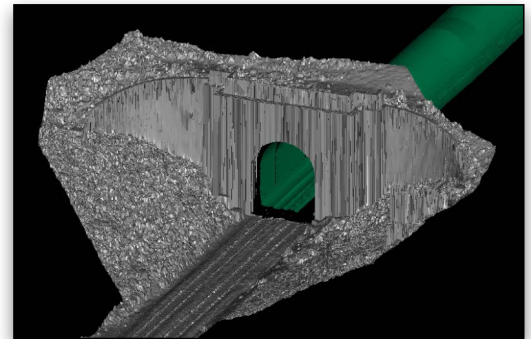
## Tunnel Modeling Using Point Clouds

The Great Western Electrification Programme includes eight tunnels (Newport, Severn, Alderton, Patchway Old, Patchway New, Sodbury, Clifton Down, and Box) ranging from 700 to 7,000 meters long, which require detailed studies to enable the planned electrification. In such a confined and potentially dangerous environment, laser scanning technology allowed fast, accurate, and safe measurement. Although the point clouds by themselves provide great 3D visualization and on-demand measurement capability, subcontractors needed traditional geometries with a high level of accuracy. Using Bentley Descartes' Model by Section tool, Network Rail was able to quickly create loft surfaces of the tunnels.

John Nolan explained, "The modeling capability of Bentley Descartes V8i (SELECTseries 4) addresses tunnel modeling perfectly. By defining a template of the tunnel cross-section and adjusting this template along the alignment, we were able to model tunnels in 3D with real-time visualization of the generated 3D surface, which allowed us to assess quality as we digitized the model."

## Extending ROI

In addition to streamlining the process among suppliers, and supporting BS 1192, the creation of an information rich scalable 3D model including terrain data, point clouds, orthoimages, and i-models, provides numerous opportunities to extend the project's return on investment from the project. The integrated model allows the creation of 4D schedule simulations showing each construction phase, supports project review, enables clash detection, and also allows driver training and signal sighting. In addition, the model is very effective for showing local authorities and individual landowners what effect, if any, the overhead line electrification (OLE) works will have on them.



*The newly generated tunnel geometries have been used for OLE clearances, niche locations, cable and catch pit locations, and more.*

## Heading Toward a Live 3D Model for Ongoing Asset Management

The Great Western Electrification Programme is currently in the design and construction stage, but Network Rail is already planning for operations and maintenance by establishing an intelligent model to support long-term asset management.

The scalable 3D model will be reused and enriched to aggregate engineering files including DGNs and i-models, and to index asset information. Asset documentation, PDFs, images, and videos, are managed with ProjectWise and indexed in the scalable 3D model. Users can therefore navigate and interact with the 3D model, and, by clicking on an asset, access associated documentation stored in ProjectWise.

## About BS 1192

BS 1192 is the British Standard that establishes the method for managing the production, distribution and quality of construction information, including that generated by information modeling software, using a disciplined process for collaboration and a specified naming policy. BS 1192 is applicable to all parties involved in the preparation and use of information throughout the design, construction, operation, and decommissioning of infrastructure across the project lifecycle and the entire supply chain.