



Link by link

Ted Selig, director (operations systems), Bentley Systems expounds the advantages of using CIM that can streamline operations of a system even as vast as the railways



Railways have become an increasingly complex industry. The world's reliance has increased on this efficient transportation mode that must run with limited resources, on constrained corridors, with increasing traffic. These demands can only be met by effective management of immense amounts of data and the extraction of excellent information.

Corridor Infrastructure Management (CIM) is the practice of using information for managing a safe, reliable, and cost-efficient transportation corridor. CIM incorporates five elements:

1. automates prediction, prioritisation, and planning of the type, time, and location of actions
2. evolutionary and low-impact data maintenance
3. connects a diverse and disparate data sources
4. turns data into information through visualisation
5. exchange of data between linear, geospatial, and hierarchy forms

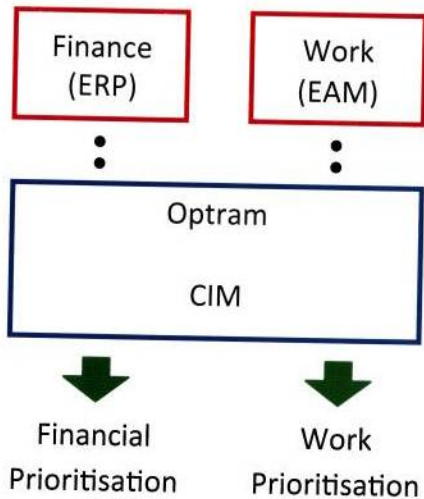
Using technology

Modern railways can improve reliability, safety, and profitability by applying technology to predict, prioritise and plan. What modern technology enables and railways require is live, automated, comprehensive, precise data that pinpoints defects impeding transport. This is information-driven prediction, prioritisation, and planning of CIM.

Railways require significant capital, large work forces, and expensive equipment working over geographically disparate regions. Planning is required to efficiently and effectively coordinate maintenance and renewals.

Planning requires a prediction of the future. Knowing how long assets will continue to safely support traffic improves budgeting and work planning. A database which details accurate and comprehensive assessment of type, condition, usage (traffic) and change in performance over time is required for accurate prediction of future performance.

No railway has infinite resources. Prioritisation allows the comparison of quantifiable facts about the asset performance. It shows the tasks that can be combined to maximise work windows and the assets that provide the largest impact on performance. CIM delivers live, automated, comprehensive, precise



planning, prediction, and prioritisation for the infrastructure and vehicles.

Data under management

CIM requires a basic set of data— assets, finance, network topology, operations and work data. Assets include vehicle, infrastructure, real-estate assets, geographical location, and relative location to other assets. Condition is a measure of asset condition and its wear and defects. Finance data involves asset value and business unit ownership, revenue, expense, and cash flow. Network Topology stores the interconnectivity of transportation network. Operations data stores record of



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vehicles travelled within the network topology. Work data stores the history and planned maintenance and renewal work performed on the system.

Transforming data

The world’s leading railways use enterprise resource planning (ERP), enterprise asset management (EAM), and CIM systems to maximise their operating safety, reliability, and profitability. EAM systems maintain work history, work plans and resources, asset information and manage the execution maintenance and renewals. ERP maintains financial information about income, expense, and capital value and manage finance and human resources.

A real-time CIM-EAM integration provides capabilities such as real-time work order management, prioritised proactive work orders based on work history and inspection. An interface between CIM and ERP enables capital and maintenance work prioritisation based on best value (such as repair cost, traffic revenue, average speed). It also makes it possible to calculate capital value using current corridor assets inventory, condition, and rate of deterioration.

The combined systems provide financially proactive work orders, project cost analysis, and cost projections by building real time integrations with ERP systems. CIM analyses measured condition, deterioration, and work influences to calculate asset lifespan at



Railways require accurate data to run smoothly

each point along the track. Railways identify peak cost areas with CIM linear data of work along the track and summarises the results. ERP uses these results to develop balance sheets and capital budgets based on actual asset condition along the rail corridor.

Railway personnel interact with location data and information in three forms -

- Geographic (latitude, longitude, and elevation)
- Linear (railway line, marker plus offset)
- Hierarchy (parent-child ownership)

Effective means information systems must model and transform data to and from these three forms of location reference.

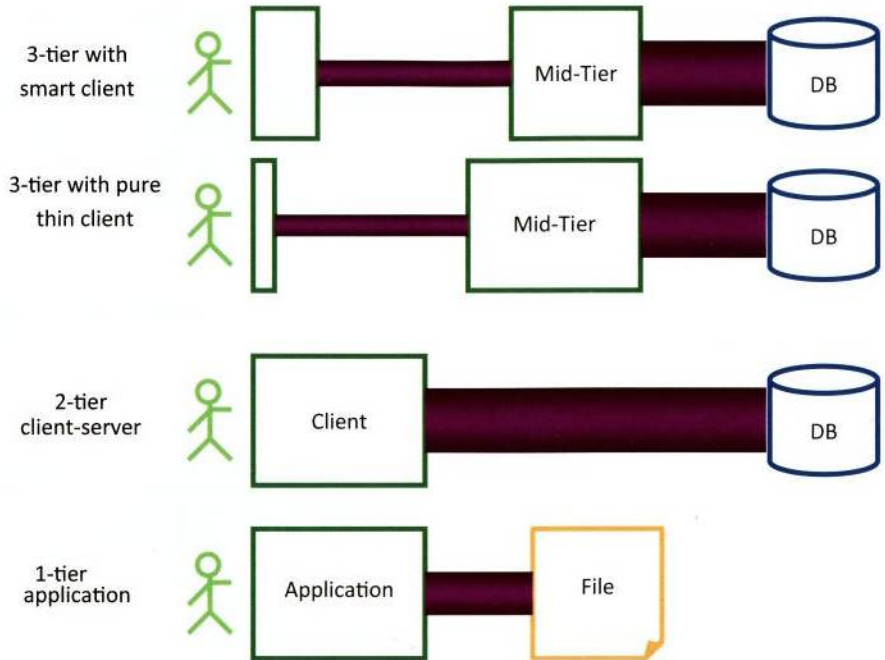
Railway track charts are a schematic representation of corridor assets with various combination of major maintenance, components (ties, substations, signals) and attributes (like curves, grade, and type of train control). A track chart is the linear representation of infrastructure assets along a rail line, based upon a kilometre + metre (milepost and footage or similar) measurement system.

Geographic Information System (GIS) technology is effective at mapping but it alone is inadequate to address the core needs of a CIM system. This is because railway employees traditionally refer to location on the right-of-way using an internal linear marker system. GIS is unable to correlate specific asset condition measurement, traffic usage, and work-record data – all essential to evaluate alternative maintenance procedures. It is difficult to portray and interpret required detail to pin-point the root cause and location of problems at the track-level.

Railways also think of information in terms of hierarchy of ranks. The labour, materials, and equipment used to repair track must be associated with a cost centre. And when repairs cross a certain limit, the costs need to be proportionally shared among the cost centres. Hierarchical or parent-child relationships are another important way to organise and review information about performance.

Comprehensive data

For effective CIM, railways require an accurate and comprehensive data set that is easy and inexpensive to maintain. Analysing inaccurate data leads to uninformative – or worse – incorrect conclusions. It is important that data collected reflects reality. Steps to improve data accuracy include collecting data using multiple sensors and comparing results, correlating different types of data,



and establishing gate-keeper filters to validate user and machine entered data prior to acceptance. Failing to identify a defect on just one wheel or a few centimetres of track can be catastrophic.

Linking data sets uncovers another dimension of information. Example of data correlation in space is when a track defect is located by a track, a marker and marker offset - or by increasing latitude and longitude. If track defects are correlated or overlaid with a geographical map or schematic diagram, the relation of defects features and assets becomes apparent.

The trick to building an accurate and comprehensive data set is to develop a set of tools that minimise the friction of collecting, correcting, and interacting with the data. Tools that collect and process data without human intervention are important in the process of improving data quality.

Architecture

The design and configuration of an information system influences the effectiveness of asset information system. This design and configuration is known as information system architecture. Different architectures have advantages and disadvantage and thus are appropriate for supporting different functional objectives.

Information system architecture defines the arrangement of software building blocks and data stores over a distributed network of continuously and intermittently connected computers. Information systems can be implemented following one of many architecture forms each with advantages and disadvantages. The distribution of data store, business logic, and user interface building blocks are generally configured in an arrangement of multiple tiers (see Figure 1). A unit application or one-tier application simply provides a computation function or may read and write to a file. Examples of one-tier systems are a spread-sheet or a system located on a wayside site that logs data as vehicles pass. A two-tier or client-server architecture bundles the software blocks into a client tier and the data store or database as a second or data server tier. An example of two-tier system is a tool connected to and access database. A three-tier, multi-tier, or distributed architecture divides the architecture into a thin-client user interface tier, one or more middle tiers with business logic and data filters, a data server tier. The many and diverse users on a railway require the advantages from each of the architecture types. An ideal CIM system simultaneously supports these architecture types with a single system. **CMI**