Five insights of a train data integrator

Rail transit systems are becoming increasingly data driven. Knowing how to effectively manage that data can provide fleet operators and rolling-stock manufacturers with invaluable observations and knowledge. The challenge lies in understanding how to collect, analyze, and utilize this information. In this whitepaper, an experienced train system integrator offers five insights into meeting these challenges and making train data management systems a key element in successful fleet operations.

In recent decades, there has been a significant increase in the amount of operations and maintenance data associated with trains. Two key factors are influencing this trend: fleet operators seeking innovative ways to streamline operations and reduce costs, and the large volume of data produced by today's microprocessor-driven and network-interconnected train equipment.

Effective data management requires commitment from participants at all levels of rail car operation, including:

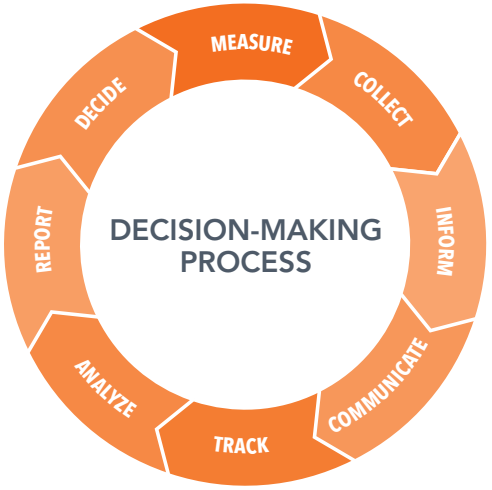
Transit authorities that procure the vehicles and define their requirements,

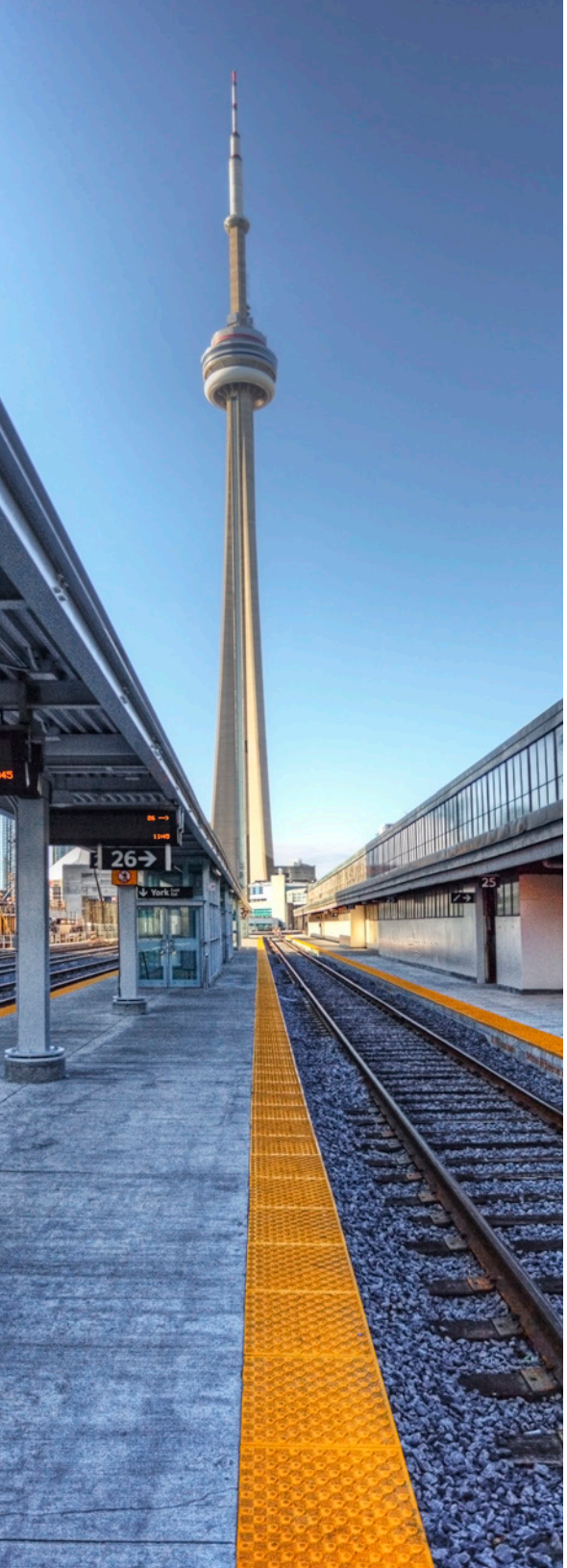
Rolling-stock manufactures that design the rail cars and integrate the onboard subsystems,

Train data integrators that define the protocols and data schemes used by the subsystems,

Subsystem suppliers that develop equipment to meet the requirements set by the transit authority, rail car builder, and train data integrator.

While the data itself may be ubiquitous, extracting the right information and converting it into good, knowledge-based decisions is more elusive. The following five insights were gained through 10 years of experience deploying train data management systems for North America's major car builders and transit authorities.





1 Begin with the end in mind

Every fleet operator should start their rail project by asking some fundamental questions to help define their data management goals. While each operation is unique, here are typical observations that apply to most transit authorities.

Why is the data being collected?
If the motivation is to collect data in case the transit authority may need it "someday," then the system will provide little benefit. If, however, the end goal is to make timelier decisions, then there is strong potential to meet end-user needs to attain operational and performance targets.

Who will be using the data?
An integrated data management structure for the passenger rail industry serves two main areas: operations and maintenance. For operations, the main users are train operators and operations center staff such as rail traffic controllers. For maintenance, the main users are maintenance staff and engineers. Fleet operators should clearly define the data to be collected and presented to these users, as well as the collection frequency and access levels.

What information is needed in real-time?
To a large degree, operations depend on real-time data, while information for maintenance includes both real-time and logged data. Real-time data can be used to identify equipment faults during revenue operation, as well as in the shop when troubleshooting. Logged data captures the running history of onboard events to record faults and system conditions as they occur.

How will the data be reported?
Data is reported to end users in various ways. Real-time data is presented to train operators through cab consoles and to the wayside operation center via wireless technology. Maintenance data is available through on-train consoles, wayside servers, specialized portable test units, and bench test equipment. The method of presentation and reporting that works best in each case depends largely on the transit authority's business processes.

How will the data be used?
For operations, typical decisions personnel need to make might be:

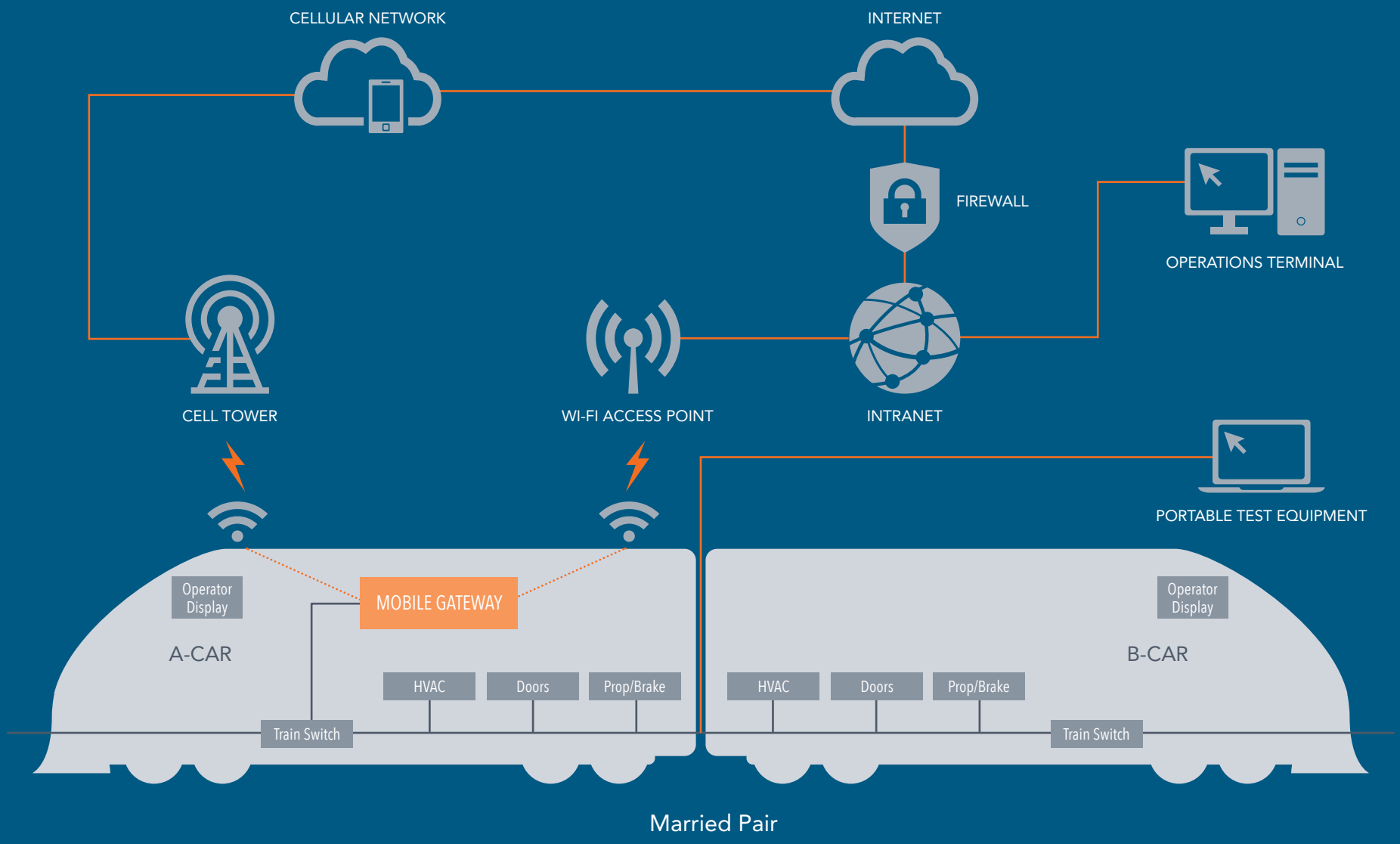
- Can this car be placed into revenue service?
- What speed is allowed for this track segment?
- Is it acceptable to open the doors on the left side of the car right now?

For maintenance, typical decisions might include:

- Where should the crew go to rescue a stalled locomotive?
- What priority work should be scheduled for the overnight maintenance crew?
- Which component should be replaced to make the car operational again?
- How to troubleshoot that intermittent fault that only occurs when the train is moving?

Preparing a clearly defined set of operator and maintainer decisions gives the train data integrator the necessary information to determine the raw data that should be collected, how it should be processed, and what information to present on consoles and in reports. Using this reverse approach, the integrator can implement a consistent, system-wide data management scheme with maximum value to fleet operators.

Train data collection



2 Address the details early on

New car builds and fleet refurbishments have tight schedules and budgets. When a "Notice to Proceed" is issued, work hurriedly begins to get all the subcontractors committed and working on their respective systems. These subcontractors, in turn, need to get their designs solidified and production underway. This is why the system subcontractors need to know as early as possible what interfaces, protocols, data formats, and network operations are required from their components.

On the whole, subcontractors try to reuse their existing systems on each new rail project. Often, however, a new train comes with a new set of interfaces, and each system must adapt to those requirements. The cost of adjustment can include both software and hardware development, which is why early definition and clarity of requirements lead to cleaner executions and fewer cost overruns.

Fleet operators should manage two sets of data requirements at an early stage:

Data exchange (networks and protocols)
Data exchange is usually defined by a hierarchal list of interfaces, including physical (Ethernet, WTB, CAN), network (TCP/IP, CANOpen, TRDP), and application (TCP, SNTP, FTP, HTTP, TTDP). Standard protocols should be used as often as possible since they are accepted by the industry, well documented, and often supported by off-the-shelf software stacks. Application-specific protocols, when required, should be defined in project Interface Control Documents, including all of the information each subcontractor needs to develop the associated hardware and software.

Data definition (managed data and metadata)
Data definition is managed as a "dictionary" that contains the reference for all data points for the train, where they come from, and what they mean. It is usually expressed as a large table or as a database with sections for each subsystem. The data dictionary must also define the metadata, or framework for data interpretation, for each data source. Common metadata elements include description, type (Boolean, numeric, string), severity, unit of measure, and source subsystem/component. The metadata can also be used to define parameters for data collection such as sample frequency, logging rate, and snapshot definition. It can also include instructions for operations and maintenance personnel and details on how the data is triggered or reset.

The data items and associated metadata for each subsystem are usually defined by the system subcontractor. As a consequence, fleet operators must work with the train data integrator to ensure that a common set of definitions is clearly understood by all subcontractors prior to development. It is not sufficient to simply state that the severity of a fault should be "high," "medium," or "low"—these definitions also require an associated impact. For example, severity levels could be defined as: high = faults that require the train to be taken from revenue service as soon as possible, medium = faults that allow the train to remain in revenue service but must be addressed in that evening's maintenance cycle, and low = faults that will require repair or investigation at a convenient opportunity.

Sometimes, top-level requirements are identified in the Request For Proposal (RFP)—such as the need for an Ethernet-based system—but all too often, there are few details defined until after the contract is awarded. The car builder must then work with the train data integrator to define these requirements as soon as possible to reduce risks and avoid delays, cost overruns, and false assumptions.

Determine early on what must be defined. Then describe all the details and workflows in controlled documents and make sure those documents are available to, and understood by, all the system subcontractors.

3 Stay flexible

It is one thing to publish a consistent set of interface documents; it is something entirely different to execute it. New interfaces and data management schemes bring challenges for everyone involved. For subsystem suppliers, the challenge is to be compliant with the new requirements while remaining within the project budget and schedule. For the car builder and train data integrator, the challenge is to seamlessly coordinate multiple subsystems and their development teams.

Managing the integration of multiple systems often means making compromises. One such example is a door supplier whose microcontroller was not able to update data at the required rate. The data integrator remained flexible, working with the supplier to determine what data needed to be transmitted at a faster rate and what could be sent out less frequently. This approach allowed the door supplier to use its current microcontroller without sacrificing overall system needs.

A flexible approach is made significantly easier when the data management system is designed for configurability and customization. For instance, once defined, the data dictionary should be implemented as a file or database that can then be updated even after system development is completed. Fault severities, sample rates, and descriptions can all be improved during the pilot-car phase and beyond with this approach. This is accomplished by using tools supplied for the wayside systems, and then distributing the updates to the fleet via portable test equipment or wireless network.

Be adaptable and encourage flexibility in other stakeholders to ensure the success of the project.

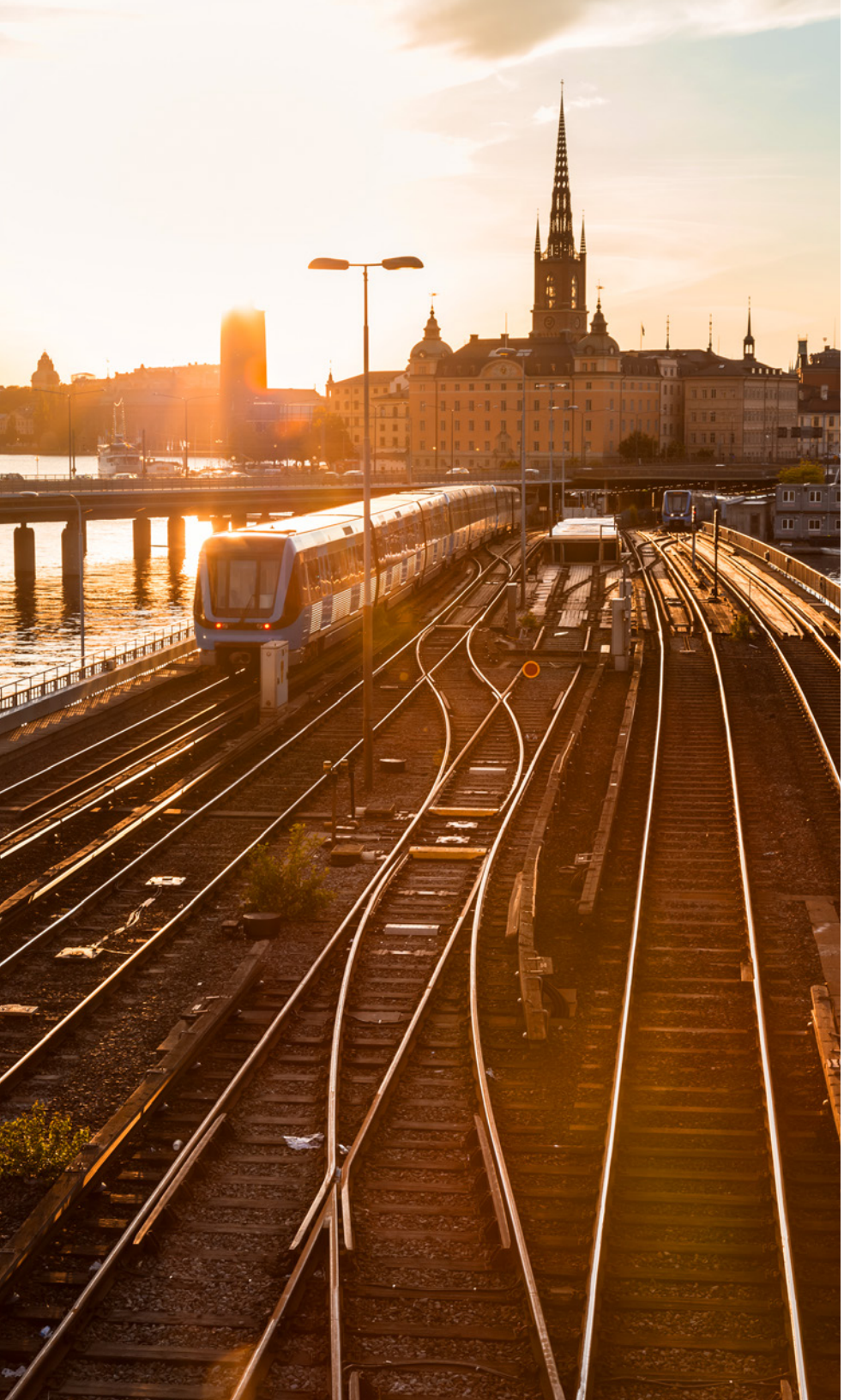
4 Be vigilant

Data integration is not a "fire-and-forget" exercise. Simply publishing a set of Interface Control Documents does not ensure that each subsystem will be delivered with a compatible set of interfaces. The car builder and train data integrator must take the appropriate steps to confirm that all subsystems are converging into a common set of interfaces that work seamlessly together and meet overall system needs.

Achieve a smooth collaboration by following two simple rules:

1. **Talk to each other:** Every successful project is backed by good communication and great coordination—and the train industry is no exception. The car builder and train data integrator should hold regular meetings with representatives from each supplier to manage any issues that can derail the project. Through these interactions, the integrator can learn and address each participant's requirements. These meetings also help pinpoint any team unfamiliar with a particular protocol and provide them with timely reference documents and relevant training.

2. **Test early:** Do not wait until all the equipment is installed on the train to verify the interfaces, as interoperability problems and any associated changes become very costly once the project enters the pilot-car or vehicle-integration phase. A more practical approach is to hold multiple off-train interoperability tests. When the equipment interoperability is verified in the lab, on-train integration becomes much easier. Interoperability tests can be facilitated at first with equipment simulators, and then by directly testing the equipment to be installed on the train.



5 Focus on stakeholder needs

In any rail project, there are three main stakeholders aiming for the success of the train data system. These are the fleet operator, the car builder, and the subsystem suppliers. A data management approach should focus on the needs of each:

» **Fleet operators** need to be able to make swift decisions, adhere to industry standards, ensure compatibility with existing and future fleets, and use simple interfaces and easy-to-use tools to help manage the system during revenue service.

» **Car builder** requirements include well-defined ICDs, ease of system integration, and strong support before, during, and after pilot-car integration.

» **Subsystem suppliers** want clear, consistent information provided early in the project and require a flexible approach to overcome any limitations.

Ensure that these needs are addressed properly and tackled with an open, cooperative, and team-oriented approach.

Conclusion

Creating an effective system for managing train data is an ongoing process that begins at the earliest stages of project definition and carries on through the life of the fleet. Care must be taken by all parties to put the proper systems in place and follow them through to completion. Following the principles behind these five insights will ensure that train data is not just noise, but valuable information supporting the efficient, cost-effective operation of any fleet.

About the Author

Rick Pearson is senior solutions engineer at Quester Tangent. He has more than 20 years' experience in the development of software-controlled electronic systems in the marine, telecommunications, and rail transit industries. Rick has been at Quester Tangent since 1999 and has been the lead on various projects, including system and software development for Quester Tangent's monitoring and control systems, braking control products, and wayside monitoring and diagnostic systems. He holds a Bachelor of Science in physics from the University of Victoria.

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About Quester Tangent

Founded in 1983, Quester Tangent is a leading North American manufacturer, supplier, and integrator of train electronics and software solutions for the passenger rail and locomotive industries. Quester Tangent features a complete portfolio of technology products for the rail transportation industry: **TrainWise®**, flexible on-board train and locomotive electronics, **FleetWise®**, innovative wayside software and **TestWise®**, comprehensive test equipment products.

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