

COMMUNICATION

The Regional Transportation District (RTD) of Denver maintains and operates a fleet of Light Rail Vehicles (LRV) for public transportation in the Denver metro area. The existing LRV train cars operated as intended but did not provide ample feedback to the operators during operation, or to mechanics about causes of failure. RTD approached National Instruments (NI) and Optimization about incorporating a data logging, communication, and display system into the trains.

System Design

An RTD Supervisor provided a description of the project requirements, including incorporation of GPS satellite data, TTL/RS232 communications with existing control equipment, and a GUI (Graphical User Interface) for the Light Rail Vehicle Operator. The GUI screens were defined such that an operator could quickly determine the source of problems, and correct them if possible. If problems were beyond the abilities of the operator, maintenance could be summoned with out delay.

Because Optimization has a strong background in National Instruments LabVIEW software (NI Gold Alliance Partner, NI LabVIEW Certified Architects and Developers), system developers were able to easily create a data logging system for individual cars. The individual systems involve reading and recording digital and analog signals that are unique to each end of the car. This data is then transferred via Ethernet Modbus communication between the two cRIOs in the car and logged locally to one of the touch screen computers in the car.

Besides the acquisition of data, the individual systems are able to receive a GPS signal to accurately set and synchronize system clocks throughout the train. This allows data acquired on two different pieces of hardware at opposite ends of the car to be related to each other through this GPS timestamp. The system also writes this GPS time to the train car's internal computer system through serial ASCII communication. This is very helpful to the RTD personnel when trying to correlate a generic error signal in the train's existing computer with a more detailed signal-by-signal record of events logged in the NI hardware.



A Challenge

The most impressive and challenging portion of the system was communicating data through the entire length of the train. Car-to-car communication is accomplished through Serial Modbus via the couplers that join two individual cars together. In order for a piece of data to make it from the very back car of a train up to the front cab where the operator display resides, it had to alternate between Ethernet communication internal to the cars and serial communication between the ends of two adjoining cars. An additional communication challenge was that RTD's LRVs are able to be driven or coupled from either end in either direction. This means that the software had to be flexible in order to propagate data in the correct direction (Modbus Slave vs. Modbus Master).

Reducing Troubleshooting Time

When the complete set of data is delivered to the lead cab of the train, it is displayed on an NI Touch Panel Computer. In the event of equipment failure this GUI allows the driver to quickly determine what possible cause would be keeping the train from successfully moving. Before the Optimization solution was incorporated into the train, the driver was only provided with a single warning light that illuminated when the train was not capable of moving, and the driver would have to search the whole train for the cause. The new system drastically reduces troubleshooting time by telling the driver specifically which car and signal is malfunctioning.

Benefits/Results

The Optimization system has greatly benefitted RTD's mechanical operations, by providing more information related to mechanical failures through utilization of the data logs. RTD has also noted a gain in efficiency and decrease in downtime by providing train-wide signals to the driver.