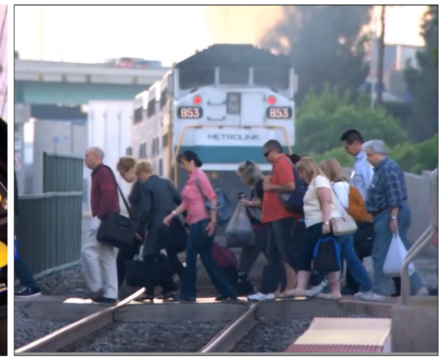
Metrolink Employs IoE Capabilities to Improve Safety, Increase Fuel Efficiency, and Plan More Effectively



EXECUTIVE SUMMARY

Objectives

- Successfully implement Positive Train Control (PTC) technology to avoid rail accidents

Strategy

- Adopted aggressive technological upgrade to implement PTC
- Contracted with multiple parties to run rail line; other contractors provide maintenance and IT support

Solutions

- PTC utilizes train location data provided over multiple redundant networks to inform automatic braking systems, which activate if a collision is imminent

Impact

- Improved rail travel safety
- Increased fuel efficiency
- Reduced headways (space between departing trains)
- Ability to plan more effectively

Background

In January 2014, Cisco released the results of an in-depth analysis of the economic benefits of the Internet of Everything (IoE) for the public sector. Cisco's model revealed that some $4.6 trillion in "Value at Stake" would result from the adoption of IoE capabilities across 40 key public sector use cases over the next 10 years, including smart water, smart buildings, smart energy, smart parking, and more (http://bit.ly/1aSGlzn).

As a next phase of its analysis, Cisco engaged Cicero Group, a leading data-driven strategy consulting and research firm, to undertake a global study of IoE capabilities across these 40 use cases – how the best public sector organizations are "connecting the unconnected," as Cisco terms it. To that end, Cicero Group conducted interviews with dozens of leading public sector jurisdictions – federal, state, and local governments; healthcare organizations; educational institutions; and non-governmental organizations (NGOs) – to explore how these global leaders are leveraging IoE today.

The research examined real-world projects that are operational today, are being delivered at scale (or through pilots with obvious potential to scale), and that represent the cutting edge of public sector IoE readiness and maturity. The aim of the research was to understand what has changed in terms of the jurisdictions' people, processes, data, and things, and how other public sector organizations can learn from (and replicate) the trail blazed by these global IoE leaders. In many cases, these jurisdictions are Cisco customers; in others, they are not. The focus of these jurisdictional profiles, therefore, is not to tout Cisco's role in these organizations' success, but rather to document IoE excellence, how public sector entities are putting IoE into practice today, and to inform a roadmap for change that will enable the public sector to address pressing challenges on multiple fronts by drawing on best practices from around the globe.

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About Metrolink

Metrolink is one of the first train operators in the world to implement the Positive Train Control (PTC) collision-prevention technology. PTC utilizes train location data provided over multiple redundant networks to inform automatic braking systems, which activate if a collision is imminent.

Metrolink was created in 1992 by the Southern California Regional Rail Authority (SCRRA), a publicly owned joint powers authority. It is governed by an 11-member board representing the transportation commissions of Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties. Metrolink provides transportation throughout six counties in Southern California, transporting passengers via a network that includes seven service lines and 55 stations spread across a 512-route-mile network. Metrolink handles approximately 44,000 daily boardings.

Jay Peterson is manager of Metrolink's Positive Train Control Network Architecture. He worked for 10 years as Metrolink's manager of information technology, and prior to that as the director of information technology for the Riverside Transit Agency. Mr. Peterson has a background in computer science.

Objectives

In 2008, Metrolink experienced a devastating rail accident with multiple fatalities, the worst in its history. The accident prompted the U.S. government to enact the Rail Safety Improvement Act (RSIA), which requires all U.S. railways to implement Positive Train Control technology to avoid such incidents.

Strategy

Metrolink has adopted an aggressive technological upgrade to implement PTC, which is to be completed and operational in late 2014. The budget for the PTC initiative is roughly $210 million. This includes approximately $120 million allocated to the main subcontractor for the PTC system. The subcontractor is responsible for coordinating the installation of the program infrastructure and software systems. Mr. Peterson indicated that Metrolink is installing fiber-optic cabling, the network infrastructure, and the microwave equipment at a cost of several million dollars. Most of the remainder of the budget is being applied toward support to deliver the work. Funding was publicly raised and is primarily from local sources, but the project also received some federal grants.

Operationally, the actual Metrolink staff is small; the company contracts with multiple parties to run its rail line, and other contractors provide maintenance and IT support.

Metrolink holds regular press conferences, including a large rollout for PTC with a demonstration of the technology. It issues regular newsletters and updates on the progress, and press is generally positive.

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Manager,
Metrolink Positive Train Control Network Architecture

Solution

Mr. Peterson described the technology involved in the PTC system as "path diverse and technology diverse." The various technologies involved include a central control center or "back office"; onboard triplex computers; and a proprietary radio system for communication among the back office and each train, control points, and signals installed along on the wayside. A number of redundancies are built into the systems to provide backup in critical situations.

"What we're really trying to do is move the intelligence of the railroad to the onboard locomotive, and give it the ability to understand where it's at and what's in front of it," Mr. Peterson explained. "We're using a lot of telemetry within the train itself. It's got GPS. It's got basically a speedometer or odometer running so it can keep track of itself. Because we have some very good accurate surveys of the rail itself – where it is, its elevations, its speeds – we keep that in what we call a track database."

In this way, each train not only keeps track of itself, but the master system monitors each train as well and provides data to a control center. Dispatchers can see where each train and other trains are on the network. Dispatch and supervisory personnel in the control center can also monitor where the trains are. In addition, with PTC, the trains themselves are keeping track of the traffic on the network. In this way, there are three layers of monitoring, all aimed at ensuring trains do not collide.

According to Mr. Peterson, PTC does not actively control the train under normal conditions; in virtually all settings, engineers still manually control the trains. PTC works only as a backup system that will apply emergency brakes if it senses an imminent collision.

Mr. Peterson explained the redundancies throughout the system, saying, "This is a safety-critical system that we're putting in. When you look at failure-type scenarios and the critical nature of the safety itself, we want to ensure that the communication links are redundant, and there are multiple ways to communicate."

Back Office Computer Aided Dispatch System

The back office employs a Computer Aided Dispatch (CAD) system and several dispatchers to communicate with each train engineer and conductor. The CAD system includes detailed mapping information of the system's rail lines, with communication links to the wayside control points, signal systems, and crossing monitoring systems. "They have a picture of the field," explained Mr. Peterson. "They talk to the engineer in the field. Commuter trains have a schedule to keep. We know what it is and use it to aid in moving additional freight trains through the network. To move the freight trains, we need additional data from them, such as how many loads they've got, how many cars they've got, how many tons they've got."

Mr. Peterson added, "The dispatcher can look at occupancy. He can watch his CAD displays and look at the track, and he will get an indication from the field that says this train is located within this track segment. The dispatcher can then set the route within the CAD system to wherever the train is destined. That will then talk to the field, will clear up signals, move switches back and forth, whatever the dispatcher requests to be able to move that train along."

From the CAD system, the information is translated to the BOS, or "back office server" system. Information from the BOS is sent to trains via a 220 network infrastructure or Wi-Fi, depending on the train's location or the station from which it is departing. "That BOS is produced by the same company that produced the onboard train management computer (see below)," Mr. Peterson explained. "Now it interprets all of that using the track database, and builds what they call track clearances, so that they can actually move the train. The onboard system then receives those authorizations to move and knows where the train is going. He now has authorization to run."

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Onboard Train Management Computer

Mr. Peterson explained that each train carries a train management computer (TMC), which, Mr. Peterson explained, is actually "a triplex set of computers that basically 'votes' on critical functions. It is a failsafe device – a vital component within the system. That vital component is what has the ability to stop the train if it thinks there is something unsafe. It is wired into the braking system."

The TMC interacts with the BOS through the computer display unit (CDU). Mr. Peterson explained the function of this portion of the TMC: "The CDU basically helps us control which file sets are brought down and which file sets are actually running on board, and brings those file sets in and out from the back office. They're all communicating together. It's all basically its own little area network."

Mr. Peterson explained the method of operation between engineer and the triplex computer: "The engineer on board has to interact with the TMC. As he's looking down the right-of-way, it tells him what's coming up in front of him from a signal perspective – whether he needs to be able to stop the train, or if he's going over speed, or if he's approaching a worker zone where you have reduced speed. If the engineer doesn't react properly by slowing down the train, the TMC has the ability to stop the train."

BOS/TMC Communication

One communicating link between the BOS and TMC systems is the proprietary PTC radio system developed by Meteorcomm (MCC), a coalition company created by the Class I railroads. The system utilizes the 220 MHz radio frequencies for onboard, wayside, and base station communication. It uses both CDMA and TDMA technologies in transmitting and receiving data with each train.

Trains also carry cellular modems, and many have two cellular modems as a safety redundancy. In the case of two modems, each modem is path diverse, with each using a different telecom operator for service. Communication from the trains is on a private cellular network and delivered to the back office via dedicated MPLS links.

Trains are equipped with 802.11n Wi-Fi, which Mr. Peterson explained is particularly useful in areas of heavy traffic. "When we come into a heavy location such a one of our maintenance yards, or one of our dispatch points such as L.A. Union Station, "One of the big things about Positive Train Control has to be this interoperability piece: we have to be able to operate on other people's railroads, and they need to be able to operate on ours."

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we have Wi-Fi access to slow the train down so we can do diagnostics. We can get logs, or they can actually do what we call an initialization through it. So if it needs to pull down files or update itself or something like that, it has the higher bandwidth to be able to do that."

Communication with Other Railways

The Meteorcomm Interoperable Train Control Messaging (ITCM) system will be the primary message transport tool in the industry. Mr. Peterson said, "It's actually a layer 4, 5, and 6 messaging system that interconnects not only the trains with our back office, but it also interconnects our back offices with other railroads. We run the L.A. Basin for the most part. We control a lot of track here, but we have a number of partners that run across our railroad, and we run across theirs. One of the big things about Positive Train Control has to be this interoperability piece: we have to be able to operate on other people's railroads, and they have to be able to operate on ours."

Mr. Peterson described the importance of this compatibility portion of the technology, saying, "For instance, when we come out of our L.A. Union Station, we come out on our own track for about two or three miles. Then we may jump right onto the Union Pacific Railroad (UPRR) tracks or the Burlington Northern Santa Fe (BNSF) track. At that point, our train has to talk to our partner's back office as well as our back office. Now we are running on their track and being dispatched by that other railroad."

Mr. Peterson described the scale of the industry-wide initiative, saying it includes a large number of rail service and IT service and infrastructure providers. While he believes Metrolink has progressed further than others in the industry, Mr. Peterson stated that Metrolink's implementation of PTC is still "heavily ... in the testing phase." Metrolink is currently conducting compatibility tests with BNSF, and preparing to test with Union Pacific and Amtrak.

Figure 1. Metrolink: New and Better Connections.

Source: Cisco Consulting Services, 2014

Impact

Improved rail travel safety is the primary focus of PTC systems, although there are other benefits as well. The technology is expected to increase fuel efficiency as system data gives train operators the ability to better manage and stabilize speeds. “[The TMC] will have the information of how long it’s going to take to get to its next point. [The engineer] won’t have to necessarily go full throttle up to one point and then stop for an hour. It would be better to have him run at maybe 25 miles an hour for a distance, and get there and be able to proceed,” Mr. Peterson explained.

Reduced headways, defined as the space between departing trains, is another expected improvement. “Our headways right now are anywhere down to 20 minutes, which is pretty tight for a heavy rail system,” Mr. Peterson said. “We think by the data that we will be able to gather – both from a maintenance perspective, as well as how well we can run through each segment of track – that we are going to have much more granular information on the movement of the trains themselves, and that we will be able to do better planning.”

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Lessons Learned / Next Steps

Mr. Peterson said that misunderstandings often arise among the public from the newness of PTC technology, and from a lack of comprehension regarding its limits. “One of the key challenges is how do you communicate and help people understand what we’re trying to accomplish? Sometimes there is an assumption that this is going to cure all rail accidents.

“This is not going to cure all rail accidents,” Mr. Peterson continued. “We still can’t prevent a car from going around a grade crossing and getting hit by a train, or a person walking out in front of the train, or walking down the right-of-way with headphones on. It’s not going to solve those kinds of accidents. But what it *is* going to help us understand is how the trains move and how we can better control that. And it will jump in if it does think there’s something unsafe, and it will stop the train. Is it the ‘end-all’ type of thing? No, but it is definitely a very good step in the right direction. The challenge is to make people understand where the industry is going.”

According to Mr. Peterson, one of the most formidable challenges with PTC arises from the vagueness of the law that requires it, and from the extra layer of reporting on top of the technology. “[RSIA] is very broad, and it’s very limiting all at the same time,” he said. “If you read the law itself, they don’t tell you necessarily how to do some things, but they tell you what the result has to be. There are a number of documents that we have to produce. All railroads are going to have to produce a safety plan. There are a number of other papers that we also have to publish, but that’s going to be one of the biggest ones.”

Being the first in the industry to implement the technology presents other difficulties. “Putting together a technology product that is so diverse and widespread across our entire system is a big challenge, along with getting people up to speed on how to use it and how to maintain it,” Mr. Peterson said. He gave examples of everyday

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difficulties such as "making sure the train has the right software onboard," and "making sure the radios are programmed to talk on the right channel at the right time."

Cost is another issue, affecting not just Metrolink but all railways. According to Mr. Peterson, "This is a technology that is going to be throughout the U.S. It's already being deployed in other countries as well. People really need to understand it's not just the money up front. It's also going to be the ongoing maintenance and support of it in the future. A lot of that is also going to go back to really understanding and documenting your actual railroad – understanding how you do business, and then how this is going to change how you do business. That is really going to be one of the key things that the industry has to understand."

Mr. Peterson emphasized the importance of system redundancy, indicating that a "technology-diverse" system creates a more stable environment. In addition to redundant technology on board each train and within the back office, Mr. Peterson described the construction of a new primary data and dispatch center, which will be used in addition to the current center. "We are now building a Train Control and Operations Center," he said. "It's located about a mile away, but still right on our own right-of-way." Plans are for the current center to become a secondary center, called the Metrolink Operation Center (MOC).

Two operational centers mean that all data will lie in two separate systems. Metrolink is now in the midst of what Mr. Peterson describes as "a very robust overhaul of our backhaul network" of data to duplicate the systems communicating with each train. Mr. Peterson explained the complexity of such a project: "To build this backhaul to every node on the network, every control point out there – every wayside signal location, every base station – has to be connected into the network two different ways, using two different technologies. At some locations we are using Ethernet radio and cellular. Other locations we have hooked up directly on fiber; we have fiber running along a number of miles of our own right-of-way. We also have built a microwave network to get some of our outlying areas back into the network backhaul."

Mr. Peterson said that the benefits of granular information regarding train scheduling and performance is not only valuable for operational purposes, but is useful for commuters as well. He is studying ways to link real-time train data into Metrolink's customer information system. "We are looking at really tying our customer information system into some of the benefits of PTC," Mr. Peterson said. "Because we know where the trains are. The trains all have GPS on them now. We get those position reports back to our back office. Our plan right now is we are going to utilize that data to drive our customer information systems." As part of this process, Mr. Peterson intends to link the information to platform signage, and drive the displays directly from the CAD system, including arrival and departure times, tracks, and other updates.

"Our ability to manage our field is going to intensify because of this effort," Mr. Peterson concluded. "Our ability to do remote diagnostics for most of our equipment is completely changing, given our new access into all the different equipment that's in the field, including the onboard system [and] being able to mine that data to really tend locomotive health and on-time performance. It's going to revolutionize the industry."

More Information

For more information, visit http://www.metrolinktrains.com

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