Wireless data communication for the New York City Transit system

Energy costs have been drastically reduced

In the New York City Transit system, heating elements are used to keep snow and ice off the electrified third rail, ensuring that the subway continues to run reliably during the winter. A wireless SCADA solution based on Trusted Wireless technology helps reduce the energy costs involved.

New York City Transit (NYC Transit) is a train network that contains 1,320 kilometres of track. It is the largest public transport company in North America and one of the largest public transport companies in the world. Around 5.6 million people ride the subway each day. In September 2014, NYC Transit even recorded five days with more than six million riders each. That year, around 1.751 billion people in total rode the subway. NYC Transit’s fleet of nearly 6,400 subway cars covered around 581 million kilometres in 2014 – they operated around the clock, seven days a week (although some routes are shortened at times). The train network contains 469 subway stations, 109 of which feature elevators and ramps for disabled access. NYC Transit serves the boroughs of Brooklyn, Bronx, Manhattan, and
Queens 7,883 times per weekday. Carmen Bianco, President of MTA New York City Transit, expects ridership numbers to continue to rise. Improved transit services, combined with a growing population and an improved economy, have resulted in the strongest subway ridership growth occurring among discretionary riders and during off-peak times. This presents new challenges for maintaining and improving the subway system. Moreover, NYC Transit would also like to introduce additional features that benefit riders.

**Heating elements keep snow and ice off the electrified third rail**

Railway lines such as those operated by NYC Transit usually feature a third rail that lies outside the railway track. This third rail distributes necessary electricity to the motors of electric rail vehicles as well as other mobile electricity consumers, such as crane systems. Since the third rail only serves to supply power, and not to support the weight of vehicles, it is easier to insulate. It is often an aluminium alloy, which makes it easy to install. It can therefore use higher voltages – up to 1500 V, as opposed to the other rails, which can only use up to 200 V. The electrified rail supplies the vehicles with electricity via current collector shoes that supply power to traction power motors that drive the wheels (trucks) of the railroad car. The electric current flows back over the wheels and rails. The third rail of the New York City Transit system distributes 625 V DC nominal, and up to a peak of 925 V DC, as well as up to 4,000 A. The transport system is capturing rectified AC power at the power substations. Circuit breaker houses and high-voltage cables supply the third rail with a direct current along its entire length. This system taps off the 625 V DC cables (figure 1).
During the winter, snow and ice may build up on the top of the electrified third rail, disrupting train service. To prevent this problem from occurring, NYC Transit places special heating elements at strategic points outside of the subway tunnels. Traditionally, these heaters were manually turned on in October and were not turned off until the following May. In other words, they would run continuously, even when there was no snow or ice on the ground. The manual system also presented a safety hazard. When employees go out to the tracks to turn the heaters on or off, or perform other routine maintenance, they put themselves at risk. NYC Transit sought a cost-efficient, reliable solution for remotely controlling and monitoring the heating elements to reduce the drastic current consumption and costs that this practice entailed (figure 2).

**Inline controllers monitor the field devices**

To this end, Phoenix Contact’s American subsidiary and Kapsch TrafficCom USA Inc. worked together to develop a SCADA system based on wireless communication. Kapsch TrafficCom belongs to Kapsch OP, a telecommunications and transport telematics group based in Vienna, Austria. The Kapsch TrafficCom business unit specialises in technologies, solutions, and services for intelligent transport systems (ITS). These include electronic toll systems, traffic management solutions that prioritise traffic safety and monitoring, electronic access control systems, fully automated video detection, and parking space management solutions. Kapsch TrafficCom operates subsidiaries and agencies in 33 countries. The company’s 3,500+ employees generated a turnover of €456 million in fiscal year 2014/2015.

The SCADA system, which is based on Kapsch’s DYNAC software, allows NYC Transit to manage the train infrastructure lying adjacent to the rails. NYC Transit employees can now remotely perform system diagnostics using a central user interface. This ensures that the heating elements always function perfectly. Phoenix Contact Inline controllers were installed at select sites to monitor the field devices. These compact programmable logic controllers (PLCs) communicate using the Modbus TCP protocol and feature various state-of-the-art
functions. It is easy to add I/O and function modules to the controllers, as necessitated by the respective application requirements. Some of the controllers feature a slot for SD cards, making it easy to upload and save program changes (figure 3).

**Trusted Wireless technology is highly robust and reliable**

The NYC Transit application includes different types of interface panels. They serve as the primary link between the DYNAC-SCADA master and a network of 670 control point nodes installed to date throughout the entire subway system, with more installations planned in the near future. Each of the control point nodes collects, monitors, and saves data relevant to the SCADA system, and sends this data to the control centre over a 900-MHz wireless network based on Phoenix Contact’s Trusted Wireless technology. These control point nodes feature NEMA 4x housing that contains relays, power supply units, and transducers by Phoenix Contact, in addition to the inline controllers, connected I/O modules, and Trusted Wireless Ethernet (RAD-ISM-900) wireless module. Power surge protection devices ensure high reliability by protecting the electronic interfaces from surge voltages, which can occur frequently in this environment (figure 4).

Kapsch employees set up the wireless network together with Phoenix Contact’s wireless experts. Installing a wired network would have been cost-prohibitive, while also disrupting passenger services for the millions of daily users. They used Trusted Wireless Ethernet (TWE) radios because this technology is suited for SCADA applications, as it addresses the special needs of extensive infrastructure applications. Various setting options are available for different application requirements. RF path studies and site analysis address the different node requirements. The network is designed to be a self-healing mesh network, and at times, point-to-point. Trusted Wireless technology, which works on the license-free 900-MHz frequency band in the U.S., is also characterised by a high degree of robustness and reliability as well
as the ability to span distances of up to several kilometres. This was especially important in an RF-rich metropolitan area such as New York City, where interference from other radio systems could potentially cause problems. Over the past seven years, this system has gone through two hurricanes, sub-zero temperature degree days, and several ice and snow storms, which have dumped up to 30 inches of snow. The system has worked reliably all through those conditions. The transmission speeds of the wireless interface can be individually modified – thereby increasing reception sensitivity. A low data rate allows a significantly longer distance to be spanned than high transmission speeds do. Trusted Wireless also boasts good diagnostic functions and the ability to coexist with other systems transmitting on the same frequency band (figure 5).

**Annual savings total over $1 million**

Over 670 control points have been automated to date. The new SCADA solution enables employees at the NYC Transit control centre to remotely control and monitor over 1,700 heating elements for the third rail, both automatically and manually. The system extends the life of the heating elements, while also reducing energy consumption, allowing NYC Transit to save nearly $12,000 per day (soon to be $15,000), which adds up to annual savings of over $1 million. Even more importantly, the system improves safety by reducing the time that crew members spend on the tracks. In the future, employees will be able to remotely control and monitor all of the heating elements in the subway system using the wireless SCADA system (figure 6).

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