NYCT gets resignaled

by Tom Sullivan

Initial price tag for New York City Transit's first segment alone could reach $3 Billion

In 1998, the longest subway system in the world signed agreements with three signal suppliers to develop the next generation of wireless train control technology.

The initial phases of NYCT's 20-year program are geared to verifying and proving basic system concepts and designs. With 722 miles of track and nearly 6,000 subway cars, it is the most massive re-signaling program ever undertaken.

The new signal technology is known as Communications Based Train Control (CBTC). Not only are many industry professionals closely watching NYCT's unique program, but NYCT is actively encouraging participation by peers around the world to help further its program and develop standards for this new CBTC technology.

Many rail transit properties may benefit by following in NYCT's enormous wake, but signal firms which want the entire NY apple are going to be disappointed. The key focus of the initial program is geared to ensuring NYCT has multiple sources of supply for this new technology. The heart of the system is a wireless digital radio network.

Railway Signaling 101

Until recently, virtually all signal and train control systems used track circuits for train detection. Track circuits detect trains by injecting a tiny electric current into one end of a rail section. As long as there is no train in the track circuit the current travels

Kasten Chase's Alex Oprea (left) and Charles Elliott show off the wayside communication unit, WRF 3000, which is being used for NYCT's multi-billion dollar signal program.

down the rails where it energizes a relay at the other end.

In its most basic form, the energized track relay causes a green light to be displayed to the train operator. But when a train enters the track circuit, the steel wheels and axles short out this signal current and cause the track relay to drop. The de-energized relay makes the green light go dark and illuminates a red light for the operator in the following train.

Track circuits served the rail industry well for more than 100 years. And as heavy steam trains gave way to light rail systems and DC and AC propulsion, it became increasingly difficult to make track circuit-based systems work reliably. And there were other problems.

All track circuit-based systems are designed to be failsafe. As a consequence of traditional signal design, nearly all are "fail stop." This means that when they fail safely these systems present a more restrictive aspect (usually red) to the operator or on-board train control system.

For small systems with few track circuits, or systems with long headways, "fail stop" may be an infrequent annoyance. But in the case of NYCT and other transit systems "fail stop" can mean frequent operational disasters that are expensive to mitigate.

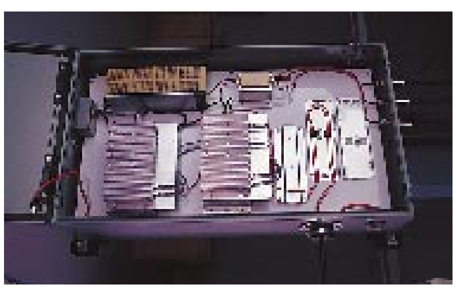
For example, every 10 hours (on average) NYCT's operating department reports to its signal maintenance group that it believes there is a signal system failure. To fix the problem and get trains rolling within 10 minutes, NYCT maintains a staff of nearly 1,000 in its signal maintenance department. Many, poised like firefighters, are ready to spring into action 24 hours per day.

A 10-minute delay on a roadway may seem like smooth sailing in today's big cities, but for subway commuters, especially New Yorkers, it can feel like eternity. Worse, a ten-minute signal system delay on a high capacity rail line can throw the line's schedule off for the rest of the day. Clearly, there had to be a better way. And there was.

CBTC: A better way to control trains

CBTC technology, originally known as "Moving Block," received its debut at the Deutches Bundesbahn in 1972. More recent examples of transit properties with CBTC include Vancouver SkyTrain, London Docklands and SF Muni.

Key advantages of CBTC technology over traditional fixed block are increased system capacity and very high availability. When compared with older systems (such as those in NYCT, many of which are over 50 years old) CBTC reduces the possibility of human error by automating many manual operations.



Kasten Chase's RF Routers are housed in a NEMA enclosure along the wayside. Also in the enclosure are a power supply, a combiner/splitter and two fusion splicing trays for optical fibers.

CBTC offers improved capacity because it is able to locate trains with greater precision. By knowing more precisely where trains are located, CBTC allows trains to operate closer together.

To accomplish the same objective with track circuit based systems, it is necessary to add track circuits. But track circuits are expensive and unreliable as NYCT's experience reveals.

CBTC systems use inexpensive microcomputers. This makes it practical for two or more to be configured in parallel so that when one fails the system is able to seamlessly switch over to a working unit. This "fail-operational" aspect of CBTC is attractive because it reduces the frequency of service disrupting failures and allows more flexibility in managing maintenance crews.

A look under the CBTC hood

CBTC technology is fundamentally different from traditional track circuit based systems. Instead of low data rate, one-way communication from track to trains, CBTC uses high-speed bi-directional communication between the train and the control system.

The most common implementation of CBTC communications today uses a simple inexpensive wire loop that runs down the middle of the rail and loops back in the web of the rail. While simple and effective, transit properties now appear to be gravitating to radio-based designs which eliminate the wire loop.

Unfortunately, radio-based CBTC systems are still largely under development. The key problem is ensuring reliable and continuous radio communication in steel subway tubes and underground structures.

The transit industry has been slow to embrace CBTC technology but the decision by NYCT to install this technology and to develop standard interoperable systems is welcomed by many in the transit industry.

By virtue of its size, any change at

NYCT affects many in the signal industry. So how did this transit giant change its course and still keep everyone reasonably satisfied?

Don't be held hostage by your own plan

Dr. Nabil Ghaly leads NYCT's massive capital signal modernization program. While most signal procurements at NYCT today are still based on traditional track circuit designs, Ghaly's attention, and the attention of many at NYCT, is radio-based CBTC and the improvements this technology will bring.

Dr. Alan Rumsey of the Parsons Transportation Group leads the consulting team managing NYCT's CBTC program. Staring at Rumsey in his office in lower Manhattan is a plaque with the motto from the story of Apollo 13: "Failure is Not a Option." From all indications, the multi-billion-dollar program is a significant success story. One measure of the success is that it is ahead of schedule.

Credit appears largely due to Rumsey's effective management style. "We fostered a partnership philosophy with the signal industry," Rumsey explains, "and this partnership resulted in a high degree of cooperation with NYCT and the signal supply industry." In an era when protests by signal firms are common, the calm following the shortlisting of the original six firms down to three was a very pleasant surprise.

The three shortlisted signal firms — Alcatel Transport, Alstom and MATRA/US&S — are now beginning to install prototype CBTC equipment on NYCT's Culver Line. Testing will begin in January 1999. Six months later, a leader will be selected.

The leader will be awarded a contract to install its system on NYCT's aging Canarsie Line. The other two "pre-qualified" firms will follow by building compatible systems using the leader's interface specifications. Key system interfaces are between vehicle and wayside CBTC equipment and between wayside CBTC equipment and the control center. All three shortlisted firms selected the same radio and network supplier, Kasten Chase Applied Research (KC), a specialty data communications supplier located just outside of Toronto.

Network interface units, either wayside or carborne, translate the train control messages between native and IP format.

The radio network: A key to CBTC interoperability

Starting as early as 1993, NYCT was advising the signal industry that interoperable systems and multiple CBTC suppliers were essential ingredients to NYCT's future procurement strategy. Billions of dollars of procurements, each in the neighborhood of $100 million, are planned over many years. NYCT simply could not permit itself to be held hostage to a single proprietary design.

Thus, while the best technical approach and the lowest price were important, NYCT desired at least three compatible CBTC suppliers to foster true competition. From NYCT's perspective it simply was not that important that a proprietary 6-33 screw might be superior to a 6-32.

NYCT also understood that achieving interoperability among radios from multiple suppliers would be difficult — a feat analogous to reworking a VHS tape player to accommodate a BETA formatted tape.

Prior to NYCT's shortlisting of Alcatel, Alstom and Matra/US&S, there were a number of possible radio/network scenarios. In two cases signal firms either acquired or internally developed the necessary technology to build their own radios. In a third case, a supplier partnered with an established radio supplier. Three other firms independently selected KC.

Several signal firms that initially approached KC wanted an exclusive deal, but KC said no. Herman Chang, vice president of Kasten Chase states, "We did not believe that this would be consistent with NYCT's philosophy of using non-proprietary solutions."

These firms may not have been initially pleased with KC's response but NYCT's shortlisting of the firms who did propose to use KC as its radio supplier had a key benefit: The issue of interoperability of the radio network systems appears largely to have vanished. The viability of the KC radio and network, and ability to meet NYCT's operational, performance and functional requirements will be determined in Phase I of NYCT's CBTC program.

It appears unlikely that the three shortlisted firms would want to compromise the security of their shortlisted position. Issues that may cause friction in the current arrangements likely will be worked out among the partnering participants. With the perspective that one-third a loaf is better than no loaf at all, it seems reasonable to expect that all three suppliers will be highly motivated to ensure a successful CBTC program for NYCT. Chang states, "Our objective from the start has been to develop a very open solution which can enjoy rapid market acceptance and become the standard for the CBTC industry. We will be exploring all possible options, including the licensing of our technology to interested parties in the coming months."

The KC radio network

Kasten Chase is planning to use an IP-based digital radio network. "The radio link employs a 2,400 MHz hybrid direct sequence/frequency hopping spread spectrum radio combined with a robust over-the-air protocol," says Chang. "In contrast with many other wireless network systems, our system was designed specifically for CBTC and the harsh radio environment typically found in subways."

Spread spectrum, once the secret domain of the military, is everywhere today. This is the same technology used in new secure and low noise wireless telephones. It also permits hand-held GPS receivers to capture weak satellite signals many times lower than the ambient RF noise level. "IP" stands for Internet Protocol, which is an advanced open communication protocol used daily by millions for e-mail communication. Rob Ayers, a senior communications expert at ARINC in Annapolis, Maryland, has many years of experience with advanced communication systems for the railroad and transit industry. He sees no reason why IP cannot be used successfully for NYCT's CBTC project.

Future possibilities for NYCT

The advantages of a standard multiple-sourced digital wireless network for NYCT are significant. For starters, with one less interoperability hurdle to overcome, it increases the chances of a successful NYCT program. There are longer-term benefits as well.

It may take several years to fully characterize RF noise levels in the diverse NYCT subway infrastructure and determine the ultimate bandwidth requirements for CBTC. But once this work is complete, spare capacity in its new wireless network could be used for other vehicle-related functions such as passenger information signs, train operator messaging and reporting vehicle health status to the control center.

Because of these potential benefits, NYCT may want to advance its new wireless network on a separate schedule and possibly in advance of its CBTC procurement schedules. This could be of value to NYCT because its current CBTC implementation schedule is constrained by many factors including the age of its existing signal systems, the need for interoperability among its many lines, and coordination with new vehicle procurements. Removing one constraint by advancing the radio network may provide NYCT with additional flexibility and benefits.

As part of separate vehicle procurements, NYCT now specifies LonWorks®, one of two advanced serial protocol trainlines recently defined as part of new IEEE Rail Transit Vehicle Interface Standards. The "information synergy" formed by joining NYCT's standard vehicle serial trainline networks to its new wireless digital network should not be underestimated.

In time, other transit agencies may adopt the standards developed under NYCT's program. We should know in a few years whether the approach NYCT is taking with CBTC and its new wireless and vehicle networks will succeed but, for now, it appears to be headed down the right track.

More information about NYCT's CBTC program, similar projects and related standards activities are available on the Internet at: www.tsd.org ■

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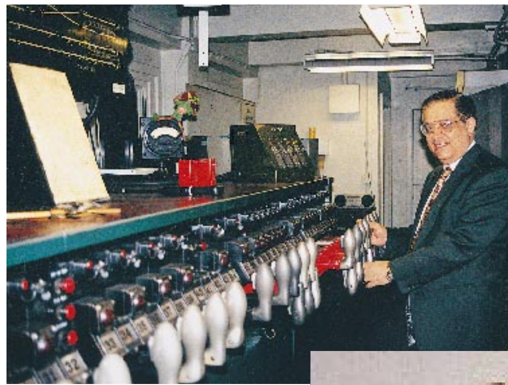
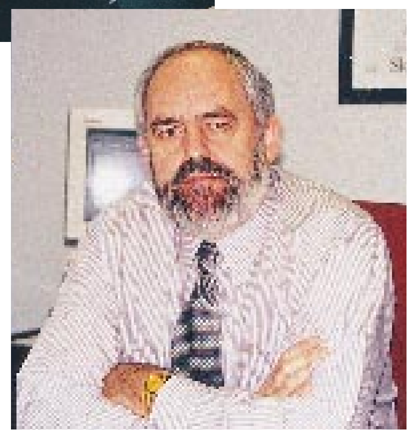


NYCT's Dr. Nabil Ghaly at the controls of a 60-year old mechanical interlocking still used today to control trains.



"Failure is not an option," says Dr. Alan Rumsey, who leads the consulting team for NYCT's massive resignaling efforts.