An overview of the IRSE CBTC Seminar, Toronto, December 2016

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Introduction
More than 110 attendees representing 40 firms from around the globe came together in Toronto at Fairmont Royal York on 1 December 2016. This was the first IRSE “CBTC and Beyond” Seminar in Toronto and 14 speakers from the industry shared their visions and experiences about Communications Based Train Control Systems.

In recent years major transit projects have been launched in Toronto and many firms have increased their presence in the region. Most of these projects employ CBTC technology for the train control system. The region is rich with the CBTC experts, mainly due to the presence of the Thales Rail Signalling Solutions CBTC Centre of Excellence in Toronto, the Bombardier manufacturing and development in Kingston, and the Alstom TTC ATC CBTC project.

Yousef Kimiagar, the chairman of the organizing committee, welcomed everyone to the first IRSE CBTC Conference in Toronto, and on behalf of the IRSE thanked the attendees, the speakers and the sponsors of the event. Yousef said that despite increasing the capacity of the event by 10% in the final days, some last minute applicants had remained on the waiting list because of its popularity.

Yousef introduced the 92nd President of the IRSE, Charles Page, and invited him to make the opening presentation. For the benefit primarily of non-members, Charles started by explaining that the IRSE is a ‘Professional Engineering Institution’, promoting best practice and professional standards for benefit of the signalling and train control systems profession, and society as a whole. He explained the activities of the IRSE, which include the presentation of technical papers and site visits, publishing technical information and a monthly journal “IRSE NEWS” that is available to all the members in 53 countries around the world. The IRSE Licensing Scheme, introduced in 1994, provides a means of competence certification in 50 categories for personnel undertaking work in the railway signalling and telecommunications industry.

The speakers
The keynote address was given by Mike Palmer, the Toronto Transit Commission’s (TTC) acting Chief Operating Officer. He is responsible for the operation of the four subway lines in Toronto with an annual ridership of well over 500 million/year. Mike presented his golden rules for success – the concept of operation, good human factors, operational integration, winning hearts and minds, scope creep and it is all about ‘people’.

This address was followed by presentations from experts and professionals covering a range of CBTC-related topics, which are summarized below.

Jane Ng, Vice President with Thales, has been in the urban rail signaling industry for 40 years. She summarised the history and the evolution of the CBTC over the past three decades, noting that Toronto is the birth place of CBTC that was successfully demonstrated in 1980. Subsequently, moving block CBTC was deployed on Scarborough Rapid Transit (SRT) in Toronto and the Sky Train in Vancouver in 1985. This was considered a game changer, introducing a disruptive technology after more than 100 years of fixed block signaling. By 1995, Tampa APM in the US, London DLR, Newark APM, Ankara, San Francisco and Jacksonville ASE had all started employing CBTC technology. This growth has continued worldwide, and in the last few years there seems to be a lack of experienced resources who could support the demand. Jane highlighted the benefits of the CBTC and
the adoption of this technology in new regions such as China and the Middle East. Based on the statistics presented, CBTC continues to be the safest and the most cost efficient train control system while offering the maximum grade of automation, GOA4, a fully driverless unattended system as was deployed on the Sky Train in 1985.

Adrian Peach, Senior Associate, and Mridu Dutton, Senior Project Engineer with Hatch gave a presentation on CBTC in Heavy Passenger Rail Applications and the associated challenges for the industry. They looked at the present day CBTC systems, a generic heavy passenger rail, mixed fleet network and analyzed the key issues that must be overcome to implement CBTC in this environment. These include infrastructure complexity, mixed-mode operation in mixed fleets, overlay on other systems, reconfiguration after commissioning, and interfaces with grade crossings.

Shantilal Morar, Technical Director with Thales, examined the recent cases of resignalling large and complex conventional signalling systems using CBTC. He analyzed the challenges with London Jubilee and Northern lines, the lessons learned throughout the resignalling of an old infrastructure, and the benefits of high return resulting from investing in CBTC systems. He spoke about current trends in resignalling projects such as London Four Lines Modernization (4LM) and the Hong Kong MTR 7 lines resignalling by reviewing the challenges and the migration strategies.

Jonathan Hulse, Engineering Director with Parsons, spoke about the Secondary Train Control (STC) for the Bay Area Rapid Transit (BART) System that is currently undergoing a brownfield Train Control Modernization (TCM). This involves implementing CBTC across the entire network with the objective of increasing the line capacity, improving the reliability availability and the maintainability. This will be the largest CBTC project in North America and the objectives are expected to be achieved in parallel with keeping the Bay Area passengers moving throughout the program implementation. He continued with the review of the FTA Report #45, Level 0 to Level 5, that ranges from CBTC only to adding a secondary train protection system such as wayside signals or cab signals with mechanical/electronic train stops, providing a back-up ATP for non-CBTC maintenance vehicles and non-communicating trains.

The luncheon address was given by Dr Alan Rumsey, on the topic of "Are you a Visionary or a Skeptic?". Dr Rumsey is a member of the IRSE’s governing Council and a well-known figure in the industry. He was the Chair of the IEEE Working Group that developed industry consensus standards for Communications-Based Train Control (CBTC) systems. He took the audience back to the early 1970’s when he included the following definition of an ideal transportation system in his thesis:

“An ‘ideal’ transportation system should be capable of moving people safely and efficiently from any given origin to any given destination with minimum delay and at a reasonable cost. Vehicles should be available ‘on demand’ and should be quiet, comfortable and pollution free. A direct origin-to-destination service implies a high-density network linking all major centres of activity with frequent access points. Such a network would almost certainly be on or above ground level because of the high cost of tunnelling, and therefore must be designed so as not to intrude on the urban environment. This suggests a system of relatively small vehicles travelling on lightweight guideways.”

“Any new transportation mode will undoubtedly be either partially or fully automatic since only by automation can full use be made of the system capacity. With a computer controlled system it is possible for vehicles to travel in safety at much shorter headways and they will no longer be required to operate on a fixed time-table since schedules can be continuously updated to suit fluctuating passenger demands.” [The entire paper is published on the IRSE website at http://bit.ly/2i1QYR8.]

Dr Rumsey spoke about the birth of CBTC technology and the first deployment in Toronto and Vancouver. From his point of view, the vision for ICTS/SkyTrain embraced many of the earlier visions of PRT, with respect to fully automated (driverless), small, lightweight vehicles, operating on lightweight elevated guideways, with frequent stations, integrated into the urban environment. The success can be measured by the degree that the industry has now become comfortable with CBTC and Moving Block. Dr Rumsey’s final message was:
“By all means listen to us grey-haired old-timers, learn from our experiences, and try to avoid the mistakes we have made in the past. But more importantly, have the courage to create and pursue your own visions for the future. We are fortunate to live in a world where we are no longer constrained by technology. We are only constrained by our imagination and our vision.”

Gregoire Sulmont, Vice President with Systra, was the first speaker in the afternoon, presenting the highlights of the NYCT multi-supplier interoperability program. He described the New York City Specific Transit situation and project road map for the future. He spoke about the I2S interoperability concept initially developed in 1999 and comparing that with the current concept. The safety certification of the Queen Elizabeth Line (QBL) project is the next critical step in the development of NYCT. In conclusion, over the last 20 years, NYCT has developed a comprehensive strategy for its CBTC program based on multi-supplier interoperability.

Xiaoguang Sun, a Senior Research Engineer from the China Railway Signal and Communication Corporation (CRSC), continued with the interoperability theme and spoke about the development of the interoperability of Urban Rail Transit in China. By 2018 four metro lines supplied by four signal companies will be put into operation in the city of Chongqing to explore and apply the interoperability of CBTC systems. He spoke about the standardization of system structures and functions distribution, telecom protocol, electronic map description mode, engineering standardization of system structures and functions distribution, and CBTC interoperability. In addition, compatibility between CBTC and CTCS-2 (Chinese high speed rail train control system level 2) for interoperability between urban transit lines and regional intercity lines will be explored. There are solutions under development for adding track circuit readers on CBTC vehicles, adding wireless communication system on intercity vehicles, adding CBTC modules on mainline onboard signal systems, and adding mainline modules on CBTC onboard signal systems.

Kate Dobson, Senior Human Factors and Ergonomics Specialist with SNC-Lavalin, presented the topic of Human Factors and Ergonomics in Advanced Train Control Systems. According to the Federal Railroad Administration, “Human errors now account for more than one third of all train accidents in the US railroad industry”. Kate reviewed the impact of advanced train control technologies on the context of operation itself and the opportunity for design in simplicity and transparency to ensure that users remain informed about what the automated activities are and why they are being undertaken. Based on case studies from CBTC work experience in the UK, USA, Canada and Japan, suggestions have been made to further integrate signalling or train control systems seamlessly with other operating elements of a metro or railway system, both onboard the trains and at central control from the operator’s point of view. She elaborated on the cause of human errors and what the designers can do to avoid these errors. It has been suggested that automation amplifies the consequences of equipment and human failures unless the operator remains ’in the loop’ until such time as automated systems can sense, interpret, and control all the myriad of variables that influence train control. The benefits of integrating human factors into the design of advanced train control systems were summarized as lower cost, improved systems performance, improved usability, intuitive and integrated design, reduced human error, improved worker well-being, increased user acceptance and compliance with human factors regulations and best practices.

Dave Keevil, Technical Director with Parsons, was the next speaker, presenting the benefits of CBTC systems in providing a high grade of automation (GOA), whether for a greenfield project for the deployment of a new transit system, or for upgrading from a more traditional signaling system. He questioned whether a higher GOA is always desirable, and the factors for consideration in selecting the GOA. He reviewed the historical timeline of the evolution of automation, the benefits and drawbacks of increased GOA, and the limitations of signaling technology in providing a higher GOA.

Joseph Greco, Manager Technical Solutions with Bombardier Transportation, spoke about advanced diagnostics with CBTC. With traditional systems, diagnostics are split between wayside and on-board subsystems and data is not easily integrated and sequenced between the onboard and wayside. With CBTC, communication between the wayside and the vehicle includes ATP information, Movement Authority, Speed Restrictions, etc. from the wayside to the vehicle, and reports of train location, speed and travel direction, etc from the vehicle. This data is integrated so that data mining can be easily performed to evaluate many operating aspects of the system. He identified some of the types of analysis that can be performed on the data,
for instance to identify improvements that can be made in system operation, to detect system components that are degrading to a point of failure to help schedule predictive maintenance before failure, and to provide the capability to review events in order to identify root causes of failures.

Raheel Qureshi, Cyber Security Design Authority with Thales, highlighted that the communications based signaling technology (CBTC) has transformed the rail signalling industry in the era of digitization and mobile communication. With the new technology, CBTC provides numerous benefits such as increasing capacity, operational efficiency, reducing headway and improving the ability to respond to growing passenger demand. With this evolution, together with growing business requirements for connectivity, and the evolving cyber threat landscape, it has become vital to ensure the confidentiality, availability and integrity of signalling networks. Raheel shared insights on proven security architecture best practices to ensure a defense-in-depth approach, including embedded cyber solutions to detect and prevent cyber-attacks.

The last speaker was Naeem Ali, Director & Principal Consultant with CBTC Solutions, who spoke about the next steps in the evolution of CBTC. He highlighted the limitations of the current CBTC products and the opportunities for restructuring the CBTC architecture to overcome the limitations imposed by three specific subsystems. These are Automatic Train Supervision (ATS) which monitors and controls trains; the Zone Controller (ZC) which controls all elements along the track; and the Vehicle On-Board Controller (VOBC) which controls the equipment on the train. Naeem regards these subsystems as technical ‘silos’ which, although they communicate with other subsystems, pass only the essential information required to keep the trains moving. However, there is an opportunity to strip the ZC of its primary functions such as train tracking, safe train separation, routing and movement authority, and move these into the VOBC. This would reduce the role of the ZC to being object controllers responsible for controlling the switches, platform doors and other objects on the track. This architecture could open the doors to reduced headways, reduced (but still adequate) safety distances, reduced response times, reduced trackside/wayside hardware, and trains that are able to communicate with each other.

**Technical visits**

The second day of the Seminar featured a technical tour of the TTC’s CBTC Test and Training Facilities at Wilson Yard. Two TTC shuttle buses picked up the attendees from the Fairmont Royal York Hotel at 7.30am and headed to Wilson Yard, about 20 km north. The agenda included visiting the training facilities, experiencing the cab simulator, visiting the car house and riding the CBTC equipped train. Delegates saw the test facility equipped with the newly developed Automatic Train Control (ATC) equipment from Alstom that is being deployed on the Yonge University Spadina (YUS) line and the Toronto York Spadina Extension (TYSSE). The different types of equipment that were installed in the trailers by the side of the test track used for testing the hardware, software and the communication network were explained to the delegates. The technical tour included visiting the maintenance and repair facilities. At the end, the visitors rode on a train equipped with the CBTC system demonstrating the automatic ride. On board tour guides explained the equipment installed on the train and the different modes of operation.

**Sponsors**

Our thanks to our sponsors and supporters of this event – Parsons, Gannett Fleming, Hatch, TUV Rheinland RSC, the Toronto Transit Commission, CRSC, Thales, Systra and Canarail.

The event was organised by IRSE member Yousef Kimiagar, MMSc, PEng, PMP. Yousef is a senior executive with over 30 years of engineering and management experience. He can be contacted at yousef.kimiagar.ca@ieee.org.