RESIGNALLING AND INTEROPERABILITY

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ABSTRACT

In the past few years, on a worldwide basis, the subject of resignalling of existing networks has emerged. The reasons are various, such as how to deal with technology obsolescence, transport capacity upgrades, and with overall service quality improvements due to modern operation practices. Simultaneously, there was the additional issue of getting suppliers to commit to long-term after-sales services and procurement in a rapidly changing technological world. This last point has made railway transport companies realise the need to push for multi vendors' policy or for interoperable systems solution.

This paper will present the various issues surrounding the need of resignalling and interoperability. The different methods of implementation strategy (Hong Kong, Paris, New York, etc) will be presented too, as well as the actual status of their progress.

In order to cover the above issues, in the medium term, a program called UGTMS – Urban Guided Transport Management System - and followed by MODURBAN – Modular Urban Guided Rail System - was launched, thanks to the European Rail Community. Various mass transit corporations, suppliers, universities and research centres are members of this program. The objective is to define and specify standards and agreed on specifications, in particular, common architecture specification including interfaces between interchangeable equipment. The content and status of this project will be presented.

1 INTRODUCTION

For the past few years, resignalling lines in revenue service has become a real issue for mass transit authorities. Needs for resignalling originate either from an obsolescence problem – the lifetime of equipment has been exceeded and consequently systems become unreliable, requiring increased maintenance and time for repairing – or from a quest for service quality improvement – increasing throughput, safety and system availability.

Recognizing the need for upgrade, New York City Transit (NYCT) and Paris Transport Authority (RATP) have undertaken the most massive resignalling programs ever. Their targeted objectives are to increase operational safety and upgrade the signal system according to standards. What has also become another reality is that these large-scale authorities are forging ahead the next generation of train control systems. Indeed, because of their size and complexity of the networks, they are requesting multi-sourced standardized solutions.

Actually, Hong-Kong MTR Corporation and RATP are the first transport authorities to have implemented a multi-sourcing strategy with SACEM. It was then followed some years later by NYCT and RATP with CBTC technology. Even though the overall objective of these strategies is to avoid being "locked in" to sole source supplier, they differ in their implementation.

2 PARIS AND SACEM ON RER A

It all started in the late 80's when RATP together with the French National Railways (SNCF) selected a consortium consisting of Alstom, Siemens Transportation Systems France (formerly Matra Transport International) and CSEE to design jointly SACEM for improving throughput on Paris Réseau Express Régional RER A by 20%. Two main constraints were clearly identified: a) to interface SACEM with the existing signalling system, b) to minimize the perturbation on passenger service during upgrading.

Few years later, SACEM not only reached the targeted operational objectives but it enabled RATP and SNCF a diversification of suppliers. In fact, on RER B, SNCF made use of this key feature by awarding either to Alstom or to Siemens the provision of trackside or onboard equipment.

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3 HONG-KONG AND SACEM

3.1 MTR Corporation Strategy

Meanwhile, MTR Corporation was preparing a call for tenders to upgrade the lines of this network equipped with Westinghouse speed code technology. Even though the call for tenders was opened to any ATC technology, MTRC had clearly in mind to elaborate a multi-sourced procurement strategy for the whole network which would enable a) to force price competition, b) to ensure long-term warranty for extensions, maintenance and procurement, c) to shorten return on investment.

As a first step, MTR Corporation awarded Alstom the contract for equipping with SACEM three lines. In this quest of multi-sourced ATC suppliers, the choice of SACEM was no surprise as it could be provided by three different suppliers. The idea of the second step was to achieve cost savings by fostering true competition between suppliers for line extensions. In 1999, Siemens Transportation Systems France (formerly Matra Transport International) was awarded for the Tseung Kwan O Line. The contract not only included the equipment of new track sections (total of 13 km) and of 13 trains 8-car trains but also the demonstration of interoperability between wayside and onboard equipment both provided by Siemens and Alstom.

Commissioning was done step-by-step, starting in August 2001 from Lam Tim to North Point, in August 2002 from Po Lam to North Point, and in September 2002 for the depot located at Tseung Kwan O South.

3.2 Technical Focus On SACEM For The Tseung Kwan O Line

3.2.1 SACEM principle

Safety of train movement is ensured through fixed block principles. The target point of a train – ie the point the train shall not overrun - is the entrance of the first unoccupied track circuit ahead. The distance-to-go is the distance separating the front end of the train and its corresponding target point. A sub-division of the blocks is made in the vicinity of the stations and in the stations. Therefore, a train can enter a station before the leading train has cleared the sub-block at the far end of the station. This specificity enables shorter headways.

The system architecture is depicted in in Figure 1.

3.2.2 Onboard SACEM equipment

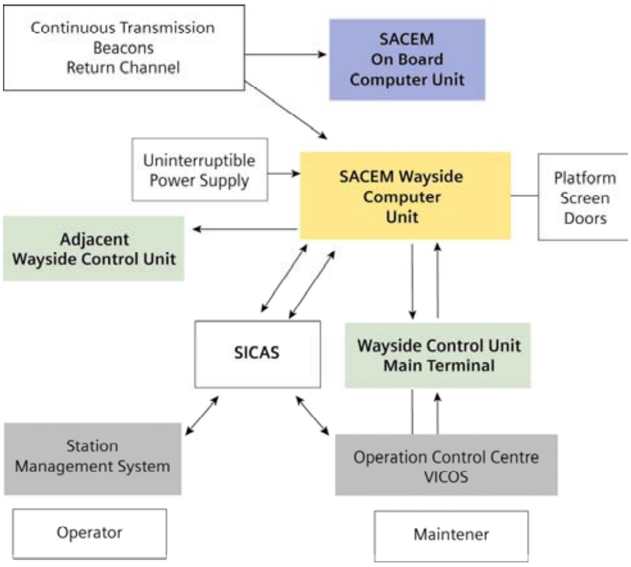

Figure 1 – SACEM system architecture

The intelligence of SACEM is onboard so that the train computes its own speed curve according to:

- Information about fixed blocks occupancy transmitted to the onboard ATC equipment by a continuous wayside-to-train communication.
- Information describing the operation of the line such as: stopping points, track circuits location, speed limit, temporary speed limit restrictions…
- Individual characteristics of the train.

3.2.3 Wayside SACEM equipment

The Wayside Control Unit role is mainly confined to provide trackside information (occupancy of track circuits, stopping points, transponders positions…) to the onboard computer unit. It also interfaces with the interlockings. Each wayside equipment is responsible for a specific geographical zone.

Track circuits used are the audio frequency track circuits FTG type S from Siemens.

S140 Tunnel Signals combined in a modular way in accordance with MTR Corporation requirements are used for visual display of signal aspects.

3.2.4 Data Communication system

The wayside-to-onboard continuous transmission is ensured by continuous inductive loops on the track. For onboard-to-wayside communication, rails are used as an intermediary medium for transmission. A coaxial cable ensures the transmission from the rails to the Wayside Control Unit.

3.2.5 Operation Control Center

The Operation Control Center, VICOS by Siemens, monitors trains to maintain schedules and provides data to adjust service to minimize the inconveniences caused by irregularities (regulation activities). It performs key functions such as train tracking, automatic train regulation, automatic route setting, time table management, system monitoring and display, maintenance diagnostic.

3.2.6 Interlockings

SACEM interfaces with SICAS (Siemens Computer Aided Signalling) interlocking system from Siemens based on a 2 out of 3 vital platform. SICAS includes an operator console, an interlocking computer, element operating module systems and the associated outdoor equipment. A standard bus system allows communication with the ATC systems and Operation Control Center.

3.3 Interoperability Requirement

The interoperability of SACEM is the technical translation of multi-sourcing procurement strategy. SACEM is split between wayside equipment and onboard equipment which can be developed by the suppliers who own the technology. The challenge is to ensure interoperability between wayside and onboard equipment provided by two suppliers ie to ensure that the global performance including safety issues of the ATC (Automatic Train Control) meets the MTR Corporation requirements.

What has been achieved for Hong Kong is:

- Between Yau Ma Tei and Lam Tin: Ensuring interoperability between the trains equipped with SACEM by Siemens and the wayside system equipping the line.
- Between North Point and Po Lam: Ensuring interoperability between the wayside SACEM equipment from Siemens and the trains already equipped.
- Between Lam Tin and Quarry Bay: Ensuring migration by night so as to avoid traffic disruption.

4 NEW YORK CITY TRANSIT AND CBTC

4.1 NYCT Strategy

In the specific case of NYCT, the procurement strategy is strongly constrained by operational concerns that makes interoperability is really issue. Indeed, the New York City subway network comprises interconnected lines and interoperability is a way to maintain such flexibility. The procurement strategy implemented by NYCT not only aims at retaining operational flexibility but also at fostering true competition between suppliers, given the size of the network.

As a first step, an investigation of existing ATC technology was performed worldwide, having in mind both operational and cost-effectiveness issues. Communications-Based Train Control (CBTC) was selected as the technology. As a second step, shortlisted suppliers were asked to demonstrate their ability to build such technology, bearing in mind the needs to fulfill. The idea of the third step was to select a system to be regarded as the standard solution which serves as the reference to upgrade the whole NYCT network. In December 1999, the CBTC system engineered by Siemens France has been chosen by NYCT for the modernization of the Canarsie Line, which foreshadows the standard of the whole subway. Siemens was awarded the leadership contract. As a fourth step, the other suppliers (Alcatel and Alstom which withdrew since) were awarded the follower contracts, meaning that they are asked to reengineer their system so that it is interoperable with the leader’s.

The Canarsie Line contract includes designing, furnishing and installing CBTC equipment for mixed fleet operation, upgrading existing interlockings to be CBTC-ready and providing six brand new CBTC-ready interlocking systems. 17 km of line will be equipped with CBTC together with fifty steel-wheel trains. The time schedule for commisionning is as follows. Formal shadow mode starts in September 2005 together with the training of train operators. ATS will be in operation from January 2006. The line will operate in full CBTC mode from April 2006. CBTC operation in the yard will start from August 2006.

As far as the interoperability demonstration is concerned, testing with Alcatel's CBTC will be done by the end of 2005.

4.2 Technical Focus On CBTC On The Canarsie Line

CBTC in New York City is made of five main systems:

1. Onboard System
2. Wayside System
3. Automatic Train Supervision (ATS)
4. Data Communication System
5. Auxiliary Wayside System (Interlocking)

The system architecture is depicted in Figure 2.

4.2.1 Onboard Systems

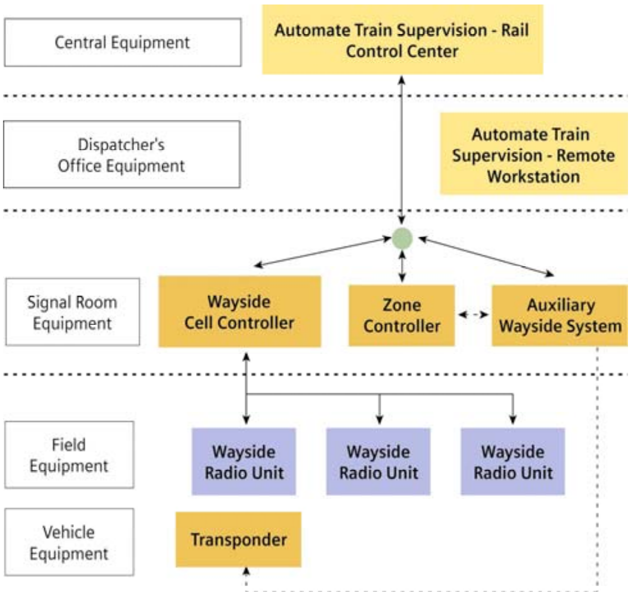

Figure 2 – CBTC system architecture

With the CBTC technology, the intelligence is onboard the trains. Onboard system:

- Computes the train location on the network thanks to information from Digilioc® and Osmes®.
- Protects the train movement in the various operating modes, including ATO mode, and computes its speed profile.
- Supervises traction sub-system
- Provides ATS with operation and maintenance data.
- Manages train configuration.
- Performs the station process.
- Displays information to the train operator and conductor.

4.2.2 Wayside Systems

A zone controller is in charge of wayside CBTC functions for a specific area. It ensures:

- Vital tracking of trains.
- Moving Blocks anti-collision.
- Supervision of wayside equipment and report failures.
- Management of critical track circuits failures.

4.2.3 Automatic Train Supervision

The ATS main functions are:

- Controlling and supervising power supply
- Monitoring and supervising trains and wayside equipment
- Regulating traffic
- Enforcing the schedule
- Route Setting
- Train tracking
- Trains' mission management
- Managing the interfaces with other systems (Public Address/Computer Information Screen, SCADA…)

4.2.4 Data Communication System

Continuous and bidirectional data communication is performed by Airlink®, the free-propagation radio data communication system engineered by Siemens Transportation Systems France.

4.2.5 Auxiliary Wayside System

The Auxiliary Wayside equipment is a reduced conventional relay based signalling and interlocking system, based on the current principles in use on the entire NYCT track network. It is meant for trains unequipped with CBTC.

5 RATP AND CBTC

5.1 RATP Strategy

In its quest for standardized solution, RATP is directly tackling the obsolescence problem through the definition of interchangeability concept and considerable efforts in standardization committees.

In order to guard itself against obsolescence, RATP has undertaken a vast resignalling program, called OURAGAN – Offre Urbaine Renouvelée et Améliorée Gérée par un Automatisme Nouveau - based on interchangeability. The underlying idea lies in splitting the CBTC system into a predefined number of subsystems (wayside, onboard systems and the communication system between the wayside and onboard CBTC systems) which will be easy to replace by a plug-and-play approach by selected suppliers. Whereas interoperability from NYCT originates primarily from an operational concern, interchangeability is not derived from such operational concern, as RATP operates a network consisting of self contained lines. The primary concern of interchangeability is cost savings in the procurement strategy.

Depending on the characteristics of the rolling stock in operation on lines 3, 5, 9, 10 and 12 concerned with OURAGAN, the CBTC systems to be provided are broken down into five interchangeable shares, allocated to different suppliers:

- Share 1: data communication system between the 5 lines.
- Share 2: wayside CBTC for lines 3, 10 and 12.

- Share 3: onboard CBTC for lines 3, 10 and 12 (MF67 type rolling stock).
- Share 4: wayside CBTC for lines 5 and 9.
- Share 5: onboard CBTC for lines 5 and 9 (MF2000 type rolling stock).

In February 2004, Siemens Transportation Systems France was awarded three of the five shares, that is to say:

- Share 1: Data communication system, consisting of the wayside network and the wayside-to-onboard transmission system. All of the 5 lines, ie 150 km of track and 234 trains, will be equipped with Airlink.
- Share 3: Onboard CBTC for lines 3, 10 and 12, ie the equipment for 117 trains.
- Share 4: Wayside CBTC for lines 5 and 9, ie the equipment for 70 km of track.

In order to guarantee interchangeability between the three different suppliers, an interchangeability working group managed by RATP has been created.

5.2 Technical Focus On CBTC On OURAGAN

The system architecture proposed for OURAGAN is similar to the one on the Canarsie Line, except that the speed is measured by the conventional coded wheel as a free axle is made available.

6 PERSPECTIVE CONCLUSIONS

Driven by operational issues and most importantly by cost savings factors, transit authorities that operate large networks like New York City and Paris have opted for the multi-sourced procurement strategy resulting from the design of standardized CBTC systems. Not only RATP and NYCT will benefit from such procurement strategy, other transit authorities will also take advantage of such a quest for standardized systems, even though their short-term primary concern lies more in acquiring state-of-the-art proven CBTC system. Equipping a line with a CBTC system compliant with standards will enable a transport authority in the middle-term future to implement multi-sourced procurement strategy when upgrading the system or extending the line.

From a commercial viewpoint, industrial suppliers can really benefit from the design of standardized CBTC systems only if such systems comply with the requirements of operators worldwide. Several initiatives have been taken in bringing together all majors suppliers of CBTC and transit authorities to discuss in a voluntary consensus manner the sensitive issue of developing standards for new train control technology. As partners in the UGTMS project – Urban Guided Transport Management Systems – Siemens Transportation Systems benchmarked the needs expressed by the major European transit authorities to take them into account, at the design stage, both at the functional and architecture levels. The idea was first to establish some degree of standardization on the system performance and functional requirements – through the benchmarking exercise – and then develop some standardization at the system architecture level. UGTMS was not only seen as a forum for exchanging on the technical design of future standardized CBTC. It was also an opportunity for transit agencies to meet and discuss on the way transit networks are operated, to understand their differences in terms of operating principles, signalling and safety procedures and to reach a common agreement on how far operating rules and principles could be standardized. Launched in January 2005, MODURBAN is the follow-up of the work done in UGTMS. It is a European project, lead by UNIFE, the Association of the European Railway Industries. It aims at designing, based on the outputs of UGTMS, an interchangeable CBTC solution for driver attended operation, that can be upgradeable to driverless operations.