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Institution of Railway Signal Engineers

January 2020

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in Hong Kong

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improving customer experience

Completions
delivering full benefits

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Are we realising the benefits?

As I near the end of my presidential year, I reflect on successful changes to the world's railways that I have seen or read about this year. Delivery of change is challenging but, just as importantly, it is essential to be clear about the benefits of change if the benefits of a sustainable change are to be realised in practice. The question 'why are we doing this project?', which is so often not clearly communicated to those delivering a project, or is lost during the drive to achieve project milestones, must be kept at the forefront of our minds at all times.

The theme of this year's ASPECT conference (summarised later in this issue) was "resilience", and while this can be interpreted many ways, one key message was that being clear on the actual customer benefits makes a difference. This was well illustrated by the presentation on the London Underground Victoria Line capacity enhancement project – the customer benefit was a consistent 36 trains per hour (tph) peak service operation. That delivery of a resilient system was as much about competent people and process as it was about the technology. In this case the success has been further built upon by lengthening the peak periods of 36tph running to provide greater capacity to meet ever increasing passenger demand.

Delivery is challenging, and you only need to look at the work being undertaken in Hong Kong described in this issue of IRSE News, or the ERTMS roll out in Denmark that featured in the December 2019 issue, to see that the capacity-driven benefits can be delivered by embracing the latest technology. Railway signalling projects are indeed embracing new technologies, but must look beyond traditional sources to maximise the achievable benefits. Last November I hosted the first IRSE Webinar which focused on the world of communications systems. That focus was as much on the non-rail arena as it was on rail client expectations. The round-table discussion after the event (a video of which will appear in the members area of the web site) showed that we have a lot to learn when our asset strategies span the 20+ year life of signalling systems but technology is moving at a pace which makes those systems out of date in five years.

So, are we realising the benefits? Does the end customer see these in the form of a sustainable solution? I see the need for much wider change, becoming far more pro-active and with clearer goals, if we are to truly realise the benefits of the huge investments in railways being made around the world.

George Clark, president, IRSE

Cover story

The Glasgow Subway is an underground light rapid transit line in Glasgow, Scotland and on p30 we report on the Young Rail Tours visit to the depot at Govan. Opened on 14 December 1896, it is the third-oldest underground metro system in the world after the London Underground and the Budapest Metro. It is also one of the very few railways in the world with a track running gauge of 4ft (1219 mm).

The Subway is currently undergoing a £288m (€336, $370m) modernisation programme that will see the introduction of all new driverless trains, new signalling and 15 stations upgraded.

Photo David Westcough

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Delivering CBTC in Hong Kong – carrying the changes

Gordon Lam

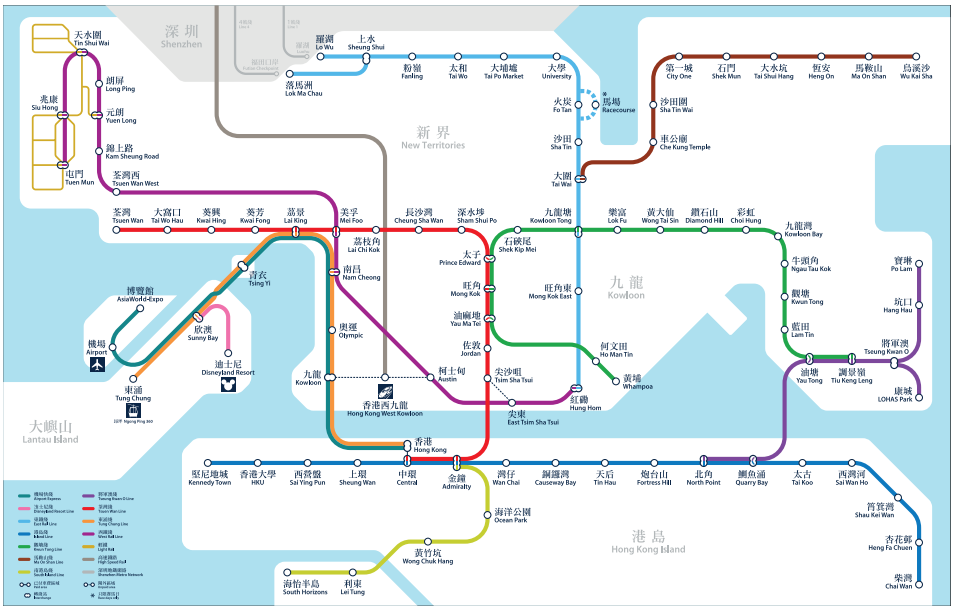
This article is based on the third Presidential Paper of the 2019/2020 year which was presented in London on 5 December 2019.

MTR operates 11 domestic heavy railway lines and a light rail system and carries more than 5 million daily passenger trips on average in Hong Kong. In addition, we also operate high speed rail connecting Hong Kong to the high-speed rail network in China. Reliability of on-time service is continuously maintained at a high level and the railway strives to keep up its high performance. Similar to other railway operators in the world, we are facing a number of challenges including Near Capacity Operation (NCO) and increasing demand for train service reliability.

To meet growing demand for mobility in Hong Kong and further enhance the customer experience, a series of initiatives known as Rail Gen 2.0 has been launched which aims to upgrade and extend the existing network in order to bring superior connectivity, better facilities and services. One important mission is to upgrade most of the signalling systems in our network. The signalling upgrade will bring enhancement to 8 out of the 11 heavy railway lines and cover over 70% of MTR's existing heavy railway route length in Hong Kong.

Key features

The new systems adopt a number of key features with an aim to maximise the capabilities of MTR's signalling systems, enhance reliability and improve operational efficiency.



The MTR network in Hong Kong is complex and carries more than 5 million passengers every day.
Image MTR Corporation.

- Moving block Communication Based Train Control (CBTC): Compared to the previous generation of signalling, trains are able to operate with shorter headways achieved by moving block signalling.
- Enhanced redundancy and resilience: The new systems have enhancement initiatives on service reliability and availability. Fault tolerant design is adopted by providing enhanced redundancy. For trackside subsystems responsible for the train control, for instance, the Zone Controller, which provides integrated functions for interlocking and train control, is provided with warm standby as well as the usual hot standby, giving extra assurance on availability. On the other

"Reliability of on-time service is continuously maintained at a high level"

Lines		Route length	Existing (legacy) signalling system (ATC and interlocking)	New signalling system	Expected completion
DUAT Lines	Tsuen Wan Line, Island Line, Kwun Tong Line, Tung Chung Line, Airport Express	127.7km	Alstom SACEM with relay interlocking/SSI	Alstom-Thales SelTrac CBTC	By phases from 2021 earliest to 2026
	Tseung Kwan O Line and part of Kwun Tong Line		Siemens SACEM with SICAS interlocking		
	Disneyland Resort Line		Thales SelTrac CBTC		
East Rail Line		41.1km (existing) + 6km (extension)	Alstom TBL with SSI	Siemens Trainguard MT CBTC	2020/2021 earliest (extension)

Table 1 – signalling upgrade projects being undertaken by MTR in Hong Kong.

hand, 4G-LTE also serves as a back-up for Wi-Fi communication with a similar consideration of enhancing availability.

- Readiness for Fully Automatic Operation (FAO): The new signalling systems are equipped with facilities to enable Fully Automatic Operation. FAO will bring more flexibility to train deployment and operation, further enhancement in reliability, and hence improved customer service.

Signalling upgrade

"Projects cover more than 160km of route length across eight railway lines"

The signalling upgrade projects cover more than 160km of route length across eight railway lines. Works on four lines are underway concurrently. The current priority is given to the East Rail Line and Tsuen Wan Line (TWL), which are the busiest railway lines in Hong Kong carrying more than 2 million passengers per day. The upgrading of these two railway lines is expected to be completed from 2020 onwards. Further works on a 6km railway extension of the East Rail Line that is under construction is due for completion by 2021 earliest. Signalling upgrade works for the remaining lines are expected to be completed progressively to 2026 (refer to Table 1). The contract sum of the signalling upgrade projects amounts to about HK$4.16bn (about US$530m, £410m). The works have been progressing steadily since the contract award for the East Rail Line and DUAT Lines projects in December 2012 and January 2015 respectively.

Progressive migration – changes little by little

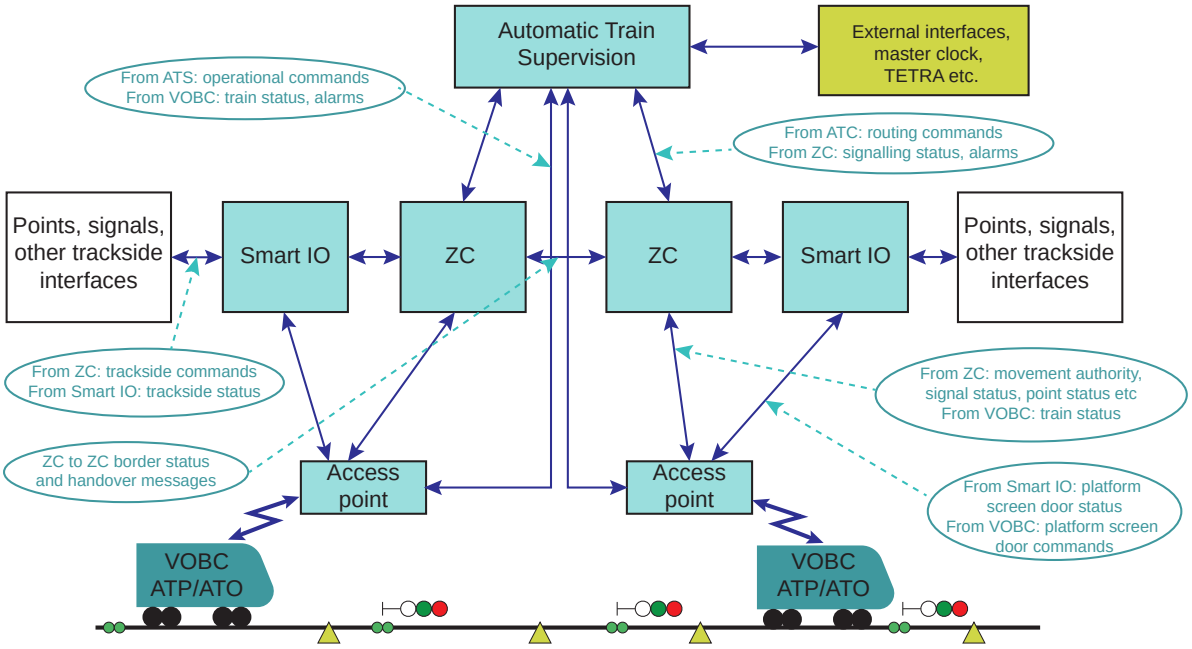
The TWL is the first line to be commissioned as part of the signalling upgrade for DUAT lines. There are 12 migration steps in total for replacement for DUAT Lines. Some key steps are summarised as below. In summary, the migration strategy adopted for TWL is Mixed Mode Operation (MMO).

In TWL, 36 existing trains (M-trains) will be dual-fitted with existing and new signalling systems, which enable them to operate in either existing mode SACEM (Système d'aide à la conduit, à l'exploitation et à la maintenance), or with new CBTC controls. The commissioning of the TWL will be performed in three different phases:

Shadow mode

All the central, trackside and on-board CBTC equipment will be powered up in this phase after the completion of acceptance tests on site. The CBTC system will however only monitor the statuses of the trains and infrastructure.

In shadow mode, the new CBTC system is not in charge of the protection of the trains or the management of the infrastructure. Instead, it monitors the status of existing equipment, health of the trackside CBTC equipment and train positioning such that train tracking is performed. Dual-fitted trains operated in SACEM control with



The underlying system architecture and information flows. ZC is zone controller and VOBC is vehicle on-board computer.

communication between the Vehicle On-Board Controller (VOBC) and the CBTC trackside system maintained will also facilitate CBTC functions related to SACEM-Communicating Train (SACEM-CT) testing in this phase.

For trackside subsystems a relay-based trackside changeover mechanism is used to connect or isolate the new system from the field devices (i.e. points, signals, etc.) while allowing the new system to continuously obtain the status of the field devices. Local and remote changeover controls will be provided to command switching of the change-over mechanism. When the trackside control is in SACEM control, the field devices are isolated from the command of the CBTC system. When the trackside control is switched to CBTC, the system can operate the field devices.

"For trackside subsystems a relay-based trackside changeover mechanism is used"

As for trains, dual-fitted trains will operate in SACEM control mode with the train borne CBTC powered on and they will be treated as SACEM-CT by the CBTC system. Communication between the train borne CBTC and the Automatic Train Supervision (ATS), Zone Controller (ZC) and Smart IO (SMIO) can therefore be tested in Shadow Mode. Similar to trackside, train borne CBTC will not command any output and its outputs are isolated from the train by the on-board changeover relay.

The CBTC system in shadow mode will behave as the final system with full trackside elements implemented and configuration i.e. ATS, ZC, VOBC and SMIO will exchange their information but no controls will be issued to field elements, train interfaces and external interfaces.

To ensure no Limit of Movement Authority (LMA) will be issued by the CBTC system, the CBTC system will 'close' all tracks in shadow mode as no LMA will be computed by the train borne VOBC.

In particular the shadow mode will enable the testing of the following:

- Communication robustness between subsystem: ZC-SMIO, ZC-ATS, ZC-VOBC, ATS-VOBC, ATS-SMIO and VOBC-SMIO.
- Primary positioning: VOBC in SACEM_CT Train will establish and maintain its position and report it to ATS and ZC. Trains will be tracked on ATS line overview and by the ZC.
- Performance in tag reading e.g. missed tag or loss of position will be logged to enable investigation.
- Non-communicating train (NCT) tracking: ATS will track SACEM-equipped train (NCT) using secondary train detection devices e.g. track circuits. The ZC will track the SACEM train as an obstruction based on secondary train detection.
- Timetable regulation and automatic route setting: ATS and ZC internal logic only and no commands will be issued to field elements and external interfaces.
- Train launching and reception in and out of depots.
- Trackside equipment including points, signals, platform screen doors (PSD)/Automatic Platform Gates (APG), Platform Emergency Plungers (PEP), Emergency Stop Switches (ESS) and floodgates will be monitored.
- Data Communication Systems (DCS) will be tested and any loss of communication will be logged for investigation.

The in-service reliability performance monitoring can start at this stage. It will be limited to the early monitoring of equipment reliability. Passing criteria for shadow mode operation will be developed with the different stakeholders and will form a confidence basis before the system enters into the next phase.

Mixed-Mode Operation (MMO)

With the trackside changeover mechanism switched to CBTC, the central and trackside subsystems of the CBTC system both control and monitor the trains and infrastructure. The trackside subsystem of the CBTC system (i.e. ZC and Smart IO) also provides information to the existing trackside SACEM allowing existing trains and dual-fitted trains operated in SACEM mode to

Smooth migration is critical to upgrading the MTR network. Kowloon Tong station (below) is a heavily used interchange between East Rail services and other lines. *All photos MTR Corporation.*

MTR's network is the life-blood of Hong Kong's thriving economy with high levels of ridership. Keeping the railway running is critical to the area's continuing growth.

continue passenger service on TWL. During this phase, trains in either SACEM or CBTC control mode can be operated concurrently during traffic hours. In the initial stage of MMO, the dual-fitted trains will be switched to CBTC control in traffic hours progressively without carrying passengers. After the dual-fitted M-Train has demonstrated the required stopping accuracy and fault-free operation in CBTC control, they will be operated in CBTC control in traffic hours with passengers.

The concept of MMO applies to migration in TWL, ISL, AEL and TCL, so to realise the change with an incremental little by little approach.

As the CBTC system is in full control of the infrastructure and the trains during this phase, the SACEM-fitted trains and dual-fitted trains operated in SACEM mode require that the CBTC system continues to provide a SACEM movement authority with equivalent protection level. This is achieved by the replication of the safety critical SACEM logic in the ZC and the ZC processes such logic and issues output to the trackside SACEM system through relay contacts for the TWL and Island Line (ISL) and the solid-state interlocking interfaces for the Airport Express Line (AEL) and Tung Chung Line (TCL).

"The legacy trackside SACEM system is maintained for the whole duration of this phase"

The legacy trackside SACEM system is maintained for the whole duration of this phase and serves as the gateway between the CBTC system and the SACEM train borne system. In MMO, the trackside change-over mechanism will be switched to CBTC control and the dual-fitted trains will be switched to CBTC control progressively for non-passenger operation during traffic hours. Following successful operation, passenger operation on these CBTC-controlled trains during traffic hours will commence after completion of 100km of fault free mileage for each VOBC and the station stopping accuracy for each VOBC under automatic control.

Full CBTC

Once the reliability of the CBTC system finally meets the defined target and the whole fleet for the line is operated in CBTC control for passenger service, full CBTC operation would commence. Headway performance and full CBTC functionalities will be demonstrated during this phase.

A separate strategy has been established to replace the whole DUAT train fleet, 93 new trains (Q-trains) are therefore required to be equipped with CBTC. The CBTC-equipped new Q-trains are to be introduced into revenue operation shortly after TWL MMO commencement as planned. Their introduction would release existing dual-fitted trains from TWL to other lines to continue the MMO migration strategy with proven train borne equipment performance.

There are other steps involving conversion of SACEM locomotives into CBTC-equipped locomotives, optimisation of the number of secondary train detection devices, commissioning of depots, and decommissioning of existing signalling systems to be implemented in subsequent stages.

Implementation – changes step by step

Trackside system

The trackside change-over mechanism is implemented to allow full changeover to be performed between the new ZC and SMIO and the legacy interlocking during the testing and commissioning phase. This switch-over is performed through dedicated Latched N.S1 relays.

The change-over from legacy to the CBTC system can be performed in two different ways:

Train fitment. Left, additional operator's display in existing cab. Right, CBTC underframe interrogator transponder added.

- through dedicated ATS secure commands (from ATS to ZC) with a secondary confirmation to set the logical state of the area to CBTC and to remotely operate the changeover switch inside the respective interlocking equipment room.
- to locally operate the changeover switch to CBTC inside the respective interlocking equipment room.

The change-over from CBTC to the legacy system for a signalling control area can be performed in two different ways:

- through dedicated ATS secure commands (from ATS to ZC) with a secondary confirmation to set the logical state of the area to legacy.
- to locally operate the changeover switch to legacy inside the respective interlocking equipment room.

The local changeover switches only allow operation through a robust system secured with access key. The status of the change-over relay is reported at all times to ATS and ZC and locally through a light indication.

"Modifications on trains are made through multiple steps"

Train modification

Modifications on trains are made through multiple steps which were developed and defined during fleet survey and interface design. A thorough survey was conducted for each train in order to facilitate a successful mechanical design. Following this step, a detailed Vehicle Interface Control document was produced. This step included the following works:

- definition of all cut-in points to allow SACEM/CBTC cutover for dual-fitted trains;
- modifications of the required train schematics to enable the train to support new functions such as FAO mode.
- modifications of existing train door open and closed circuits in order to ensure train doors and PSD/APG synchronisation.
- train mechanical design including but not limited to the CBTC equipment mounting brackets, on-board enclosure, cable conduits, installation of equipment inside the enclosure, under the seat and driver's cab.

Overall, all these changes are implemented in the following stages, with the approach of little by little and step by step, for TWL:

(i) Installation and testing: enabling works, installation of changeover systems, CBTC equipment, train modification, site acceptance tests and integrated tests. The early integration of the CBTC system using part of the main line track was used for pilot integration. The testing was later extended to other main line areas.

(ii) Shadow mode: CBTC system operation in shadow of the in-service signalling system. This phase concluded the works including relocation of relays/frames, installations for trackside CBTC functions, and dual fit of the trains. Meanwhile the testing of Mixed Mode Operation is performed during non-traffic hours.

(iii) Mixed mode operation: The system operates with a mix of SACEM and CBTC trains after the infrastructure has switched the control to the CBTC system. During this phase the trains demonstrate reliability of the CBTC system through the passing of the required fault free mileage and stopping accuracy performances. CBTC trains will be put into passenger service progressively.

(iv) Final CBTC: the CBTC system will provide full CBTC functions and CBTC mode is the normal mode of operation. The CBTC system retains the capability to maintain SACEM traffic until decommissioning of the SACEM system. Removal of the changeover system will be carried out.

(vi) Final CBTC with track circuit optimisation which remains as the secondary detection devices during CBTC operation.

"SCL will strengthen the current railway by connecting several railway lines"

Direct migration – changes in one step

Another form of migration is adopted in another signalling upgrading project to suit the context of the legacy architecture as proposed by the selected supplier.

The Shatin to Central Link (SCL) is a strategic railway line that runs through multiple districts in Hong Kong. It comprises two sections. The first section, the East West Line (EWL), extended the existing Ma On Shan Line from Tai Wai to the West Rail Line through East Kowloon. The second section will bring the East Rail Line (EAL) across the harbour to Hong Kong Island (Hung Hom to Admiralty Section), eventually forming the North South Line (NSL). The SCL will strengthen the current railway network by connecting several railway lines through six interchange stations. It will save travelling time and provide the community with faster and more convenient railway services.

Upon completion of the SCL project, Hung Hom Station (HUH), being one of the six interchange stations, will be transformed into an important railway hub for Hong Kong as an interchange station between the EWL and NSL, benefiting passengers to all destinations in Hong Kong. When the Hung Hom to Admiralty Section is completed, passengers from the boundary at Lo Wu or Lok Ma Chau stations will be able to take trains on NSL to Hong Kong Island directly. Passengers on the West Rail Line and Ma On Shan Line may also change at HUH for trains on the NSL for destinations on the Hong Kong Island.

The signalling system for EAL will be replaced to form a single NSL and cover the new tracks from Mong Kok (MKK) to HUH with an extended section including Exhibition (EXH) and Admiralty (ADM) for seamless operation. The system will be operated with nine-car trains after completion of the NSL.

"The existing 12-car trains will be replaced by new nine-car trains"

Migration strategy for EAL – Mixed Fleet Operation (MFO)

The existing 12-car MLR Trains will be replaced one after another by the new nine-car Rotem Trains solely equipped with the Siemens Trainguard MT (TGMT) and Airlink onboard equipment with replacement to be completed before NSL opens. This leads to a period of around 18 to 24 months duration with MFO. 12-car MLR Trains and new nine-car Rotem Trains will operate simultaneously and terminate at the existing HUH platforms during MFO.

As a result, the existing EAL signalling system needs to be modified to support the trains introduced, MFO, NSL operation and allow running of existing Intercity through train services from mainland China.

The migration strategy depends on overlaying the new signalling system on the existing one and switching over between the existing and new signalling systems to ensure that both 12-car trains and new nine-car trains are supported during MFO. The migration strategy focuses on developing the new signalling system without any temporary interface to existing signalling equipment. This ensures, as required, that the operational system is not affected. Consequently, the new signalling system can run in shadow operation from the beginning and correct configuration, function, availability as well as overall system reliability can be verified by all parties. Test runs after site acceptance tests and integrated tests under real conditions are conducted with switching over to the new signalling system and back to the existing system afterwards.

In order to enable MFO, the existing 12-car MLR Trains are dual fitted with the new signalling system. Accordingly, the final switch over from operation under control of the existing signalling system to operation under control of the new signalling system is made before MFO. Related phases are summarised as: (1) shadow operation, where the existing system is still in operation, (2) non-traffic hour test runs, as necessary to prove system functions and reliability and (3) non-traffic hour trial runs, as necessary to prove operational reliability. Finally, direct changeover and migration to the new signalling system would commence with the final switch-over to the new signalling system, which starts traffic hour MFO.

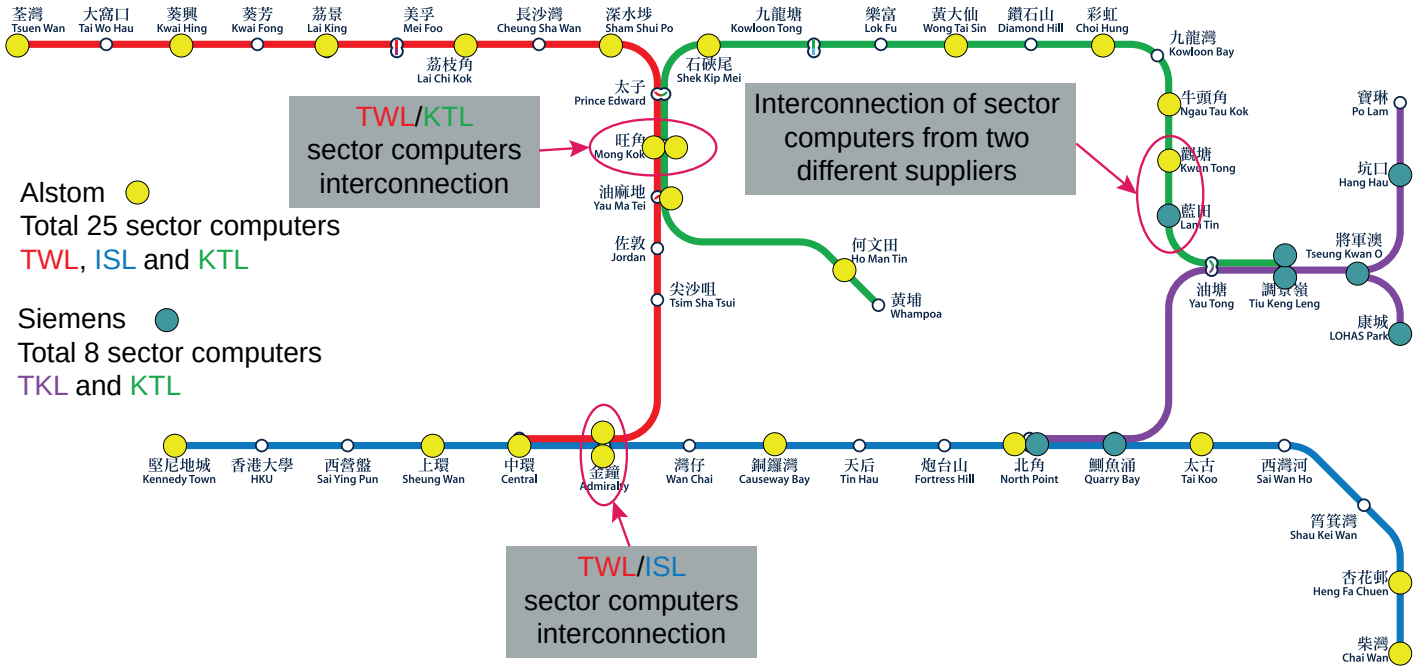
Software – changes in integration governance

While MTR has been implementing CBTC upgrading works, events were also observed in existing operating signalling systems, as well as new CBTC systems works under delivery during non-traffic hours. Both cases of events had drawn further attention to emphasis on software development, which is compelling in carrying the changes in software integration governance.

Case 1 – software integration

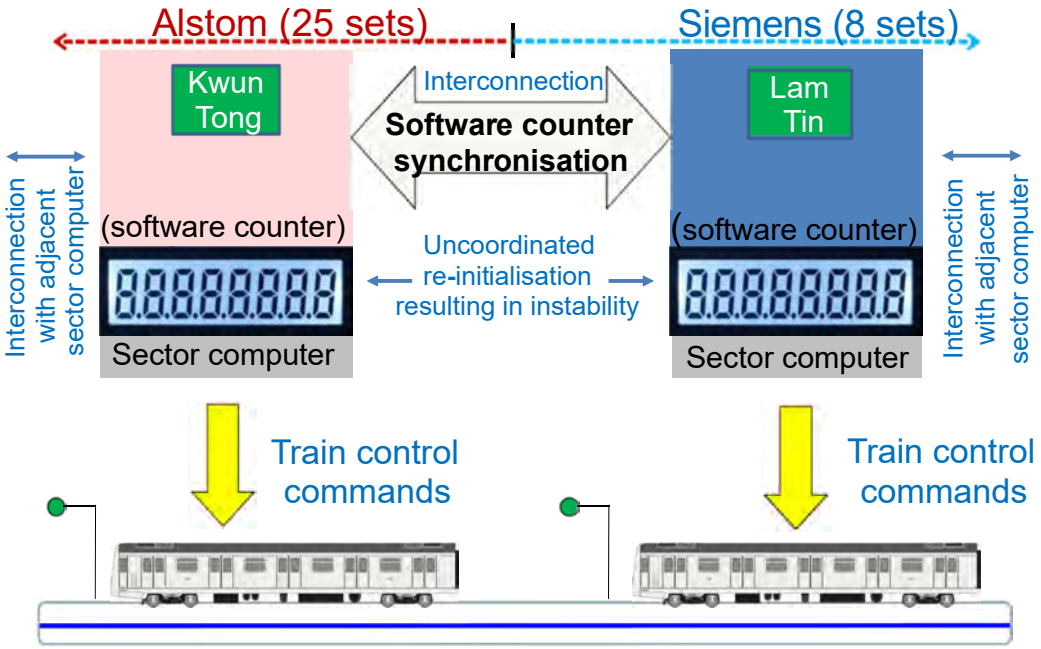
The MTR network in Hong Kong was affected by a signalling system failure on 16 October 2018 that was unprecedented in scale as the failure involved four of MTR's urban lines. From 0528 on that day, the Operations Control Centre started receiving reports that trains on three lines were receiving unstable train control commands. The trains could only be operated in manual restricted mode (RM) during train deployment and preparation before the start of revenue operation. Subsequent to that, about five hours later while recovery on the three lines was underway, trains on a fourth line were reported to be losing train control commands which also resulted in similar manual RM operation.

Normal service on all four lines was resumed progressively from 0920 onwards to 1145. During the incident, all trains in revenue service on the affected lines were operated at low speed with overspeed protection, with all train movements to be authorised by a traffic controller according to procedures. With such an extent of failure, the general public in Hong Kong experienced massive delays and inconvenience in their journeys. Other public transport operators were coordinated to provide emergency support.



Case 1 – Above, the location and suppliers of sector computers on the lines affected by the situation.
Image MTR Corporation.

Right, uncoordinated counter resetting resulted in the propagation of an endless loop.

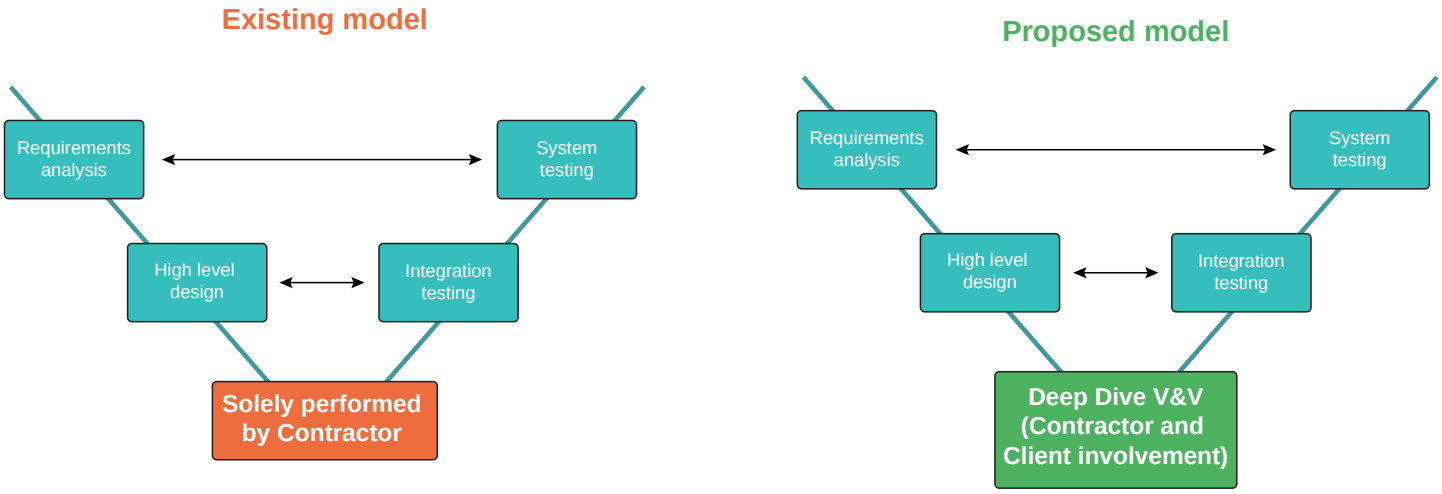


"Re-initialisation arrangements for the two suppliers' sector computers are different"

How the software behaved

An investigation panel was established and immediate review of the system failure was conducted with both suppliers. Failure scenario simulation was attempted in non-traffic hours and further analysis was carried out shortly thereafter. It was revealed that data transmission between sector computers is always synchronised through an internal software counter in each sector computer. These internal software counters have commenced incremental counting since deployment for revenue operation. Once any individual sector computer is rebooted, its counter will be re-initialised and will immediately synchronise to the higher counter figure for the whole synchronised network. Given this principle, when Siemens sector computers were commissioned and put into revenue operation in 2001/2002, the relevant counters were synchronised to the Alstom sector computers with a higher counter figure, which were installed in 1996. If the counter reaches its ceiling figure, which is bounded by its allocated number of bits, the associated sector computer will halt and need to be re-initialised. However, the re-initialisation arrangements for the two suppliers' sector computers are different.

The Alstom ones will be re-initialised automatically once their counter reaches a built-in re-initialisation triggering point approximately 5 hours before reaching the ceiling figure. However, the operators and maintainers had not been made



MTR proposes to use an enhanced model in future software governance.

aware of this internal software function. The Siemens ones do not have an automatic re-initialisation function and therefore need to be manually re-initialised through rebooting on site by maintenance staff.

Counter issues

The investigation found that at around 0526 on the incident day, the Alstom software counters reached the built-in triggering point for automatic initialisation while the Siemens software counters continued counting up, creating an inconsistent re-initialisation situation between the two sector computers at the Kwun Tong (KWT) and Lam Tin (LAT) boundary between Alstom and Siemens. This resulted in repeated execution of re-initialisation in the Alstom sector computer at KWT followed by re-synchronisation with the higher counter figure from LAT, hence the KWT sector computer became caught in an endless loop causing corresponding instability in all 25 Alstom sector computers connected in the system.

"Our proposed way forward aims to increase vigilance during the lower and deeper parts of the V-cycle"

When all the Siemens software counters reached the ceiling figure at around 1022, about five hours after the Alstom software counters first passed their automatic re-initialisation triggering point, the eight Siemens sector computers halted as designed.

Among a series of recommendations from the investigation panel, actions completed include regular checking of software counter figures for all relevant lines, and implementation of a maintenance programme for manual re-initialisation of all the software counters in the signalling systems at relevant lines before the software counters reach the relevant triggering or ceiling figure. It was also recommended that a dedicated team with advisors from academia should be established to ensure the integration and performance of modified software-based systems is well controlled.

Comparing the established enhanced model against the original model shows how our proposed way forward in software governance aims to increase vigilance during the lower part and deeper part of the V-cycle, through more coding review and extending coverage of testing extremities in software.

The four-line incident also posed a more far-reaching question to us: as signalling practitioners how do we face the challenge of knowing in-depth coding and its behaviour within the system itself, and also consider its interfaces to connected systems? The assurance mechanism to enhance software performance and integration, in view of the deployment of more and more software-based systems, inevitably turns out to be one of the keys to sustainable and successful operation in the future.

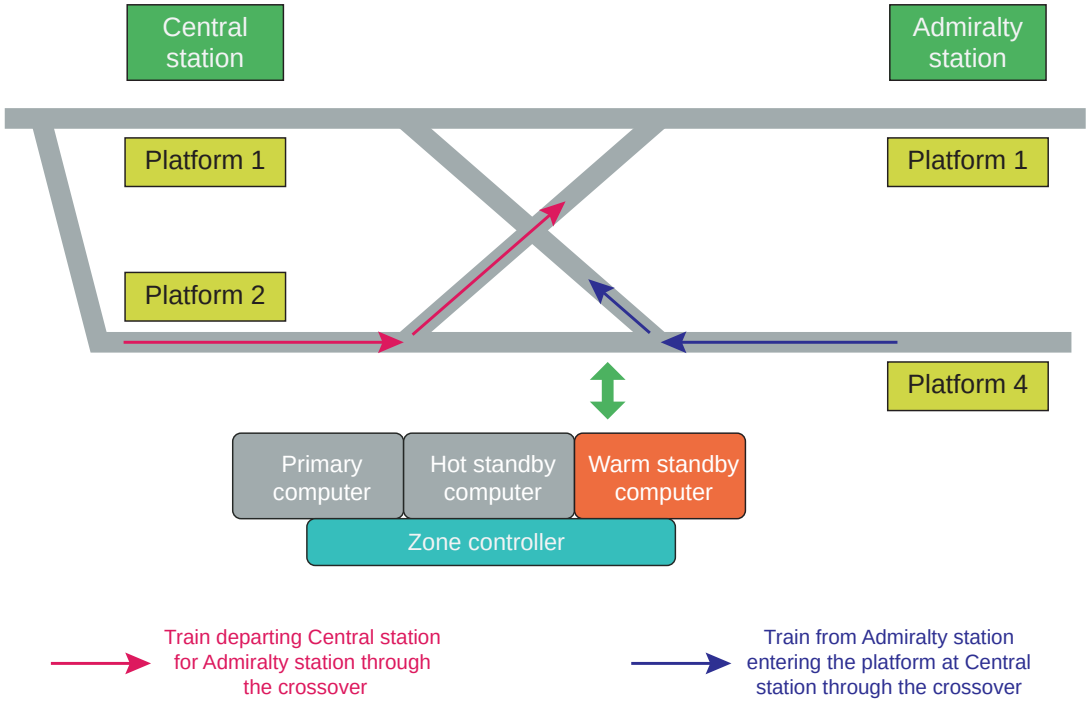
Case 2 – Software development

During the non-traffic hours on 18 March 2019, a drill during the test running stage was conducted on the new CBTC signalling system provided by the contractor on the TWL. The objective of the drill was to familiarise the operators with the system behaviour and the application of operational procedures in a situation in which both the primary and hot-standby computers failed and there was a need to switch to the warm-standby computer.

A software issue was experienced at around 0244. A non-passenger test train which was heading to a platform of Central Station (CEN) through a crossover collided with another non-passenger test train that was departing from CEN for Admiralty Station (ADM) through the same crossover, causing damage to both trains. Both train captains were sent to hospital for medical checks and they were discharged on the same day.

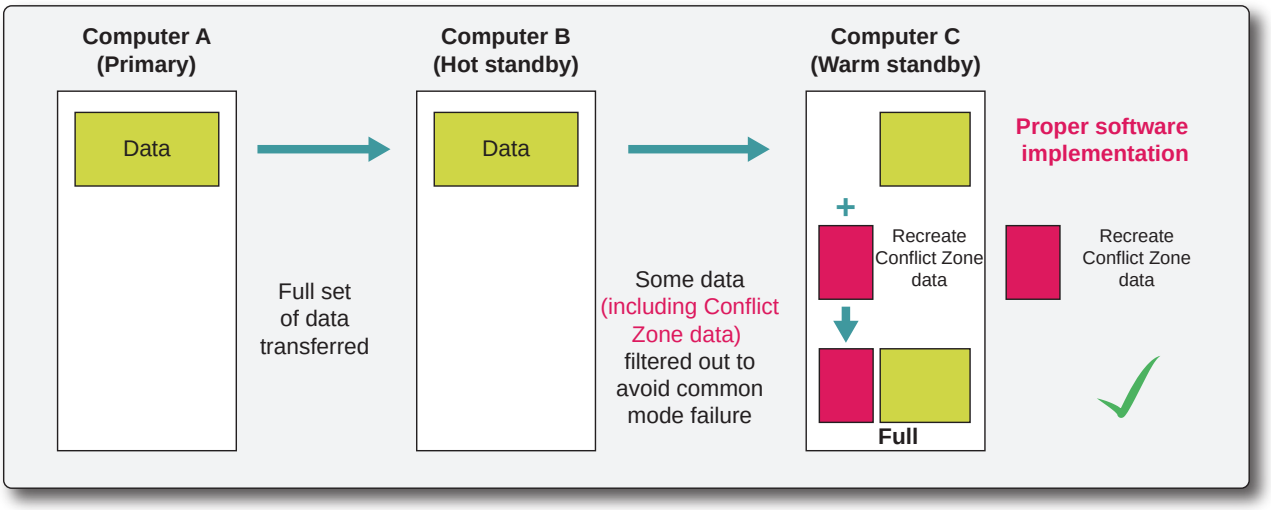
MTR was greatly concerned about the incident and therefore set up an investigation panel with membership consisting of MTR senior personnel and external experts to investigate and identify the cause of the incident, and make recommendations to prevent the recurrence of any similar incident.

The investigation concluded that a software issue existed which led to the missing of conflict zone protection i.e. interlocking in software at the

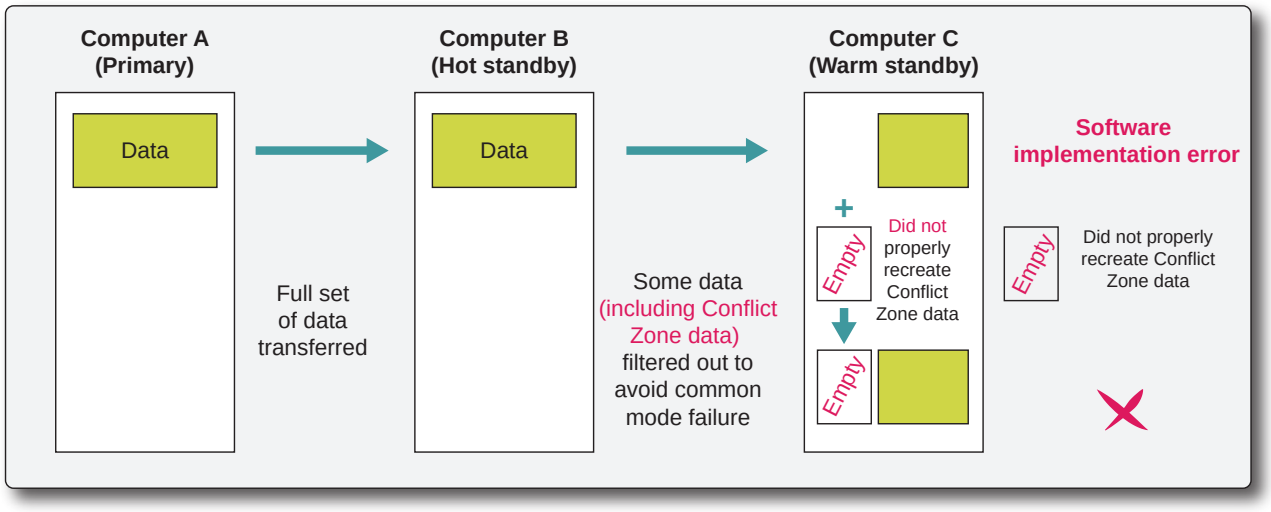


Case 2 – Train movement during drill.

Design intention developed



What happened



Software implementation errors resulted in an unknown software issue.

"Concerted and timely efforts from all stakeholders should be of great benefit"

crossover, resulting in the two trains being allowed to enter into and collide at the crossover. The software issue was created as a result of software implementation errors made during the process of performing a software change.

It was concluded that the software implementation errors reflected inadequacies in the software development process with respect to software quality assurance, risk assessment and the extent of simulation of this software change.

Recommendations were made to fix the software change issue and confirm with substantiation that there are no wider implications in software development quality. Enhancement in the software coding and testing practices shall be made to avoid future programming errors. Extra vigilance would be exercised to strengthen the monitoring on software deliveries, including upgrading the simulator in Hong Kong to act as a testing simulation tool to perform more operational scenario simulation tests as far as practicable.

The two cases of significant software-related events, whether directly related to CBTC upgrading works or unrelated as revealed in legacy systems in operation for over 20 years, drew a common focus again on the significance of software integrity in contemporary signalling applications.

Conclusion

The challenges we have been facing in CBTC upgrading are indeed by no means different from similar upgrading works in other parts of the world. In a nutshell, the works would inevitably bring significant changes to our operation and performance. We have to be mindful, during the whole course of works introduction, to maintain optimised methodology and proper vigilance whether it be from migration strategy to works implementation or in software governance from development to integration. Concerted and timely efforts from all related stakeholders should be of great benefit in guiding us along the pathway of carrying out changes in our railways.

About the author ...

Gordon Lam is the chief signal engineer (operations) overseeing resignalling works and overall signalling development for MTR in Hong Kong. He is a railway signalling engineer with over 30 years' experience covering design, installation, integration and commissioning. He has managed MTR signalling projects in Hong Kong including the Lantau Airport Railway, Tseung Kwan O extension, and Disneyland Resort Line, and also spent over ten years working in MTR's Mainland China hubs including Shanghai, Hangzhou and Beijing covering implementation of CBTC in hubs, E&M project management, operations management and joint venture company management. Gordon is a Fellow of the IRSE and serves on the Education & Professional Development Committee and the Executive Committee of the Hong Kong Section.

What do you think?

What is your experience of delivering upgrades in complex operational scenarios? Have you faced similar issues to those overcome by Gordon and his team? Have you adopted a different approach to the introduction of CBTC on a busy railway?

Our Institution thrives on the exchange of information between our members across the globe. We'd love to hear from you about how you have delivered change, share your experience by emailing **editor@irsenews.co.uk**.

How much of your work counts towards your CPD?

Continuing professional development is an essential part of being a professional engineer and a member of the IRSE.

Had you ever thought about how many ways there are to carry out this CPD though? Here are just some examples of how you can do this – just remember to record your activities!

Additional responsibilities: Increasing or refreshing your skill set and demonstrating your personal responsibilities by volunteering to take on additional duties such as supervising others.

Buddying, coaching or mentoring: Sharing your knowledge of your company, discipline or industry by acting as a buddy, coach or mentor.

Shadowing: Increasing your understanding of your company or industry or widening your domain knowledge through work shadowing.

IRSE events and conferences: Increasing your technical knowledge and widening your network.

Management skills: Increasing and practicing leadership skills by organising sharing knowledge sessions such as 'lunch and learn'.

Developing your career: Increasing your profile by transferring to another grade in IRSE.

Technical knowledge: Increasing or refreshing your knowledge by reading up in technical papers, journals (like IRSE News) and specifications on projects, techniques or equipment being used.

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How digitalisation is delivering improved customer experience

Rob Morris

"The ultimate aim of our industry is simple ... to improve the overall experience of the railways' customers"

Digitalisation is driving change in industries worldwide, with the rail sector one of many to take advantage of new technology and processes to deliver operational, performance and value benefits. But if we as an industry are to make the most of this, I think we also need to transform the culture of our industry. To do that, we first need to understand why we are digitalising our railways – quite simply to improve the experience of the railways' passengers and freight users.

Digital solutions are increasingly being applied to rail projects worldwide, with many recent and planned schemes either incorporating digital systems or at the very least ensuring programmes are 'digital-ready' and future-proof. My own company's focus is to use digitalisation to enable mobility operators worldwide to make trains and infrastructure intelligent, to increase value sustainably over the entire life-cycle and to enhance passenger experience.

The technology brings major benefits to network owners, operators and maintainers, but perhaps even more importantly, it brings significant improvements to our customers' experience, whether they are buying freight or passenger services.

The rail industry has an outstanding record of innovation and delivery, with major advances in infrastructure, vehicles, communications and control systems evidenced in recent projects around the world. However, for many businesses involved in delivering engineering programmes, the passenger experience is often seen as a by-product of the project rather than being at its core. It's easy to become so focused on the development and evolution of new technologies that the effect individual design decisions have on the customer's experience becomes a secondary consideration.

If engineers are absorbed and focused solely on writing interlocking data, designing telecoms, control equipment, or a power supply scheme for a major project, then we can lose sight the ultimate aim of our industry. That aim is to improve the overall experience of the railways' customers, be they passengers or those sending freight by rail, recognising the importance of railways in today's world. So whilst change is vibrant and exciting, not to mention vital for the progress of our industry and the businesses that operate in it, we need to continue to drive towards a focus on customer service, For our industry this means putting the passenger and freight user first. There are a number of reasons why this is so important.

Sustainable business

Firstly, as well as being a critical element of national infrastructure, the railway must be a sustainable business, attracting and retaining customers, and making sufficient profit to allow ongoing investment in its maintenance and upgrade.

The socio-economic impact of the railway is enormous. In the UK alone 1.7 billion passenger journeys are made by rail every year, using the network to get to and from work, for education or leisure, and many industries rely on the railways for movement of goods. In addition, the railway is not only a major national employer itself, but it also fuels a supply chain which employs an additional 250 000 people in the UK alone. Rail underpins the smooth running of this country, but we must deliver what our customers need to support this.

This is summarised neatly in the Rail Sector Deal, a new collaboration between the UK Government and the rail industry, which says: "A well-functioning railway is a driver of economic growth, as it allows people to travel more widely

Technology offers huge potential benefits to railways worldwide, but do we always remember why we are digitalising? *Photo Siemens.*

"Safety underpins everything we do as an industry"

"The use of technology allows for capacity to be unlocked on many of these lines"

for work, makes more effective use of our existing network's capacity, and moves goods between suppliers, manufacturers and customers reliably and cheaply.

Rail is increasingly an environmentally sound means of travel. However, its customers often have other travel options, so we need to stay attractive and competitive, helped by digitalisation which enables us to reduce energy usage and improve our environmental impact – factors which resonate with our environmentally-aware audience.

Safety is often overlooked when we talk about customer experience, but it underpins everything we do as an industry. We have a responsibility to provide safe transport for those who use the railway and ensure the safety of those who work or live close by, or who need to cross the tracks.

Affordability and value for money

We need to remember that in many countries the railway infrastructure is owned by the government and that everyone who uses it is a taxpayer. Quite rightly we expect our taxes to be spent wisely and efficiently, bringing the best possible value for money.

Affordable travel is essential if we are to meet our customers' expectations and aspirations and so fares and private sector profits need to be reasonable. Passenger levels have grown for many years, as has the cost of fares, to meet the cost of investing in and maintaining the railway. To make best possible use of investment we need to tackle the rising cost of maintaining and upgrading railway assets.

Using technology to bring change

Technology and digitalisation can improve the efficiency of this investment, with a direct link to the amount of money required to operate the railways and the costs experienced by network providers, train and freight operating companies.

We can also better manage the demand for rail, allowing app-based technologies to better inform passengers about travel costs and alternatives, with the aim of matching supply and demand throughout the day.

In other words, leading to optimising capacity. Much of our railway is significantly constrained by where it runs, and new infrastructure or significant changes to existing routes can be prohibitively expensive. The use of digital technology allows for capacity to be unlocked on many of these lines. More trains mean a more convenient service, and the availability of more seats on potentially less crowded services, all directly improving customer experience.

Digitalisation provides a huge opportunity for us to achieve this, with technologies that have the potential to radically change the way we think about transport. Demand responsive transport (the provision of trains, trams or buses in response to real-time passenger demand) and the concept of 'Mobility as a Service' (where privately owned vehicles are replaced by a fully integrated multi-modal transport system) are real development opportunities for the industry, both of which will see customer experience driving the transport network.

Train control systems are one way of unlocking capacity

There are many ways in which digitalisation can have a positive impact on customer experience, many of which are already being employed. For example, technologies like the European Train Control System (ETCS) have been installed on many rail networks in recent years. Using digital radio messages between trackside and train, ETCS improves the performance and safety of the railway, with on-board systems monitoring speed and position continuously, and applying the brakes if a potentially hazardous situation arises.

One example of recent deployment of ETCS is the technically complex Thameslink Programme, one of the highest profile infrastructure programmes to have been delivered in the UK in recent years. To achieve the programme's performance targets, Thameslink also introduced automated train operation (ATO), which will allow every train to follow an optimum speed/distance profile as it moves through the network.

Through this combination of ETCS and ATO, the digital signalling system has unlocked much of the latent capacity that existed on the Thameslink network and provides the capability for greater numbers of trains per hour to operate in the core area during peak hours. The solution also brought significant passenger benefits, with smoother, more frequent and more reliable journeys together with access to better information – including directing passengers to coaches where there is available seating.

"The Thameslink Programme is a great example of how digital technology can help unlock capacity on a constrained network"

The Thameslink Programme is a great example of how digital technology can help unlock capacity on a constrained network. But it is not unique. The UK is by no means alone in having infrastructure that has to operate on an ageing network with old structures and alignments. And with the provision of new infrastructure or significant changes to existing routes being prohibitively expensive in most cases, the use of digital technology can have a major impact. More trains mean increased capacity, with more seats on potentially less crowded services; all directly improving customer experience.

While ATO provides consistent driving, high-intensity railways need traffic management (TM) to improve regulation and minimise the impact of service disruptions, providing information to operators to better assist them in making the hundreds of decisions they face every day. This technology directly helps both operators and customers, delivering a more reliable, predictable and punctual railway, with improved capacity and better-quality information.

Managing the network

Intelligent software and accurate data are vital; not only to the successful application of TM systems, but also for timetable management systems to become valuable and trusted long, medium and short term tools. The data that underpins these off-line and on-line planning tools opens a real opportunity to not only optimise network operation, but also to revolutionise the provision of information to the travelling public, helping them to make informed decisions and so ultimately improve their travel experience.

Digitalisation has a role to play not only in underpinning these new and sophisticated planning and control tools, but also in the products that have been at the heart of the railway's operation for decades.

For example, interlockings, the cornerstone of safe operation, have benefited from digitalisation, with engineers now commonly developing network-based signalling systems for the world's most complex railways. These systems use ethernet-based networks to connect signalling assets and control systems to deliver significantly improved levels of reliability and availability. This technology reduces the likelihood of delays due to equipment failure and so has a direct positive impact on customer service.

From a service perspective, big data techniques and artificial intelligence will help accelerate the drive to predictive maintenance on everything from trains to structures, signalling to telecoms, as well as the provision of better information for both railway staff and passengers. For example, the latest remote condition monitoring solutions monitor the condition of track assets using the accelerometer sensors that are already present in our latest cab radio.

Using this technology, the capabilities and reliability of this software-based solution have been proven in trials, with asset owners, managers and maintainers all benefiting from monitoring the track network remotely – and passengers experiencing improved reliability and availability.

Real-time connected driver advisory systems (C-DAS) which give route information and speed advice to drivers, or indeed on-board computers on automated railways, allow energy consumption and arrival times to be optimised. This ensures smoother, more reliable and more predictable journeys for passengers. Route data, timetable updates and temporary speed restrictions can all be uploaded remotely to the system, ensuring that operators and passengers benefit from improved reliability, punctuality and performance.

In London ETCS and ATO have been used together to unlock capacity on the tightly constrained Thameslink line across central London. *Photo Siemens.*

Sometimes those involved in railway engineering can get caught in a mindset of 'moving trains around', but the railway exists to move people and freight. Can we be confident that everyone on the concourse has all the information they need to have a safe, smooth and pleasant journey through the network?
Photo Shutterstock/ Willy Barton.

The end-to-end journey

When we talk about the customer experience, we need to look beyond the train itself – and even the platform – to examine the 'end-to-end' journey. Ticketing and pricing could no doubt warrant an article all of its own, but it is undoubtedly an area where digitalisation can bring significant passenger benefits.

One such approach is the use of mobile-device applications. By providing live information to the railway's customers in return for information about where they are and what their plans are, we can rapidly move towards situations in which a ticket doesn't have to be bought, but a traveller will be charged based on their actual movement through the network.

We have seen the successful deployment of these approaches in major European cities such as Copenhagen and Hanover, where a quick check on a phone can give passengers information about not only the fastest route, but the cheapest alternative mode of transport, updated in real-time and tailored to that individuals' needs.

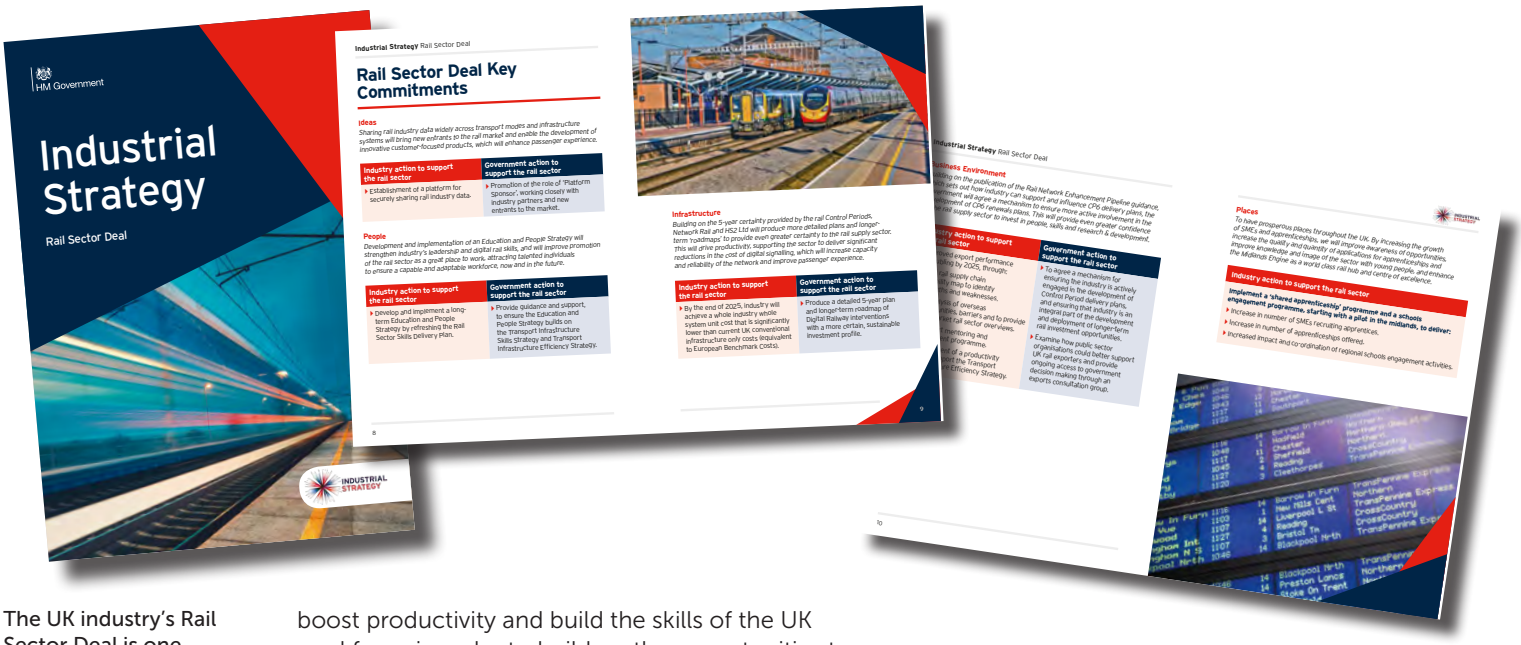
In Dubai, a new app has been launched that brings together all transportation modes from 12 different operators; previously all had their own apps. The Dubai Integrated Mobility Platform (DIMP) is a cornerstone of the city's smart city strategy and the operator's vision of safe and smooth transport for all. The app allows customers to benefit from improved information, integrated journey planning and smartphone ticketing and represents an ideal platform on which to build towards a complete 'Mobility as a Service' solution.

The technology is already making a difference to the customer experience – and is providing more than a glimpse of the future, bringing our visions much closer to reality.

The UK Rail Sector Deal

However, we also need to use technology to improve the way we deliver the railway of the future. In the UK, the Rail Sector Deal (**irse.info/h9nbp**) is bringing this vision closer to reality and represents a new approach to collaboration in order to increase the use of digitalisation on the railway. The document was created by the UK Government and the rail industry, recognising the importance of the railway to the nation, and the collaboration necessary to accelerate the delivery of a truly innovative network. The Sector Deal sets out how this will

Systems that use "check in/check out" technologies are commonplace today, but smartphone apps can offer yet more to help those travelling to make correct decisions.
Photo Siemens.



The UK industry's Rail Sector Deal is one country's approach to seek cross-industry commitment to innovation, collaboration and delivery focused on the experience of those using the railway. *Image BEIS/UK Government.*

boost productivity and build the skills of the UK workforce in order to build on the opportunities to improve customer experience of our railways.

Specifically, it recognises that there are many stakeholders in the industry who have access to huge amounts of data. The Sector Deal looks to establish a platform for securely sharing rail industry data, allowing those already in the industry, and dynamic, innovative start-ups and smaller businesses, to use the data to derive value for the network.

Investment in automation is critically important, using one 'single source of truth' to create all the data necessary to configure modern command, control and signalling systems, and we are seeing significant progress across the industry in this area.

Conclusion

Quite possibly we are only just beginning to realise the customer benefits that digitalisation can bring, although we as an industry should be proud of what has already been achieved.

We should look to successes such as the automated trains and ETCS-enhanced safety levels, the implementation of TM and C-DAS technology at locations around the world, and the massive improvements in reliability and availability that many railways have seen and build upon them.

I believe that it's important that to continue this innovation and the exploitation of digitalisation. We should look to countries and industries that have had successes in related applications and recognise the huge opportunity that the global railway industry has ahead of it. We can build on the industry's strong supply chain, world-leading academic institutions, committed infrastructure organisations and innovative operating companies.

This isn't going to be easy, largely because of the rapid rate of change we face. However increasingly governments, the railway supply and delivery industries and all other stakeholders have already committed to use digitalisation to bring a real change in the levels of customer experience.

"Quite possibly we are only just beginning to realise the customer benefits that digitalisation can bring"

About the author ...

Rob is the managing director of Siemens Mobility Limited, Rail Automation, responsible for all of its UK rail command, control, signalling, digital rail and automation activities across rail infrastructure for Network Rail, London Underground and Crossrail.

His career spans four decades in multi-disciplined major projects working for mining, power, general construction and technology-based businesses both internationally and in the UK. He graduated as an electro-mechanical engineer, expanding his knowledge and experience through a multitude of technologies and disciplines throughout his career.

Rob is Industry Champion for Digital Transformation for the Rail Sector Deal and is a member of the Rail Supply Group Council.

What do you think?

Do we as an industry do enough to remember why we're here? Do we tend to concentrate on the physics of moving trains around networks rather than moving people and freight by rail? Do we do enough to collaborate with others in our industry and key stakeholders like government?

Have you got experience of where digitalisation has shown real social and economic benefits on your project or in your country?

Let us know, we'd love to hear from you, email us at **editor@irsenews.co.uk**.

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Delivering change through the completions process

Steve Boshier

With a new generation of people and technologies involved within the rail industry, the need for a high performing and well understood completions process has never been greater. Projects are being pushed to do more work, more quickly, and more smartly, resulting in the completions process being ignored until it is too late. For many project personnel, Completions is viewed as the end phase of the project, a part of implementing new technologies, or the close-out of staff competency requirements. I argue completions is much more than that, and an area that is most often misunderstood.

The completions process starts at the beginning of the works and is only completed when stakeholders are provided with the promised deliverables and outcomes. This means project teams delivering long after physical works are complete. The key to achieving the promised outcomes is proper planning and having the right people accountable for driving the process. In addition, these people need to be supported by clear frameworks and easy to use technology systems.

A completions framework is required that ensures the end users receive the full benefit of their investments, and that the assets being delivered can be properly operated and maintained. The completions process starts at the beginning of the project with the end very much in mind, and success is achieved by using technology and a progressive completions approach. With this process, projects can be delivered on time and within budget. Stakeholders are provided with what they need, and the project team can walk away knowing that they have delivered what they promised.

Completions

"What is completions all about?" I hear you ask. So often, I hear people saying that completions is just about as-built drawings and Operations and Maintenance (O&M) manuals handed over at the close-out of the project. "We will provide it later" really means just before the last person standing on the project disappears into the sunset – never to be seen again.

Similar common sayings are "We are too busy designing and constructing the project and will deal with completions at the end when we have some time" or that "People are rushing around to get things done and just don't have time to consider the end of the project."

Does it all sound too familiar? Completions is much more than as-builts and O&M manuals; it is about assuring that the end stakeholders receive everything they need to efficiently operate and maintain the new assets provided.

Unfortunately, completions is often considered as an end of project activity, and not part of the design and construction phases. This perception results in completions assigned with less time and resources than required, often to the project's serious detriment.

Completions is a process that must commence at the start of the project and finish after all notified defects are fixed, typically called the Defects Liability Period (DLP) or Defects Corrections Period (DCP). For a large project, this is usually recognised by a Final Completions Report (FCR).

Therefore, instead of just talking about completions, we all need to be talking about the 'completion process' and plan for it during the development phase of the project, not once construction has finished!

Completions process

The completion process is a new mind set which is helping to refocus our project team's approach to how they deliver project outcomes in a timely fashion. The process needs to be considered from the start of the project, and not limited to only one department. This sounds to be obvious good planning practice but is so often not occurring.

The aim of the completions process is 'making the impossible – possible' by creating a culture change and focusing the project teams to ensure that they deliver the right outcomes. This means finishing the project off and ensuring that stakeholders receive an asset, which they can both operate and maintain to the required standards. It's very much more than just activating a new project involving bringing a new project into operational service.

The completions process has been around for many years, perhaps even thousands. I bet even the Romans knew how to design, construct and hand over a completed project designed to meet the end stakeholders' requirements.

The process Steve describes in this article has been used to great effect during the level crossing removal programme being carried out across the Victorian network.
Photo Level Crossings Removal Authority.

So why should we care about the completions process, you may well ask. It is the unloved part of the project and is often seen as not being important. However, in reality, the only people who don't care about completions are the ones who have never operated or maintained an asset. Operations and maintenance managers know only too well the cost blowouts caused by poor data or missing technical information which should have been handed over but wasn't. Poor completions can seriously impact the end user's bottom line.

Engineers have a great ability to design solutions to problems and in this day and age the design work is often performed using digital engineering tools. Why tools? Because they provide the benefits of clash detection, collaborative working, and increased productivity. Unfortunately, these benefits often disappear at the construction phase and the Issue of Drawings for Construction (IFC).

The construction team start their work based on the designs provided. They build some innovative infrastructure, mostly in accordance to the IFC drawings. There are always some changes necessary, and any changes are hand marked up onto hard copies of the drawings, then set aside for updating at a later stage. Why not update straight away? Because they are too busy building the work to do it now. The pile of red line drawings just grows bigger every day until near the end of the project, until someone asks for the as-built drawings, so they can maintain the works. The construction works have finished (mostly) and the new asset is brought online so that the users get benefit of it as soon as possible. Trains are back running again. Cars, buses and trucks are using the new roads. The landscaping is still to be finished off, some road and footpath sealing to be completed and stairs finished off, so it's nearly there. Or is it?

One key question that should be asked is "do the stakeholders and asset owners have everything they need to operate and maintain their new works?".

Other key questions are "Have staff been trained on the new equipment provided? Has all the asset data been provided including updates to geographical information systems (GIS), asset registers, warranties, maintenance agreements, certificates and approvals, system safety assurance reports, defects closed-out? Has the as constructed acceptance sign-off been received from all stakeholders?".

Out of the blue near the project's conclusion I often hear "Where are the as-built drawings?". What follows is a mad scramble, and eventually the last few engineers on the project are tasked with sorting it out. As they can't read or understand all the as-built hand mark-ups, these remaining engineers end up spending days back out on site trying to figure out exactly what was built. The site engineer who originally marked up the drawings is long gone, having moved onto their next project that is far more interesting than closing-out the current works. It sounds like a familiar situation, doesn't it? You can imagine the asset owner's frustration trying to operate the asset with incomplete drawings and missing data.

Progressive completions

To have a successful completions process, you need to be looking at where you are, where you want to be, and how you are going to get there, all this with the mindset of progressive completion. Management needs to be planning for completions from the start, which means ensuring there are the right types of skills and resources provided at the right times throughout the project. In addition, there needs to be an adequate level of funding provided for all the completions' activities required, not just a baseless guess.

Often, we talk about delivering a whole life approach, but it's not always followed through or gets forgotten about along the way. This is an area where the completions manager can work closely with the design and construction teams to ensure what was promised is delivered on. Whilst the cost of delivering project outcomes is getting more expensive every year, we are being pushed to do more with less. This can be achieved without cutting corners if the deliverables and outcomes are well defined, and by the appropriate standards.

Progressive completions means working on the completions activities from the start of the project. To drive these activities, a completions manager should be appointed at the start of the project, and this person will be accountable for ensuring the right outcomes are achieved. They will need to work closely alongside the engineering manager, design manager, construction manager and project manager throughout the project life-cycle, and not just be brought on at the end of the project to try and pull together the deliverables to be handed over.

Getting you to the finish line sooner

Completions Process

LEVEL CROSSING REMOVAL AUTHORITY

WORKS COMPLETION (IN OPERATION)

Acceptance
- Stakeholder Acceptance to Operate
- Certificate of Train Running & Cert 36 – Ops & Completions, Driver Training
- Certificate of Occupancy

As Built Drawings
- Red Line Markups (RMU's) & Signalling Test Copies

Asset Data (F24)
- Drawings & Documents Required for Operation & Maintenance
- EACR Asset Data (Ellipse Data)/Asset Registers
- Operation & Maintenance documentation & Training

PRACTICAL COMPLETIONS REPORT (TYPICALLY 12 WEEKS POST WC/OR PAA)

Management Plans
- Completions & Handover Management Plan
- Design Engineering & Management Plan

Completions WBS
- Area/Sub Area/Component

As Built Drawings
- Master Drawing List
- IFC – Issued for Construction
- RMU's – Red Line Markups
- Back Drafting
- Review
- As Built Drawings certified for DMS/VicRoads/Other Stakeholders

Asset Data (F24)
- Drawings & Documents Required for Operation & Maintenance
- Asset Data (PASS Assets, Ellipse Data, GIS, Rail Map, Asset Registers)
- Guarantees, Warranties & Service Agreements
- Operation & Maintenance Documents
- Asset Handover/Maintenance Responsibilities/Access Agreed

Assurance
- Approvals & Certificates (Design & Verification)
- Certified Survey's & Boundaries
- Rail Infrastructure & Rail Service Approvals
- Training Material & Records to support Safe, Reliable & Efficient Operation
- Project Assurance Report (PAR) - Requirements Traceability (DOORS reports)
- System Safety Assurance Report (SAR)
- Audit Reports

Acceptance
- Stakeholder "As Constructed" Acceptance

Defects Correction Period
- Defects Correction Period

POST PRACTICAL COMPLETION DOCUMENTATION (TYPICALLY 12 WEEKS POST PC)

Residual As Built Drawings
- All As Built Drawings accepted into DMS/VicRoads/Other Stakeholders

Residual Asset Data (F24)
- Sustainability Management Plan & Report
- All Asset Data Accepted into Ellipse & PASS (Images)/Other Stakeholders

Residual Assurance
- Data & Information to support the Value for Money Report

Final Close Out
- Final As Constructed Completed Documentation
- All Documents as per the Doc Control & Doc Management Plan
- Landowner/Occupier – handback close out
- PTV Legacy Package

FINAL COMPLETIONS

Close Out
- Final Completions Report – end of 2 year Defects Correction Period (DCP)

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Figure 1 – Illustrating the completions process. A picture tells a thousand words and this example illustrates how the completions process can be applied to a large, complex project in order to show how a progressive completions approach can get you to the finish line on time.

Let's look at some fundamental principles where the completions process can help drive the right outcomes.

At the start of the project, having a clear understanding of the project requirements is really important, as is identifying who the asset owner and maintainer is and getting their sign off on what is going to be delivered. In achieving the sign-offs, it's important that a completions acceptance criterion, which includes a generic list of completions artefacts, is produced against the actual scope of works. These documents will be used as the basis for the acceptance of the completions and handover deliverables.

The above process ensures that stakeholders and asset owners are involved early on in the project, and not forgotten about during the rush to get going. For large projects, which can be spread over many years, this process provides protection on both sides for when people change roles or leave during the project. The approach also helps mitigate the usual close-out challenge where stakeholders and asset owners have different completions expectations to the project team. The resulting reluctance of stakeholders to sign-off can jeopardise the project budget and schedule.

Throughout the project, you will need to ensure that change management is used to track, approve and document the agreed changes with all applicable stakeholders. When you get to the end of the project, there needs to be clear traceability of any modifications made to the agreed handover deliverables.

Progressive completions artefact filing

A progressive completions approach is all about collecting, filing and reporting on the status of the deliverables. Progressive means starting at the design phase of the project, not a week before the practical completion milestone. This way, you avoid the last-minute rush of trying to find the required documentation and evidence, which ultimately leads to missed schedule targets.

Best practice is to file the artefacts (deliverable items or evidence such as documents, drawings and certificates) as they become available, not at the end. This will avoid trying to find items buried on people's desks or in emails a week before a milestone. When changes occur to an artefact, having it in the electronic filing system means that when there is a change, reporting metadata is automatically updated.

Another benefit of the progressive completions approach is that it also drives progressive submission for stakeholder review. This results in flattening out the workload. There is nothing worse than getting hit with a huge wave of details and documents to check all at once. The progressive completions approach is a more efficient way of turning around the reviews and keeping the stakeholders onside at the same time.

Completions milestones

The completions process can be highlighted by including key milestones within the project programme. A good example of what the key completions milestones might look is:

1. Completions & handover management plan
2. Work Breakdown Structure (WBS) – this is based on how the project is going to be designed and constructed. The WBS is used to structure the completion's reports by areas, sub-areas and construction elements.
3. Master drawing list – presents a master list of all drawings that the project plans to use.
4. As-built drawings – Drawings are produced progressively through the Design Phase until they are Issued for Construction (IFC). Red Line Mark-ups are produced during the construction phase through to practical completion. Red line mark-ups are drafted into as-built drawings and then issued for review/certification, before being issued out to stakeholders.
5. Physical works completions – represents the milestone when the new asset is activated and brought into commercial operation.
6. Practical completion is issued along with deliverables including as-built drawings certificated ready for handback to the stakeholder, defects have been closed-out, spare parts, warranties and work lots are all closed-out.
7. Final completions is at the end of the defects correction period (DCP) commencing at the award of practical completion. The project finally ends two years later with the delivery of a final completions report.

How are we going to get there?

The 'Completions process on a page' as seen in Figure 1 was created to:

- Explain the completions process.
- Show how we need to deliver completions deliverables.
- Illustrate that completions deliverables are more than just as-built drawings & O&M manuals.
- Highlight completions activities across the project life-cycle.
- Demonstrate completions commence at the start of the project (it really does!).
- Emphasise progressive delivery.

Conclusion

There are many great challenges for major projects, but by using the Completions Process mindset to change project culture, the result will be projects ending on time, on budget, and with happy stakeholders.

We need to move away from "people just doing stuff" and towards understanding what the project requirements are, what the deliverables are, who the stakeholders and asset owners are, and creating a plan to provide this outcome. Then when it comes time to hand the project over, there must be a clear set of documented completion deliverables for the stakeholders to sign off on. The process is designed to reduce any last-minute surprises, preferential engineering or new requirements being introduced last minute.

We need to be doing the right things at the right time during the project to ensure that a quality outcome is achieved on time and within budget.

My measure of success is:

- Firstly, getting people talking about completions.
- Secondly, people actually performing completions – that is putting in place the plan up front and delivering on it. This includes having completions milestones included in every project programme.
- Finally – the stakeholders and asset owners receive all the details they had signed up to at the start of the project by the time you get to the end of the post practical completion milestone.

Imagine how happy they will be!

About the author ...

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Managing obsolescence in the rail industry

Stuart Broadbent

This article was originally published by the International Institute of Obsolescence Management on the subject of obsolescence in the rail industry.

Obsolescence is a subject that is of particular importance to signalling and telecommunications throughout the world. Stuart Broadbent, obsolescence director of Alstom, and a director of the International Institute of Obsolescence Management (IIOM), describes how the rail industry can mitigate the risk of component and software obsolescence.

The increased use of electronic systems in rolling stock and rail infrastructure has undoubtedly improved operational efficiency and safety for the rail operator (passenger and freight), as well as enhancing the passenger experience. For the rail engineer, however, these electronic systems come with the added challenge of managing obsolescence.

Latest technology vs legacy

There is a simple reason why the rail industry is vulnerable to obsolescence and that is because most electronic component and equipment manufacturers are focused on their next-generation products and on emerging technologies. Moore's law is the observation that the number of transistors in a dense integrated circuit (IC) doubles about every two years, meaning more processing power in less space and using less energy; a five-year-old IC will never be used in the latest consumer product. This reliance on R&D to provide new revenue streams means that today's hot new products quickly become legacy parts as the component manufacturers follow development cycles that are driven by fast-moving consumer markets.

Mobile phone users will expect to upgrade their handsets every 18 to 24 months, whereas the planned life-cycle for rolling stock is usually 30 or 40 years.

There is also a significant difference in the volume of units shipped to the consumer and rail industries. Global shipments of mobile smartphones reached 1.47 billion units in 2017; compare that to the 6000 main line vehicles planned for delivery in the UK between 2014 and 2020, and the difference in the component requirements becomes clear. The difference in the expected operational lifetimes and the production volumes means the focus for manufacturers of electronic components will always be on latest technology components for high volume markets rather than legacy, low volume parts.

The expected lifetime of software also falls short of the life-cycle needs of the rail industry. Microsoft withdrew support and automatic upgrades for Windows 1998 after just eight years and ceased support for Windows XP after 12 years.

As Figure 1 shows, the challenge facing rail engineers is to ensure the continued operation of electronic systems well past the point at which the manufacturers no longer produce or support the components within them.

There are two types of obsolescence that need to be managed: functional obsolescence and technical obsolescence.

Functional obsolescence

Functional obsolescence occurs when installed equipment cannot be adapted to meet new standards or regulations for issues such as quality of service and efficiency. Examples of functional obsolescence include updated regulations for People of Reduced Mobility (PRM); changes in the availability of the radio spectrum for voice and data communication; and the lower processing power of a legacy computer being unable to support greater demand for sensor inputs or system intelligence.

Technical obsolescence

Technical obsolescence means that the correct operation of the equipment cannot be guaranteed because spare parts or technical support is no longer available from the manufacturer. Technical obsolescence may occur when a component manufacturer withdraws a legacy part so that the equipment in which it is used can no longer be supported, or when a supplier no longer wishes to support a product range or goes out of business.

In addition to the obsolescence of electronic components, the rail engineer may also have to consider the obsolescence of materials (regulations such as RoHS and REACH have stopped or restricted the use of hazardous chemicals and some raw materials), changes in production tools and even workforce skills. As older employees retire, younger recruits may not have been trained on the legacy systems and technologies that are still operating in the rail industry.

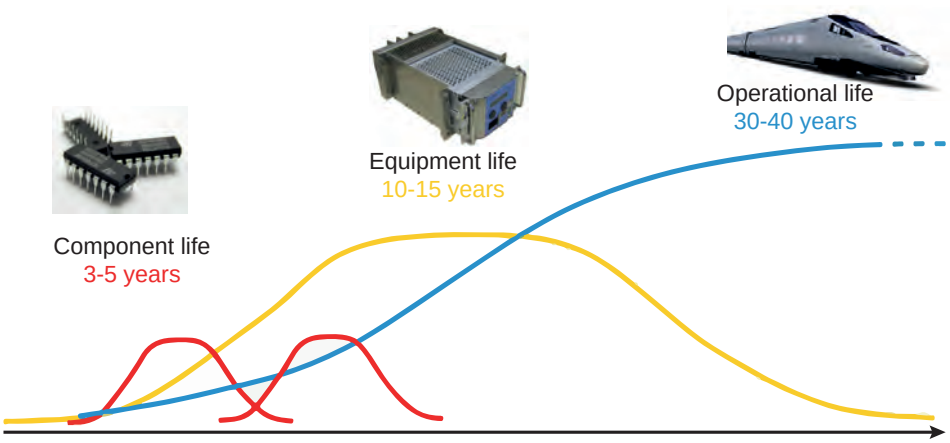

Figure 1 – Short component life-cycles make obsolescence inevitable in equipment with a long life-cycle.

GSM-R, the European standard for rail voice and data communication, and used in the UK for both voice communication and for ETCS, will only be supported by the manufacturers until 2030, and beyond this it will become increasingly difficult, and expensive, for infrastructure managers to maintain the same quality of service.

Managing obsolescence

In order to determine the obsolescence strategy for a product or system, the engineer needs to assess the likelihood and impact of obsolescence during the life-cycle. This assessment takes place at initial design stage and is reviewed periodically.

- If the combination of likelihood and impact of obsolescence is low, a reactive approach can be followed – in which nothing is done until the obsolescence materialises.
- If the combination of likelihood and impact of obsolescence is medium or high, a proactive approach should be followed – in which case there needs to be an obsolescence management plan to mitigate the obsolescence risks.

If the product or system includes software, the likelihood and impact of software obsolescence during the life-cycle also needs to be considered. Within the same product or system, there can be equipment and components that can follow a reactive approach, and equipment and components that requires a proactive approach. These strategies are described more fully in the new standard for Obsolescence Management, IEC 62402:2019.

A coordinated obsolescence management plan is essential for a proactive approach. It is also important to create a business-wide culture of obsolescence awareness, particularly in the R&D, engineering, maintenance, sourcing and supply chain functions.

Proactive obsolescence management should start during the initial stages of product design. At this stage, the risk of obsolescence can be mitigated by using techniques such as Preferred Parts List, obsolescence checks on proposed Bills of Material, dual sourcing, technology transparency (specification of interfaces) and by undertaking technology assessments and risk-mapping. Anticipating and planning for upgrades, and considering the road-map for each technology are also crucial.

When the system is installed and in service, obsolescence should be monitored at component, product and system level. This is achieved by periodically reviewing the market for emerging technologies and generating a watch list of critical parts. By monitoring the availability status of electronic components, the product manufacturer is able to make life-time buys of components based on forecast demand for production, spare parts and repairs when the end of production of components is announced. With good storage techniques, components can be stored for 20 years or more, helping to ensure that the product can be supported for its complete life-cycle.

A reactive approach is applicable to products with low or stable technology, or containing items with low likelihood of obsolescence such as mechanical or machined parts, and where the impact of obsolescence is assessed as low.

Sharing information and best practice

The International Institute of Obsolescence Management (IIOM) **www.theiiom.org** is the professional body for those involved in, or interested in, Obsolescence Management. The Institute is for professionals worldwide who wish to further their knowledge and understanding of the Obsolescence Management discipline, obtain professional recognition, and network with like-minded individuals from its global membership.

IIOM started in the United Kingdom as COG (Component Obsolescence Group) in 1997 and now has Chapters in Germany, India and USA as well as the UK. Members come from all industry sectors and all levels of the supply chain, and are located in countries around the world; members include asset owners and operators of systems and equipment, manufacturers of systems, equipment and components, and obsolescence solution providers.

Those joining the IIOM are able to network with people from other companies and industries on obsolescence management best practice in both obsolescence management and counterfeit avoidance.

The regular member meetings provide a mix of formal presentations and informal discussions at which obsolescence engineers, buyers and solution providers can exchange ideas on key issues such as REACH, conflict minerals and counterfeiting. The meetings also provide access to the latest tools and systems developed to reduce the administrative costs of obsolescence monitoring and management. IIOM members were heavily involved in the development of the new version of IEC 62402:2019, issued in June 2019, and IIOM has a series of guidance booklets on various aspects of Obsolescence Management.

Conclusion

Effective obsolescence management requires partnership between the asset owner, operator, system integrator and the equipment suppliers, built around a formal obsolescence management plan.

It helps rail engineers to ensure that the operational lifetime of equipment can be extended far beyond the timescales supported by the electronic component manufacturers and software suppliers. So, despite the throw-away culture of consumer markets, the rail industry should still be able to measure the operational lifetime of its equipment in decades rather than years.

Industry news

Main line and freight

DB future plans to control German train traffic

Germany: Deutsche Bahn (DB) have announced that their future plans for train traffic control will be delivered by 280 digital signal boxes. Germany's 33 400km network will feature new digital interlockings, replacing over 2 600 current interlockings of numerous types. The first digital interlocking, on the long-distance rail line between Rostock and Warnemünde is now in service.

Ronald Pofalla, DB Infrastructure Board member, said: "The railway can only make its contribution to the improvement of mobility and climate protection in Germany if it becomes more efficient. Digitalisation will make a decisive contribution to this. Digital interlocking units working in unison with the European-wide uniform train control system (ETCS) intelligently networking all data of infrastructure and vehicles. They enable a completely new organisation of rail operations for all companies. The rail will gain significantly more capacity, become more reliable.

EU funds for Dutch railways

Netherlands: The European Commission has approved funding of €22.2m (£19m, $24m) to equip freight locomotives with ERTMS. The funding is part of the EU's plan improve interoperability without affecting competition in the sector.

The funds will be used to install ERTMS on the 99 cross-border freight locomotives. Approximately 30-40% of the European Core Network Corridors are to be installed with ERTMS by 2023 and the Netherlands is planning to install ERTMS on the majority of its rail network that forms part of the European Core Network Corridors. The EU also noted that owners of the trains will need to upgrade equipment to ensure the effective use of ERTMS and the Dutch state will provide €23.8m (£20m, $26m) to support this

New world record: 375 wagons on single train

South Africa: Transnet SOC Limited has broken its own world record with the launch of a 375-wagon manganese train. The train is 4km (2.49 miles) long and runs over a distance of around 861km (535 miles), from Sishen to Saldanha in South Africa. The number of wagons was increased from 312 to 375 wagons, resulting in manganese volume rising from 19 656 tons to 23 625 tons per train. The previous record was an iron ore freight train carrying 342 wagons, also operated by Transnet.

The extra-long freight train was a direct response to rapidly increasing volumes of manganese export. Transnet's share of this export surged exponentially from 5 million tonnes in 2012-2013 to 15.1 million tonnes in 2018-2019.

Uruguay's Central Railway ERTMS

Uruguay: The Central Railway PPP project has awarded a €50m (£43m, $55m) contract to a consortium of CAF Signalling and Revenga Smart Solutions to install signalling and telecommunications, including ERTMS Level 1. The scope includes provision of an electronic interlocking and centralised traffic control.

The Central Railway project involves the rebuilding the 273km line linking the Port of Montevideo with Paso de los Toros. The line will be designed to allow 22.5-tonne axle load freight trains to operate at up to 80km/h. A 36km section of the line between Montevideo and 25 de Augusto will be used for passenger services.

New ERTMS testing and training centre

Norway: Infrastructure manager Bane Nor and Siemens have opened the Campus Nyland test, training and signalling simulation centre, marking a milestone in Norway's goal of becoming the first country to operate with a single digital interlocking. The centre will prepare staff to work within the ERTMS digital system and when fully rolled out in 2034 the system will cover 4200km of track and more than 350 stations.

Campus Nyland will be an industry centre for digital education and will house more than 5000 employees, who will learn the necessary skills needed to ensure ERTMS is successful when it becomes operational. This will include staff from Bane Nor, train operators, maintenance companies and contractors. The Campus will have simulator training as well as physical training facilities, using new technology such as virtual reality to communicate how lines are equipped with ERTMS, as well as the design of trains and traffic control centres. More than 150 different scenarios are available for training within the highly digitised training hub.

The Roa-Hønefoss ERTMS test line is due to open in spring 2020, with the new signalling technology to be monitored and tested from Campus Nyland, with the next milestone being the digitalisation of the Grong-Bodø Nordlands line, which is due to become operational in October 2022.

Swedish level crossing controllers

Sweden: Swedish rail and road infrastructure manager Trafikverket has contracted EFACEC to develop a new-generation automatic level-crossing system, known as XSafe. XSafe is the latest version of EFACEC's automatic level crossing control system and is based on the SIL4-certified HIMatrix series from HIMA.

EFACEC and HIMA have already successfully deployed XSafe level crossing systems on Portuguese and Polish rail infrastructure, and a similar architecture based on HIMatrix platform is also used in EFACEC's AEGIS Interlocking system, already in service in Oporto Metro (Portugal), Dublin Light Rail (Ireland) and being installed at Odense Light Rail (Denmark).

Leeds and Bristol commissioning

UK: Alstom has recently completed two large signalling commissionings for Network Rail.

West of England (Bristol) Filton Four Track Phase B was signed into use in November 2019. The final commissioning represented a milestone in the area, as the newly commissioned bi-directional signalling was an enabler to the new timetable introduced in December 2019.

Filton Four Track follows on from the commissioning completed at Leeds over the weekend of 26 27 November 2019 for the first commissioning stage for the Leeds station signalling and remodelling project. This project forms a part of the programme of works for providing capacity enhancements at Leeds Station

and includes the provision of new platform 0 and the remodelling of the approaches to platforms 1-6 to provide more parallel moves.

The scope included signalling alterations in order to maximise the benefit of the new layout, involving the re-lock of eight SSIs controlling Leeds station into a new Smartlock based in York Railway Operating Centre, and a new auto re-configurable feeder to power the new signalling equipment.

Scotland to upgrade north-east and Highlands network

UK: Network Rail Scotland has announced plans to make an investment of £4.5m (€5.2m $5.8m)to improve performance in the north-east and Highlands rail networks. The Highland main line, East Coast main line, Aberdeen-Inverness line and the Far North line will receive upgrades; with new machinery, equipment and extra staff for depots in Inverness and Perth.

The money will be primarily used to renew or upgrade signalling systems and to acquire remote monitoring systems capable of identifying potential faults. The money will also be spent on track maintenance, new machinery and equipment, as well as line-side vegetation clearance.

Network Rail stated that it has increased the infrastructure reliability in Scotland by 26% compared to last year. It also plans to conclude the £330m (€382m, $426m) Aberdeen-Inverness Improvement Project in December, to cut journey times and increase service levels. Last year, Network Rail announced its plans to invest £4bn (€4.6bn, $5.2bn) in Scotland railways between 2019 and 2024.

Poland's Legnica-Głogów line

Poland: Services on the Legnica-Lubin-Rudna Gwizdanów-Głogów line in western Poland recommenced in December following a Zlotys 200m (£40m, €47m, $52m) reconstruction of Legnica -Rudna Gwizdanów section of the line. The project has renovated the stations at Rzeszotary, Raszówka, Gorzelin, and Chróstnik, and constructed a new station at Lubin. A new traffic control system has been installed, together with the renewal of the track and electrification system, and a new 5m-high viaduct has been built in Koźlice to remove a level crossing.

The investment will increase capacity to allow more trains to operate and will improve services for passengers with limited mobility. It is hoped the extra capacity for freight will also result in a modal shift from road to rail.

New locos for BLS Cargo

Switzerland: Rail freight operator BLS Cargo has awarded a contract to Siemens for 25 Vectron MS multiple-system locomotives. The 6.4MW locomotives have a maximum speed of 160km/h, and will be used to haul trains on the Rhine-Alpine freight corridor connecting the Netherlands and Belgium, Germany, Switzerland, and Italy.

The locomotives will be equipped with ETCS as well as the national signalling systems. Delivery of the locomotives will start at the end of 2020 and continue through to 2025. The order will add to 15 Vectron locomotives which BLS Cargo ordered in 2015.

Metro and light rail

Crossrail opening and cost forecast update

UK: Crossrail Limited (CRL) has advised Transport for London (TfL) that there are some projected delays in the opening of the Elizabeth line and it is likely that additional funding would be required to cover the higher levels of risk contingency.

The latest projections show a central cost forecast (including risk contingency) of approximately £15.4bn (€18bn, $20bn), which is £400m (€467m, $514m) more than the funding committed. Further modelling scenarios consider even higher levels of risk of £650m (€759m, $835m) more than the funding committed.

TfL has been advised by CRL that their latest assessment is that the opening of the central section will not occur in 2020 which was the first part of the previously declared opening window. The Elizabeth line will open as soon as practically possible in 2021. A more comprehensive update is expected early in 2020.

The Elizabeth line will stretch more than 60 miles (100km) from Reading and Heathrow in the west through central tunnels across to Shenfield and Abbey Wood in the east. The new railway will stop at 41 accessible stations, 10 newly built and 30 newly upgraded, and is expected to serve around 200 million people each year. The signalling architecture for the route includes ETCS, CBTC and conventional signalling.

Crossrail is delivering one of the most complex and challenging signalling system implementations in the world, involving the integration of ETCS, CBTC and legacy signalling systems. Technical director Colin Brown explains how Crossrail are delivering the systems and what the benefits will be long term, in a video which can be seen at **irse.info/xzy9d**.

Victoria Line capacity improvements

UK: Following the completion of a signalling upgrade in 2017, London Underground's Victoria Line services have been running every 100 sec between 08.15 and 09.45 and between 17.00 and 18.30.

Transport for London has now introduced a new timetable that doubles the length of time during which services run at 100s headways. In the new timetable this has been extended so that it covers a morning peak of 07.15 to 10.15, and an evening peak of 16.15 to 19.15. Off-peak services will continue to run every 135s.

The Victoria Line currently provides for 250 million passenger-journeys a year and TfL says that the change increases line capacity by 5%. Running peak-hour service frequencies for longer periods is a good way of increasing passenger capacity and to make best use of signalling improvements. It also complements businesses providing more flexible working hours.

Docklands Light Railway signalling contracts

UK: Two contracts for signalling and train control equipment on the Docklands Light Railway light metro in east London have been awarded.

Transport for London (TfL) has awarded a contract to supply upgrades to the signalling software subsystems on the network, which uses Thales SelTrac CBTC, and CAF has awarded Thales a contract for the supply of onboard train control systems for the 43 trains on order to replace the fleet from 2023.

Earlier this year TfL awarded a contract to CAF for £350m (€405m, $452m) to supply a fleet of 43 five-car driverless trains. The order includes 10 trains to enable an increase in frequency and capacity across the network, for which signalling software upgrades are required.

Hurontario LRT contract award

Canada: The Mobilinx consortium, consisting of Hitachi Rail, Astaldi Canada Enterprises Inc., Salini-Impregilo S.p.A., John Laing Investments Limited, Transdev North America, Inc. and Amico Concessions Inc. and Bot Engineering & Construction Ltd., has signed a C$4.6 bn (£2.7bn, €3.2bn, $3.5bn) contract with Infrastructure Ontario and Metrolinx for the Hurontario LRT in Mississauga, Ontario. The Hurontario LRT is an 18-kilometre (11.2-mile), 19-station light rail transit system that will run along Hurontario Street from Port Credit in Mississauga to Brampton Gateway Terminal.

The scope covers 18 stations, plus one underground station, as well as other related infrastructure work, at-grade and elevated guideways, trackwork, operations control centre (OCC) and an operation, maintenance & storage Facility (OMSF), signalling and train control, telecommunications and SCADA, traction power and catenary, 28 Light Rail Vehicles (LRV) together with Operation & Maintenance (O&M) of the infrastructure and LRVs for 30 years.

Hitachi Rail STS will install its Wayside Standard Platform CBTC (communications-based train control), which includes onboard, wayside and central office systems and AI (Artificial Intelligence) technology.

Telecoms

Europe's first 5G 'slicing store'

Europe: Hutchison Drei Austria has partnered with ZTE Corporation in China to demonstrate the first 'slicing store' in Europe and the first end-to-end 5G network slicing operation in the telecoms industry.

With 5G slicing, a predefined service parameter can be selected according to the requirements of the application, such as guaranteed bandwidth, maximum latency. This may be of interest to railway operators for 'mission critical' important low bandwidth low latency applications, and higher bandwidth higher latency secondary applications.

In the Hutchinson ZTE 5G slicing store, designed for a public 5G network, consumers or enterprise customers can select the predefined slice template and set the service level agreement (SLA) parameters according to the characteristics of the user or individual industry requirements. The user can log into the online sliced based service store, and choose services with different SLA. Once the payment is completed, the service is activated.

If the number of users increases or the Key Performance Indicator (KPI) decreases, the system can automatically adjust its resources to maintain KPI. The slicing solution can be used in vertical industries to meet variable requirements.

Ofcom 5G spectrum auction

UK: Ofcom manages the UK's spectrum and has announced updated plans to release additional mobile spectrum through an auction in spring 2020 to support the rollout of 5G.

Ofcom recently proposed rules that would require mobile companies in the UK to increase coverage in rural areas, in exchange for winning discounted spectrum through the auction. In response mobile operators BT/EE, O2, Three and Vodafone have proposed an alternative 'shared rural network' plan. This was aimed at delivering good quality 4G coverage to at least 92% of the UK over the next six years.

The UK government has announced that the companies have committed to reaching this target and also confirmed it will provide £500m (€580m ,$640m) of funding for the plan. Ofcom has welcomed this agreement and will make it a condition within the companies' spectrum licences. The companies' new agreement will achieve higher coverage than the requirements Ofcom could have set through an auction, so Ofcom is no longer proposing to include coverage obligations in the auction.

Ofcom has a duty to ensure spectrum is used efficiently and to ensure companies can compete fairly and customers have a good choice of mobile networks. So, to promote competition, it is still proposing a 37% cap on the overall spectrum that any one mobile company can hold following the auction.

Private LTE and 5G mobile radio network spending to hit US$8Bn by 2023

World: Research from SNS Telecom & IT, a market intelligence and consulting firm with a primary focus on the telecommunications and information technology industries, concludes that private mobile radio networks are expected to become the preferred way of delivering wireless connectivity for critical communications, such as for rail, industrial Internet of Things (IoT), and some public venues.

Annual spending on private LTE and 5G network infrastructure (including radio access, core and transport networks) is expected to increase from US$4.7bn (£3.7bn, €4.2bn) at the end of 2020 to US$8bn by the end of 2023, growing at 19% per year. The report notes that 5G will be the preferred wireless technology for Industry 4.0 automation and industrial premises, such as factories, warehouses and ports. This level of investment should provide private mobile radio network systems that could be used by railway operators, should they wish to invest in private LTE 5G.

The report says that the first private 5G network deployments will span a wide range of use cases. These include connected robots in factories, augmented and virtual reality (AR/VR) applications as well as massive sensor networks that control Automated Guide Vehicles (AGVs). One example is Mercedes-Benz's car production plant in Sindelfingen, Germany, which will use 5G and Wi-Fi to connect machines and production systems throughout the complex. See **irse.info/x1vbp**.

Spectrum for Indian Railways

India: Telecom Regulatory Authority of India (TRAI) has recommended allocating 5MHz spectrum in the 700MHz band to Indian Railways for its use in areas such as passenger information display system and live feed of video surveillance and other public safety and security needs. The spectrum will be allocated to Indian Railways for implementing Mission Critical Push To Talk (MC PTT) voice, Internet of Things (IoT) based asset monitoring services, passenger information display system and live feed of video surveillance for certain coaches of a train. TRAI said "the spectrum will be assigned to Indian Railways on administrative basis for captive use only and not for any commercial services such as on-board passenger Wi-Fi.

Indian Railways had urged the reservation of 15MHz of spectrum in 700MHz band for the purpose, and for 10MHz to be allocated free of cost, emphasising that the proposal was devoid of any commercial gain, and aimed at enhancing security and passenger amenities. TRAI said that to implement the video surveillance system for all coaches for train for security purposes the railway may explore other communications means, such high capacity Wi-Fi when a train reaches a station via a public telecommunication network.

The regulator noted that the Indian Railways has proposed to install Long Term Evolution (LTE) based corridor for 'train-ground' and 'train-train' communication and added the 1.6MHz spectrum already assigned to Indian Railways in the 900MHz band may be taken back upon migration to an LTE based network.

Greater reliance on 5G equipment makers

Europe: The EU coordinated risk assessment of the cybersecurity of 5G networks is designed to help EU member states prepare for the security threats of 5G (**irse.info/h0y8z**). It warns that telecom operators will be more dependent on equipment makers in general and this may introduce potential security issues. The report says that in addition of the new technical features of 5G, such as software defined and virtualisation networks, network slicing, and mobile edge computing, it will also raise new challenges, both in terms of changing risks and involvement from new suppliers.

"In particular, they will give additional prominence to the complexity of the telecoms supply chain in the security analysis, with various existing or new players, such as integrators, service providers or software vendors, becoming even more involved in the configuration and management of key parts of the network. This is likely to intensify further the reliance of mobile network operators on these third-party suppliers," the report says.

With greater reliance comes greater potential for attack. "Among the various potential actors, non-EU states or state-backed are considered as the most serious ones and the most likely to target 5G networks", it explains. "In this context of increased exposure to attacks facilitated by suppliers, the risk profile of individual suppliers will become particularly important, including the likelihood of the supplier being subject to interference from a non-EU country." The main 5G suppliers with sizeable market shares are Ericsson, Huawei and Nokia, but the report also lists Cisco, Samsung and ZTE as other large suppliers, none of whom are EU based.

The report also highlights the risk of dependency on a single supplier, the implication being that relying on one vendor for everything increases the risk of problems, which may result in interruption in service from a commercial failure or from a malicious attack.

Safety and standards

Bangladesh collision

Bangladesh: Two trains have collided head-on in Brahmanbaria with fatalities and people injured. The incident happened in the early hours of 12 November when the Chittagong-bound Udayan Express hit the Dhaka-bound intercity train Turna Nishita. Local news publication the Daily Star reported that this crash cut off rail communication between Chattogram-Sylhet and Dhaka-Noakhali. It has been suggested the collision may have occurred because signals were passed at danger by one of the trains.

Three committees have been formed to investigate the incident. Chief mechanical engineer Mizanur Rahman will lead a four-member committee and divisional transport officer for Chattogram Nasir Uddin will lead another four-person team. A third team will be led by the Brahmanbaria additional district magistrate.

Research and innovation

Shift2Rail's Catalogue of Solutions

Europe: Shift2Rail's Catalogue of Solutions see (**irse.info/u1w6c**) brings together the innovative products and methods which Shift2Rail has been working on together with its members and key stakeholders to deliver transformed future-proof rail systems. The Catalogue of Solutions illustrates successful Research and Innovation results in the form of solutions, including their delivery date and highlighting benefits for final users, operators, infrastructure managers and/or suppliers.

The Catalogue of Solutions includes signalling applications such as: ERTMS next generation solution, Automatic Train Operation ATO (up to GoA4), moving block, fail-safe train positioning, adaptable communication systems and integrated mobility management.

Data Sandbox+ research

Great Britain: The GB rail industry's independent safety body, RSSB, Data Sandbox+ research competition is aimed at developing data driven solutions to improve operational rail performance. The Data Sandbox+ competition is part of the PERFORM programme, a cross-industry initiative led by RSSB, to achieve performance improvements.

The cross-industry collaboration is supported by Network Rail and various train operating companies. The budget is £1.3m (€1.5m, $1.7m), of which £650k was contributed by RSSB, with Network Rail matching this figure from its research and development portfolio. Four initial projects, which started in November 2019, have been awarded funding in the first round of the competition. These are:

- "Real time prediction and mitigation of disruption through personalised passenger communications", led by Zipabout and the University of Birmingham, in collaboration with LNER.
- "Data-driven robust timetabling", led by the University of Southampton, in collaboration with Network Rail and Bellvedi/Tracsis.
- "Rail performance modelling for strategic decision making", led by Risk Solutions, in collaboration with City University London, Heriott-Watt University, University of Southampton, Steer and Tracsis.
- "IntelliDoorDwell", led by Porterbrook in collaboration with ScotRail, University of Southampton and Elastacloud.

Data and big data

Indian Railways introduces IT-enabled services apps

India: The Ministry of Railways has released three online applications to improve project monitoring and IT-enabled services throughout the country.

Common Reporting Standard (CRS) Sanction Management System deals with work related to level crossings, such as closures, minor bridges, and manning and shifting. It also speeds up the processing of CRS Sanction cases and improves monitoring of compliance. The system offers a repository of CRS Sanction circulars, checklists, guidelines, and reports.

Rail-Road Crossing General Agreement Drawings (GAD) Approval System was developed to quicken the approval of GADs for roads over and under bridges. The system maintains the accountability of railways and governments at different stages of approvals, as well as facilitate better coordination between the stakeholders.

Track Management System (TMS) for Construction is dedicated to the construction of new assets. Data for the assets can be filed by construction officials before final checks. This application is for source data validation, smoother data entry and checks and accountability on the data.

Data to improve Tube journey estimates

UK: Transport for London (TfL) has analysed 2.7bn pieces of anonymised data since June 2019, which has been gained through tracking people's usage of Wi-Fi networks at stations across the capital. The data has been obtained by tracking passengers' phone usage and is helping (TfL) to improve its travel time estimates.

The analysis has allowed TfL to update its Journey Planner app to better estimate journey times between 55 different stations and the same information will also be used in the future to alter train timetabling to optimise routes. Lauren Sager Weinstein, chief data officer at TfL, said: "we are working to use this data to allow our customers to better plan their journeys and find the best routes across our network."

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News from the IRSE

Blane Judd, Chief Executive

Blane's World

Members will have already received the nomination forms for council members and awards, and some have already been returned. I urge all members to get engaged in the election process, full details can be found on the IRSE website at **irse.info/governance**. We have been in discussions with the Electoral Reform Service who will be helping us with the election process including voting online. In future years we will be looking at online nominations too. All of this is designed to allow a much wider engagement in the election of representatives and to make sure there is a good representation from all our international membership as we move into 2020 and beyond.

In late November 2019 I had the pleasure of attending the annual Scottish Section dinner in Glasgow and enjoyed the warm welcome I received. The guest speaker was Andrew Haines, the CEO of UK infrastructure operator Network Rail, and we had an interesting discussion about the important role of the Institution, professional ethics and competence development. This has been a theme in many of my recent discussions and engagement activities which culminated in a meeting I attended with Keith Upton (chair of the Younger Members' Section. Attended by the CEO of all of the UK professional engineering institutions (PEI), the CEOs of the Engineering Council and Engineering UK, and the CEO and president of the Royal Academy of Engineering, and young members from the PEIs, the meeting was a plenary session addressing, among other things a key question about the relevance of PEIs to younger members. The outputs are to be published and there are some key activities which all the PEIs have agreed to work on together to maximise resources.

On a more personal note I am extremely grateful to all those who arranged a surprise birthday celebration for me in the month. It is the generous nature of the staff here that make the task of CEO even more enjoyable.

Rail Performance Think Tank

The Institution is a key member of the Future Integrated Railway Think Tank (FIRTT) which is a cross industry working party made up of senior representative from the Rail Delivery Group (RDG), the IRSE, WSP and KPMG.

Our remit is to stimulate debate and action in four key areas of rail performance – accessibility, dependability, affordability and sustainability. During the first workshop held at WSP's head office in London on 5 November we had a lively and stimulating discussion on 'accessibility' addressing the question "How can we make rail travel more user-friendly, easy to undertake, and more attractive to people who would not normally contemplate using rail as part of their end-to-end journey?" The resulting paper will be published in a future issue of IRSE News.

Annual Dinner

Booking will open soon for the 2020 IRSE Annual Dinner which will be held for the first time in historic Landmark Hotel 222 Marylebone Road London on 24 April to accommodate larger numbers. The ticket price has been held at £159 and we are expecting another full house at this stunning venue, see the IRSE website for full details.

The Landmark has a railway connection as it was originally built as a hotel in 1899 by the Great Central Railway for passengers travelling through Marylebone station. In 1945 it was owned by the London & North Eastern Railway Company who had a shortage of office space, so they bought the building from Frederick Hotels.

In 1949 the nationalisation of the railways in the UK meant the LNER became part of the British Transport Commission, which later became British Rail. A newspaper article in the 1950s stated that the ballroom was being used as a basketball court and a railway worker canteen, an officers' mess and a senior officers' mess with a bar for meals, in what are now the hotel event spaces.

Please don't keep us in the dark!!

Do we hold the correct email address for you? If you have just joined the digital community or recently changed your email address you will not be receiving important membership information or IRSE e-communications.

Don't miss out. Please email your new contact details to membership@irse.org to enable us to update our database.

London & South East Section

IRSE
Institution of Railway Signal Engineers
LONDON & SOUTH EAST SECTION

Acoustic monitoring

Report by Paul Baker

Thursday 28 July 2019 turned out to be a somewhat more challenging meeting than normal, but then isn't that what committees enjoy.... a challenge!

The London and South East Section invited Nicholas Kay, operation director of Track IQ Wabtec to present on a subject a little outside normal signalling matters, trackside acoustic monitoring systems for train axle journal bearings. Having made all the arrangements, the committee hadn't anticipated that the day would be one of the hottest on record and there would be significant disruption to train services. Our guest was a victim of such events, his train was involved in an incident near West Hampstead so instead of a relaxed arrival to meet members and deliver the talk he arrived just in time for questions and answers! This challenge was met with a quick transfer of the presentation file, a rapid rehearsal by one of the committee, who had fortunately worked with Nick on this equipment. He delivered the first part of the evening followed by questions and answers with Nick when he arrived to round off the evening.

Many railway engineers and operators are familiar with the Hot Axle Box Detector, HABD, with some 220 locations around the Network Rail system dating from the 1960s. This system relies on the detection of heat, which means something is going wrong and so is a reactive response to a developing failure and action is needed quickly. The HABD technology does not lend itself to third rail systems and requires significant equipment both within the track structure and lineside. These also only tend to be reliable detectors for plain metal bearings but todays rolling stock is increasingly employing roller bearings and so mechanical collapse can occur before a significant and reliable heat signature can be detected.

The commercial demands of the heavy-haul railway that have developed in both Australia and America, at least, with long trains of roller bearing fitted wagons with only a 'head end' operator. This drove the demand to develop a monitoring system that was far more predictive rather than wait until some 10 000 tonnes of valuable ore was spread all over the railway infrastructure with direct loss of that resource and knock on impact to subsequent service and product delivery, all hitting the 'bottom line'.

From this emerged one such technology product in the form of the Rail Bearing Acoustic Monitoring (RailBAM) by the then VIPAC Company of Adelaide Australia, now Track IQ and part of Wabtec. The principle is simple and with modern technology and communications allows application in such a way that condition based monitoring of fleets can be effectively implemented to deliver significant cost and operational benefits through much improved identification of bearing defects being removed before impending failure.

Our speaker's unorthodox journey involved being evacuated from a disrupted train. *All photos N Kay/TrackIQ.*

Examples of defective bearings.

Located beside the track is a cabinet within which there is a microphone array. The array is protected from the elements by a shutter door which opens with the detection of an approaching train and the system then 'listens' to each bearing as it passes. With RFID (radio frequency identification) readers identifying the rolling stock and rail mounted sensors detecting the position of each wheel, each vehicle and axle bearing can be identified accurately and repeatably. The acoustic signal is analysed for defects at site in the trackside cabinet. Should a defect be detected, the data is transmitted to a server where the users can access the data from any internet connected computer or mobile device. Alarms and alerts are automatically generated by FleetONE providing predictive notification to change the wheelset or bogie, so removing the time-honoured preventative mileage or time-based methodology or routine changing, thus allowing significantly longer bearing life in service with the safety net of regular ongoing monitoring. Where fleets would previously operate a preventative wheelset overhaul at 800 000 miles, fleets are now exceeding 2 000 000 miles without costly overhaul or maintenance. Safety is being improved through continuous monitoring of the bearings

The trackside cabinet with the shutter door open and the microphone array bar just visible within.

Single track array in Norway, cabinets both sides of the track.

in service. Indeed, the author has experience from the first permanent installation shortly after commissioning when a unit passed the site, the IQ engineer detected audibly that an axle-box didn't sound right and within minutes, indeed an alert was raised and the train maintenance planned to remedy the defect some weeks later, and yes, a defective bearing was found.

One factor in deployment is locating the system so that outside factors do not affect the acoustic signature. The optimum operating speed range is between 30 and 80mph, with neither hard acceleration nor deceleration. Ideally the track should be straight and the track structure sound and consistent with minimal vertical movement, e.g. voiding. The ideal is also that there are no rail joints nor welds, especially site cast ones, installed and, if there is conductor rail, it is continuous with no ramps to generate shoe noise which might otherwise interfere. These details minimise any interference that could affect the acoustics output coming from a defective axle journal bearing. These requirements can usually be met at numerous locations on a route, but usually two or three are selected for their ease of access or proximity to a suitable electrical supply. The French TGV fleet has achieved this with installations in depot areas where operating speeds >20km/h are permitted.

The first system of this type in the UK was successfully trialled in 2007 near Three Bridges. The first permanent installation was in 2009, by Siemens, targeting their Class 444/450 fleet. The system was installed between Southampton Airport Parkway station and Swaythling, close to the then newly-built Northam depot, the main maintenance facility for this fleet and where all units return to in due course over a period of a few months, at worst case but quite adequate for such monitoring. Besides the South West fleet, trains from various freight operators pass that location with traffic to and from the Southampton Docks along with infrastructure vehicles from Eastleigh and further afield.

In the heavy-haul world many track miles are single and an acoustic cabinet can be installed either side of the track to enable both vehicle sides to be monitored at the same time. With the typical two track layout of passenger systems and a very limited '6 foot' this is not practical, so this leads to the system being split with a cabinet in the cess of each track and one side of the train monitored in one direction and the other side on the other. The basis of this layout is 99% of the trains passing will do on both sides within a reasonably short time of each other. The RFID tags fitted to the carriage or units which interact with the system identify the orientation.

South West trains then looked to its remaining fleet and a second system was installed at Mortlake on the Reading lines and effectively now all the fleet was covered.

A further system was later installed at Kensal Green on the Great Western Main Line at around the 2 mile post at the side of the up and down main, this enabled monitoring of the GW HST fleet and the suburban and Heathrow Express trains that also passed through the site. The usage there initially surprised the engineers and they queried "over 200 trains a day through the site?", perhaps something they were not used to in heavy-haul but the system was able to cope.

Worldwide RailBAM has been deployed in many countries, and that number is increasing, monitoring freight, metro/interurban and high-speed passenger vehicles through strategically placed installations.

It would be unfair not to mention that other systems are in use. The TADS (Trackside Acoustic Detection System) is an equivalent produced in America developed by the Transportation Technology Centre Incorporated which operates a significant test facility in Pueblo, Colorado, funded by the Class 1 railroads of the US system. The principle is similar but with very different physical architecture trackside. The presenter can recall sitting in the cab of a train travelling north from Denver passing such a site and the cab suddenly being filled with the verbal message saying "Loco NNNN, 26 axles, all good, have a good day".

Nicholas, having been de-trained trackside and required to leave his overnight luggage behind, and having travelled across London was able to join the meeting for a lively question and answer session. He was able to give some more detail on the use of the system in "FleetONE", the management system, and how the information can be used to increase availability and performance. Nicholas commented on the RSSB project T986 that conducted an assessment of the UK network, concluding some 35 sites of RailBAM would effectively capture the whole of the UK fleets. With the HABD system reaching the end of its life perhaps such a system as RailBAM is the next generation with the possibility of developing the hardware of the system to be less intrusive trackside and so more cost effective to install and maintain. With the drive to longer operating days and access only when train movements are blocked this is an important step for the future.

The committee of the London and South East Section thank Nick for his support and sterling efforts to make the meeting and Track IQ for sponsoring the tea and biscuits. By the way his baggage was at his hotel when he got there later that evening, well done East Midlands Trains.

A more detailed technical article on the RailBAM system is available in Rail Engineer Magazine, August/September 2019.

Younger Members Section

Young Rail Tours – Scotland

Report by David Westcough

As reported in IRSE News November 2019 issue, Young Rail Tours (YRT) is a newly-founded organisation that has been collaboratively set up by the Younger Members Section of the IRSE, Institution of Mechanical Engineers (IMechE) and Institution of Engineering and Technology (IET), as well as Young Rail Professionals (YRP), in order to deliver a programme of domestic, European and international railway study tours made affordable and accessible towards young professionals working in the UK rail industry.

On the evening of Friday 20 September 2019, a group of 22 delegates travelled to Glasgow to partake in YRT's first railway study tour to Scotland. The majority of the contingent travelled up from London Euston by train, which provided a fantastic opportunity for the delegates to make acquaintance with one another prior to the start of the tour's activities. Upon arrival in Scotland, there was a brief opportunity for the tour-goers to network further over drinks before heading to bed.

On Saturday morning, the delegates were hosted by Transport Scotland (the national transport agency for Scotland) who delivered two presentations. The first looked at plans to develop Scotland's high speed rail network. The second presentation, delivered by the director of rail at Transport Scotland, Bill Reeves, detailed recent successful rail projects and the future outlook of rail north of the border. The question and answer session that followed allowed the group to gain further insight into the presentation topics, as well as scrutinise Transport Scotland's plans.

In the afternoon, the group travelled to the Govan area for a tour of the Glasgow Subway depot. Opened in December 1896, the Glasgow Subway is a light rapid transit subway system with a circular loop which extends both north and south of the River Clyde. On arrival at the depot, the delegates were given an overview of the history of the Glasgow subway, before a guided tour of the depot and its facilities. During the tour, there was opportunity to look and sit inside the driver's cab of the subway cars.

Touring the Glasgow Subway depot at Govan.

Bill Reeve of Transport Scotland presenting to the YRT group.

The group had a brief outing on a canal boat, in the rain.

As part of Strathclyde Partnership for Transport's plans to modernise the subway, 17 new trains are expected to enter service in 2020. The upgrade will feature the potential for driverless operation, an additional carriage and wider gangways for persons of reduced mobility. However, the delegates were unfortunately unable to view the new rolling stock as they are currently being stored at an alternative site. After a short break back at the hotel, the group attended an evening social at the Hillhead Bookclub, where delegates were able to network with local members of YRP over dinner.

Sunday morning saw the group travel to Linlithgow for a presentation on Scotland's major infrastructure projects, delivered by Rail Engineer magazine editor, David Shirres. This included a discussion on the regeneration of the Levenmouth line, which highlighted the wider benefit that rail provides in connecting communities to ensure access to higher education and employment, as well as added economic benefits. Once again, the group were able to ask questions, in order to develop their knowledge of rail in Scotland. David's presentation was followed by a brief outing on a canal boat, adding a cultural aspect to the tour, as well as developmental.

The tour's final activity included a visit and ride on the Bo'Ness heritage railway. Prior to the train ride, delegates explored the railway's museum and enjoyed the small model railway on exhibit. The 90-minute ride provided a relaxing end to the tour activities before heading back to Glasgow Central station for the journey home.

The trip to Scotland was thoroughly enjoyed by all of our delegates who thought that the tour provided good value for money.

The Bo'Ness heritage railway.

YRT is currently organising an 11-day study tour to Japan in March, where places have now been allocated to 25 lucky young professionals following a ballot. The tour will cover a number of cities across Japan, including Tokyo, Kyoto and Osaka, where main activities include visits to the Shinkansen control centre, SCMAGLEV and Hitachi's Kasado manufacturing facilities.

If you have any questions regarding YRT or its future tours, please get in touch with the YRT team on **youngrailtours@gmail.com**.

York Section

IRSE

Institution of Railway Signal Engineers

YORK AND THE NORTH EAST SECTION

Annual Dinner 2020

The IRSE's York Annual Dinner 2020 will take place at the National Railway Museum, York, on the evening of Thursday 12 March 19:00 for 19:30.

Members or companies interested in booking places or tables are asked to contact Becky Radnage at rebecca.radnage@networkrail.co.uk.

Professional development

Recording your development activities

Judith Ward, Director of Operations, IRSE

All IRSE members and IRSE licence holders sign up to maintain and develop their professional competence to retain the safety and efficiency of our railways.

It is good practice to record the regular planning, doing, reflecting and reviewing of these development activities. This maintenance and development of competence is called "Continuous Professional Development (CPD)" by the IRSE and is sometimes known as "Professional Development (PD)".

There are many forms of recording and the IRSE don't want members and licence holders to create additional work by duplicating records.

Many of our members and licence holders have their annual appraisals, training and some work experience logged in their employer's human resources (HR) records. Others use IRSE logbooks, or similar. Many others make use of the Mycareerpath database which is free to all IRSE members. Others use apps, spreadsheets, documents and even pieces of paper. All of these are acceptable ways of recording, but what should be recorded?

Action plans

When planning to maintain and/or develop your professional competence, you should consider; what skill, knowledge or experience would you like to do/develop/maintain in the next year-or-so?; how will you be able to do this?; what do you need to do?; what support do you need, and by whom?

To do this, you may need to consider where you are at present in your career, and where you want to be, whether that is to remain in your current role, obtain promotion, or move to another employer.

Once you have these in mind, you can formulate SMART (specific, measurable, achievable, realistic and timed) objectives. These might be the same as those discussed with your manager at your annual review, in which case your annual review would be a suitable record. However, you might have some objectives which you do not wish to share with your manager, in which case these need to be recorded elsewhere.

Some examples of action plans are shown in the table opposite.

Action plan title	CPD Plan Objectives
Action plan for 2020	To remain in my current position as xxx at xxx: Need to keep up to date with standards and processes by attending standards briefs and reading briefing notes from my manager. Aim to ask one question per briefing to demonstrate my understanding. Need to keep my trackside competence by going on and passing my training course before end of November. Teach Sam, the apprentice, how to do xxx task themselves. Bring in my training notes to go through together while waiting work allocation. Aim to complete by September.
Action plan to get xxx promotion	Planning move to next position (promotion to xxxx role): Find out what competencies and experience are required for that role. Talk through with my manager and looking at the role profile. Aim to do this in April. Then revisit this action plan to look at next steps – how to gain experience and knowledge required.
Action plan to be recognised as signalling/telecoms/systems engineer	To increase signalling/telecoms/systems knowledge by taking IRSE professional exams. Will participate in study group and request place on xx course in December. Aim to sit modules 4 and 6 in October 2020 and modules 1 and 7 in October 2021.
Plan to get more management and planning experience to expand my potential career options.	To get management experience, I plan to volunteer to organise xxx IRSE local section seminar with assistance and guidance from other IRSE volunteers. Event takes place in October 2020, I need to start planning this in March.
Action plan to get project management knowledge	To become more efficient in managing projects through attending in-house training on company project management system in February, so will be able to understand the principles of a successful project. Ask for own small project at 6 monthly review in July.
Action plan to improve my communication skills	To improve my communication skills, use in-house company e-training (xxx and xxx courses) in March and April and use this knowledge to write an article for IRSE News about xxxx. Aim to submit article in August.

Activities

It is good practice to keep records of your CPD activities and what you have learnt after reflection on your activities. Producing a record helps to organise your thoughts and experiences; records don't have to be complicated, but we recommend at least:

- Evidence title including a brief description of the activity.
- Date and duration of activity.
- Type of activity (events, seminars, self-learning, formal learning, voluntary work, academic study and/or work experience).
- Any additional information about the activity, such as speaker name, name of training provider, author of book/article.
- Reflection (sometimes referred to as "lessons learnt" and "benefits gained") (see below).
- Follow up, where appropriate, stating what you will do differently as a result/how you will apply what you've learnt (see below).

When recording an ongoing activity, such as committee membership or attending IRSE exam study groups, split this into separate CPD events for recording purpose and link to your main objective. Whilst it may take a little longer to record, detailing each event, even with a few lines, will show your learning, progression and work more easily.

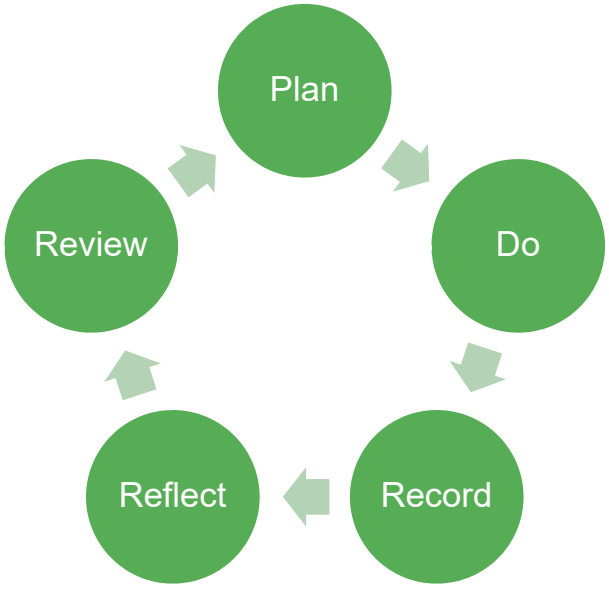
Reflect

Attending a technical presentation or training course should not be considered a 'tick box exercise' to satisfy your manager or someone reviewing your CPD records.

To show that you were thinking about the CPD activity, it is good practice to reflect on it. This is sometimes known as "lessons learned" and "benefits gained". The aim is to recognise and record the benefits and change in experience and abilities.

It is acknowledged, however, not all CPD activities are as useful as may have been expected. This could be because you have developed more quickly than expected when a course was booked, or the article you read was not at your level, or a mandated course to be attended at regular intervals, or another reason. These are still useful reflections to record, as they demonstrate your awareness of your own knowledge and abilities.

If you are recording your CPD using your employer's system, you may find that there is no opportunity to record reflections, so it is good practice to record this elsewhere.



The mantra of plan, do, record, reflect, review and repeat is a useful way of considering how best to carry out your development activities.

Some examples of reflection are below.

- Introduction to xx. Key areas covered were xxx and yyy however should have read up on xx before workshop.
- Repeat of mandatory health and safety training which I took last year – while it helped to maintain my competence nothing new was learned.
- Successful seminar organised and run through team work and efforts of the whole organising committee. I learnt how to plan an event like a mini-project using Project software which I hadn't used before.
- I had already learnt most of the subjects covered in the training. Will recommend for new staff in team.
- Interesting article. Will read references given to find out more about the subject.

Review

Your action plan should be reviewed regularly as it serves to demonstrate how your original objectives have been met and record what you are going to do with your new-found knowledge and skills.

This review might be done as part of your annual appraisal with your employer. However, this might not be applicable or suitable for you, in which case take the time yourself to review your action plan. If you have a mentor or trusted colleague, involve them too.

You should review your progress against your action plan, whether it was to develop or maintain your knowledge, skills and competence, and celebrate your achievements.

It is also an opportunity to re-evaluate your objectives and modify them as necessary or to develop a new action plan with further objectives.

It is very likely that your Development Action Plan will alter during the course of your career, with changes to personal and professional circumstances, interests and technology.

In summary

The maintenance and development of your professional competence should be a key part of your working life, regardless of what career stage have reached. Using technology through apps or online databases such as Mycareerpath may help you plan, record, reflect and review your progress but is not mandatory for the IRSE – use whatever method suits you.

If you are professionally registered with the Engineering Council (that is an Engineering Technician, Incorporated Engineer or Chartered Engineer), then you may be asked for your CPD records at regular intervals for monitoring by your engineering institution. If you do not engage with this monitoring, then you could be removed from the list of professionally registered engineers and technicians.

This is why it is so important that you respond to our requests for your CPD records – your plans, your activities, your reflections and your reviews. CPD helps you to realise your goals and can be so much more than just 'ticking the box'.

IRSE events

ASPECT 2019

Report by Ian Mitchell

ASPECT2019///
Institution of Railway Signal Engineers | Delft University of Technology | IRSE Nederland

After many years as a London-based event, the IRSE's ASPECT conference series is now truly international. The first foray outside the UK to Singapore in 2017 was a great success and the policy is now to hold ASPECT at a different location every two years, alternating with the IRSE Convention so there is a single flagship international event for the institution in each year.

For those who have not attended either, it may be worthwhile to clarify what is the difference between these events – the Convention focuses on learning about the country in which the event takes place, with invited speakers, technical visits and some sightseeing, including a partners' programme, whereas ASPECT is primarily a conference with an open 'call for papers' so it reflects the global range and diversity of current activity in the IRSE's field of interest.

ASPECT 2019 took place in Delft in the Netherlands from 21-24 October. The venue was the splendid AULA conference centre at the Technical University of Delft. The traditional ASPECT format of a two-day main conference, preceded by an introductory day and followed by a day of technical visits, gave plenty of options to participate for all or part of the event. There had been an excellent response to the call for papers, and the main conference was arranged with parallel sessions to allow as many speakers as possible. Over 50 papers were presented in total; this represents quite a challenge for your reporter, given the limited space in IRSE News and my inability to be in two conference sessions at the same time, so what follows is inevitably a selective report based on what I found most interesting.

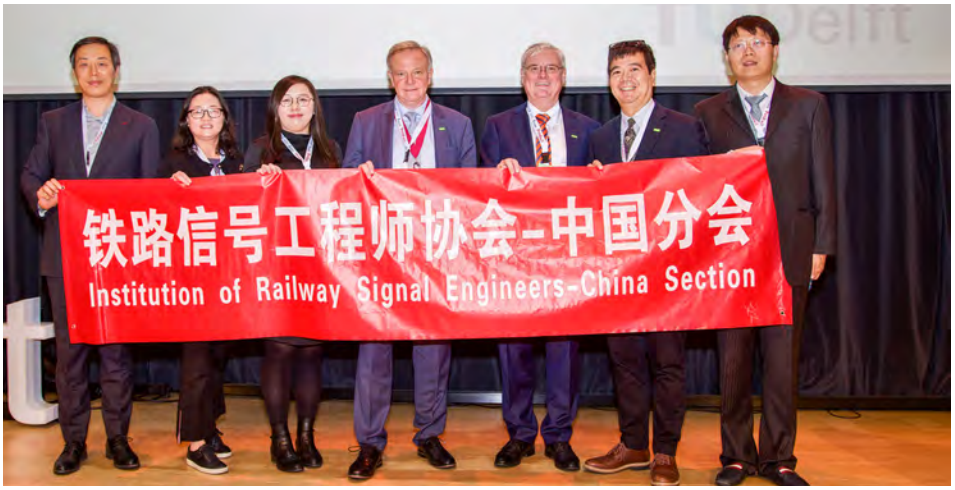
The theme of the conference was 'Resilience' and it was fascinating to hear all the different interpretations of what that word might mean. For example I hadn't expected to hear about pandemic flu as a threat to railway operations, but in his paper "**A whole-railway reliability approach to planning for things that will probably never happen**", Andrew Love (SNV Lavalin) pointed out that the UK government national risk register ranks this as the highest societal risk (likelihood multiplied by impact). How many railway operators have considered a scenario where perhaps 50% of staff are unable to work due to illness?

Another example of out of the box thinking was from Prerna Sharma (Siemens) who spoke on "**Building a resilient railway through its workforce**", in which she challenged us to ensure our recruitment and staff development activities reflect the true diversity of the communities that we serve, not only considering gender and ethnic diversity, but also neuro-diversity – how can we best exploit the talents of those who are dyslexic or autistic?

IRSE President George Clark opening ASPECT 2019.

Several speakers dealt with resilience in terms of the train capacity delivered by the signalling system and rapid recovery of normal service after a disruptive event. Joost Jansen (TU Delft) "**ETCS Hybrid Level 3: A Simulation-based Impact Assessment for the Dutch Railway Network**" compared Traditional Dutch lineside signalling and automatic train protection, with various ETCS options. All of the ETCS options showed a significant capacity improvement, and ETCS Hybrid level 3 additionally allowed much more rapid recovery from disruptions. Jan Hoogenraad (Spoorgloren BV) "**Arrival Time Robustness of Eco-Driving Strategies Under Two ATP Systems**" studied the interaction between different ATP subsystems and an 'eco-driving' driver advisory system that is aiming to minimise energy consumption by avoiding early arrival at station stops.

Maarten Bartholomeus (ProRail) "**No barriers for level crossings with ERTMS**" examined opportunities to optimise road closure times at level crossings by announcing train approach based on speed and position reports from an ETCS fitted train instead of a trackside train detection system. Two further level crossing papers came from Japan. Ryuta Nakasone (RTRI) "**Obstacle Detector for Level Crossing using Infrared Camera and Image Processing**" described how an aging population is increasing the frequency of slow moving pedestrians becoming trapped between level crossing barriers, leading to a need for obstacle detection technology that can detect people as well as vehicles. Akimasa Okada (JR-East) "**Clarifying design guidelines of level crossing logic with functional resonance analysis method**"



Clockwise from top left:
Lively question and answer sessions were a major part of ASPECT 2019. Speakers covered a wide variety of topics, for example Shivani Singh spoke about innovation in delivering a signalling project near Peterborough, UK. Committee member and TU Delft host Rob Goverde. Members of the China Section with George and Blane.

illustrated the use of the functional resonance analysis method (FRAM) to capture tacit knowledge for design of level crossing control logic in complex station areas.

Two of the academic presenters explored the implications of the 'virtual coupling' or 'train convoy' concept, where vehicle to vehicle communication could allow two or more trains to run together with a separation less than the absolute braking distance. Felix Schmid (University of Birmingham) "**Closer Running: Magic Potion or Deadly Poison?**" looked at the safety implications, with an attempt to quantify the risk of a leading train coming to stand so rapidly that the following train would be unable to brake in time to avoid a collision. Egidio Quaglietta (TU Delft) " **Exploring Virtual Coupling: Operational Principles and Analysis**" examined the benefits compared with conventional fixed block and moving block signalling, taking account of scenarios such as station stops and trains entering and leaving a convoy.

There were a number of papers dealing with system architectures. André Radomiak, (Alstom) "**A Fair Signalling Architecture**" and Luke Church (Thales) "**Architecting Railway Systems for Resilience**" both considered issues such redundancy of equipment and communications links, and distributed versus centralised architectures. The use of internet protocol (IP) communications is now widespread in signalling systems and some of the implications were explored in papers by João Martins (EFACEC) "**Moving Safely Towards IP Protocol for Signalling Equipment**" and Jeong-ki Hong (Korean Railway Signal Research Association) "**Development and Commercialisation of IP-based Railway Interlocking in Korea**" – it was interesting to hear how EULYNX interface standards developed in Europe are being adopted in Korea. Natsuki Terada (RTRI Japan) " **Scalable and Relocatable Interlocking Device**" and Matt Slade (CPC Systems) "**Virtualising Railway Control Centres: Can Virtualisation and Cloud Computing Deliver Increased Resilience?**" looked at options where interlockings or traffic management systems are no longer deployed on dedicated hardware in a railway's control centre, but as software in a remote data centre managed by a signalling or IT services supplier. Bob Janssen (Siemens) "**Taking a Legacy Interlocking to the Era of Internet of Things**", described how dynamic and static data can be extracted from an older electronic interlocking system and published via an OPC UA server to allow new applications to discover and consult information without the constraints of the legacy system architecture and interfaces.

Cyber security was inevitably one of the aspects of resilience to be covered, for example by Henry Cheung (Kone Elevator, Hong Kong) "**Protection of a Communication Based Train Control System from Hackers**" and Eylem Thron (Ricardo) "**Evaluating the impact of cyber security and safety with human factors in rail using attacker personas**". Alex Patton (Siemens) "**Developing Cyber Resilience Together: Industry Cooperation for a More Secure Railway**" focused on the need for railways and suppliers to work together to mitigate this threat, how this might be achieved and the challenges that are faced in doing so.

Clockwise from top left:

Disney Schembri presenting about how resilient railways are about a lot more than just reliable electronics. The organising committee with George Clark and Blane Judd. The model railway representing Heathrow Airport Terminal 5 transit system described in Aaron Sawyer's paper.

The challenges of delivering complex projects were addressed by several speakers. Alexandra McGrath (VicTrack) "**The Art of Interrogation – for better requirements capture**" based on her experiences of working with multiple stakeholders involved in the 'Big Build', a decade long programme of transport investment projects across the Australian state of Victoria. Ian Jones (Siemens) "**Providing System Resilience as the Goalposts move**" described how a combination of the traditional 'Waterfall' software development methodology with the alternative 'Agile' approach allowed a more rapid improvement in reliability growth after initial commissioning of a new signalling system.

Another topic of concern was how we manage major disruptions to a train service, both unplanned due to external factors or equipment failure, and planned interventions required to deliver 'brownfield' projects. Wim Coenraad (Movares) "**Business Continuity in Railway Signalling**" reviewed the role of 'secondary systems' that could keep trains moving in the event on a primary signalling system failure. Victor Abbott (Jacobs) "**ROCC and role: Implementation of rail operational control centres for resilience**" examined the critical role of the people and technology in a railway's control centre. Alexandra McGrath (VicTrack) "**Rail's particular challenge with Resilience: Shifting from Controlled Complicatedness to Working with Complexity**" described how experience of the disruption caused by a control centre systems failure in Melbourne was put to good use in planning for an extended shutdown for upgrade of the railway a few years later.

Through the Hewlett-Fisher bursary scheme, the IRSE provides funding for young engineers to attend major events such as ASPECT and the Convention. This year the bursaries were awarded to young members who were prepared to make a presentation at the conference, and these were every bit as professionally presented and topical as the papers from the older generation. Shivani Singh (SNC-Lavalin Atkins) "**Peterborough ground switch panel – a novel design development approach**" covered a seemingly mundane subject – replacing a mechanical ground frame – but in fact not a straightforward project as there was a gap in standards for this type of application. Alessandra Sternberg (Siemens) "**Crossrail integration facility and test automation**" described the fully automated off-site test facility that is being used to test the integration of CBTC, ETCS and legacy signalling systems installed on the trains that will run on the Crossrail route through London. In the following Q&A session, a delegate asked why such a "ludicrously complicated" system had been chosen. IRSE President, George Clark, intervened to provide a reply, pointing out that he was around at the time the decision was made, but the speaker was still at school then! Aaron Sawyer (SNC-Lavalin) "**What building a tangible model taught me about the real railway**" generated a lot of interest by describing the use of model railway and off the shelf micro-controller components to build a physical model of the tracked transit system at London Heathrow Airport Terminal 5, to demonstrate performance and resilience of a proposed upgrade to a client that was not familiar with railway operations.

In his closing address, George Clark said that ASPECT 2019 had certainly achieved its objectives by covering all aspects of resilience (pun possibly intended). It had been a great three days of sharing of knowledge from all around the world. He particularly thanked five presenters who were previously awarded bursaries to attend ASPECT 2017 in Singapore two years ago and had now persuaded their employers to sponsor them to attend and present at ASPECT 2019. He hoped we would be seeing more of this year's bursary winners in future years. The networking opportunities for old and young to meet are a key element of the IRSE's activities. Finally, he thanked the organising committee and the Dutch section for all their efforts in delivering such a splendid conference.

Attendees at ASPECT have access to written papers for all the presentations via the conference app, but we hope to publish a small selection in IRSE News in coming months. If you attended ASPECT, we'd welcome your suggestions of which papers we should choose.

Your letters

An operator's view of headway

Trevor Foulkes (Your Letters, October) is quite right to pick out tunnels and station approaches as an 'area of interest' for headway.

A key example is from HS2 [The new high speed line currently under construction between London and Birmingham in the UK] where tunnel ventilation shafts were initially located simply with respect to emergency services requirements, about 3.3km apart (implying a maximum of a mile for responders to walk to a disabled train). A complication arose when a 'one train between shafts' rule was added to the constraints, to be enforced by aligning signalling section boundaries with ventilation shafts. This introduced longer block sections in the tunnels than in open air, increasing the technical headway, but not beyond acceptable limits – so long as trains are running at speed. But the last shaft to portal section approaching a station becomes the binding constraint on headway as it is traversed at low speed reducing to zero in the station. Finally, an aspiration emerged that braking in tunnels should be planned to rely on regeneration without invoking friction braking, to avoid excessive generation of ambient heat, further increasing the transit time of trains through the critical section.

The learning from this is that shafts should be located evenly in terms of transit time rather than simply distance – just like block posts in Absolute Block signalling, as the Victorians knew very well.

With all due respect to those developing ETCS, as an operator I am not interested in shaving seconds off the plain line headway in open air, as it rarely if ever presents the binding constraint on capacity of a network (still less am I interested in yet another diagram of a cartoon locomotive with lightning flashes coming out of it). What I want to hear is what Level 3 will do to reduce headways at constraints such as this, and I suspect the answer is, in the apt words of Speaker [of the UK Parliament] John Bercow, "the square root of not very much".

But there is a component of headway that bears investigation, and I would be very glad to hear how digital railway in its various incarnations might affect it – the system response time. In our article "Headways – what effect does ETCS have, and how do we know?" (IRSE News, May 2019) to which Trevor kindly refers, a value of 10 seconds was blandly assumed, on the basis of very little evidence. If in practice this were to double, some technical headways would rise uncomfortably close to the maximum tolerable value. If it could be halved, however, a very useful additional performance buffer would be introduced, everywhere and not just on plain line. Quicker-acting turnouts would also have a benefit, specifically in headway critical-areas.

Can I ask the signalling engineering community what values they think are realistic for the system response under ETCS – the minimum time from Train 1 clearing a section to Train 2 being issued with a Movement Authority into it? And, what is being done, and what more can be done, to reduce it, as the risks and potential benefits around response times are probably greater than anything else being offered by advancing signalling technology?

William Barter, UK

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Elections

We have great pleasure in welcoming the following members newly elected to the Institution:

Member

Simon Clark, VolkerRail, UK
Charlie Dacanay, SMEC International, Indonesia
Olivier Grossin, CERTIFER, France
Bartolo Guggion, Network Rail High Speed, UK
Shashikant Gupta, AECOM, India
Morgan Lachuer, SNCF Reseau, France
Simon Marshall, Network Rail, UK
Abbi-Jo McCaffery, Network Rail, UK
Harry Omorodion, St Claradion Ltd, UK
Yat Lee Frankie Tsang, Alstom, Hong Kong

Associate Member

Afzal Ahmed, Louis Berger, India
Muhammad Talha Ali, TEAM Nigeria, Nigeria
Eric Berntson, Colling Aerospace, USA
Medha Bharti, Network Rail, UK
Bhuvanesh Gupta, Alstom, India
Saruabh Gupta, AECOM, India
Narendra Kumar, AECOM, India
Dezhi Li, Alstom, Hong Kong
Carole Markou, Network Rail, UK
Pavanchander Putta, AECOM, India
Tossaporn Srisooksai, Kyosan Electric, Japan

Accredited Technician

Jodi Hurcombe, Amey, UK
Ryan Van Dort, V/Line, Australia

Promotions

Member to Fellow

Stephen Smith, VolkerRail, UK

Affiliate to Fellow

Stephen Brennan, Transport for London, UK

Associate Member to Member

Ariharan Karunanithi, Alstom, Australia
Niels Neumann, TuMotus, Germany

Affiliate to Member

Gareth Jones, Network Rail, UK
Paul Staines, Bechtel Saudi Arabia, UK

Affiliate to Associate Member

Matthew Hogg, London Underground, UK

Professional registrations

Congratulations to the members listed below who have achieved final stage registration at the following levels:

EngTech

Kevin Njuguna, Network Rail, UK

IEng

Simeon Cox, Sydney Metro North West, Australia

New Affiliate Members

Rama Addala, WSP, India
Puneeth Behanagere Rudresh, L&T Smart World, India
Galvin Chiam, Land Transport Authority, Singapore
Shruthi Chilangani, WSP, India
David Coleman, Irish Rail, Ireland
Leah-Marie Dennett, AECOM, UK
Harry Enright, Arup, UK
Jeremy Goode, WSP, Australia
Subbaiah Gorla Bala, Intermodel and Eotd Engineer, USA
Garrett Gutstadt, Global Signals Group, USA
Alastair Jones, Hitachi, UK
Joel Jones, Arup, UK
Manroshan Jusbir Singh, Metro Trains Melbourne, Australia
Pankaj Kumar, AECOM, India
Ka Leung Lee, Faiveley, Australia
Kelvin Liu, John Holland Group, Australia
Taylor MacDonald, Herzog, Canada
Paul Mannion, VolkerRail, UK
Abhishek Mishra, WSP, India
Mohammad Nazir, Wabtec, Australia
Somto Victor Okonkwo-okom, Siemens Mobility, UK
Jayalakshmi Pasalpudi, ETOE Rail Transportation Infrastructure, India
Alessandro Rocchi, London Underground, UK
Daniel Rodriguez, UK
Mohamed Samra, University of Birmingham, UK
Arco Sierts, InteVice, Netherlands
Poonan Singh, AECOM, India
Ian Thompson, Ineco, Spain
Tanay Verma, Arup, UK

Past lives

It is with great regret that we have to report that the following member has passed away: Craig Longley.

Resignations: Edmund Gerrard, Robert Keates, Dean Simpson, Yihan Wu and Zhiwei Zhang.

Current Membership: 4994