ERTMS Level 3: the Game-Changer


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This Presidential Programme technical paper was presented on 14 March in London.

Why Level 3?

Our railways are full. Our networks do not currently have enough capacity to meet our customer needs. In Great Britain for example passenger numbers have doubled since 1996 and are set to double again over the next 25 years. It is not possible to meet projected demand with existing technologies.

Conventional lineside signalling systems have been optimised to their limits. In many locations the use of conventional methods to increase capacity such as building extra tracks, flyovers and introducing larger trains has been exhausted. But there is an alternative – use of digital technology. This provides a great opportunity to deliver increased capacity for our networks.

A key digital technology which can provide this is ERTMS. Currently most worldwide implementations of ERTMS are of ERTMS Level 1 and ERTMS Level 2 systems. Of these it is ERTMS Level 2 which can, with careful implementation, provide improvements in capacity. To get significant improvements in capacity from ERTMS Level 2 means increasing the amount of trackside train detection systems. This is clearly technically feasible, but is it affordable?

For significant capacity increases on a line, 50 metre train detection sections may be needed. This means purchase, installation and maintenance of a significant amount of train detection equipment at the trackside. This is not affordable from a financial perspective, and would not easily enable high performance and reliability of ERTMS Level 2 operation.

Moving to ERTMS Level 3 solves this problem. ERTMS Level 3 can deliver better capacity, reduce costs, improve flexibility and increase reliability in comparison with ERTMS Level 2, removing reliance on train detection equipment. But does ERTMS Level 3 actually exist, or is it a theoretical concept not yet fully defined?

In fact ERTMS Level 3 is already defined in the CCS TSI (Command Control and Signalling - Technical Specification for Interoperability) [R1], and there are some applications of ERTMS Level 3 in operational service. Implementations to date, such as the ERTMS Level 3 line between Malung and Borlänge in Sweden and Uzen to Bolashak in Kazakhstan, are typically on railways which are largely single lines with low traffic levels. So whilst ERTMS Level 3 clearly does exist and has been implemented, application experience to date is limited. Further development is required before it can be considered as a solution ready for immediate Europe-wide deployment alongside ERTMS Level 1 and ERTMS Level 2.

This need has already been recognised by the European railway industry and has been included in the European Union Agency for Railways long term perspective plan [R2]. This plan published in 2015 identifies the development of ERTMS Level 3 as one of five business-driven game changers to be taken forward over the next few years.

During European level discussions on the ERTMS long term perspective plans, ProRail and Network Rail identified strong and similar interests in the development of ERTMS Level 3 as part of their commitment to increase capacity on main line railway networks. Both networks have similar challenges, being complex mixed traffic networks with areas of high capacity demand, with the need to deliver high reliability and availability.

Our key drivers were the need to build on our current ERTMS Level 2 programmes and to find a cost effective way of increasing capacity on our networks step by step at minimal risk. ProRail and Network Rail had both previously run some ERTMS Level 3 tests to understand the state of the available ERTMS Level 3 products. In 2013, Level 3 tests were performed by ProRail in Lelystad in the Netherlands. In 2014 in Great Britain, Level 3 tests were run on the test track at the ERTMS National Integration Facility (ENIF). These tests provided a good foundation for the future work.

With this common interest ProRail and Network Rail agreed to take a joint approach on the definition of an effective path to deploy ERTMS Level 3. To facilitate the cooperation (sharing a road map of activities and resources), a Memorandum of Understanding (MoU) was signed by both parties on 2nd February 2016 [R3]. As ProRail and Network Rail are both members of the ERTMS Users Group and the European Rail Infrastructure Managers (EIM), the work is being shared proactively as it is developed. Members of these organisations are also showing a strong interest in ERTMS Level 3. Alongside this work sits Shift2Rail, where Innovation Programme 2 also includes an ERTMS Level 3 work package titled Moving Block [R4]. Network Rail is an active member of this work stream, which provides another opportunity for development.

So a need for ERTMS Level 3 has been established and an agreement to do some work is in place, but to move forward it was first necessary to confirm an agreed understanding of ERTMS Level 3.

As specified by the CCS TSI, Subset-026 [R1] ERTMS Level 3 is a radio based train control system where movement authorities are generated trackside and are transmitted to the train via Euroradio. ERTMS Level 3 provides a continuous speed supervision system, which also protects against overrun of the authority. The Radio Block Centre (RBC) knows each train individually by the ERTMS identity of its leading ERTMS on-board equipment, which regularly reports its speed, position and integrity information to the RBC. ERTMS Level 3 is based on Euroradio for track to train communication, and on balises as spot transmission devices mainly for location referencing. This is all common functionality with ERTMS Level 2.

The main difference between ERTMS Level 2 and ERTMS Level 3 is that in ERTMS Level 3 the train position and train integrity supervision is performed by the RBC, using the position and integrity reported by the train to determine if it is safe to issue the movement authority. This provides more accurate train location and removes the need to use fixed blocks and trackside train location equipment (such as track circuits and axle counters) which are essential features of Level 2. ERTMS Level 3 allows the shift from the use of fixed blocks using trackside equipment (as in Level 2) to more frequent train position information (fixed virtual blocks or moving blocks).

These changes allow ERTMS Level 3 to provide capacity benefits (allowing more trains on a line), to reduce costs (e.g. removal of trackside elements) and to improve reliability (due to less equipment on the trackside).

Challenges of Level 3

Level 3 requires trains to be fitted with additional functionality in the form of Train Integrity Monitoring (TIM). The purpose of the TIM function is to inform the ERTMS trackside that the train is complete with respect to the reported train length, providing confidence in the location of the rear of the train and that the train has not broken or split since the previous reported position. Whereas it appears possible already to provide a TIM system for passenger trains, providing one for variable composition trains such as freight is currently an open issue. There is not yet a reliable and operationally robust TIM system implementation available for use with variable composition trains. This is a critical area to resolve for Level 3, as failing integrity of just one train could affect the operational performance of many trains in a large Level 3 area.

In the absence of trackside train detection, the Level 3 concept relies fully on the condition that the RBC knows at all times the position and integrity status of every train or vehicle that is physically present in the area under its control. The problem is that in practice this condition cannot always be fulfilled when degraded modes of operation are considered.

Take the situation where there is no radio connection. Here the train will not be visible to the RBC. For example, if the ERTMS on-board enters shunting mode, it is switched off intentionally (Cab close, No Power mode). Even if the RBC remembers the last reported position of the train and the area in which the train was authorised to move, there is no guarantee that the train will stay within this area whilst disconnected. For example there could be reasons to move the train under the supervision of operational procedures, or the train could move without any authorisation. Without trackside train detection, there is no way for the trackside to know the location of such a train in a sufficiently reliable way.

Then there is the case to solve where an RBC is switched on or off (e.g. an intentional restart, or due to a crash). In this scenario an RBC would lose all knowledge of the trains in its area. Recovering from this situation would be cumbersome (involving sweeping the whole RBC area) and could take a long time, causing significant operational disruption. The safety of such a process would be based only on operational procedures.

Another issue is the accuracy of the reported train position. The margin in the reported train position and safe train length can result in points being kept locked behind the train on the basis of this information when in fact the area is physically free. This would reduce performance, and could result in a deadlock situations e.g. on an overtaking area on a single track. Also in this situation, where a train loses its valid position the Level 3 system cannot locate the train and so additional operational procedures are required.

Types of Level 3 implementations

In order to overcome these challenges as well as to take account of how to migrate from existing railway systems, a number of types of Level 3 have been proposed.

These types have been developed based on the following items.

- The need to migrate the existing fleet of trains into ERTMS, i.e. the potential need to overlay Level 3 on conventional signalling systems.
- The need to have train integrity monitoring solutions available and fitted on all types of trains.
- The use for trackside train detection if no ERTMS train information is available.
- The existence of two types of technologies for the safe train separation in Level 3:
    - Fixed Virtual Block: This solution relies on the use of virtual fixed sections (based on reported integer train position information).
    - Full Moving Block: The safe separation between two trains is given dynamic handling of reported integer train position information.

Note: an 'integer train' is one which allows the trackside to release infrastructure behind it on the basis of its position reports. This is because it is possible to guarantee its completeness (i.e. no carriages or wagons left behind) thanks to Train Integrity Monitoring Systems. In the case of a fixed-formation unit, this completeness information will be available permanently.

The types of Level 3, which are at different levels of maturity in terms of definition and development, have been named as follows:

- Level 3 Overlay.
- Level 3 Hybrid.
- Level 3 Virtual block.
- Level 3 Moving block.

Of these, Hybrid Level 3 is the most mature and is defined in detail in the following sections. The others are less well developed, and so are covered at conceptual level only, building on the understanding gained in the definition of Hybrid Level 3.

Hybrid Level 3

Hybrid Level 3 has been developed as a type of Level 3 which mitigates the Level 3 challenges described above using existing technology solutions. It does this by dealing with the potential issue of insufficient train information by using a limited amount of trackside train detection. In this way this concept avoids the need for new and complex operational procedures and should secure performance when introduced. It means trains which are not able to report confirmed integrity can still be authorised to run on the line, albeit with longer, but still acceptable, headways. Trains which are disconnected from the RBC are no longer lost. They are still visible by means of the trackside train detection, which facilitates operational movements of disconnected trains, protection against unauthorised disconnected trains, and recovery after RBC crashes. In addition, in certain key locations trackside train detection should enable good performance by providing faster release of critical infrastructure (e.g. points) than on the basis of train position reports (e.g. if the position reports are delayed, or there are margins in the reported train length).

When considering the migration to Hybrid Level 3 on existing railway lines, the concept enables the use of legacy trackside train detection equipment, re-using that already in place. This introduces advantages when commissioning works take place for capacity increases on the line. It means there is a minimum of engineering work required on the trackside when compared to the works required for increasing capacity using other ERTMS levels, thus providing a cost effective way to increase the capacity of the line.

The Hybrid Level 3 concept supports both integer and non-integer trains, that is trains with and without train integrity. This provides a migration path for trains on the line, enabling full operation of all trains when all types of train have not yet been fitted or are unable to be equipped with TIM. The capacity of the line will increase as the level of trains equipped with TIM increases. This enables the creation of a high capacity line if predominantly TIM equipped trains are scheduled (e.g. to create extra capacity in the peak hours). It also enables trains without TIM (e.g. freight trains) to run, although to retain maximum capacity benefit in the peak these would need to be scheduled in off-peak timetable slots.

This solution also aids simpler operation of non-ERTMS equipped trains if they are needed to be able to run procedurally on the line, (e.g. to move engineering trains to work areas). In these circumstances the normal operation recovers automatically after the passing of these trains without operational procedures such as sweeping being required. Identical considerations apply for shunting movements where trains do not report their position to the RBC.

And last but not least: Hybrid Level 3 is fully compliant with the ERTMS specifications as defined in the CCS TSI [R1]. There are no additional requirements which require introduction for the ERTMS onboard.

Moving or Fixed block

The Hybrid Level 3 concept as currently defined uses virtual blocks. This is not a fundamental requirement for the concept but is for pragmatic reasons. In comparison to moving blocks, fixed virtual blocks have less impact on the systems involved such as the RBC and traffic control centres, as well as on operational procedures. These are illustrated in Figures 1 and 2.

In a Level 3 moving block system, train separation is based on the last reported safe rear end position of the leading integer train, providing an optimal Level 3 capacity. The 'moving block' is based on periodic position reporting of the train's rear end position, and so it jumps periodically. For instance for a speed of 160 km/h the moving block jumps with distances of >200m. By reducing the length of the virtual blocks, only known by the RBC, moving block performance is also achieved in Hybrid Level 3 concept.

Main principles for Hybrid Level 3 with virtual blocks

For Hybrid Level 3, trackside train detection sections can be divided into several Virtual Sub-Sections (VSS). This is with the constraint that a trackside train detection section containing movable elements should not be divided into several VSS sections.

The 'occupied' and 'free' status of the VSS is based on both train position information and trackside train detection information. A VSS is reported 'free' if the underlying trackside train detection is reported free. It is reported 'occupied' if a train reports inside this section (based on front end position and reported train length).

As shown in Figure 3, the ERTMS trackside considers that a train occupies only the relevant VSS in which it is located, and the TIMS provides confidence as to the location of the rear of the train. However, a train not fitted with TIMS occupies the sections in rear, because for the RBC the train rear is not safely known. A train not fitted with ERTMS occupies the entire train detection section, because for the RBC the train position is not known. An ERTMS train without a TIMS can follow an integer train on VSS sections, but other trains can follow it only on separate train detection sections. The result of this is that capacity benefits are only achieved for ERTMS trains, and full gain is achieved around ERTMS trains fitted with TIMS.

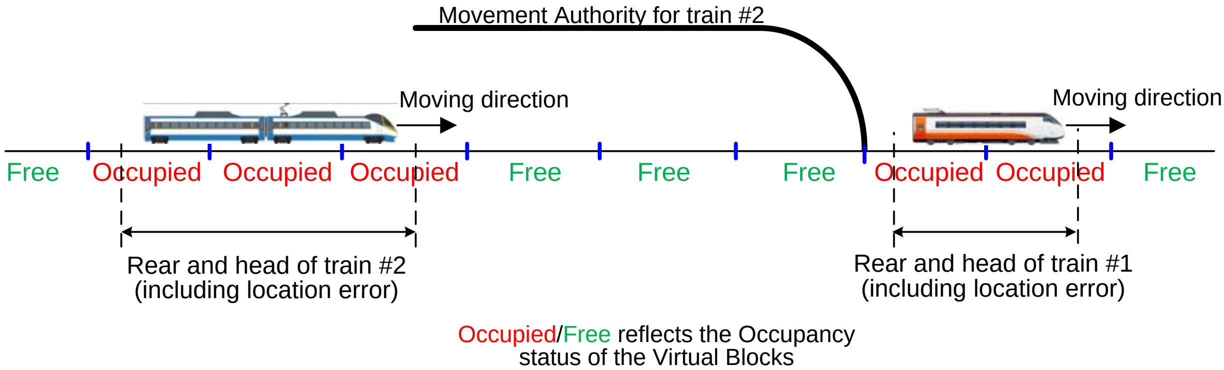


Figure 1 – Virtual Block system.

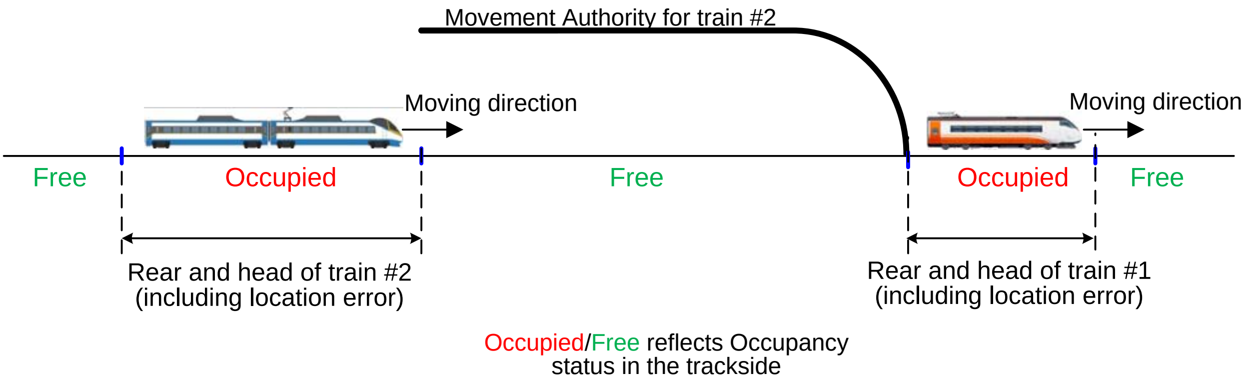


Figure 2 – Full Moving Block system.

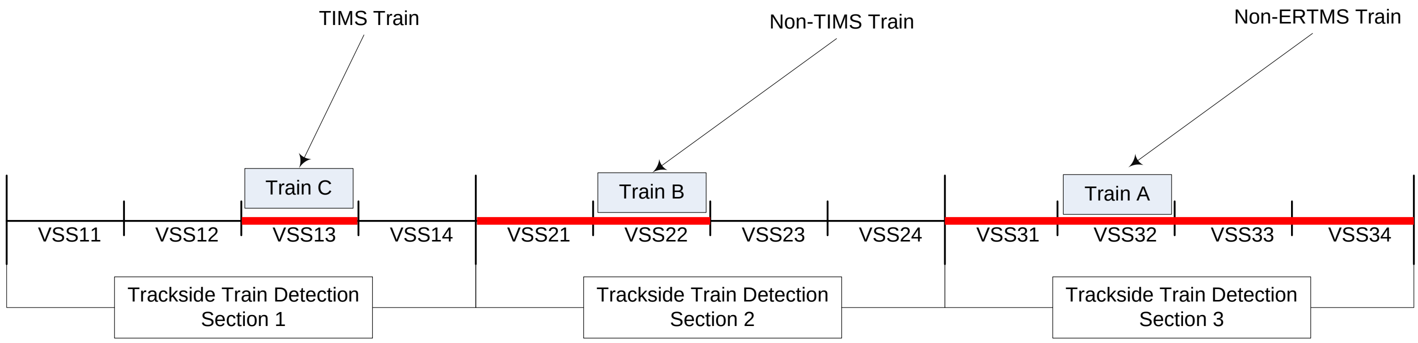


Figure 3 – Different capacity exploitation depending on the presence of the ERTMS on-board and TIMS.

If the capacity benefits of Level 3 are to be realised in situations where there is a mixed fleet of trains operating (i.e. some trains are fitted with ERTMS, TIMS and others are not) consideration will need to be given to optimising the timetable for these different train types.

Because the timing and spatial accuracy of the trackside train detection and ERTMS train position vary considerably, two additional internal VSS states are introduced: 'ambiguous' and 'unknown'. These statuses will be reported to the external systems (e.g. the Traffic Management System) as 'occupied,' and so no new requirements or operational procedures are needed for such systems. The trackside train detection occupancy information is used only as an input for the VSS status.

This is the enabler for using existing systems with this concept.

The different VSS state transitions, as shown in Figure 4, are defined based on reported train information and trackside information which is explained in more detail in the General Principles Level 3 VSS [R6]. For instance the transition from 'occupied' to 'free' takes place if an integer train reports it has left this VSS. Another example is the transition from 'occupied' to 'ambiguous'. This happens when a train loses its integrity or does not report integrity. VSS sections left by a non-integer train in an ambiguous VSS section will become 'unknown' until the underlying trackside train detection reports unoccupied.

Protection against non-reporting trains

To protect against undetected movement of non-reporting trains, the VSS sections on which the train is located when disconnection is detected by the trackside are set to 'unknown'. To enable the train to still use its Movement Authority (MA) completely, all the VSS in advance of the last train location which are part of the MA sent to that train need also to be set to 'unknown' if the underlying trackside train detection reports 'occupied'.

As the train may move after the disconnection of the radio link without the trackside being aware of the movement, the status 'unknown' is propagated after a specified time on to adjacent VSS, forward and backward, until either a free trackside train detection section or another train is reached. On reconnection of the same train with an unchanged length, the VSS statuses can be restored to allow continuation of its journey. The propagation time can be configured to be location and direction specific. This means the system can take into account conditions where changing direction and opposing movements are required. This is illustrated in Figure 5.

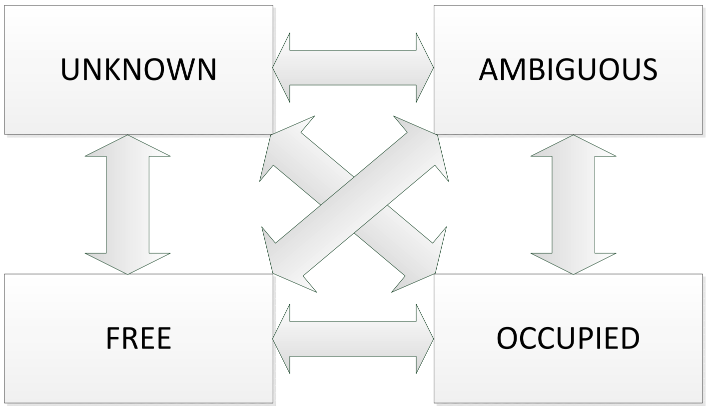
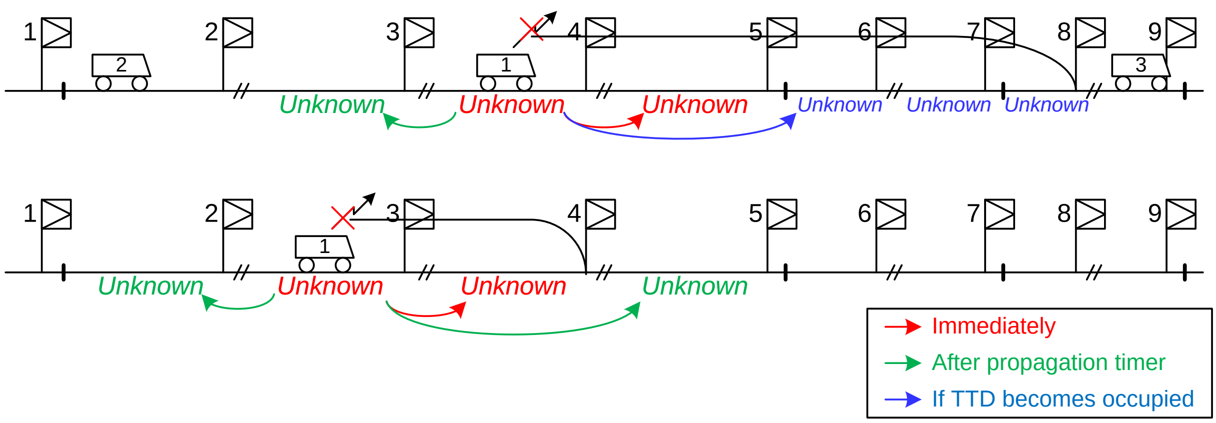


Figure 4 – VSS section state diagram.

Figure 5 – Propagation of 'unknown' after disconnection during mission.



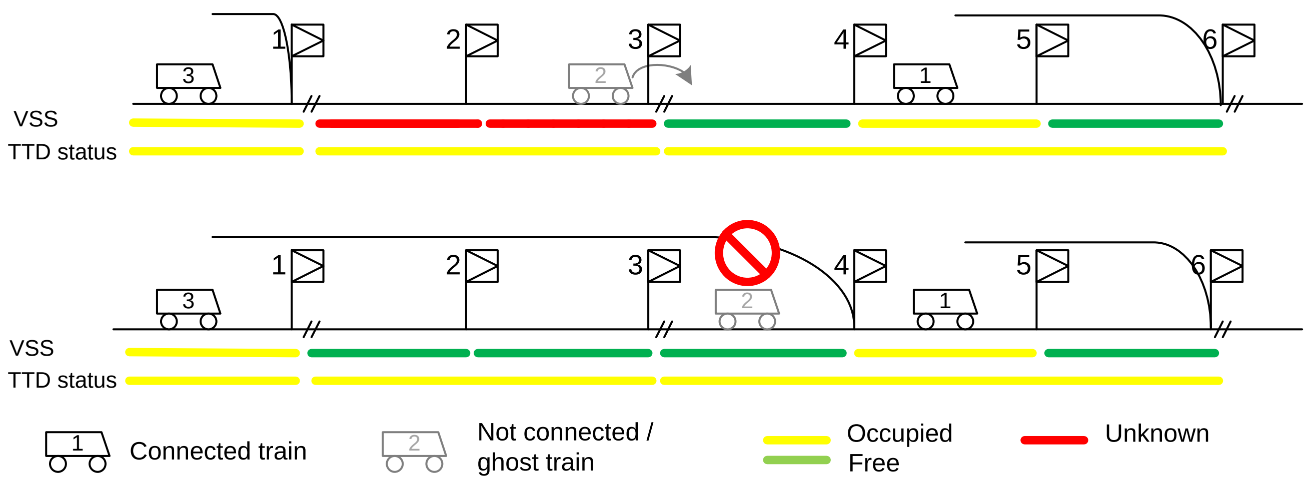


Figure 6 – Shadow train hazard.

Backward propagation can also be configured for the situation where a train reports loss of integrity. This covers the risk that a detached part of a train could roll back undetected into free VSS sections.

This mechanism and the additional information from the trackside train detection allow areas to be configured within the Level 3 system where trains can be parked, split and joined. The presence of trackside train detection means impact on normal operation is avoided, meaning that some benefits of Level 3 are still able to be provided when insufficient train position information is available.

'Ghost' and 'shadow' train risk

For a Level 3 system a 'shadow train' hazard could occur as depicted in Figure 6. In other words because of the undetected movement of train (2) the trackside could authorise another train (3) on to the infrastructure released by the integer train (1).

To add protection against shadow train movements in the Hybrid Level 3 concept, the trackside train detection information is used to check if releasing infrastructure in rear of the train is safe. This includes the detection of possible 'ghost' train movements with trackside train detection.

Trackside train detection can be used, in addition to position reports, to release sections of track and clearing points, overcoming potential performance issues and to prevent possible deadlocks. Additional performance is achieved in situations in which the train position reporting is not fast enough (e.g. due to the frequency of the position reports) or not accurate enough (since the train position is defined including margins from the odometer confidence interval). Deadlocks can be avoided, for example, by detecting the movement of trains when communication has been lost or by safely releasing points on overtaking areas that otherwise would remain unnecessarily locked when they are considered occupied due to margins added to the train position.

For situations where the trackside train detection cannot release 'unknown' sections, an integer train can 'sweep' these VSS sections. The train information can also be used to increase the availability of the infrastructure by supporting 'sweeping' trains for recovery from trackside train detection failures. That is, in this case the train position information function increases the availability and reliability of the trackside train detection.

Benefits and Opportunities from using Hybrid Level 3

The possibility of reusing existing trackside train detection in the Hybrid Level 3 concept brings with it a number of advantages.

Hybrid Level 3 allows the management of scenarios where no train information is available, i.e. train disconnection and failure of train integrity. It also manages scenarios at locations where a train is parked, changes direction, shunts, etc. These scenarios have to take into account that a train, or parts of a train could be moved without being connected to the RBC. Hybrid Level 3 deals with these by using trackside train detection systems to mitigate the problem.

The combination of train position and trackside train detection information also provides protection against ghost and shadow trains risks, particularly required at entrance and exit points of a Level 3 area.

In addition the combination of trackside train detection and train position information provides mutual benefits in performance and reliability of these systems.

In Level 3, trains are normally required to correctly monitor their integrity (that is, the completeness of the train). However the challenge is around the safe management of this integrity information: finding solutions for all types of trains, both freight and passenger. Hybrid Level 3 allows the running of a mixed fleet of trains; i.e., those with and without integrity monitoring are supported. So there is no immediate need to upgrade an existing fleet with TIM. However it should be recognised that this solution brings capacity benefits only around those trains equipped with TIM functions. Therefore, provisions should be made on trains to allow the implementation of TIM systems as soon as possible, ideally as part of ERTMS fitment. It is recommended that new trains should as part of initial design come fitted automatically with ERTMS and TIM.

The migration of an ERTMS Level 2 trackside to Hybrid Level 3 will mainly consist of updating the software in the RBC. The existing interlocking and trackside hardware (such a track circuits or axle counters) will be reused.

Finally it is expected that the Hybrid Level 3 should be able to be operated using the operational rules developed for Level 2 deployments with minimal alteration. This is critical in the case of trains not yet fitted with TIM devices, as they will be expecting to run in Level 3 as they do in Level 2. This means it is expected that staff training requirements for such an implementation will be minimal (assuming drivers, signallers and others have already been trained to operate Level 2).

The solution allows easy migration for trains, operational rules and trackside.

Level 3 Overlay (overlay on class B national systems)

Level 3 may be applied alongside conventional signals and class B national protection systems. Trains capable of using ERTMS are able to run using the Hybrid Level 3 variant as described above, or using the alternative Level 3 variants as described below. Trains unable to use ERTMS (due either to lack of on-board ERTMS equipment or to driver competency constraints) can run according to the existing fixed block sections, using conventional signals and trackside train detection (i.e. they can run using the class B system). This means that the trackside will be equipped with signals and trackside train detection to which ERTMS Level 3 will be overlaid. Special attention is required for more complex operational procedures due to the mix of trains and the national signal aspects for the ERTMS trains. Special attention is necessary for the scenario where an ERTMS Level 3 train is allowed to pass at line speed a lineside signal showing a Stop aspect.

The advantage of this solution against using Hybrid Level 3, as described above, is that it enables non-ERTMS trains to run.

Level 3 Virtual block

ERTMS Level 3 virtual block management relies on virtual objects (software- and database-related ones) for managing track occupancy and train separation. The term 'virtual block' is used to designate a headway section defined in the ERTMS RBC.

The occupancy of such virtual objects is defined through the reporting of trains. The RBC assigns trains to these sections on the basis of location messages supplied by the trains, and ensures that no section is subject to more than one train movement at a time.

Even if the virtual blocks have predefined fixed limits (as in conventional fixed block systems), this configuration provides flexibility in the length and number of blocks which can be defined for application on the line. The benefit of this approach is the possibility of adapting the size of the virtual blocks according to operators' needs (for example to reduce headways). Such refinement for adapting the size of blocks is easy to achieve through an update of the corresponding databases. In theory a line can be divided into an almost infinite number of virtual blocks of infinitely small length. In practice, the need to protect points and junctions will constrain the safe distance between consecutive trains and the length of the blocks in some areas.

Figure 1 shows an example of a virtual block system, where the second train's movement authority is defined downstream by the first occupied virtual block.

Trackside train detection systems are removed in this type of ETCS Level 3. This requires that all trains operating within the virtual block area must be fitted with TIMS, and Level 3 operational procedures are required for degraded situations.

Level 3 Moving block

Here the trackside is not divided into sections; safe separation between two trains is no longer given by a static value enforced by fixed blocks, but by an adjustable distance based on a real time calculation of the train speed and the reported train location among other elements.

As shown in Figure 2, each reporting train is therefore associated with one, and only one, virtual block that moves with the train. As the leading train moves forward, the next train follows while maintaining a safe distance separation; movement authorities are calculated up to the rear of the leading train. Since the separation is kept to a bare minimum, there is no wasted space, the train is not left waiting for a block to clear (as it is in fixed block) and, most importantly, the headway is kept as short as possible.

As moving block utilizes the track in the most efficient manner while ensuring safety, the result is that consecutive trains run closer to each other than in a Level 3 virtual block solution, while safety is maintained.

Trackside train detection systems are removed in this solution; this means that all trains operating within the moving block area must be fitted with TIMS, and Level 3 operational procedures are required for degraded situations.

Summary of the types

Table 1 overleaf provides a summary of the different types of Level 3 and their main characteristics.

Having demonstrated above that a lot of conceptual development of ERTMS Level 3 has taken place, we acknowledge that there are some steps required to complete before going into implementation. These are outlined below.

How is Level 3 development being taken forward?

Development of Level 3 is being taken forward in two related and complementary work streams.

The first work stream aims at minimising risk in early implementations of Level 3. It plans to facilitate the management of degraded scenarios and to target a simple migration, of both trains and tracks, from Level 2 to Level 3 to gain capacity advantages through the development of Hybrid Level 3. This work is being developed by a collaborative team from ProRail and Network Rail with support from other rail partners.

The second work stream focuses on developing the other types of Level 3 implementation. This work stream has to confront two key challenges: further requirements on the trains, and the need to manage degraded scenarios without train detection systems in place. This work is being developed in the Shift2Rail Innovation 2 Programme which commenced in September 2016.

Development of Hybrid Level 3

This solution is being developed through collaboration between ProRail and Network Rail. The plan is to have requirements and standards ready to allow an early deployment demonstrator of a Hybrid Level 3 system from 2017 onwards, and to integrate these standards in cooperation with the European Union Agency for Railways into the European ERTMS specifications as needed.

The involvement of the European Union Agency for Railways is intended to minimise the risks of the project, keeping the Hybrid Level 3 solution within the EU ERTMS specifications. This is particularly important as, if parts of the development did require a change in the existing European ERTMS specifications, they would have to be agreed through the European ERTMS change control process.

The development process

The Hybrid Level 3 solution will be developed and then validated to achieve technical demonstrators in several steps.

Type of Level 3	Fleet Fitment	Infrastructure	Benefits and challenges
Overlay (on Class B)	ERTMS recommended but not mandatory, allowing fleet fitment of ERTMS. TIMS not mandatory, allowing phased fleet fitment.	Signals (Class B system) and trackside train detection retained. Use of virtual block technology.	Moderate increase in capacity for trains with ERTMS+TIMS only compared with operation using the Class B system (may also need to update the time table to assist in delivery of benefits). Solution needs to be found to allow ERTMS L3 trains to pass a lineside signal showing a Stop aspect.
Hybrid (virtual blocks)	ERTMS required. TIMS recommended but not mandatory, allowing phased fleet fitment (especially relevant for freight).	No signals. Trackside train detection retained. Use of virtual block technology.	Increase in capacity for trains with TIMS without adding trackside train detection. Increased reliability because of redundancy in train localisation.
Hybrid (moving block)	ERTMS+TIMS recommended but not mandatory, allowing phased fleet fitment (especially relevant for freight).	No signals. Limited trackside train detection. Use of moving block technology.	Increase of capacity by adapting the size of the virtual blocks in software data bases. Impact on traffic management systems and operation impact (two trains in a block) to be considered.
Virtual (without train detection	ETCS+TIMS fitted trains only	No signals. No need for trackside train detection. Use of virtual block technology.	Increase of capacity by adapting the size of the virtual blocks in software databases. Reduction of costs and increase in reliability due to the removal of trackside equipment. Solutions for trains without radio connection and degraded situations have to be found.
Moving block (without train detection)	ERTMS+TIMS fitted trains only	No signals. No need for trackside train detection. Use of moving block technology.	Maximised capacity on the available infrastructure. Reduction of costs and due to the removal of trackside equipment. Solutions for trains without radio connection and degraded situations have to be found.

Table 1 – summary of the different types of Level 3 and their main characteristics.

- A set of common Hybrid Level 3 principles have been developed in cooperation with Alstom, Bombardier and Siemens, in conjunction with an operational concept.
- A laboratory simulation of the Hybrid Level 3 principles was organised by ProRail in 2016 with support from Network Rail, Alstom, Bombardier, Siemens, Ansaldo, Arup, SNCF Réseau and the ERTMS User Group.
- A Network Rail/ ProRail demonstration will take place in 2017 at the British ERTMS National Integration Facility.
- A Hybrid Level 3 pilot line could be delivered by 2018. An option analysis will be performed to determine the most suitable location for a pilot demonstration. Options for undertaking pilots in both Great Britain and the Netherlands are currently under investigation. The pilot demonstration will be used to verify compliance with the specifications and to check the expected performance of the system.

The development of this early ERTMS Level 3 solution will bring return of experience for the other possible implementations of Level 3. In particular it is expected to give an insight into the benefits of having some train detection systems at the trackside (as in Level 2) for Level 3 degraded mode operation, for example in areas of complex switch and crossing work.

The development of Level 3 in Shift2Rail

There are several Level 3 solutions which require the following elements to be further developed for the main line railway: systems to manage operational Level 3 constraints, safe train integrity monitoring solutions for all type of trains, and the Level 3 technologies for the safe separation of trains.

Shift2Rail addresses these issues through the following activities [R4].

- The Level 3 operational scenarios and additional constraints will be analysed (e.g.: a train or part of a train without a RBC connection shall not move).
- For the Level 3 train separation management system, the scope of Shift2Rail covers the definition of an operational concept, engineering rules and system specifications, with a delivery date by the end of 2018. This includes several variants of Moving Block, 'Virtual Fixed Block' and 'Full Moving Block', both with and without train detection, as each may be important in different applications. While 'Full Moving Block' would in theory bring maximum benefits in terms of train capacity, its use could be challenging around junctions. In complex trackside configurations 'Virtual Fixed Block' will be easier to implement and the benefits in capacity could be in practice as good as using 'full Moving Block'

if implemented correctly. The starting point for this work in Shift2Rail will be the moving block principles that were developed and validated as part of the Next Generation Train Control (NGTC) programme [R5].

- On-board train integrity definition and prototyping. The functionality will be developed notably for those market segments (freight and passenger low traffic lines) where such a function is not yet available using reliable existing on board features.

The Shift2Rail work on this area is currently at the start of its development cycle having commenced in September 2016. Network Rail as a Shift2Rail member is directly involved in this work and looks forward to providing continuity and lessons learnt from the Hybrid Level 3 work into this development programme. The ERTMS Users Group, as a linked third party within Shift2Rail, will also support this work.

Conclusions

There is a clear requirement for ERTMS Level 3 on our networks today to improve capacity, and there are a number of ERTMS Level 3 solutions which are able to meet it. They are currently at different levels of development, as is the business case analysis to support application of the different variants.

Of these solutions, ERTMS Hybrid Level 3 is the most advanced and is currently seen as the low risk solution for application on rail networks. This is due to its built-in optimal use of both train position and existing train detection information and its simple and smooth migration path from existing trackside systems and trains.

As the solutions move towards ERTMS Level 3 without trackside train detection there are more issues to solve in terms of application on complex interconnected main line networks. Will there ever be a moving block system without trackside train detection which will add benefits, or will the developments show that the optimum benefit comes from a hybrid system? These are questions that must be answered as these developments continue.

It is applicability and the ability to migrate these solutions from existing trackside systems and trains which will ultimately determine how to implement Level 3 on our networks in future.

References

R1 Commission regulation (EU) 2016/919, of 27 May 2016, on the Technical Specification for Interoperability relating to the 'Control-Command and Signalling' subsystems of the rail system in the European Union

R2 ERTMS long term perspective version 1.5, 18/12/15

R3 Memorandum of Understanding between Network Rail and ProRail signed on 2/2/2016

R4 Shift2Rail Multi-annual Action Plan, Rev 3, November 2015.

R5 NGTC-WP5-D-DIM-064-01_-_D5.1_Moving_Block_Principles_Draft_15

R6 General Principles ERTMS Level 3 with Virtual SubSectioning, ProRail, 27-08-2015

INDUSTRY NEWS

In order to bring IRSE NEWS readers the latest global signalling, telecomms and train control information, we have teamed up with the **Railway Gazette International** *(**www.railwaygazette.com**) to supply brief summaries of major news in our industry. We will of course also publish items of news from other sources when we receive them.*

Siemens opens new depot in Glasgow

UK: Siemens' new rail depot was officially opened on 24 February 2017 by the Scottish Government Minister for Transport and the Islands, Humza Yousaf, MSP.

With passenger numbers in Scotland growing every year and a comprehensive programme of rail infrastructure works planned across the country over the next decade, Siemens took the decision to relocate its site teams to this purpose-built facility in Cambuslang, on the outskirts of Glasgow.

Siemens Rail Automation Operations Director, East, Richard Cooper, said: *"We are delighted to welcome Humza Yousaf to the new Cambuslang depot and honoured that he performed the official opening ceremony. I am particularly pleased that he took such an interest in our apprentices; we are proud of the young people we have recruited from the surrounding area and look forward to the positive contributions they will make to our business in the future."*

Transport Minister Humza Yousaf said: *"I'm delighted to open this new facility and get the chance to meet some of the people who work here."*

Industry backs faster ERTMS deployment

[RGI] EUROPE: The Chief Executives of the eight signalling companies that are members of the UNISIG association renewed their commitment to the development and roll-out of the European Rail Traffic Management System at a meeting in Brussels on 7 February attended by DG Move Director-General Henrik Hololei, ERTMS Co-ordinator Karel Vinck and EU Agency for Railways Executive Director Josef Doppelbauer.

Alstom, Ansaldo STS, AZD Praha, Bombardier, CAF, MerMec, Siemens and Thales all signed individual Letters of Intent supporting the updated ERTMS European Deployment Plan which was formally adopted by the European Commission on 5 January.

The commitment by the suppliers follows on from the signing by various rail sector associations including UNISIG and UNIFE of a fourth Memorandum of Understanding with ERA and the European Commission in September 2016. This is intended to secure long-term stability for the ERTMS specifications following the adoption of Baseline 3 Release 2 and promote a *"swift and co-ordinated"* deployment across Europe.

The suppliers hope that their commitment to the future development of ERTMS will encourage individual railway operators and infrastructure managers to sign similar letters of intent in the near future, following on from the signing of the memorandum by both CER and EIM.