

Technology deployment

ETCS Level 2 without signals: a new vision for the future of rail operations



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In this article the author seeks to set out a bold and transformative strategy for the deployment of ETCS Level 2 (European Train Control System) without traditional lineside signals ('signals away').

Whilst this is written from a Great Britain perspective, the principles could apply elsewhere. This initiative, presented in two parts, 'what if?' and 'way forward', lays the groundwork for an improved approach to delivering a future where digital signalling becomes the norm, unlocking significant operational, safety, and economic benefits.

Why a new vision?

A refreshed vision for implementing the ETCS presents an exciting opportunity to build on past successes and address emerging challenges in a more coordinated and strategic way. Evolving current practices could unlock greater efficiency, consistency, and innovation across the British rail network.

Here are some key areas where a new vision could add value:

Enhancing coordination in onboard fitment

Currently, ETCS onboard fitment is managed independently by individual Train Operating Companies (TOCs). While this decentralised approach has enabled progress, adopting a more unified strategy could help promote consistent quality standards across the network, streamline implementation timelines, and reduce duplication in logistics and scheduling efforts.

Optimising infrastructure across the network

Infrastructure for ETCS fitment varies significantly across operators and depots. Transitioning to a more standardised model could help lower costs through shared solutions, accelerate installation processes, and minimise integration risks across the network.

Aligning trackside and onboard deployment

Trackside resignalling and onboard fitment are often planned separately, which can result in missed opportunities. Achieving greater alignment between these activities could improve commissioning timelines, enable better synchronisation, and simplify overall project delivery.

While the current model has supported early deployments effectively, the scale and ambition of future roll-outs, particularly those involving 'signals away' operations, call for a more cohesive and forward-thinking strategy.

A new vision isn't just about refining processes; it's about reimagining how we modernise the railway. By working together across the industry, we can fully realise ETCS's potential as a transformative technology for the British rail network.

What if? The vision for a fully digital railway

The first part of the strategy explores a compelling scenario: what if all trains operating on a particular route to be resigalled are to be fully equipped

with ETCS onboard systems in the same timescales as the infrastructure fitted? What if all personnel, (drivers, signallers, and maintainers), are also to be comprehensively trained in ETCS operations at the right time?

This would create the conditions required to eliminate traditional signals entirely. With the requisite network change processes and early assurance and authorisation secured from regulatory bodies such as the Office of Rail and Road (ORR, the GB rail regulator) and NoBo (Notified Body), the vision of a 'signals away' railway becomes not only feasible but highly desirable.

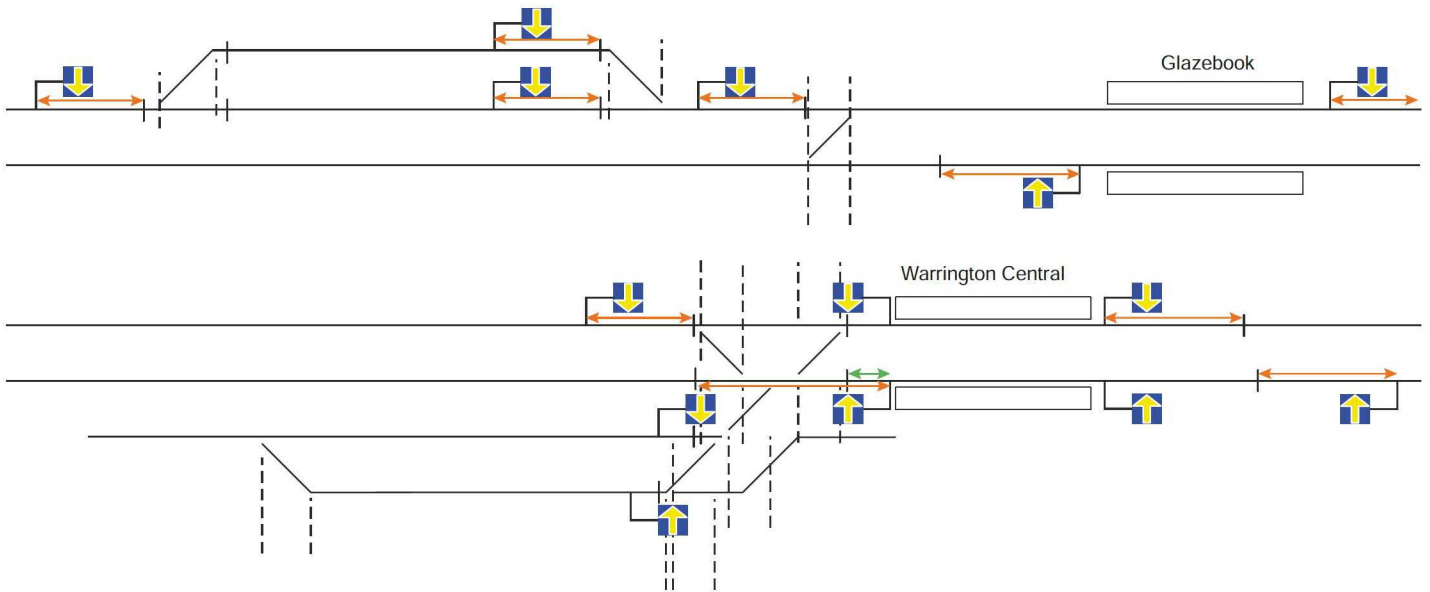
The benefits of such a transformation are substantial. Capital expenditure (CAPEX) would be significantly reduced by eliminating the need for signals, cables, and associated power infrastructure. Operational expenditure (OPEX) would also decrease due to lower maintenance demands.

Safety would improve for track and maintenance staff, and the philosophy of developing a 'signals away' route from the beginning would become a blueprint for future deployments. Use of an equipped section of line as a testbed for other fleets and driver training, would further enhance its strategic value.

How? A phased and strategic implementation

Implementing ETCS Level 2 without lineside signals demands a carefully orchestrated strategy that balances innovation with operational continuity.

Figure 1 – ETCS design, 'blank sheet of paper' approach.



The proposed approach is structured around several key phases, each designed to mitigate risk while accelerating progress toward a fully digital railway.

Design from the ground up

The foundation of the strategy lies in designing the system without signals from the outset (Figure 1). This involves developing a new Computer-Based Interlocking (CBI) and Radio Block Centre (RBC) specifically for ETCS Level 2 operations, keeping these systems independent of legacy signalling infrastructure to ensure a clean break and reduce complexity.

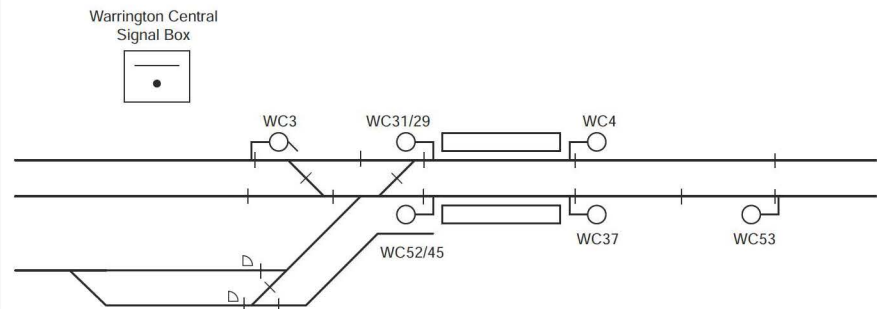
The design process would leverage model-based simulation tools to optimise equipment positioning, ensuring the best possible operational outcomes. Block section boundaries, such as axle counters, would be installed in their final operational positions from the start, avoiding later adjustments and ensuring full compatibility with ETCS requirements. Additionally, all ETCS-related trackside hardware would be installed separately from existing systems, allowing for parallel development and testing without disrupting current operations.

Testing strategy: overlap and assurance

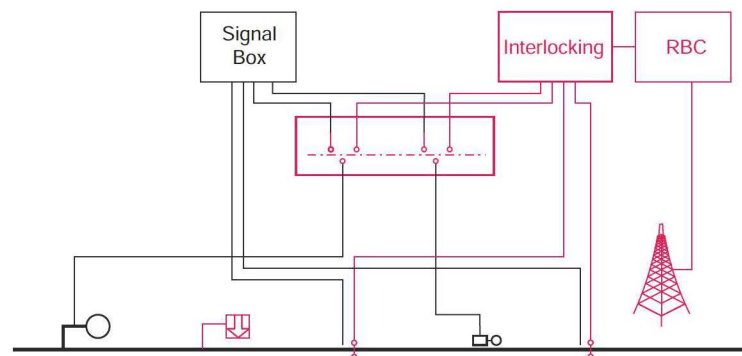
Testing is a critical phase, and the strategy includes both night-time and daytime testing regimes. 'Over and back' testing: During night-time hours, trains would operate using ETCS control under supervision of the new RBC. After testing, operations would revert to the legacy system. This allows for iterative validation without impacting daytime services. (Figure 2)

Figure 2 – Testing strategy.

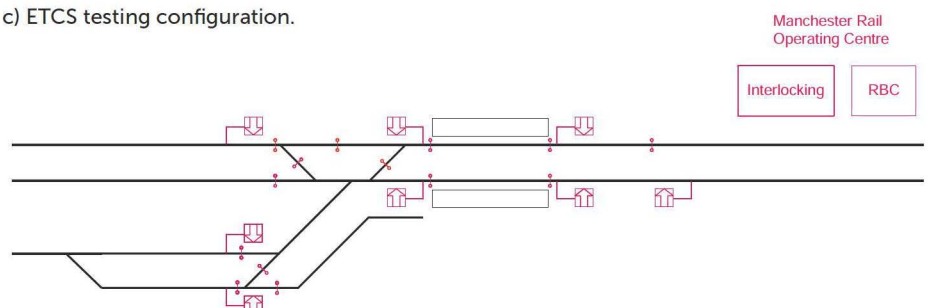
a) Existing control.



b) Switchover (and back) architecture.



c) ETCS testing configuration.



Shadow operations (Figure 3): During daytime running, ETCS-equipped trains would operate with the onboard ETCS placed in data-collection mode (ensuring the DMI is extinguished and the on-board ETCS Vital Computer isolated). This would allow trains to continue running normally under the existing conventional signalling system, while still gathering performance and behaviour data, typically via a dedicated data logger. This approach makes it possible to analyse and refine ETCS system behaviour under real operating conditions without interacting with, or influencing, the legacy signalling. The term 'superimpose' is preferred here instead of 'overlay,' as it more accurately reflects the fact that the two systems coexist side-by-side without integration.

Commissioning: 'big bang' approach

Once all trains are equipped and personnel are trained, the strategy calls for a 'big bang' commissioning approach. This involves physically bagging and decommissioning all lineside signals, marking the full transition to ETCS-only operations. Following commissioning (the decommissioning of the signal box and permanent removal of signals), only ETCS-equipped trains would be permitted on the route, eliminating the complexities and risks associated with mixed-mode operations and ensuring consistency in control and safety protocols.

Early engagement and network change

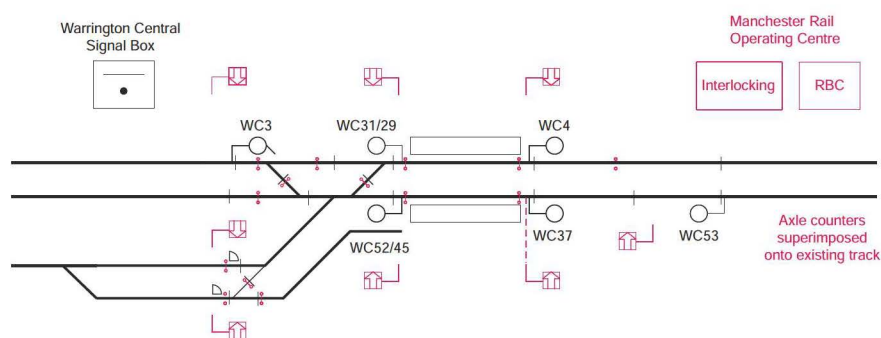
To support this transformation, early engagement with regulatory bodies and stakeholders is essential. Consultation with the ORR, NoBo, and Network Change Board (NCB) would begin early in the programme to streamline approvals and ensure compliance. The Network Change process would also be initiated as early as possible to align infrastructure, operations, and regulatory frameworks with the ETCS deployment.

Integration planning

Integration between train and track systems would be facilitated through dedicated test environments. Simulated environments would be used to model operational scenarios, stress-test the system, and validate safety protocols before live deployment.

Facilities such as the ETCS National Integration Facility and the Rail Innovation and Development Centre would be employed to validate train fitment and system interoperability. These test tracks support both low and high-speed testing capabilities for handover between RBCs and interlockings.

Figure 3 – Shadow operations. ETCS 'superimposed' (not overlaid) onto existing layout.



The communications infrastructure would support both circuit-switched and packet-switched communications via GSM-R and future FMRCs technologies, ensuring robust and flexible connectivity.

Rethinking train fitment: a more regional-centric approach

One of the key areas for enhancing ETCS deployment lies in the fitment of onboard equipment. While the current decentralised approach, led by individual TOCs, has enabled progress, it also presents an opportunity to improve consistency, efficiency, and delivery timelines.

To support a more streamlined and scalable rollout, the concept of regional ETCS fitment centres is being proposed. These centres would operate as a one-stop-shop for ETCS onboard installation, using a production-line model with dedicated workstations for underframe, cab or saloon, and roof-mounted equipment.

They would feature standardised infrastructure and modular installation jigs to accommodate multiple train types and conduct testing and commissioning on-site using a purpose-built test track. The fitment process would also integrate NoBo and DeBo (Designated Body) certification, ensuring compliance and efficiency throughout.

Such a model would foster standardisation in quality and processes, enabling economies of scale through shared resources. It would streamline logistics, minimising duplication and delays, while enhancing scheduling and reducing installation lead times.

Time efficiency would be achieved through lean manufacturing practices such as Kanban, and risk would be reduced via pre-installation testing and centralised control of critical path activities.

Additionally, it would strengthen collaboration across operators and suppliers, supporting a more cohesive and efficient rollout.

By evolving the fitment model, we can better position the industry to meet the demands of future ETCS deployments and maximise the benefits of this transformative technology.

Sites like the Long Marston Rail Innovation Centre, already undergoing modernisation and featuring an 11km test track, could be ideal for this purpose. Leveraging existing infrastructure investments would align with national transport policy and deliver public value by accelerating timelines and reducing taxpayer burden.

The development of the Global Centre of Rail Excellence (GCRC) in Wales presents a promising opportunity to explore the inclusion of an ETCS-dedicated fitment centre. Integrating such a facility could support more coordinated, efficient, and scalable onboard deployments, while leveraging GCRC's broader innovation and testing capabilities.

Training coordination

Human factors remain central to the success of ETCS deployment. Driver training requires significant preparation, while signallers and maintainers undergo intensive programmes lasting two to three weeks per person. To ensure readiness, training must be scheduled well ahead of commissioning, ideally aligning with the final stages of trackside commissioning.

Benefits realisation and tracking

To ensure the programme delivers on its promises, a benefits tracking tool should be deployed from the outset. This would include an investment logic map to identify problems, define expected benefits, and establish Key Performance Indicators (KPIs) to measure success.

Benefits such as reduced capital and operational expenditure, improved safety, and enhanced capacity should be tracked continuously throughout the programme lifecycle.

Way forward: from vision to reality

The second part of the strategy outlines the practical steps required to bring this vision to life. Central to this is the development of a Concept of Operations (CONOPS) that focuses on delivering the existing and future passenger service levels for a line—while also exploring opportunities for increased capacity and freight integration. A clear vision of how the railway can improve its service delivery strategy through the exploitation of the enhanced ETCS capabilities is key.

A detailed migration plan will define dependencies and timelines, while a robust RBC strategy will ensure seamless communication and control. Stakeholder engagement, particularly with TOCs and Freight Operating Companies (FOCs), is essential to align operational needs and expectations.

The ETCS design should reflect a 'signals away' philosophy from the outset, and assurance engagement with regulatory bodies must begin early to streamline approvals. Integration planning will need to involve configuring test tracks for both low and high-speed testing, with handover capabilities between RBCs and interlockings.

Simultaneously, train fitment and training coordination must be closely monitored and managed. Training programmes for drivers, signallers, and maintainers should be planned well in advance, with a focus on readiness by the time the infrastructure fitment is nearing completion.

To ensure the programme delivers on its promises, a benefits tracking tool, such as an investment logic map, should be deployed from the start. This will help measure the effectiveness of the solution against key performance indicators and ensure that the anticipated benefits are realised.

Conclusion: a blueprint for the future

I believe this ETCS Level 2 'signals away' strategy represents a pioneering step toward a fully digital railway.

By combining visionary thinking with rigorous planning, stakeholder collaboration, and a reimagined approach to train fitment, the vision aims to deliver a safer, more efficient, and future-ready rail network.

Key considerations for taking this strategy forward include developing robust RBC strategy concepts, detailed migration planning with clear dependencies, and establishing stakeholder engagement frameworks.

The approach is grounded in a 'blank-sheet-of-paper' design philosophy, supported by ongoing assurance engagement with bodies such as NoBo, AsBo (Assessment Bodies), and DeBo. Integration planning will be critical, particularly in relation to the test track strategy, while the training philosophy must incorporate tools like cab simulators and robust tracking systems.

Realising the benefits of this transformation will require careful measurement and evaluation, and equipping future lines in manageable phases will help build experience and confidence across the industry.

It's recognised that this vision may challenge traditional approaches to ETCS implementation. But as with all pioneering ideas, meaningful innovation often requires us to rethink established norms. Disruption isn't a threat, rather it's a catalyst. It's how we move from incremental change to transformative progress.

By embracing bold thinking and collaborative action, we have the opportunity to reshape how ETCS is delivered, unlocking greater efficiency, consistency, and long-term value for the British rail network.

Now is the time to come together, challenge the status quo, and lead the next chapter in railway modernisation. Let's build the future, faster, smarter, and stronger.



About the author

David Ashby is a technical director at Tilt Consulting, based in the UK. With over three decades of experience in the control, command and signalling systems domain, David has worked on numerous projects across Asia, Australia, Europe, North America, and the UK. He brings expertise in the delivery of advanced train control technologies on to high speed, main line, light rail and metro networks.

David has led the development of flagship projects on railways including Sydney Metro, Bangkok Skytrain and Metro, as well as Kuala Lumpur's MRT schemes and Singapore's high-speed rail programme.

What do you think?

Do you agree with the vision David is proposing?

Do you think that in many ways it reflects the aims of current projects in the UK and elsewhere, or do you think that a different approach is required.

Perhaps your railway or company has successfully delivered an approach similar to this – or even radically different?

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