The Next Generation Railway

Pioneering digital signalling on the East Coast

ECDP at a glance

1 in 3
Britons live within 20 minutes of an **East Coast Main Line Station**

39%
reduction in embodied carbon

42%
reduction in signalling unit cost

46%
less track access
to install digital signalling

Up to **33%**
improvement in system
capability & performance

5,000
jobs in the Supply Chain

Over
3,000
drivers to train

Over
1,000
signals to be replaced

Over
700
rail vehicles to prepare

Over
30
organisations working
together on ECDP

5
system manufacturers
(OEMs)

A foundation for a more capable railway

It is fitting that the East Coast Main Line – the route of *Flying Scotsman* and *Mallard* – should become Britain's first inter-city railway to have digital signalling. Having been at the forefront of pioneering change through different eras, this key economic artery will now lead the way into a new landscape of digital rail.

Last year the Government made a strategic investment in the future of our rail network when it confirmed £1 billion for the East Coast Digital Programme (ECDP). The new in-cab technology will create a higher performing, more resilient, greener, more reliable and even safer railway, on a route that more than a third of the nation's population live within 20 minutes of.

ECDP creates a foundation for an industrial strategy of progressively rolling out digital signalling. As ECDP builds capability and upgrades train fleets, it unlocks the opportunity to deliver future renewals for much less cost and disruption. Our plan states that replacing conventional signalling with digital at the point of renewal is the cost-effective strategy. This will provide a sustainable railway for future generations, where digital skills and innovation continue to flourish.

I was pleased to experience digital signalling myself when I used the driver simulator on a recent visit to London King's Cross. At present the driver gets a brief glimpse of an approaching signal – digital signalling will give the ability to see what is going on much further ahead and to be given a constantly updated safe maximum speed. Likewise, the technology involved will equip a range of frontline staff to make the best decisions in their day-to-day roles. The trade unions have been longstanding advocates for digital signalling and there has been good engagement with them by the partners involved.

On that visit I also met with leaders from across all parts of the industry – Network Rail, operators, suppliers, technology providers – who are all collaborating like never before to deliver the system change needed across track and train. The collective pioneering spirit of all those involved with ECDP is crucial in bringing together the tens of organisations from across the industry. Success requires strategic leadership and aligning incentives, underlining the case for rail reform, which Government remains committed to.

There will be challenges along the way, but the prize – a more capable railway that works better for all who depend on it – is worth persevering towards. Here's to the next generation railway! ▪

Huw Merriman MP
Minister of State for Rail and HS2

Digital signalling in close-up

There is much more to ETCS than removing lineside colour light signals, explains *Modern Railways* Industry and Technology Editor ROGER FORD

Sitting at the controls of an LNER high-speed train as it raced through a snowstorm at 125mph provided me with a dramatic demonstration of what European Train Control System (ETCS) will mean for drivers. In similar conditions, with trackside colour light signals, you would be straining to see the next signal as it emerged from the gloom.

But in the cab of the simulator I am 'driving', the ETCS display provides all the information I need to know to drive safely, and more. Not only does the speedometer indicate the maximum speed allowed, beside it a separate display shows me how far ahead I can run at that speed, my 'movement authority'.

Enhanced skills

Far from reducing the role of drivers to simply following the indicated speed, as some have claimed, the system being installed on the East Coast Main Line (ECML) enables drivers to apply their professional skills and judgment to better effect through greater knowledge of what lies ahead.

Take the movement authority indicator. This supports precision driving, resulting in a smoother journey with more exact timekeeping.

At present a driver approaching a signal showing a double yellow aspect (see box) doesn't know what the next signal aspect could be and so starts braking. But often the next signal can be another double yellow or may even have reverted back to green, requiring the train to accelerate back up to maximum speed.

'Having the driver looking out of the window at intermittent signals is a major limitation to the railway system' points out Toufic Machnouk, Director, Industry Partnership for Digital Railway. 'What you really want to do is talk directly to the train, give the driver the maximum view ahead, give them speed protection and suddenly you've solved major constraints and fundamentally improved the capability of the system.'

The fastest trains on the ECML average over 100mph between London and York, and the line is one of Network Rail's most congested routes. With multiple-aspect signalling, late clearance of a double yellow to green can cost minutes which may never be recovered. And the knock-on effect of those minutes counts if the aim of a 'boringly reliable' railway is to be achieved.

A minute's late arrival at a busy junction can delay other trains, disrupting hundreds of passengers' journeys. This also has the effect of reducing the capacity of an already busy route like the ECML.

Allowance for this risk is written into today's timetables. Smoother traffic flows will enable journey time reductions as well as more reliable services, without having to run faster.

Nor are the benefits confined to passenger services. 'The new signalling system will enable us to operate longer, heavier, faster freight trains' points out David Golding, GB Railfreight's Asset Director. 'It will enable a more agile network and release capacity that will allow us to deliver more goods, more competitively by rail, with long-term benefits for businesses and the environment.'

Why ECML?

Covering the 100 miles between King's Cross station and Stoke Tunnels, south of Grantham, the UK's first main line ETCS installation is the responsibility of the East Coast Digital Programme (ECDP).

Performance driven by system constraints is one reason why the ECML south of Peterborough was chosen for the first major ETCS installation. Between Welwyn and Woolmer Green, the four-track line changes to two tracks over Welwyn viaduct. For a smooth flow of traffic through this notorious bottleneck trains have to arrive in the right sequence and at the right time. This is an ideal application for ETCS.

'In the context of the ECML, particularly at the south end, access for engineering work is so difficult nowadays' says LNER Managing Director David Horne. 'This is probably the biggest difference between the railway now and 30 years ago in terms of busyness and service frequency. Data from LNER shows that Fridays and Sundays are proving to be the most popular days for people to travel. To reflect

East Coast capacity constraint: a GB Railfreight intermodal train and Thameslink Class 700 pass on Welwyn viaduct on 5 July 2017. This two-track section is part of the Welwyn to Hitchin stretch which will be the first on the main line to migrate to ETCS, albeit with conventional signals retained initially. **JAMIE SQUIBBS**

this new pattern, we recently worked with industry partners to trial carrying out the work midweek to reduce disruption for passengers. If we had to renew the railway with conventional signalling, the engineering access demand would be significant.'

Cost

The central aim of the new approach is to change the economics of railway signalling.

Over the coming decades, Network Rail faces a bow-wave of signalling renewals. Replacing existing multiple-aspect signalling with modern versions – more of the same – is not an option, for several reasons.

First and foremost is the cost. The lineside signals are more than just 'lights on a pole'. In addition to connections to the safety signalling system, a power supply has to be provided for the lights themselves, plus monitoring equipment to warn if a light has failed.

And on a three- and four-track railway like the ECML, signals may have to be mounted on gantries above the tracks. These are expensive to manufacture and require substantial foundations. The railway then has to be closed for these large structures to be craned into place.

More for the money

In contrast, ETCS requires only beacons – called 'balises' – on the track and a radio link with the system. The balises and radio link transmit the data required by the on-train ETCS equipment, including the driver's display, as a train passes over them.

Without physical signals to renew, ETCS-based signal renewals promise to cost half of like-for-like replacement on average. There is also the hidden saving from reduced disruption to traffic.

The ETCS system can be installed and tested in 'shadow mode' while the trains run normally under the existing signalling. Then when installation is complete the multiple-aspect signalling is removed and ETCS takes over.

While costing less, ETCS can't be compared directly

with the multiple-aspect signalling it replaces. As already described, cab signalling provides significant operational and safety benefits. It also eliminates the maintenance costs of the lineside signalling equipment and structures.

Today and tomorrow

ECDP has two roles. Obviously, the current renewal of the signalling is the immediate task. But even more important is its development of the organisational capability and processes which will form the basis for the long-term installation of ETCS as signalling is renewed on multiple routes over the coming decades.

Today, installing ETCS is still novel. But by the time trains are running with cab signalling between London and Stoke Tunnels, when tens of organisations will have migrated with the system, Mr Machnouk intends that renewal with ETCS will have become 'business as usual'.

As LNER marks the 100th anniversary of the formation of its illustrious predecessor, MD David Horne comments: 'The original LNER was noted for pioneering technical innovation. With EDCP, we and the other operators on the ECML are helping to maintain that heritage.' mr

SIGNALLING FOR TOMORROW

As the man responsible for the first rollout of the European Train Control System on the Network Rail main line, Director, Industry Partnership for Digital Railway Toufic Machnouk explains that lay people can assume railway signalling is similar to traffic lights on the roads. But railway signalling was designed to solve a different problem than a simple instruction to stop.

On the roads, traffic lights just provide conflict management: when you arrive at a red traffic light, you stop. An inter-city train, weighing the same as a Jumbo Jet, takes just under 2,000 metres to stop from 200km/h (125mph). Clearly, with signals typically spaced at 1,100-metre intervals, a train driver can't wait to see the red signal before starting to brake.

Today, multiple-aspect signalling provides the necessary view ahead. The colour sequence typically goes green, double yellow, yellow, red.

Working backwards, a yellow means prepare to stop at the next (red) signal. A double yellow warns the driver to start reducing speed in case the next signal is a yellow, requiring braking for the subsequent red.

A driver at full speed on green signals expects the next signal to be either another green but, possibly, a double yellow, requiring a precautionary brake application in case a single yellow follows. In essence, railway signalling provides advance information beyond the line of sight of drivers.

Looking ahead

Contrast this with ETCS, where the movement authority

display provides a continuous update on the distance ahead before the train needs to slow or can accelerate. This can be anything up to 32,000 metres further along the line.

Similarly, the speedometer shows the target speed at the end of the current section. If a train is running under the equivalent of 'double yellows' and the line ahead clears, the new safe speed is indicated immediately – the driver doesn't have to wait until the next signal comes into sight to increase speed.

And built into this sophistication is Automatic Train Protection. If the driver exceeds the maximum permitted speed, there is a warning, followed by an automatic brake application if the warning is ignored.

A new way of working

The East Coast Digital Programme is changing behaviours in a fragmented industry, explains *Modern Railways* Consultant Editor JAMES ABBOTT

What's so tough about introducing European Train Control System (ETCS) on the East Coast Main Line? ETCS is well-established technology, in widespread use globally. Shouldn't it be easy to apply here?

'The UK rail industry has a complex commercial structure – we're having to navigate a fragmented industry, with legacy ways of working that make it hard to integrate' explains Ed Akers, Network Rail's Principal Programme Sponsor on the East Coast Digital Programme (ECDP). 'The challenge is that we need every part of the industry aligned – track, train, technology suppliers, government and others – to make this happen. The only way to do it is to have an industry partnership.'

'Industry first'

'We're pioneering a different mindset' adds his colleague Caroline Crewther, Industry Change Lead on the programme. 'We want an "industry first" mindset. We've got more than 30 partners involved in the programme, all with their own roles and responsibilities – what we need is for everyone to embrace the commitment to adopt a "best for industry" approach, rather than their own individual interests.'

This approach is brought together by the Industry Partnership Delivery Board (IPDB), the sponsoring group for ECDP. The group was recently visited by Rail Minister Huw Merriman, who met the leaders from every corner of the industry working together to deliver this programme.

Building relationships

'This commitment is demonstrated in many ways and formalised through our Industry Relationship Management Plan, the first of its kind and scale in the rail industry' explains Caroline Crewther. 'Our plan is built on the principles of ISO 44001, the International Standard for Collaborative Business Relationships, but it's so much more than that! It has provided us with the mandate to place integration and our cultural ambition at the top table of the partner organisations.'

It is clear ECDP means business when it talks about being an Industry Partnership and how the programme is 'integrating the industry like never before and pioneering Great British Railways'. The partnership has taken careful effort to create an open boundary environment across partner organisations within the programme and, as such, is transforming how the railway industry works together.

ECDP has put the building blocks in place to enable people to thrive in service of this mission, from the organisational model to the values and principles to investing in developing people. 'We are committed to developing each partner's capability to deliver the industrial strategy' says Caroline Crewther.

Best capability for the job

The 'best for industry' approach extends to the capability that is delivering the programme, where the aim is to pick the best person for the job, regardless of partner organisation. Thus, for example, a person from Grand Central is representing the passenger sector, having been elected by all the passenger operators. 'Here we have an open access employee representing government-run operators – nothing represents the partnership approach more than that!' endorses Ed Akers.

The Programme has an Integrated Resource Strategy to enable the 'best for industry' approach. Deploying best practice capability and capacity has been two-fold: unlocking the best capability to design and deliver the Programme; and ensuring capacity within the railway industry

Pioneering partnership: in December 2022 Rail Minister Huw Merriman met leaders from across the industry involved with delivering the East Coast Digital Programme.

Delivering the next generation railway: ECDP is bringing together organisations from across the industry.

to realise the benefits of this pioneering Programme.

Those involved have to trust that the Senior Executives responsible for each of the 30 partner companies are going to act in the interests of the mission. Thus operators of Hitachi-built stock, such as Lumo and Hull Trains, will have their route forward with ETCS defined by what the principal Hitachi stock operator, LNER, does with the Azumas. 'They're all trusting LNER to get it over the line' says Mr Akers.

Similarly, while first-in-class fitment of a Class 66 with ETCS equipment is being done by EMD at Doncaster on a DB Cargo machine, other freight operators are collaborating on the design.

'We can see how this approach brings out the best in people. It's amazing what can happen when you see people who really care about the industry set to work' Mr Akers adds.

Trusting the experts

'The aim is to create an environment where people trust the experts' says Mr Akers. 'We're building a community of leaders responsible for delivering the benefits of the programme, who have one foot in the programme and one foot in their parent organisations. They form part of the industry change community, where partners from multiple sectors design and deliver the change needed to embed digital signalling within their businesses seamlessly. Everyone has to be open and trusting – sharing lessons and knowledge.'

A critical success factor of ECDP is the concept of 'user-centric design'. This was built on the premise that the operators of the railway know the railway best and their operational expertise is essential in ensuring an ETCS railway that works better for everyone. Bringing together experts from across the industry to design the solution has been a crucial step.

The process has to be skillfully managed. 'If we're not careful, it could turn into a General Assembly, with too many voices – that's why people have to trust the experts to lead' explains Mr Akers. 'A key part of my job is to keep everyone focused on what we need to achieve together. It's important that when issues do arise, individuals are not blamed – we are a pioneering programme and so people have to have the space to make some mistakes and learn quickly. Without that, we will not make progress.'

Different capability

'The deep industry partnership, enabling a highly collaborative approach championed by ECDP, means investing in our people to ensure we get the best out of everyone' says Caroline Crewther. 'What ECDP is doing is unique because of the scale of participants involved, all of whom must come together to deliver the mission. The collaborative culture wraps around everything we do, we must continuously invest in our culture and our people if we are to overcome decades of legacy behaviours across the railway.'

Ms Crewther adds that the approach taps into the Programme's Equality, Diversity and Inclusion strategy, seeking to draw talent from the widest pool possible rather than being confined to one organisation. 'If we truly mean what we say and are to live up to our values and principles, then we must challenge the convention.'

Model for the future

'The whole programme is benefits-led' emphasises Ed Akers. 'The magnitude of the collaboration is on a different scale to what we have seen before.'

His colleague Caroline Crewther concurs. 'We're directly impacting almost 6,000 people with the East Coast Programme: that's why it is set up differently.'

Mr Akers provides a succinct contrast. 'The traditional system for Network Change is that, typically, Network Rail produces a Network Change document saying "Here's the change" and goes out to consultation to find out what other players think. Then on the final day of the consultation a series of letters arrives listing all the things that are wrong with the proposal.
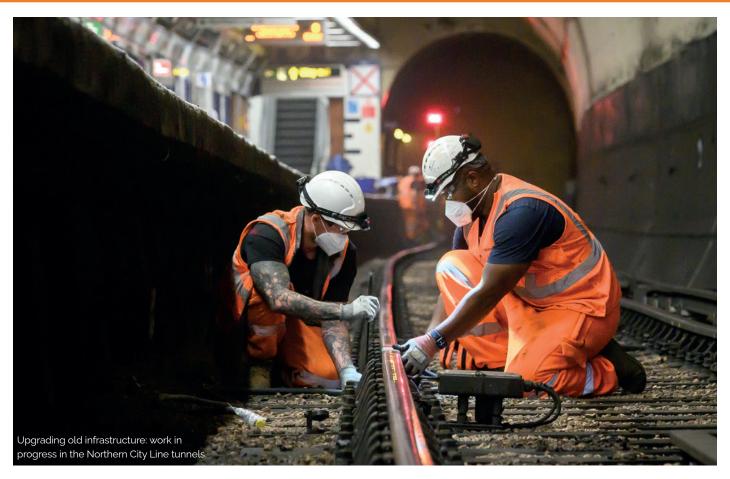
'We're turning that process on its head: we want co-authored Network Change, where everyone is explicit about any challenges up front, and the recipients of the change are collectively charged with delivering it.'

This is where the concept of user-centric design has been so pivotal. Experts from across all organisations have been involved in working collaboratively to ensure a best for industry solution which will form the blueprint for future ETCS deployments across the UK. 'This has not been easy, but with will and determination, we have collectively created the narrative for Network Change' says Mr Akers.

ECDP is an ambitious programme on many fronts, but culture change is one of the most ambitious parts of it. 'Our aim is that, when this programme comes to an end, people take our values with them' says Mr Akers. 'There are significant parallels with what Great British Railways is setting out to achieve.' **mr**

A NEW ERA

'This is the railway – but not as we know it.'
Caroline Crewther, Industry Change Lead on the East Coast Digital Programme

Upgrading old infrastructure: work in progress in the Northern City Line tunnels.

A pathfinder to wider transformation

Modern Railways Editor **PHILIP SHERRATT** explains how the ETCS pathfinder project on the Northern City Line is already providing lessons for the wider rollout on the East Coast Main Line

European Train Control System is not new to the UK: it has been in place on the Cambrian line for a decade and was more recently introduced through the Thameslink core between London Bridge and St Pancras International. But those were isolated projects – the East Coast Digital Programme heralds the first systematic deployment of in-cab signalling, and by far the most complex given the number of operators and stakeholders involved.

Having a pathfinder project to kick off the programme therefore provides an ideal opportunity to gather experience and learn lessons. The Northern City Line from Finsbury Park to Moorgate was the perfect candidate: the signalling was life-expired, it is a small and effectively self-contained section of railway with a single operator (Govia Thameslink Railway), and it has a new fleet of Siemens Mobility-built Class 717 EMUs which were delivered ETCS-ready.

'The pathfinder is all about how we can start to make this a business-as-usual activity, where ETCS becomes how we renew the railway signalling' says GTR's Head of ERTMS Oly Turner. 'If we can't do it on the Northern City Line, we won't be able to do it anywhere else – we have the perfect conditions.'

Collaborative approach

The key partners delivering the Northern City Line pathfinder – Network Rail, GTR and Siemens – worked together before on Thameslink, so had already gained experience from that deployment of ETCS. 'Thameslink was a good stepping stone – in many ways it was a pilot for this pathfinder' explains Oly Turner. 'But it was delivered with more traditional boundaries – on ECDP those have been eradicated.'

'The pathfinder enables us to stress test the collaborative approach before rolling it out across the rest of ECDP' adds Jonathan Daniels, Network Rail's Senior Portfolio Manager. 'Our teams have not had to be brought close together – they've done it themselves.'

Ben Lane, Project Director at Siemens, contrasts the convoluted process to get a message from the trackside team to the operator under the old model with the way barriers have been broken down on ECDP. 'The way Network Rail has approached it is different – it has a thin client model. There is no baggage of process and people-marking. It's a team of people working out how to get this done.'

As an example of this decision-making process, Mr Lane highlights the decision to change from going straight to a signals away railway on the Northern City Line to adopting an overlay solution. 'If we'd have gone straight to no signals without the operational capability and planning, how would Oly and his team have trained the drivers?' he asks. 'If we'd not developed the plan together, we would not have developed an operator-centric solution.'

Learning

A major element of the pathfinder has been sharing learning and experience with others on the programme, recognising that GTR has gained that experience already. Oly Turner pays tribute to GTR's Test and Commissioning

Driver Jim O'Donnell, who is now Simulator Manager at Hornsey depot. 'He has put hundreds of people from across the industry through the simulator course' says Mr Turner, who describes this approach of sharing experience as 'industry tourism'. 'When you try to explain ETCS it's hard to understand, but when you show someone, they understand it in two minutes. It's about increasing others' knowledge – for example, DB Cargo UK will be bringing its executive team to the Northern City Line in the summer.'

Nor has Mr Turner simply brought across the people who delivered ETCS on Thameslink. 'I wanted to find people who were keen to do something with this level of collaboration' he says of the team he has built for ECDP.

Already the team delivering the pathfinder project is learning lessons for the wider rollout on the East Coast Main Line. Mr Turner says this is essential – he describes the contrast between the Northern City Line pathfinder and the main line rollout as like going from 1mph to 1,000mph in one step.

'We're reviewing everything we have done on NCL to reflect on how we can improve on it as part of the next deployments of ETCS by the programme' says Jonathan Daniels. 'For instance, how to streamline the system proving and assurance process to reduce the duration and achieve right first time.'

Another valuable lesson from the pathfinder concerns maintenance, and Ben Lane highlights again the strong collaboration between Siemens and Network Rail. 'We're finding the unknown unknowns – for example, we've discovered issues with the GSM-R which we're working through.'

The desire to deliver reliability from the outset is emphasised by the decision to carry out two weeks of shadow running with ETCS on the Northern City Line during midweek nights before training drivers in ETCS. While test running has already seen two trains run in the tunnels overnight, this does not mirror the intensity of the full passenger service, and the shadow running phase will build confidence in the reliability of the trackside equipment. 'This decision is a great example of collaboration and the speed of decision-making – people are so close that it only takes a couple of phone calls' says Oly Turner. 'The last thing I want is for this programme to be remembered for the system falling over on the first day it is used.'

Progress

Authorisation from the Office of Rail and Road for the on-board equipment on the Class 717 EMUs was received by GTR in March, and is due to be followed by approval for the trackside equipment, paving the way for shadow running before driver ETCS training begins.

Training of staff is an area where the pathfinder provides a significant learning opportunity for the wider rollout – both for Network Rail's maintenance staff and signallers and for GTR's on-train staff. From an operations perspective, it has not only enabled GTR to understand its ability to release drivers for training but also to build relationships and understanding with trade unions, who are very well engaged with the ambitions of the programme.

The start of training will herald a one-year migration phase before the Northern City Line becomes a no signals railway. During that time, the option to revert to conventional signalling will remain, and performance will be closely monitored to ensure reliability has reached a satisfactory point before the decision is made to remove the lineside signals, based on an agreed set of criteria.

When it comes to the next deployments of ETCS on the main line, the dynamic around moving to a no signals railway will be slightly different. The overlay on Welwyn to Hitchin is used to set up the following section to go straight to 'signals away' (either the area around Biggleswade or the Hertford loop), driven by the phasing of work. 'Retaining the overlay for a period of time gives the industry the flexibility around training given the number of operators migrating to ETCS operations' says Jonathan Daniels.

As the pandemic begins to become a memory, it should not be forgotten that the teams delivering the pathfinder project did much of it against the backdrop of the restrictions of Covid. Despite this, it has taken just two years to commission new signalling on the Northern City Line – not forgetting that this is also a renewal of ageing infrastructure. 'If we'd not had this model and if we'd not had the one team approach, I don't think we'd have got to this point as quickly as we have' suggests Ben Lane.

The major passenger benefit of the scheme on the Northern City Line has already been delivered in terms of improved reliability. Now the key ambition is to learn and share the lessons for the wider rollout on the East Coast Main Line, and to ensure the transition is as seamless as possible. **mr**

Testing: view from the cab during an overnight run with a Class 717 on 6 February 2023. **PHILIP SHERRATT**

Train-borne equipment approved: one of GTR's Class 717s, used on Northern City Line services to and from Moorgate.

Meeting the fleet challenge

Migrating train fleets to European Train Control System Level 2 is a major challenge. *Modern Railways* Deputy Editor **ANDY RODEN** explains how a cross-industry effort is achieving this

At first glance, migrating rolling stock to ETCS Level 2 signalling on the East Coast Digital Programme might look relatively easy. After all, Govia Thameslink Railway's Class 700/717 EMUs and the LNER, Hull Trains and Lumo Class 80x fleets all have on-board ETCS equipment.

However, the sheer numbers of vehicles to be migrated to ETCS underline the technical, operational and commercial challenges the programme faces. Even on those trains fitted with ETCS on-board equipment, software must be upgraded to reflect the latest baseline. Then there are GTR's Class 387 EMUs and Grand Central's Class 180 DMUs, which must have compliant on-board equipment fitted.

Add to that at least 250 freight locomotives of designs ranging from the 1960s to the present day, plus heritage steam locomotives, and the scale of the migration becomes clear. A total of around 630 vehicles must be modified with compatible ETCS on-board equipment.

Four companies are providing on-board equipment – Alstom, Hitachi, Siemens and Thales – across 27 operators and 10 vehicle owners. To succeed will require an extremely high degree of cross-industry co-operation and co-ordination.

Ed Akers, Network Rail's Principal Programme Sponsor for ECDP, explains that the majority of the work involves retro-fitment. Upgrading to the latest version of ETCS is relatively straightforward on those fleets with the necessary equipment – but a very different technical challenge on other fleets. And, points out Programme Director Roger Hall, ETCS has had to be slightly adapted to accommodate UK operations.

The baseline chosen for the southern section of the ECML is version 3.6, the latest update of ETCS. This includes

First in Class: members of the GTR and Alstom team alongside Electrostar No 387101.

Cab changes: newly fitted displays in No 387101.

online key management, meaning older software and the security keys critical to ensure operational safety can be updated online rather than by physically uploading software onto each individual vehicle. This is amongst the very first major deployments of this technology in the railway and should make the compatibility task rather easier.

Benefits

Mr Akers and Mr Hall are keen to highlight the benefits of

ETCS operationally, pointing out that it will allow more efficient driving techniques due to having a train control system which works on an individual fleet's performance rather than a catch-all worst-case scenario for braking curves. The eventual removal of lineside signals could allow linespeed increases as signal sighting considerations become less relevant. 'ETCS will give operators and timetablers more options by removing systemic constraints' says Mr Hall.

For this to happen, however, mass modification of rolling stock must run alongside infrastructure installation. Mr Hall says that when, for example, 30 freight locomotives are fitted with ETCS on-board equipment, driver conversion training can really ramp up. Vehicle fitment is being decoupled

from the infrastructure programme – a benefit of the initial overlay approach.

'It is perhaps the biggest challenge the programme faces' says Mr Akers. 'The challenge is not the technology – it's the environment in which we're doing it with so many vehicle owners, complex private finance initiative arrangements for some passenger fleets and fleets split across multiple operators, such as the Class 66 freight diesels.' On top of that, there are variances within fleets (again, the Class 66s are a good example) to consider.

There are also commercial issues to address. Where companies have performance regimes, ETCS installation could adversely affect them – perhaps by reducing the number of trains available during fitment below a threshold – even if doing so is essential for the wider ECDP.

Freight challenges

Passenger fleets are relatively few on the southern section of the ECML, but this changes radically for freight operators. Around 11 or 12 classes of locomotive need fitting with ETCS on-board equipment, with around 250 locomotives needing to be compatible to ensure freight operators are ready for the change. This is around one-third of the National Freight fleet.

The first locomotives to receive pilot installations are Classes 66 and 67, and they are expected to be tested at the Rail Innovation and Development Centre (RIDC) in Melton later this year. There are some 388 Class 66 locomotives operating on the UK network – no other qualifying class of locomotive has more than 30 operational locomotives. Despite the competitiveness of the sector, five freight operators are working in partnership to coalesce around a single base design

for Class 66s. This gives an idea of the seriousness with which the freight sector is taking the ECDP.

Which fleets qualify for ETCS fitment is an important question. Considerations of mileage, remaining investment lifetimes and suitability all count, particularly for very old but still useful types such as the Class 37s. Each of these English Electric veterans selected for the programme is being surveyed individually. With lifespans approaching 60 years and a myriad of alterations made over the decades, there is simply no guarantee that an ETCS on-board installation which works on one locomotive will exactly fit another.

There are also new freight fleets on order – notably the Class 93 tri-mode electric/diesel/battery locos ordered by Rail Operations Group and the bi-mode Class 99s ordered by GB Railfreight. The plan, says Mr Akers, needs to be for these locomotives to be fitted with ETCS at build, making them instantly compatible with the ECML. The passenger fleets – bar the long-planned LNER new train order to replace the InterCity 225s – are broadly stable, but with new locomotives being ordered by Britain's dynamic freight operators, a constant eye is being kept on the freight fleet and the potential implications on the fitment programme.

Heritage considerations

In addition to the national network fleets, a separate initiative is under way to enable operators of heritage steam and diesel locomotives to continue running on the ECML. The first, on 2008-built 'A1' Class 4-6-2 60163 *Tornado*, is due to be tested at Melton later this year, with other locomotives to follow. Once this 'pathfinder' programme is completed, which will determine the viability of this approach, the intention is to fit further steam and diesel locomotives for the ECML.

Maintaining the ability of locomotive owners and open access operators to continue running heritage locomotives on the ECML is viewed as an important objective. Contractors Atkins and Thales are participating in a world-first with the *Tornado* installation: it will be the first steam locomotive ever to be fitted with ETCS, and its significance is being recognised by interest from around the world, particularly in Finland and the Netherlands. It may be a niche installation by global standards, but it is viewed as being very important by the ECDP team.

On-track machines

Another aspect of the ECDP's fleet challenge is the need to ensure vital on-track machines are ETCS-compatible. Retaining the ability to maintain the route is obviously important, and Mr Hall says discussions are under way to assess the number and mix of vehicles required. It could be up to 40, he says, although there is potential flexibility in using ETCS-fitted locomotives to haul machines. Questions of how much redundancy is needed in terms of numbers of on-track machines are being considered. There are also third party vehicles which maintain the railway, and a number of these will be added to the on-track machinery programmes.

On-board installation could be quite different from passenger and freight designs though. The operating environment of a tamper or rail grinder is very different from that of revenue service trains, and on-board installations may need to be rather more robust or located in different areas given the generally tightly-packed nature of much on-track machinery.

Wider legacy

Neither Mr Hall nor Mr Akers are underestimating the fleet challenge on the ECDP, but both are keen to highlight that it is this immense undertaking which will in the longer-term unlock ever more efficient ETCS deployments across the UK.

The knowledge gained from the installation and retrofit exercise are readily applicable to other operators when ETCS is extended beyond the southern section of the ECML. Furthermore, because many of the trains being fitted with ETCS for the ECDP range far beyond its boundaries, fleet requirements on other deployments will be significantly less, particularly for freight operators. For example, LNER's Azumas operate all the way to Inverness and Thameslink's Class 700s on the Midland and Brighton main lines, while the Class 387 First in Class fitment will pave the way for fitment on the whole family of Electrostars operating in London and the South East.

The ECDP may be a UK first, but its completion will offer significant network-wide benefits, of which the most visible will be the locomotives, multiple units and on-track machinery in the throes of being modified right now. ▪

Kicking off the freight fleet fitment programme: DB Cargo's No 66039 at EMD's Doncaster facility.

FLEETS TO BE FITTED AS PART OF ECDP

Class	Operator	Owner	ETCS Supplier	Number of trains
Class 43	Network Rail Route Services	Porterbrook	Thales	3
Class 66*	DB Cargo (lead for ECDP)	Various	Siemens	186 (for ECDP)
Class 180	Grand Central	Angel Trains	Alstom Atlas 2	10
Class 387	Govia Thameslink Railway	Porterbrook	Alstom Atlas 3	29
Class 700	Govia Thameslink Railway	Cross London Trains	Siemens	115
Class 717	Govia Thameslink Railway	Rock Rail	Siemens	25
Class 800/801	LNER	Agility Trains	Hitachi	65
Class 802	Hull Trains	Angel Trains	Hitachi	5
Class 803	Lumo	Beacon Rail	Hitachi	5
Tornado Pathfinder	A1	A1 Locomotive Trust	Thales	1
On-Track Machines	SCO	n/a	tbc	tbc

186 locomotives for ECDP out of 388 for National Freight Fitment programme. Class 66 is the lead freight class out of around 17 fleets, making up to national total of around 650 locos.

Upskilling challenge: one of the signal desks at York Rail Operating Centre.

A railway that works better for people

The human factors of ETCS are a key focus of the East Coast Digital Programme, as *Modern Railways* Consultant Editor JAMES ABBOTT explains

The East Coast Digital Programme is notionally a technology project, but actually it all depends on people. 'Deploying European Train Control System (ETCS) successfully is not so much about the technology, it is how we enable and realise the change across many businesses' says Ed Akers, Principal Programme Sponsor for ECDP.

'Our vision is an East Coast railway that works better for people,' he says. 'We have put people at the heart of it. It is an opportunity for front line colleagues to enhance and develop their skills, and have tools to help them.'

Getting people on board
'We are fully engaging with our trade unions in this change programme, and they are supportive advocates of the introduction of ETCS' explains Mr Akers. 'Engagement with our colleagues is essential to ensuring we maximise the opportunities from changing the way we do things, drawing on their knowledge and expertise.'

There are four key roles with ETCS: train driver, signaller, train maintenance engineers and infrastructure system maintainers, plus a wide range of integration and support roles.

There are over 3,000 drivers to train in ETCS signalling across passenger, freight, on-track machinery and the charter and heritage sectors. More than 400 of these are with inter-city operator LNER: the company's Head of ERTMS, Paul Boyle, says ECDP is being welcomed by the workforce. 'We are adding another signalling system to the portfolio, enhancing drivers' skills. The programme is introducing more diversity to their work and making the railway even safer.

'There are lots of legacy rules with all the different signalling systems – we're adding a new one, so our task is to demystify it' explains Mr Boyle. 'We're doing that with simulation, briefing materials and other information that will help to make our people feel comfortable with ETCS.'

'ECDP is investing in developing high quality video-based simulation that will provide the best training experience for drivers' reports Mr Akers. 'This is enabled by ECDP having delivered a common software specification for operators to use. There are full-cab simulators with ETCS capabilities in place across the passenger and freight operators, with more on order, along with a growing number of "ultra-lites" – double screens with a control panel – plus numerous laptop-based simulator capabilities being made available.'

Investment
Typical of the investment taking place facilitated by ECDP funding is a new training academy recently opened by freight operator Freightliner in Ipswich. The new site contains three classrooms, learning spaces and new learning resources and is already hosting drivers starting their ERTMS training. While the academy is starting work with desktop simulators, a full-cab simulator will be coming from Corys in France in the winter. Another such machine will be delivered to another Freightliner facility in Doncaster.

'Freightliner is delighted to be part of this programme, and we recognise the important role ERTMS plays in making our railways safer for both railway workers and the general public' comments Blake Jones, Freightliner Managing Director – Rail Services. 'Drivers enjoy learning about the system and how it will benefit them, with particular interest in the Driver Machine Interface which will show their movement authority. This is an improvement to the current system, with in-

cab signalling providing clear and continuous live updates.'

The passenger operators are following a similar path. Jen Clare, Service Delivery Director with London to Edinburgh open access operator Lumo, reports that Lumo and fellow FirstGroup subsidiary Hull Trains have between them 80 drivers to train on the new system. A simulator is being installed this summer at Lumo's Newcastle base, with another coming at Hull for HT's drivers. 'It's a step change for drivers' she points out. 'They will have to learn to look down at the monitor for signalling information, rather than out of the window.'

Ms Clare is impressed with the co-operative nature of the programme. 'Ordinarily people work in silos, but ECDP is getting everybody to work together: for example, we are working closely with another open access operator, Grand Central, which in other circumstances might be seen as a rival. All the operators are talking to one another, so if one operator has an issue, others can help sort it out; we're learning a lot from GTR's pathfinding work on the Northern City Line, about how long the training needs to be and so on.'

Signallers too

While fewer people are involved than in the train driver sector, there is also a human factors element in ECDP for Network Rail's signalling staff. Simplifying the task is the fact that the southern section of the East Coast Main Line, where ETCS is being rolled out, will all be controlled from York Rail Operating Centre: thus, York is the nerve centre for ECDP on the infrastructure side. Peterborough power signal box is due to hand over to York ROC this autumn, after which the ROC will control from King's Cross to Stoke Tunnels.

As with train drivers, simulators are a key technology that is helping to usher in the new system. 'There are rare faults that staff seldom see in real operating conditions that we can prepare them for with the use of simulators,' explains Sarah Hewlett, Change Programme Manager at Network Rail. 'We've got four signalling simulators in the ROC at York, with more

to come. We're also borrowing a driver simulator, to help signallers understand ETCS from a driver's perspective.'

Over 80 signallers will need to be trained in ETCS, with training under way now for the first 18. The pioneer trainees will work the Northern City Line to Moorgate – where migration to the new system is expected to begin later this year.

Maintenance function

The advent of ETCS will impact other staff besides train drivers and signallers. People responsible for maintaining both trains and signalling equipment will need to be made familiar with the new system.

Train maintainers are upskilling their engineering staff. And while, for example, the Azuma maintenance depots are run by manufacturer Hitachi, LNER's own engineering staff with an oversight role on the Hitachi contract also need to be on top of ETCS.

'A new mindset is required' adds Sarah Hewlett. 'With the legacy system, we might be changing faulty hardware, such as the light on a signal. But with ETCS, we'll be changing lines of code.

'What skills do we need to deal with that? That's an ongoing issue to be addressed through upskilling, reskilling and recruiting digital talent.'

Digital strategy

Recruitment for ECDP roles dovetails neatly with the wider skills stratagem for the industry

being implemented by the National Skills Academy for Rail (NSAR). 'Signalling skills is the biggest skills shortage in the industry' reports NSAR Chief Executive Neil Robertson. 'It takes eight years to make a good signalling technician – three years' apprenticeship followed by five years of practice. Short-termism is the enemy – that's why I like the long-term nature of ECDP... it's a paradigm shift.'

Mr Robertson argues that the programme's long-term nature eases planning for skills recruitment. NSAR is developing a Scientific Approach to the Talent Pipeline (SATP): talking to 16-year-olds in schools, steering students towards useful subjects, encouraging them to consider rail and expanding the number of apprenticeships available – aiming to grow the Routes into Rail programme. Meanwhile, NSAR's Skills Match strategy is linking up training providers to employer requirements and recruiting students for the shortage areas.

'The reason I'm so excited by ECDP is that it is a sustained approach to adopt one of the key planks of our productivity improvement programme – using digital to achieve an outcome without concrete' says Mr Robertson. 'Training people up to cope with this is the way forward.'

Quick release

LNER's Paul Boyle says he's excited by the performance opportunities. 'Being able

to see ahead, drivers will be able to modify their speeds accordingly: there's a carbon reduction dividend available if drivers can drive with regard to the state of the line ahead, rather than rushing up to a red signal and then having to accelerate away from a stand.

'We're also expecting better data from ETCS, allowing us to keep tabs on the way the railway is performing. We'll be able to monitor the situation proactively and reduce the impact of any failures, while going forward, we'll be able to identify the things that need fixing and make investments accordingly.

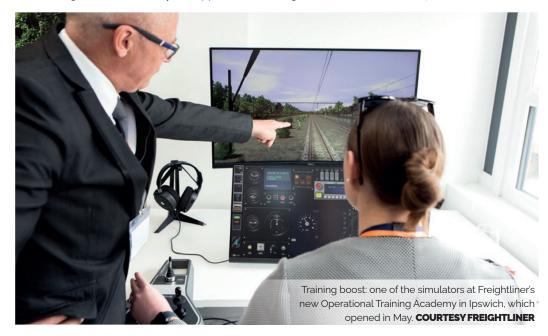'Altogether the move to digital represents an exciting time for the railway.'

Embracing change

'ECDP is a massive opportunity, but for it to be successful we need to help our colleagues understand the change, learn new skills and ways of working, including in operational delivery' says Mr Akers.

'Change Readiness Assessment is taking place in certain parts of the programme to assess, analyse and understand the state of readiness for the changes involved. This is raising the profile of culture change and providing a tool that makes it tangible.'

'We've spent a lot of time working on this with our union colleagues' adds Sarah Hewlett. 'The fear has gone and now we are preparing to make a big leap forward.' **mr**

Training boost: one of the simulators at Freightliner's new Operational Training Academy in Ipswich, which opened in May. **COURTESY FREIGHTLINER**

From pioneering programme to new normal

Modern Railways Industry & Technology Editor **ROGER FORD** explains how the ECDP is masterminding the rollout of the European Train Control System across the GB network

From King's Cross station to Stoke Tunnel on the East Coast Main Line (ECML) is just 100 miles. Yet the successful renewal of the signalling on this relatively short section of track is key to the extension of ETCS across the 20,000 route miles of the Great British rail network in the decades to come.

A resignalling scheme like no other, the East Coast Digital Programme has required a new approach, based on the active involvement of industry sectors which would previously have seen signalling as the responsibility of the infrastructure engineers alone. For example, with cab signalling, traction and rolling stock becomes part of the signalling system. The ETCS-ready train fleets on the ECML need software updates. Older passenger and freight traction is being retrofitted.

And there is much more to ECDP than new technology. New installation techniques are being pioneered by the signalling contractors. Streamlining production will play a vital role in reducing the critical unit cost.

Ensuring the successful completion of the ECML (South) resignalling is critical. But ECDP is also where Network Rail is preparing for the approaching bow-wave of long-term signalling renewals.

For this challenge to be met, ETCS will have to be 'baked into' Network Rail's future business plans as a renewals-driven, long-term rolling programme, rather than a series of discrete projects in response to individual business cases.

So ECDP will not only create the assurance – both in delivery and cost – needed to support funding for that long-term rolling programme. It is also developing the template for its decades-long implementation.

Experience

ETCS is not new to the UK. The ETCS Early Deployment Scheme (EDS) was Britain's first application and went live on the Cambrian line in 2011. Network Rail's Director, Industry Partnership for Digital Railway Toufic Machnouk refers to this as the 'Pilot' project, the first of his 'Five Ps' which define the long-term aspiration for ETCS rollout.

After EDS, it was not until the two cross-London schemes, Thameslink followed by the Elizabeth Line, that interest in ETCS revived. For Thameslink, Network Rail took the farsighted decision to resignal the core between St Pancras and London Bridge with ETCS, with Automatic Train Operation (ATO) to support the high frequency service.

Communications Based Train Control (CBTC) was specified for the central section of the Elizabeth Line. But at its western end the line runs onto Network Rail's Western Route where ETCS has been installed between Airport Junction and the Heathrow Airport terminals.

Neither of these were line-of-route ETCS schemes. Before embarking on ECDP proper, what Mr Machnouk calls a 'Pathfinder phase' was needed to understand what was involved in resignalling with ETCS.

This application had to be straightforward, not requiring further technical development. Its purpose was to prove a new approach to delivering resignalling. As Toufic Machnouk puts it, 'you can't go straight from PowerPoint to line-of-route delivery'.

Paving the way for a wider rollout: a trio of Class 387s cross the Ouse Valley viaduct at Balcombe with a Brighton to Victoria service on 14 August 2021. The Brighton main line is one of the early candidates for ETCS once ECDP is completed, while the project to fit the first Class 387s as part of ECDP will be transferrable to other Electrostars such as these. **JAMIE SQUIBBS**

Pathfinder

The Northern City Line (NCL) between Finsbury Park and Moorgate met the criteria. Not only was the Class 717 fleet already fitted with ETCS, operator Govia Thameslink Railway and its drivers had practical experience of cab signalling. ECDP contractor Siemens had been responsible for the Thameslink ETCS installation.

With the operator, the Network Rail Route and the supplier in a tripartite relationship, ECDP could test its new delivery models on a working railway. NCL would also provide valuable experience of the associated safety approvals processes.

Each phase of the project was analysed to evaluate its potential impact on delivery for when ECDP progressed to the main line. One example is system-proving, traditionally provided by test trains. Now ECDP and Siemens are working to develop pre-validated data before installation.

Another issue is approvals. To enter ETCS into service on trains and infrastructure, a complex set of approvals and authorisations are required. The approach to this on the NCL and arising lessons will form the basis of how these are undertaken for the future.

Pioneers

Third of Mr Machnouk's Five Ps is the 'Pioneer phase'. This marks the 'big leap' to the main line railway with its multiple users and operators. Uniquely, the Welwyn to Hitchin section of the ECML will retain colour light signals. Its role will be to migrate drivers to cab signalling while the railway keeps running.

This experience, explains Mr Machnouk, 'will force us to solve all the problems we will face over the spectrum of drivers – inter-city, commuter, open access, freight large and small, On Track Machinery (OTM) plus charter and heritage. You have to do it to see it and feel it and solve problems – you can't solve these in PowerPoint.'

However, with approaching 30 organisations involved, he expects most of the challenges will be commercial. For example, both the LNER and Thameslink fleets are

the subject of long-term train service agreements as opposed to simple leases. This potentially complicates changes to preinstalled on-board ETCS software.

Reflecting on all this, Mr Machnouk says experience to date has given the ECDP team 'a high definition panoramic view of all the realities our industry presents'. But tackling these issues head-on is already starting to build capabilities across the various sectors involved.

For example, operators are recruiting drivers for ETCS training. Train fitment contracts are in place and Hitachi is preparing to upgrade the LNER Azuma fleet software to the latest Baseline. Close to Mr Machnouk's heart is the current world-first project to fit steam locomotive *Tornado* with ETCS.

Long-term

Providing the capability to replicate East Coast (South) on multiple lines of route without going through the same learning curve again is ECDP's 'Portfolio phase' led by David Thomas, Senior Portfolio Manager.

The work behind developing the industrial strategy and masterplan was important in convincing Government and the Office of Rail and Road (ORR) that ETCS fitment should be part of the High Level Output Specification (HLOS). Achieving this has been a major turning point for the industry.

A radical change to the UK signalling market is central

to the Portfolio phase. This includes creating long-term relationships with technology providers and expanding the supply chain.

As part of this, ETCS technology providers who are successfully appointed onto the national partnerships will be supported through a development and proving phase such that their ETCS products meet GB requirements. This should allow new products to be matured away from the spotlight until they become viable players.

ECDP is also working with the National Skills Academy for Rail (NSAR) to expand the signalling workforce. In addition, a rolling programme should avoid the historic 'feast and famine' which has dogged all sections of the UK rail supply chain – encouraging investment in staff.

At the same time, David Thomas stresses that it is crucial market capability is improved and the way the industry does business with suppliers has to change. This includes better pipeline planning, long-term (10-year) framework relationships and contracting at a business, rather than project, level. Crucially, work allocation within frameworks will be determined by performance on existing schemes.

Future

Toufic Machnouk sees the Portfolio phase as lasting for up to a decade – effectively two regulatory Control Periods. Starting in April 2024, Control Period 7 (CP7) will see the

ETCS early deployment scheme: a Transport for Wales Class 158 arrives at Machynlleth with an Aberystwyth to Birmingham International service on 17 October 2022. **ALAN WALLWORK**

'building blocks', such as rolling stock fleet fitment and expansion of supply chain capacity, put in place.

These building blocks will enable the Network Rail Regions to start developing area schemes which, during CP8 (2029-34), will expand into line-of-route signalling renewals. These will be 'signals away', going straight to cab signalling. In this final 'Paradigm phase', ETCS will be 'business-as-usual, rather than a special enterprise'.

Which routes will follow ECML South? In parallel to creating the capability to progress several line-of-route renewals, the Portfolio Phase will also continue the work already under way on prioritising renewals within the rolling programme.

Future ETCS fitment will be determined by renewals, because this is where the capital expenditure is focused. But David Thomas points out that as train fitment extends, so the opportunities for ETCS renewals will expand. Train fitment is one example of where ECDP is doing the right thing now for the long-term, even though the right thing might not be the easy thing today. ▥