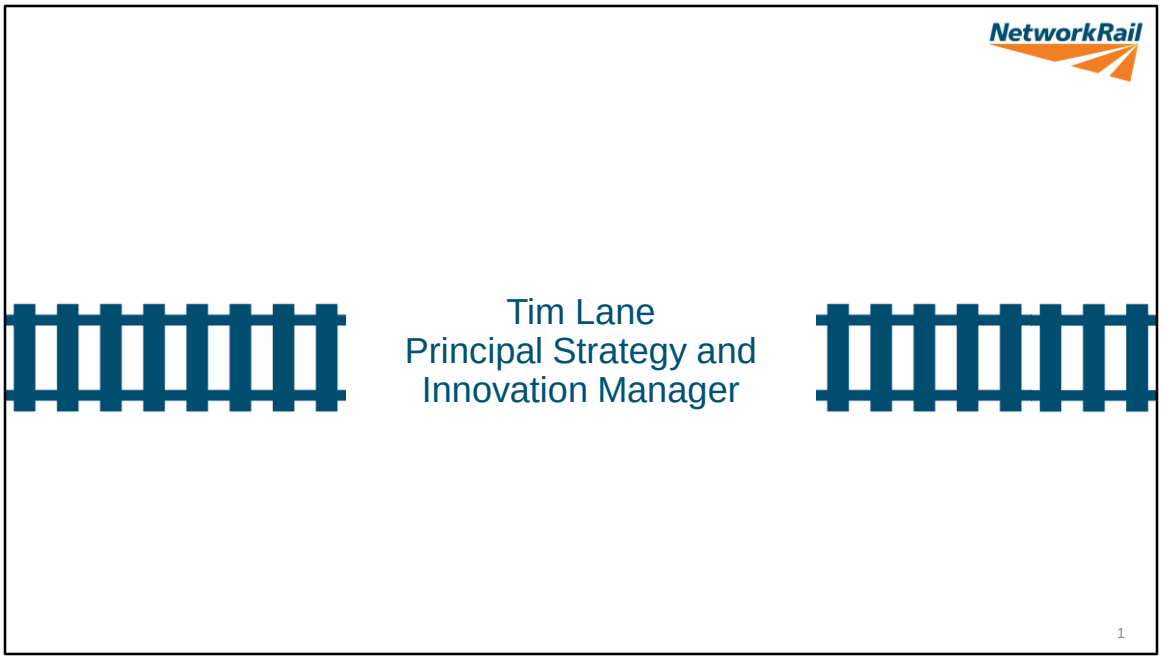
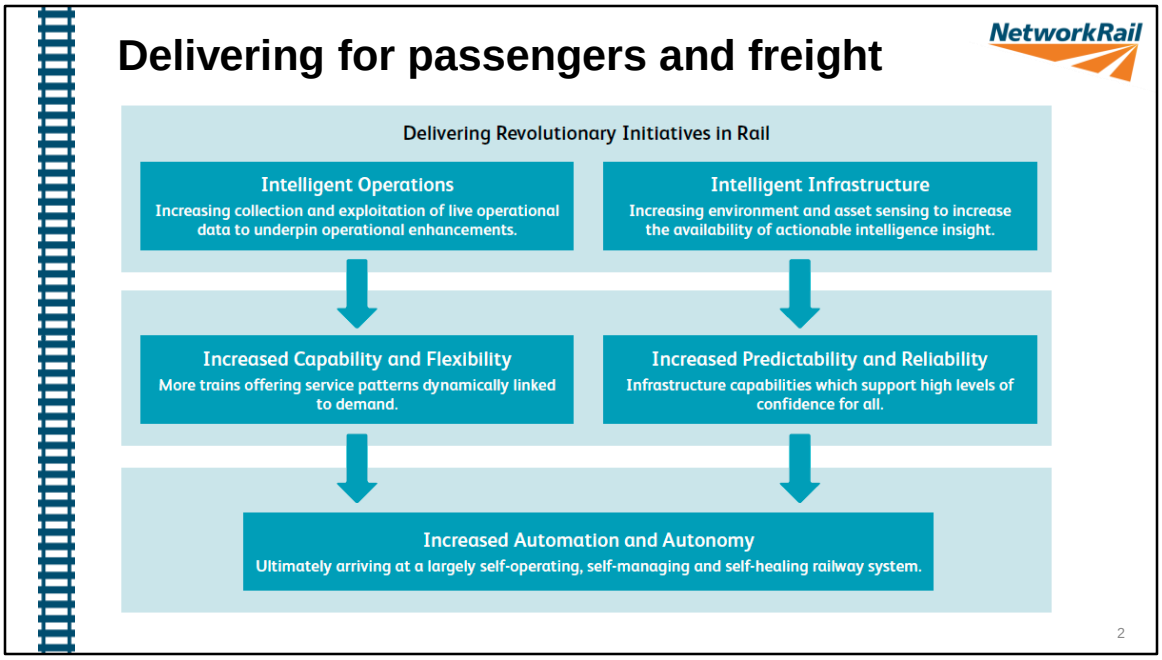


Network Rail, funded by the Department for Digital, Culture, Media & Sport (DCMS), is building a **5G innovation capability at the Rail Innovation & Development Centre (RIDC) Melton**.

Much has been said about how Millbrook has supported the AutoAir 5G connected vehicles trial. RIDC Melton is now set to become the Millbrook for rail, as we launch the 5G Rail Testbed next month.

Later in this presentation I will describe how I believe RIDC Melton can help connected and 5G innovation in rail, but I will start by considering how 5G can enable change in rail by looking at one of our infrastructure challenges.

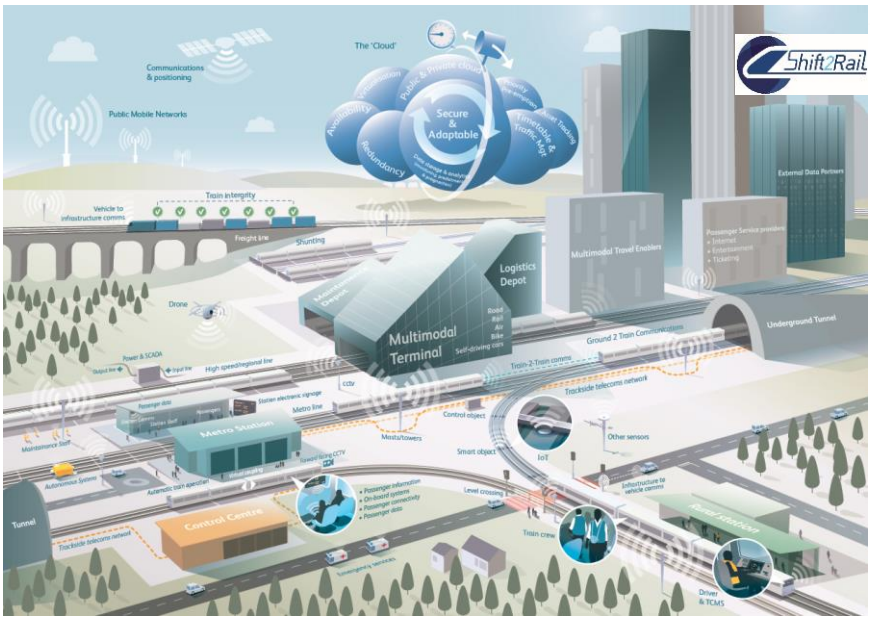


This slide illustrates an overarching requirements-led journey; the most fundamental of those requirements being the needs of the railway's passenger and freight customers.

- They need us to be able to accommodate more trains running on the infrastructure, and for us to be able to accommodate this in a more flexible manner. This drives the need for data-driven, **Intelligent Operations**.

- More trains and more flexibility of running won't meet our customers' needs if we can't deliver predictably and reliably. Consistent infrastructure performance will be enabled through **Intelligent Infrastructure**, a data-driven approach to monitoring and managing the condition of trackside assets.

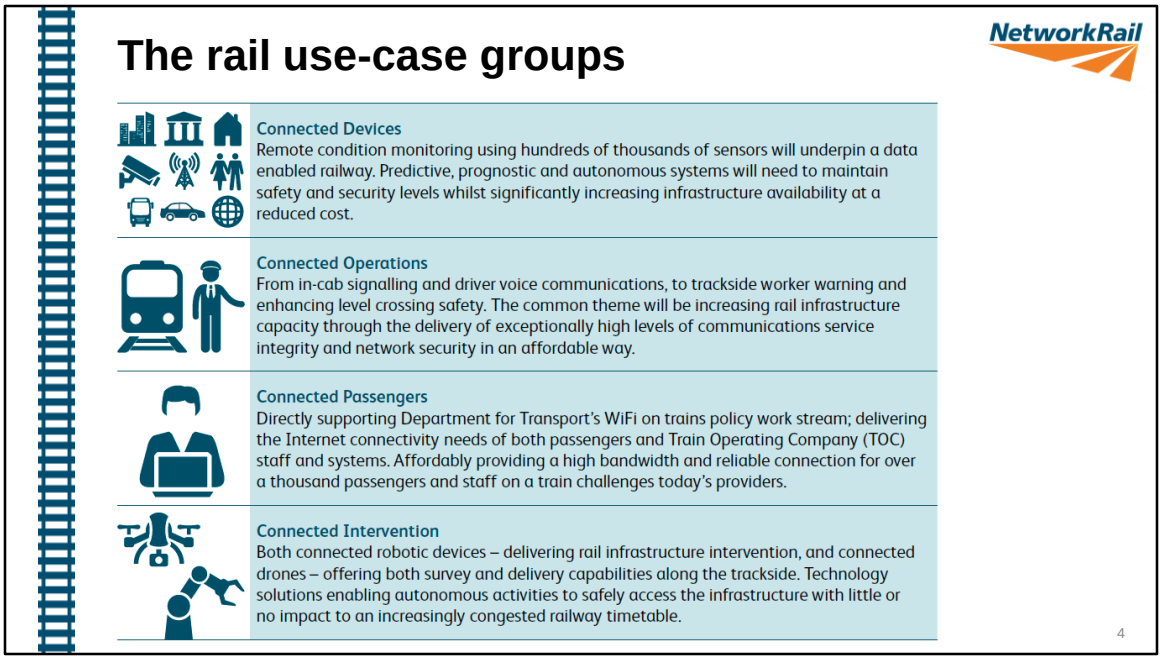
It's not difficult to conclude that such a journey would lead us to an ultimate destination of a self-managing, self-operating and self-healing railway. I'm going to describe and example of where we believe that automation can help to deliver more capacity and a better experience for all rail industry customers.



Our journey to a data-driven railway will be achieved through technology change built on the back of an increasingly **connected railway**.

Coverage, capacity and capability are the measures we'll use to define and deliver the telecoms capabilities necessary to support Intelligent Operations and Intelligent Infrastructure.

With our European colleagues in the Shift2Rail project, we've described the use-cases we see in this future connected railway. Sitting above much of the detailed requirements specifications is this summary diagram, which has proved very useful in engaging senior audiences with the discussion.



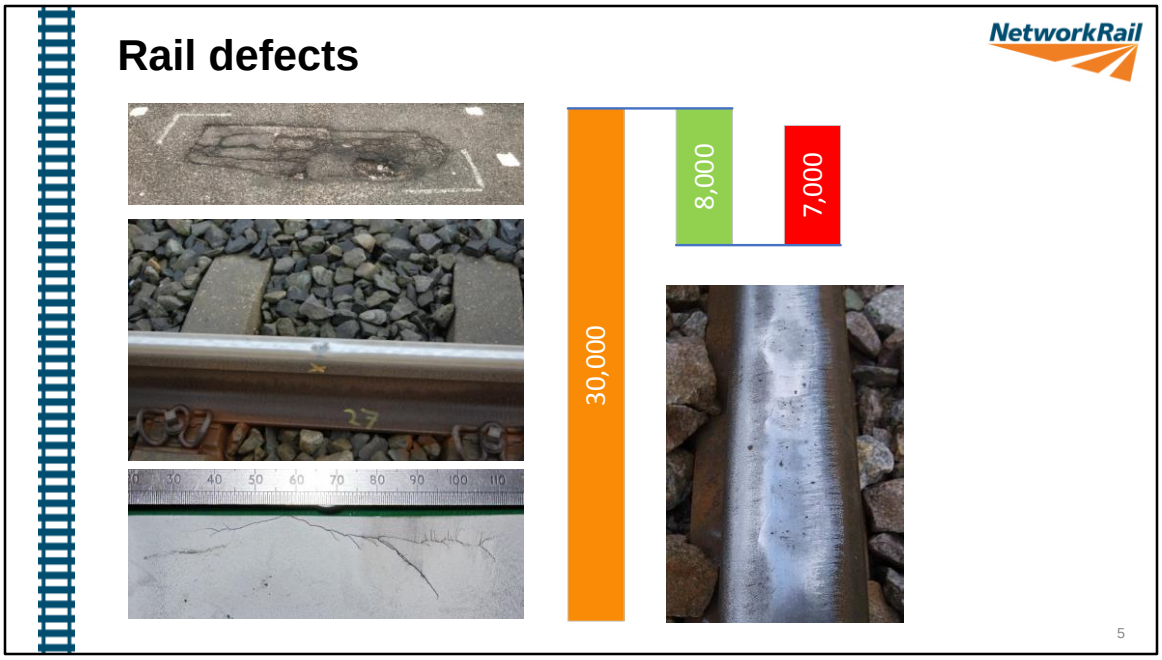
When looking at all the use-cases from the Shift2Rail work, we've observed that it's possible to distil down to four umbrella use-cases:

- **Connected Devices** (including IoT), represents the asset-base that will be the input to the data-driven future railway. Our challenges will not only be reliably and affordably connecting these, but also securing the data and sharing it with those parties who can deliver best information and intelligence value for rail

- **Connected Operations** today is largely train driver to signaller voice communications and early in-cab signalling (ETCS) deployments. In the future, critical video analytics and automatic train operation will be vital to delivering ever greater train-running capacity over existing tracks

- There is no shortage of understanding around the societal and economic benefits of **Connected Passengers** who have an 'at home' connected experience during their journey. The business case to deliver the trackside infrastructure necessary to achieve this is evolving

- **Connected Intervention**, is where emerging 5G technology could bring much to our journey to a self-managing, self-operating and self-healing railway. Let me describe how one of today's infrastructure challenges could be handled in the future railway though Connected Intervention.



As drivers, we know and ‘love’ the practicalities and politics of potholes. Regional news programmes regularly highlight local authorities and Highways England struggling with a never-ending challenge to repair the worst ones. For Network Rail, the type of rail defects shown in the photos are the potholes of the railway.

Like local authorities and Highways England, my infrastructure management colleagues undertake an ongoing programme where rail defects are identified, understood, managed and rectified before the degradation becomes too great. The parallels with road continue – the lower left photo shows the cross-section of a rail where a defect has degraded to a state where the rail will need to be replaced. Rail’s equivalent of resurfacing a road.

Network Rail lives with a rolling work-bank of around 30,000 rail defects, which are continuously monitored and prioritised. Whilst we rectify around 8,000 rail defects a year, a similar quantity of new occurrences leave us ending the year where we started. However, **with ever-greater rail-utilisation, this status-quo isn’t set to continue**.

Detection and correction



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Let's look at our **rail defect lifecycle**:

- Defects are identified at an early stage, largely by Network Rail's New Measurement Train fleet which uses high-sensitivity on-train systems to identify and report these as ride quality issues
- Severity is assessed by highly skilled staff using visual and electronic inspections, a first trackside activity that could impact on our abilities to run the published timetable
- In cases of greater severity, temporary speed restrictions are applied to limit the rate of the defect worsening. Again with an impact on timetable and capacity
- Precautionary clamping may also be required, involving further trackside access and disruption
- For rectification, a new section of rail may need to be installed, or the rail head will need to be ground-out, re-welded and re-ground to profile the rail. This isn't a quick task and requires a team of skilled people and a lot of big equipment being moved to the location, potentially giving significantly more train service disruption.

Opportunities for autonomy

Increasing network utilisation means:
- more wear on the infrastructure
- fewer maintenance windows.

Inspection and maintenance challenges:
- track
- tunnels
- overhead line
- lineside vegetation.

Automated Rail Inspection and Maintenance Vehicles (RIMV) will also:
- reduce personnel exposure to risk
- improve data collection consistency and decision making
- improve quality of repairs
- focus personnel on more skilled and rewarding tasks.

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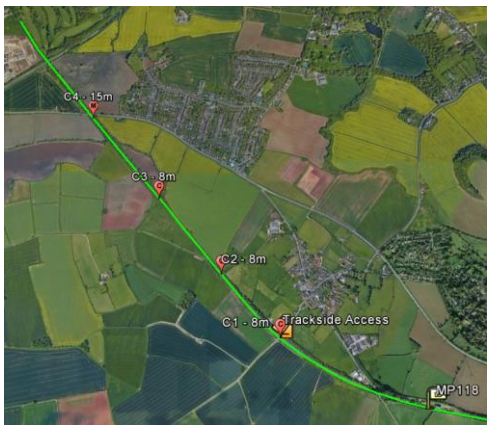
As I mentioned, we won't be able to maintain our status-quo of rail defect detection and correction using current techniques. As UK's rail infrastructure delivers more train paths, there will be more defects, they will worsen faster and we'll have less opportunity to inspect and rectify them.

Similar challenges will also apply to a number of other infrastructure maintenance requirements. One of those, lineside vegetation, doesn't even stand-still.

We believe that autonomy, delivered through a new generation of rail infrastructure maintenance vehicles (RIMVs) will allow us to deliver greater levels of intervention, supported by similarly enhanced inspection and monitoring capabilities. You can read more about this in a challenge statement on Network Rail's website: https://cdn.networkrail.co.uk/wp-content/uploads/2017/03/Challenge-Statement-Robotics-Automating-inspection-and-maintenance-activities.pdf

In the railway of the future, it's likely that we'll need to allow RIMVs to operate between trains. To do this safely, we believe that the high bandwidth, high security, high reliability and ultra low latency offered by **5G will be an essential supporting service**.

The 5G rail testbed



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We had autonomy in-mind when we proposed the design of the rail 5G testbed to DCMS, and we're thankful to them for supporting our proposal to deploy infrastructure on the northmost two miles of the RIDC Melton test track, which is not routinely used for train testing. This area is well separated from our lineside neighbours, and will now benefit from four fibre-connected masts and a newly constructed trackside access to allow early autonomy trial work to be undertaken safely.

For those not aware of rail's best kept secret, RIDC Melton (formerly know as the Old Dalby Test Track) is now in its 50th year of service. It's a 14-mile, electrified, high speed railway with most of the geographical and radio frequency challenges that are encountered on the wider rail network.

DCMS's investment has added a passive (masts, fibre and power) infrastructure supporting all of the 5G pioneer spectrum bands as an open-access innovation and testing facility. Details on RIDC Melton and the connected innovation enhancements are on Network Rail's website: https://www.networkrail.co.uk/industry-commercial-partners/research-development-technology/ridc/ridc-melton/