Business change for the Digital Railway

How will digital technology change the way we work?

siemens.com/mobility

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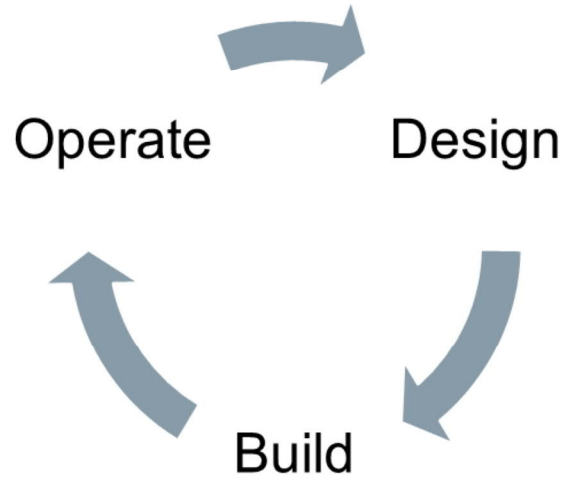*"Train delays cost passengers 3.6 million hours last year"* **The Independent** *(Dec 2017)*

"Passengers received £187M in compensation for disruption to services" The Independent (Feb 2018)

Introduction – About me

- Senior Systems Engineer for Siemens Mobility

- A decade's Industry experience in Signalling and Train Control
- Worked on Victoria Line Upgrade Programme, Crossrail and the roll-out of automatic route setting for Derby area.

- Spent the last 18 months working with Digital Railway
  - Traffic Management business case
  - Review of the requirements specs for Traffic Management
  - Traffic Management for Transpennine Route Upgrade
  - European Train Control System for Transpennine Upgrade
  - New delivery model for Digital Railway

- Also have been working in:
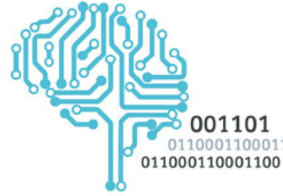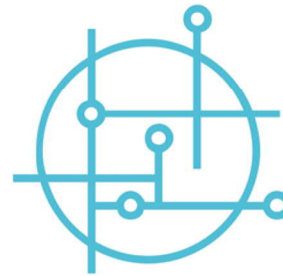 - Connectivity for signalling assets
  - Data Analytics

Notes 5

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Operate — Design — Build

Notes 6

Interconnection: The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT) or the Internet of People (IoP)[10]

Information transparency: The transparency afforded by Industry 4.0 technology provides operators with vast amounts of useful information needed to make appropriate decisions. Interconnectivity allows operators to collect immense amounts of data and information from all points in the manufacturing process, thus aiding functionality and identifying key areas that can benefit from innovation and improvement.[11]

Technical assistance: First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensively for making informed decisions and solving urgent problems on short notice. Second, the ability of cyber physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human co-workers.

Decentralized decisions: The ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible. Only in the case of exceptions, interferences, or conflicting goals, are tasks delegated to a higher level.

Design - City Mapper

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City Mapper collate data from their users and open data feeds

They have built a model of London "SimCity"

Using this they have identified a new bus route to serve East London between 9pm & 5am

This is filling in a gap in the transport service

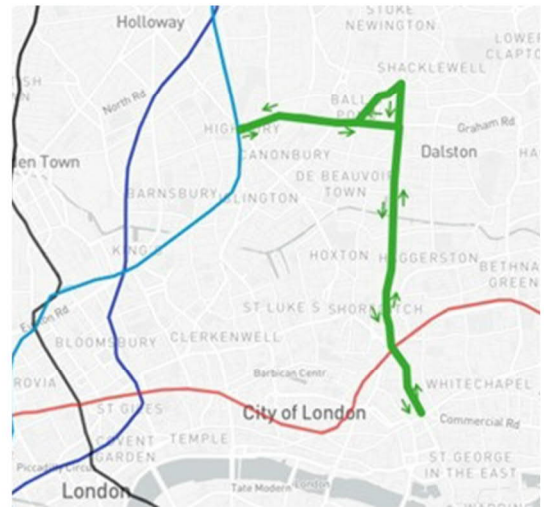There is no overarching central government control or management

Image courtesy of City Mapper
https://medium.com/citymapper/cm2-night-rider-our-first-commercial-bus-route-d9d7918be899

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https://medium.com/citymapper/good-bus-part-1-3-77d65e6f8ce3

What happens when you use data to design a bus route?

Using their city mapper app user data they built a new bus route and tested it.

It seemed to be popular. It was a success. They able to identify places and times where people wanted to travel but were underserved.

Objectives

— Increase overall investment in the railway;
— Relieve the burden on taxpayers and farepayers where possible;
— Open up the development and delivery of rail infrastructure to take full advantage of new and innovative ideas; and
— Create real contestability in the market.

Opportunities not identified by DfT or Network Rail in long term planning.
Should be financially self sufficient and require no government support. Revenue may come from increased fares, reduced costs or a mixture.

Admittance from DfT that "We recognise that central government is far from having a monopoly on good ideas"

Suppliers can go out, analyse the railway and say:

We can reduce delays, increase capacity, increase comfort. We think we can save you/make you money. Shall we share the returns? This is very different to the current method where the DfT have an idea, Network Rail build business cases for the ideas, they ask consultants to check it, get some more to design it and then ask infrastructure providers to build it.

How many schemes were "not quite cheap enough"? How many schemes could have happened if the delivery company had had pressure to reduce costs or create a "minimum viable product" for this? Can the suppliers reduce preferential engineering and unnecessary gold plating if they are the funder and customer?

https://www.gov.uk/government/publications/rail-market-led-proposals

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More Trains

Our railway carries twice as many passengers as it did just two decades ago but demand is still set to rise dramatically in the years ahead.

Digital Railway is the industry's improved plan to tackle the UK's capacity crunch by accelerating the digital modernisation of the railway.

More trains will run on existing tracks – safer, faster and cheaper – helping to increase the impact of vital upgrades like HS2 and Crossrail.

Better Connections

To sustain economic growth, our cities need a railway that connects more skills to jobs, and more goods to market, than ever before.

And to build on our success as a competitive hub of international trade, Britain needs a rail freight service that's as agile and dynamic as modern supply chains.

Digital modernisation is the essential enabler to make this happen.

Greater Reliability

In today's busy railway, a single problem can spread disruption far and wide throughout the day.

By modernising train command, control and signalling systems designed in a pre-digital age, modern railways are delivering substantial improvements in reliability at lower cost.

Digital Railway is the national initiative to bring these benefits to our railway within a generation.

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Digital Railway technologies

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European Train Control System (ETCS)

Traffic Management (TM)

Connected Driver Advisory Systems (CDAS) + Automatic Train Operation (ATO)

Telecoms + Data

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European Train Control System (ETCS): allows trains to run closer together and to travel at their best speeds whilst maintaining safe braking distances.

Connected Driver Advisory Systems (CDAS) + Automatic Train Operation (ATO): provides decision support to drivers in the cab so that they have the information they need at the right time to boost performance and safety.

Traffic Management (TM): maximises performance as trains flow across the network, maximising the throughput that existing track can support and adapting in real-time as network conditions change to aid rapid recovery.

Telecoms + Data: through FTN and GSM-R, will underpin and connect all these systems.

Industry Readiness: builds capacity and capability and develops expertise.

Enables the workforce and industry to adopt new technologies and ways of working, build digital capabilities and maximise the benefits of the overall systems.

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

We install amongst many things signals.

Signals are actually very complicated. Heavy items, need big bases, ladders for access, safety equipment.

Some Signals are put on gantries. Where they cover many tracks.

The gantry measures 46.5 metre overall and spans across six tracks at the south end of Derby station.

The total weight of the boom (across the six tracks) is an impressive 25 metric tonnes.

The total weight of the gantry's three legs and six dropper cages (for fitting the signals into) is 34 metric tonnes.

Derby Gantry video – Rightly proud of a huge safe undertaking – we won't be doing that again!

Some of the equipment needs to go lineside in these Location Cases. They each sit on base which weighs a tonne and also has "troughing" to keep the cables safe. This is also concrete.

Where we have lots of equipment to go lineside we use a Relocatable Equipment Building. This is like a shipping container and contains loads of kit. It also sits on a huge concrete base with troughing.

Notes 13

We also need to get the kit there which requires complicated planning, closures of lines and specialist equipment and teams. This all drives up cost.

Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Notes 16

Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

Notes 17
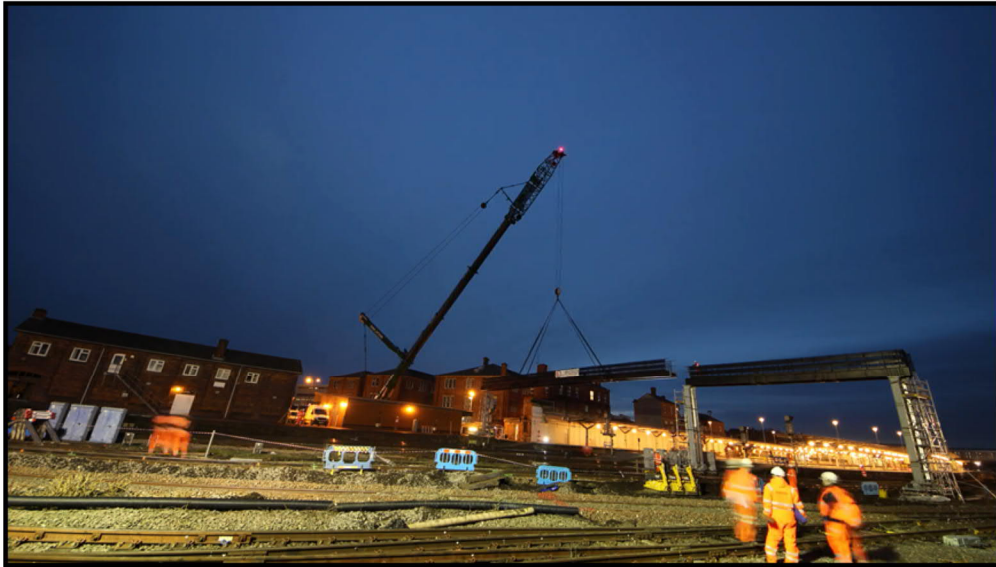
$$Cost_{Signalling\ Project} \propto Area_{Concrete\ Laid}$$

- ETCS reduces the number of signalling assets

- Costs will reduce but will change
    - Data creation and validation costs will increase
    - Automation will increase
    - Fewer humans to catch (and cause) errors
    - Design Tools are vital
    - Cyber Security will come to the fore

- Design Engineers will become more innovative

Woods' Theroem: The cost of a Signalling Project is directly proportional to the area of concrete laid.

ETCS will reduce the number of signalling assets laid. Fewer signals, Fewer Location cases, Fewer Gantries and Posts

The area of concrete will be reduced significantly, the price should also reduce significantly.

Costs will move towards data creation & validation. These are office based roles and are ripe for automation.

As design tools become more relied upon their integrity will need to increase. Fewer humans in the loop to catch errors (but also fewer humans in the loop to create errors too!).

Increased reliance on Digital Communications, Cyber Security will come to the fore.

Signalling Engineers will move away from rote design and reproduction to innovative thinking. To be successful they will to be brave, make decisions and solve problems.

Lower costs allows for faster upgrade of the network allowing for increased train paths. – More Trains

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Build – Continuous Upgrade

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News > Tesla brings new features to all cars with Version 9 software update

Tesla brings new features to all cars with Version 9 software update

By John McCann a day ago Car tech

Rolling out already in North Amercia

The long-awaited Version 9 software update has started to roll out to all Tesla cars in North America, with the rest of the world in line to get the update in the "next few weeks". *Image from www.techradar.com*

TECH & SCIENCE
IOS 12 RELEASE: BATTERY LIFE PROBLEMS, ALARMS NOT WORKING, OTHER BUGS
BY NINA GODLEWSKI ON 9/20/18 AT 1:10 PM
https://www.newsweek.com/

Software
Microsoft deletes deleterious file deletion bug from Windows 10 October 2018 Update
Let's try that one again, says Redmond, after last week's operating system build misread timestamps
By Richard Chirgwin 10 Oct 2018 at 06:04   29   SHARE ▼
https://www.theregister.co.uk/

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Digital Systems could be upgraded remotely to unlock capabilities or to implement new ones.

The use of virtual blocks can be used to increase headways.

Updates can be tested on twin systems in test facilities.

However we must be careful:

        Apple iPhone Update broke the alarm clock
        Windows Update started deleting files

We need to start designing systems now with this capability in mind.

UK RAIL NETWORK ATTACKED BY HACKERS FOUR TIMES IN A YEAR

The infiltrations appear to have been exploratory rather than disruptive but researchers say they highlight a real risk

Emma Boyle |
Wednesday 13 July 2016 16:53 | 0 comments

Click to follow
The Independent Tech

https://www.independent.co.uk/

Infrastructure is an appealing target.

We are seeing more attempts to explore and disrupt critical infrastructure.

Legacy railway systems are almost immune from hacking due to their technology and design. The flexibility of new Digital Technology is also its achilles heel as it can be turned against us.

Cyber Security must be built into systems from the beginning.

Jeep integrated their radio into the cars CAN bus to allow the steering wheel controls to be used. The CAN bus also controls the drive by wire systems.
A while later somebody decided to add a 3G modem to the radio for sat nav and traffic updates. They had accidently caused a bridge between the outside internet and their safety critical drive by wire systems.

We saw videos of Jeeps being driven from an iPhone.

Need to be careful of piecemeal upgrades which don't always look at the the whole system to understand the implications of an upgrade.

No Cyber – No safety

Security

Brit airport pulls flight info system offline after attack by 'online crims'

No flight delays at Bristol base, miraculously*

By John Leyden 17 Sep 2018 at 12:28   23 🗩   SHARE ▼

Bristol Airport deliberately yanked its flight screens offline for two days over the weekend in response to a cyberattack.

https://www.theregister.co.uk/

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Hacking

Triton: hackers take out safety systems in 'watershed' attack on energy plant

Sophisticated malware halts operations at power station in unprecedented attack which experts believe was state-sponsored

Samuel Gibbs
Fri 15 Dec 2017 11.14 GMT

389

https://www.theguardian.co.uk/

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Security

Jeep drivers can be HACKED to DEATH: All you need is the car's IP address

Hackers can connect to brakes, engine over cellular network

By Iain Thomson in San Francisco 21 Jul 2015 at 19:11   102 🗩   SHARE ▼

https://www.theregister.co.uk/

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So this is a Class 43 driver's cab. A class 43 is an HST or intercity 125. It plys the route from London Paddington to Swindon and beyond. Admittedly it is over 40 years old but is indicative of a cab. It's very grey.

Drivers carry "route knowledge" or a "map" in their head. They know things like gradients, speed limits and where stations and signals are.

They read the signals which gives them an implicit guide of how to drive. A green signal says carry on driving at the speed limit. A yellow signal says your next signal is red so you better apply the brakes to stop at that signal. A red says you can't pass me!

The driver uses thins information to drive to deliver the best performance they think they can.

However this is based upon a model of the rest of the railway which lacks awareness of the bigger picture.

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Image courtesy of: https://www.railengineer.uk/

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Class 800 cab. Lots of bells and lots of whistles. This is the direct replacement for the class 43.

ETCS – Drivers are provided an indication of how far and at what speed to drive including speed restrictions and gradient via an in-cab display. Drivers are constantly supervised to ensure compliance with the speed limits and the system will intervene to slow the train if necessary.

Connected Driver Advisory Systems increase the rate at which drivers can be updated and guided on the state of the railway ahead and the optimal way to drive.

This can reduce the energy use of trains and time wasted waiting at red signals.

The driver will have to become more aware of the C-DAS system and try to follow guidance more closely. This has to be weighed against the importance of situational awareness outside the cab for the driver.

There may be the perceived reduced autonomy for the driver but actually it is an increase in skill to use new information to deliver the final outcome to the customer.

Automatic Train Operation is widely used on metros most famously in the UK on the DLR but also Central and Victoria Lines. One of the first mainline applications has been Thameslink in the UK.

This reduces the driver's workload as they transition to a monitor and intervene workload rather than an active driving workload. They are still a skilled operator responsible for the safe operation of the train in a manner similar to a pilot under autopilot.

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Current Signaller

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Signallers set routes for trains using any of these lovely interfaces. They read the timetable and look at train locations to judge which routes to set to ensure they stay on time. They make judgements based upon their knowledge and a prediction for the future. They have a limited view of the rest of the railway and the impact of their decision.

As well as set routes they need to manage the operation of the railway which limits their area of control.

To do this The signaller also has to answer phone calls from various users such as engineers working lineside or people who want to use a level crossing. They have to deal with incidents such as break downs or escaped livestock.

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Notes 29

Operate - Signaller

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http://www.railtechnologymagazine.com/

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Using the new Traffic Management Systems the world has changed. Routes are set automatically. The operator is notified of conflicts (where two trains want to use the same piece of track at the same time) in advance and he adjusts the service to to minimise the predicted delay. This is then fed to the driver via C-DAS so he can drive to the new plan.

Because the signaller is no longer setting routes he has more time to manage the railway and deal with events. The signaller can control a larger area.

They work in a team to ensure the best (least bad) outcome for all users. No longer are they independent but collaborating with colleagues sitting close by.

Trains run closer to time and delays are minimised. Connections aren't missed and more connections are made!

Operate – Signaller Training
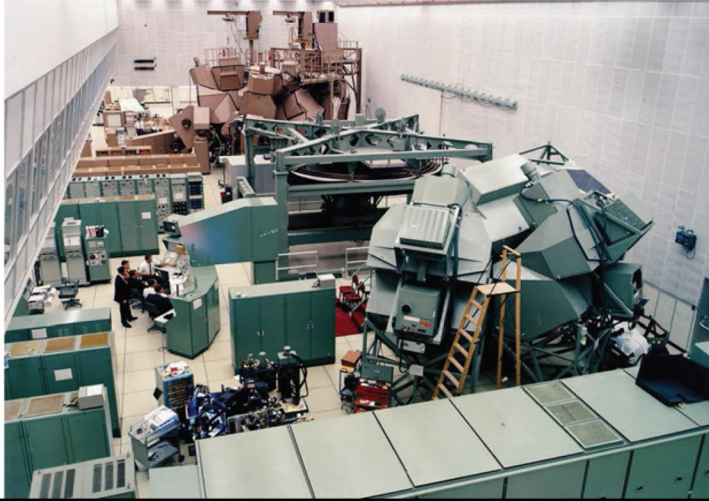
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To support this change new simulators are provided which allow the collaborative behaviours to be wargamed and to deal with emergent behaviour.

Faults and issues can be implemented to test proposed solutions and that teams can work together under pressure.

Apollo 13 – Simulator used to train pilots and errors thrown in to test skills prior to launch. Teams became more cohesive and able to know what each other were thinking. During the Apollo 13 mission the simulator was used to test the command module power up sequence to make sure it could be done within the power constraints of the stricken spacecraft.

Apollo Simulators installed at NASA - Front - Lunar Module Simulator (green)
Mid- Mission Effects Projector-Lunar surface (green)
Back - Command Module Simulator (tan)

http://www.ctandi.org/southern-tier-in-space/

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Operate - Maintainer

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System not designed for ongoing availability:
- Specifications for time to failure not availability
- Contracts judged on capital cost
- Industry standards do not allow for redundancy

Technicians are:
- Used to dealing with small frequent failures
- Experts in current (BR era) systems
- Trained through experience
- Working in a cold, wet and dangerous environment
- Nearing retirement

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Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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Currently deals with frequent small failures and interventions.

System design minimises redundancy to reduce capital cost

Aim to meet a specified MTBF not exceed it.

Continuous on the job training

Expert in current (ex-BR) systems. 20-30 years of corporate knowledge passed down.

Gets cold and wet, needs to operate in a safe environment.

Complicated planning to gain access.

Many are nearing retirement

Operate - Maintainer

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System is designed for ongoing availability:
- Specifications for availability
- Whole life costs are modelled and judged
- Standards are concerned with outcomes

Technicians are:
- Dealing with infrequent failures
- Provided information by data capture and analytics
- Multi-skilled and able to solve unique problems
- Trained and skills maintained via simulation
- Working in a warmer, drier and safer environment
- Collaborating with AI and remote experts
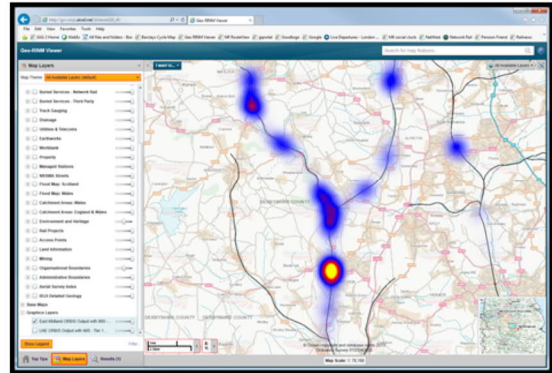
Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

Systems are designed with availability in mind. Whole life costs are modelled and suppliers are involved in the maintenance and measured on this.

Data Capture and Analytics provides information on asset status and when maintenance is required.

Maintenance is planned to minimise exposure to danger

Facilities are provided which assist to make the job more efficient and safer.

Assistance is provided to help solve complex systems provided directly to the technician regardless of location.
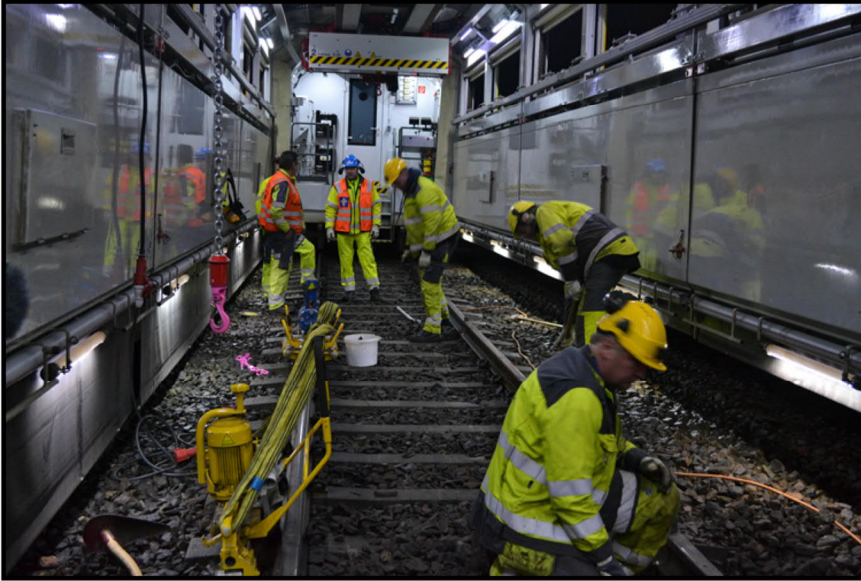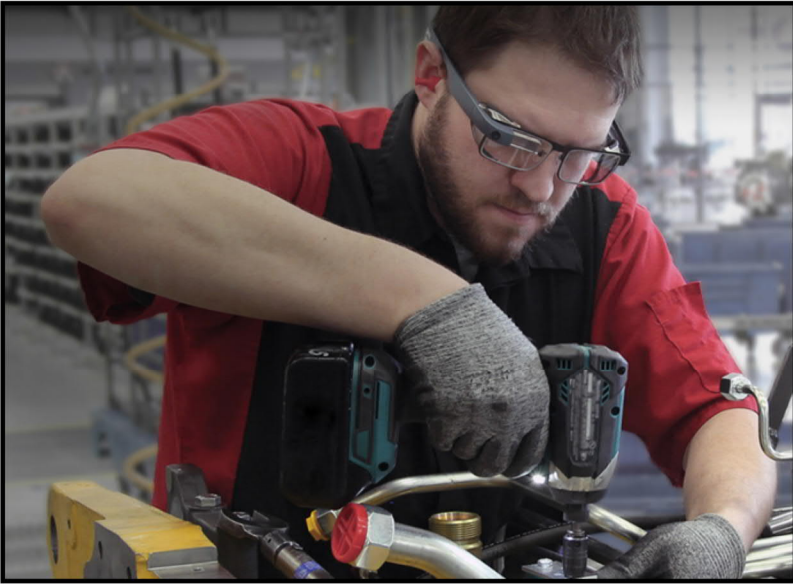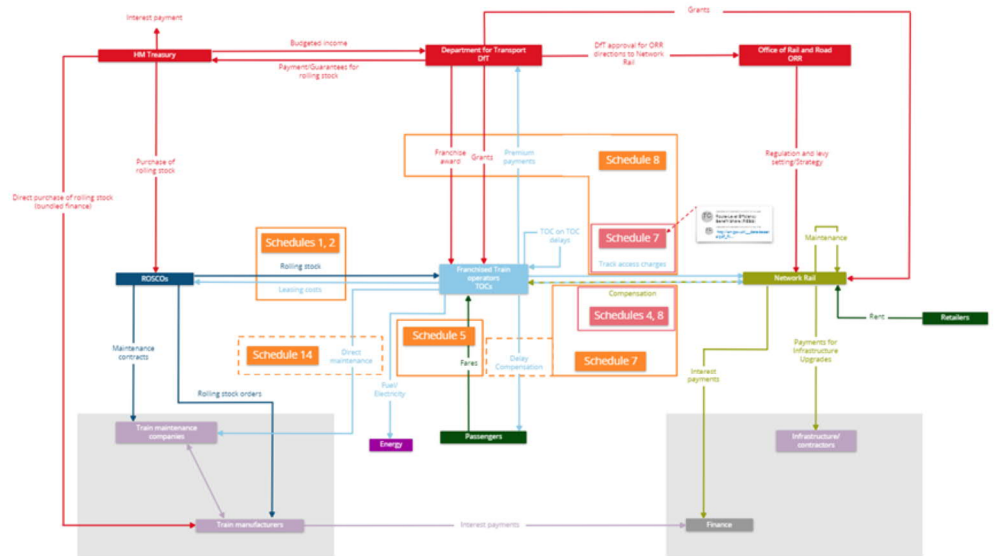
Image courtesy of Network Rail
https://www.networkrailmediacentre.co.uk

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https://x.company/glass/

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Making it happen

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- Align the industry

- Embrace change

- Serve the customer

- It's what we achieve not what we do

- Set problems not solutions

- Allow people to innovate

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Industry make-up/fragmentation – Competing over parts of a cake "wooden money"

Embrace change and be prepared to change ourselves

Remember to serve our customer "the travelling public"

Let go of how things are done, and be more interested in in what we achieve

Enjoy the ride of change and look for improvements

10 years ago Metro's were interesting and mainline was "boring" now mainline is getting really interesting!

Contact page

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