International Research and Development Partnerships

Rail Live Madrid 2023 Presentation

30/11/2023

RAILLIVE!

1. Introduction to Network Rail

Network Rail is the rail infrastructure manager in Great Britain. Network Rail own, operate and develop:

- 20,000 miles of track
- 30,000 bridges, tunnels and viaducts
- Thousands of signals, level crossings and stations
- 20 of the UK's largest stations (remaining 2,500+ are managed by the country's train operating companies)

Our Vision – "Putting passengers first"
We are a company that is on the side of passengers and freight users; that is easy to engage with and is an efficient and dependable partner; a company people are proud to work for; instinctively recognised as an industry leader.

Our purpose – "To get people and goods where they need to be, and to support Great Britain's economic prosperity".

We exist to get people and goods where they need to be and to support our country's economic prosperity. Every year:

- 1.8 billion people travel by rail
- Millions of passenger journeys start, end or pass through our stations
- Rail freight contributes £2.45bn to the UK economy each year

Introduction to Network Rail – Our Vision

Network Rail is the rail infrastructure manager in Great Britain.

Our Vision – “Putting passengers first”

Our Purpose – “To get people and goods where they need to be, and to support Great Britain’s economic prosperity

We support **1.8 billion passenger journeys** and delivery of **£2.45bn of rail freight**

Network Rail own, operate and maintain:

20,000 miles of track

30,000 bridges and tunnels

2500+ stations

Introduction to Network Rail – Our Role

Our Role

Running a safe, reliable and efficient railway, serving customers and communities. At Network Rail, safety is paramount for all, including:

- Passengers
- Members of the public
- Employees
- Partners

Our industry partners include:

Network Rail is a member of the following bodies:

Network Rail Technical Authority

- The Technical Authority is the central business function delivering RD&I to our customers and regions, led by Network Rail's Chief Technology Officer, Robert Ampomah.

2. Introduction to International Research and Development Partnerships (IRDP)

- Strategy
- Vision
- Advantages
- Progress to date

International Research & Development Programme
IRDP Introduction

Programme Vision

“To solidify Network Rail’s presence in railway research and development at an international level, solving today’s railway challenges to advance the UK rail network into the future.”

International Research & Development Programme
IRDP Introduction

- Research, Development and Innovation (RD&I) remains a critical part of Network Rail's approach to tackling existing and future challenges across the UK rail industry
- Network Rail has a long and productive history of delivering RD&I work alongside international partners, such as through the Shift2Rail Programme, and wishes to continue this as it moves into its next Control Period (CP7)
- Network Rail is looking to deliver its RD&I work, along with its UK partners, (such as Universities and the supply chain) through collaborative, agile international partnerships
- Network Rail will also continue to seek opportunities to take part in EU-funded programmes (such as the ERJU) during this period

Benefits of Collaboration with Network Rail

- Strengthening of international relationships and enhanced reputation
- Access to the United Kingdom's academic network, suppliers and test facilities:
  - Leveraged funding
- Platform for knowledge exchange:
  - Share best practice
  - Share lessons learned
  - Comparison and evaluation
- Development and identification of solutions to current challenges
- Shared resources
- Shared funding delivering return on investment
- Process of cooperation streamlined in comparison to other joint undertakings

Rail Innovation & Development Centre (RIDC)

UKKRIN Laboratory Test Facility (Southampton Uni)

IRDP team with ProRail in Utrecht

IRDP Progress to date

Live Partnerships

ProRail (Netherlands)

- On 18th August 2023, NR and ProRail signed a Memorandum of Understanding (MOU) for 5 years
- ProRail and NR have already discussed joint projects in artificial intelligence, automated inspection and fibre optic acoustic sensing
- Projects to be launched in 2024
- Collaborative sharing platform launched

SBB (Switzerland)

- On 24th July 2023, NR and SBB signed an MOU marking formal collaboration between both railways
- Together, SBB and NR have already discussed joint projects in traffic management, bridge inspection and light rail
- Projects to be launched in 2024
- Collaborative sharing platform launched

Also in advanced engagement with:

- Bane Nor (Norway)
- SNCF Reseau (France)
- Trafikverket (Sweden)
- EJRC (East Japan Railway Co.)
- Railenium

Other international activity:

- UIC Rail Innovation Coordination Group (RICG)
- Europe's Rail – member of Advisory Boards
- Europe's Rail – participating in System Pillar
- Founding member of Shift2Rail (concludes end of 2023)

3. Network Rail Control Period 7 (CP7)

Control Period 7 is a funding cycle for Network Rail, running from April 2024 to March 2029

- Definition of CP7
- CP7 Alignment to Research, Development & Innovation
- Topics and Areas of Framework Themes

Customer-led innovation portfolio – key priorities

In the next 5 years, RD&I will be:

Financially responsible - Focused on driving cost out of Network Rail

Driven by returns – Primary benefits focused on outcomes delivering return on investment and realisation of societal gain

Priority-led - Strategy developed with the objective of supporting the delivery of business priorities at pace

Focused to the end - RD&I that is regionally-owned and supported including implementation funding

Achieving NR business goals:

- Targeted Cost Reduction
- Keep People Safe
- Train Performance
- Environmental Sustainability

Aligned with government objectives:

Great British Railways TRANSITION TEAM

Department for Business, Energy & Industrial Strategy

UK Innovation Strategy

Leading the future by creating it

Rail Technical Strategy

Innovating across Britain's railway

Business-led RD&I framework – Priority Themes and Capabilities

1. Passenger experience and accessibility

- 1.1 Cross modal integration
- 1.2 Accessible and personalised journeys
- 1.3 Smart fare collection
- 1.4 Safety and security of passengers and public
- 1.5 Sustainability of branch lines

2. Freight capability

- 2.1 Optimised network access for freight
- 2.2 Increase average and maximum freight speeds
- 2.3 Future terminal concepts
- 2.4 Future wagon concepts
- 2.5 Freight vehicle remote condition monitoring
- 2.6 Freight data driven maintenance and operations
- 2.7 Zero/low emissions from freight trains

3. Traction decarbonisation

- 3.1 De-risk and future proof zero/low emission trains
- 3.2 Minimising impact from diesel legacy
- 3.3 Assets to support decarbonisation
- 3.4 Intelligent energy management

4. Environmental and social sustainability

- 4.1 Whole life carbon
- 4.2 Zero/low emission construction and maintenance plant
- 4.3 Transition to low carbon energy sources/ technologies for non-traction
- 4.4 Improve air quality
- 4.5 Support biodiversity
- 4.6 Circular economy
- 4.7 Noise controls
- 4.8 Social value
- 4.9 Water resource management

5. Optimised and resilient operations

- 5.1 Flexible and reliable train planning
- 5.2 Real-time operations and decisions
- 5.3 Signalling and train control capabilities
- 5.4 Branch line operational concepts
- 5.5 Operational safety
- 5.6 Operational staff development and competency

6. Automation

- 6.1 Remote inspection of assets and local environment
- 6.2 Automated design, compliance and approval
- 6.3 Automated/mechanised asset maintenance and installation
- 6.4 Optimisation of rolling stock maintenance/preparation
- 6.5 Principles and case for automation

7. Optimised and resilient assets

- 7.1 Location of assets, resources and materials
- 7.2 Effective, continuous remote condition monitoring
- 7.3 Predictive and preventative maintenance
- 7.4 Safer, capable and digitally connected infrastructure workforce
- 7.5 Climate change adaptation
- 7.6 System/asset design, standardisation and optimisation
- 7.7 Advanced and novel materials development
- 7.8 Manage for obsolescence/ legacy assets
- 7.9 Accelerated and affordable testing and validation

8. Digitalisation and data

- 8.1 Data availability and accessibility
- 8.2 Enabling novel data exploitation techniques
- 8.3 Digitalisation of assets and core processes
- 8.4 Advanced cyber security

NR leads

NR partners

NR supports

- Themes relate to GB rail sector's technical strategy and to the innovation strategies across other governmental sectors

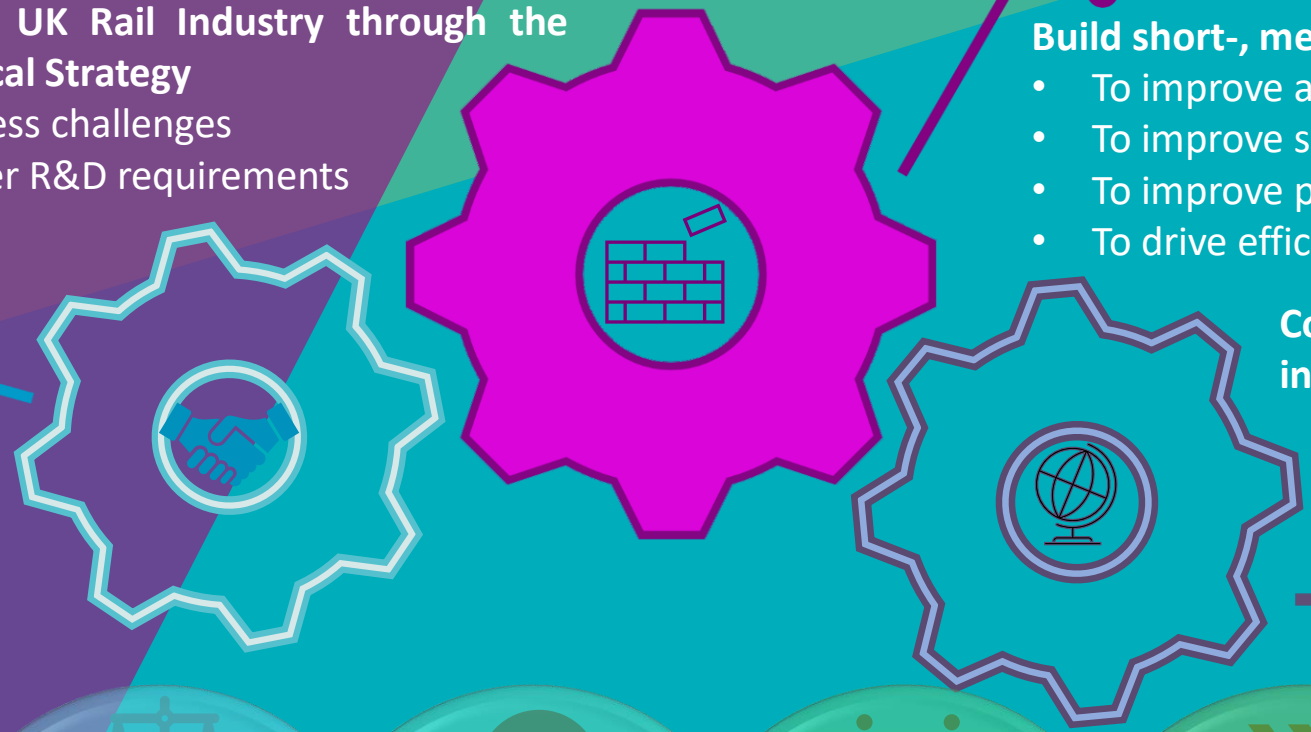
Research and innovation opportunities in UK

Research, Development & Innovation Strategy

NetworkRail

The R&D team exist to:

Work with UK Rail Industry through the Rail Technical Strategy
- To address challenges
- To gather R&D requirements



Build short-, medium- & long-term solutions
- To improve asset sustainability & reliability
- To improve safety, security & performance
- To improve productivity
- To drive efficiencies

Contribute to the EU & international strategy
- Collaborate internationally
- Leverage R&D

We deliver this by:

- Investing £245m of NR funds
- Raising matched funding from external parties
- 6 Delivering through 6 structured R&D programmes
- Deploying technology through FIC deployments, delivery programmes or as a service via AIS or RSIT
- Applying a stage-gated process to technology development (Rail Industry Readiness Levels)
- Delivering through partnerships with suppliers, academia and other Industry partners

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4. Selection of Collaborative Projects (time permitting)

Fibre Optic Acoustic Sensing

Summary

We are looking to further exploit our extensive fibre optic network to address a number of infrastructure and safety-related user cases.
These user cases relate to train positioning, trespass, wheel flats and rail condition.

Problem

Train positioning – signallers have difficulty accurately locating the presence of trains in long signal sections.

Trespass - a continuing and significant risk to safety and performance, particularly coupled with theft.

Wheel flats – out-of-circle train wheels impact huge loads onto our rails and cause delay when the trains have to be taken out of service or recessed.

Rail condition – hidden defects in the rail foot can propagate to rail breaks, causing safety and performance issues.

Solution

To initiate a design contest to select a consortia to develop and deploy their internet of things (IoT) technology onto our fibre optic network to test our use cases.
We will host the consortia at RIDC Melton and on the adjacent Syston-Peterborough line for a 12-month trial
Subject to successful trial we will consider a future service offering to the regions.

Benefits

- Reduction in safety risk due to trains striking vehicles at user-worked crossings
- Reduction in track damage due to wheel flats
- Improvement in train availability
- Reduction in safety and performance risk due to trespass
- Reduction in safety and performance risk due to reduced rail breaks

Service Providers

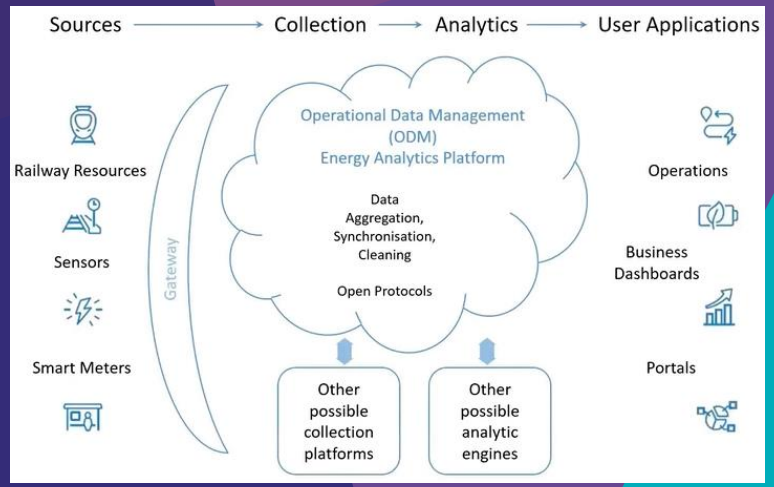
Thales are the consortium Leader; the consortium partners are:

Energy Management

Summary

How using of **Smart Metering and Machine Learning can be used for improving railway energy consumption and asset sustainability.**

Demonstrator website
https://bit.ly/3epR875



The general principle of smart metering

Solution

The project put in place a **bespoke and non-intrusive smart metering sensor network** at the railway system level; it **collects and aggregates data for analysis in an open-source Operational Data Management platform and creates user applications** to understand energy flows, manage energy and support proactive asset management.

Three operational trials were held:

1. **Commercial Operation use case, London, UK, (750V DC):**

- To obtain a data synchronisation between rolling stock and infrastructure for a better understanding of energy flows.

2. **Stationing and Maintenance Operation use case, Zaragoza, Spain, (750V DC):**

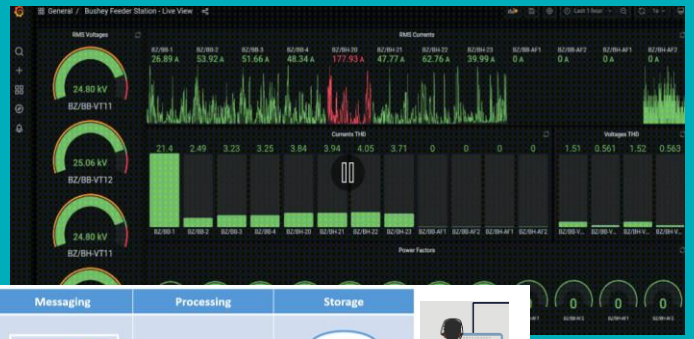
- To improve maintenance operation using predictive maintenance.

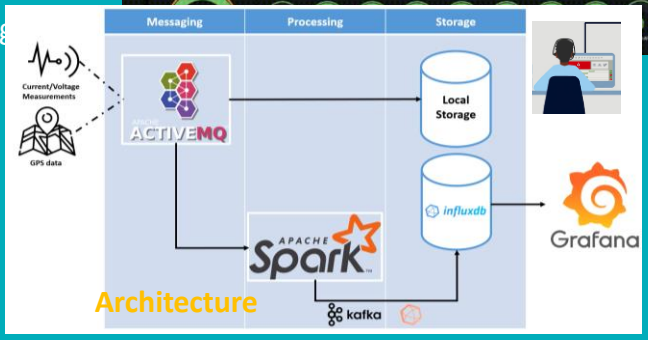
3. **Electrical Infrastructure use case, London, UK, (25kV, 50Hz):**

- For improved knowledge of energy mapping for the optimisation of the infrastructure's performance and providing support the operators in the decision-making process, providing real-time information.

Main Results

- **Fault detection for catenary system**
- **Regenerative braking quantification using Machine Learning**
- **Track Switches failure detection using Machine Learning**
- **Observed Energy potentials - Energy losses**
- **Models and simulation validated with obtained data**





Architecture

Prometheus

Summary

- Prometheus is a reconfigurable robotic platform(s) with advanced sensing for confined spaces.
- Collaborative Innovate UK project valued at £2.2m of which £220k is funded by NR.
- Network Rail is part of consortium led by Headlight AI, involving Bristol and Manchester and Royal Holloway universities, Callen Lenz and Thales.

Problem

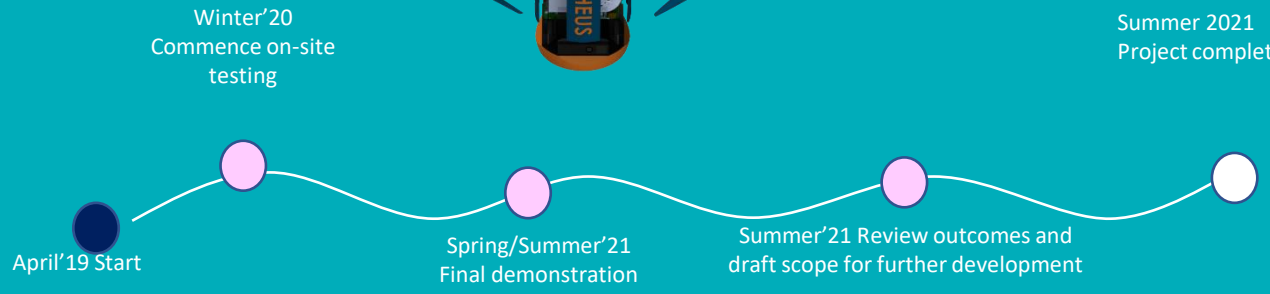
- Over 5000 shallow mine workings underneath or adjacent to the railway - constitute a risk to the operation of the railway.
- Many mines are inaccessible and can only to investigated by drilling boreholes into workings.
- Current methods of inspection are costly and pose health and safety risks to workers.

Solution

- The project will develop a fully autonomous robot capable of geo-technical surveys in unknown voids for use in the mining industry.
- This robot will be able to be automatically deployed and recovered through a standard restricted access bore of 150mm diameter, significantly increasing potential use cases over existing systems.
- Key demonstrations will be carried out during the project.

Benefits

- Level 2 BCR: 3.24
- Eliminating the requirement for human entry into mine workings to facilitate inspection.
- A reduction in ground investigation costs and environmental impact
- A reduction in cost in future mining expenditure.
- Improved understanding of mine condition
- More informed targeting and design of mitigation measures, as the 3D geometry of mine workings will be better quantified
- Improved risk visibility and decision making for resilience, safety and life cost benefits.
- Reduction in insurance premium for mines
- Entry boreholes can be drilled away from the infrastructure reducing the impact on railway and the risk of initiating a collapse



Unattended Measurement

Summary

We are working with 8 suppliers to undertake system trials on in-service trains to detect and predict infrastructure faults.

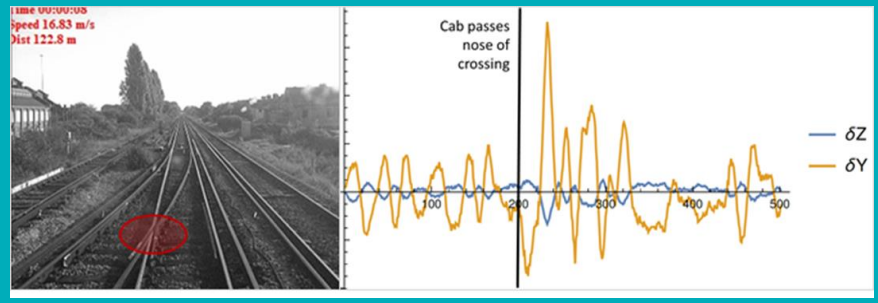
Particular areas of focus are driver-reported rough-rides (DRRR), unexpected track geometry faults, derailment risk at high-risk sites and quicker removal of ESRs and TSRs.

Problem

DRRR – these are frequently a function of train bogie dynamics rather than track faults, resulting in abortive speed restrictions and fault finding.
Track geometry – faults can occur in between track recording train runs, resulting in emergency speed restrictions being applied.
Derailment risk - sites that are not routinely inspected by track recording vehicles retain a relatively high risk of derailment.
ESRs / TSRs – these are frequently retained in place until the next scheduled track recording vehicle run, which could be several weeks.

Solution

We have held a design contest to select a number of specialist suppliers to work with us to develop and trial their technology on in-service trains. We are entering into agreement with Porterbrook to fit equipment to ScotRail vehicles and will be working closely with infrastructure maintenance units in Scotland.
Subject to successful trial we will consider a future service offering to the regions.



Timeline

Benefits

- Reduction in service affecting failures
- Improvement in asset life and performance
- Reduction in trackworker safety risk associated with repeat site attendance and maintenance

Partners

Transport Scotland / Còmhdhail Alba
ScotRail – Scotland's Railway
porterbrook

5. Q&A

Proposed allocation of CP7 RD&I budget by theme

Ref	Activity / Project / Team Name	Cost	Explanation
1	Passenger Experience and Accessibility	5%	Creation of a passenger centric experience with integrated design of services, accessibility providing seamless end to end experience and connecting communities. NR investment focusses on (i) enhanced customer experience through novel use of passenger data, and (ii) enhanced safety at level crossings.
2	Freight Capability	5%	Adoption of new models and technology to improve rail freight capacity and capability including automation of sidings and depots. NR investment prioritises improvements in monitoring wagon condition (safety) and optimising network access for freight.
3	Traction Decarbonisation	8%	Low cost and high output electrification of the network, in addition to intelligent energy management and the introduction of alternative fuels and storage technologies contributing to a cleaner future transport system.
4	Environmental and Social Sustainability	5%	Biodiversity, carbon reduction and promotion of social value. Funding to support work with other arms length bodies and infrastructure managers on decarbonising non-traction energy, air quality, circular economy, noise and whole life carbon tools.
5	Optimised and Resilient Operations	20%	Development and prioritised deployment of digital signalling to unlock additional network capacity. Also supports improvements to operational safety e.g. incident response.
6	Automation	15%	Automated inspection (trainborne, drones, satellite, NDT) for high risk asset classes. Includes first-in-class deployment funding for CP6 and CP7 R&D products.
7	Optimised and Resilient Assets	35%	Assets designed for reliability and availability through non disruptive repair and avoiding single points of failure. NR investment prioritises network model development, remote condition monitoring technology, upgraded algorithms and machine learning for predict and prevent maintenance, GSM-R obsolescence and WRCCA risk mitigation. Includes first-in-class deployment funding for CP6 R&D products.
8	Digitalisation and Data	7%	Digitisation of the physical infrastructure and operational activities enabling digital twins models allowing data driven decision using modelling and analytics platforms. Secure and accessible data within a data environment which allows for integration of data sets.

Proposed allocation of CP7 RD&I funding by project type

Funding component	Value	Purpose
First-in-class	35%	Accelerated regional first-in-class technology deployment in CP7, targeting productivity, safety and efficiency improvements. Increases confidence in the business change, accelerates benefit realisation.
CP6 roll-over programmes	7%	Completion of the remainder of the highest priority UK R&D initiated during CP6, delivering solutions ready to be rolled out in CP7 via the First-in-class fund.
Horizon 2020 (EU) roll-over programmes + ERJU 2nd call	8%	Completion of the remainder of the highest priority EU R&D initiated during CP6, delivering solutions ready to be rolled out through CP7 and into CP8 via the First-in-class fund.
International Research and Development Partnerships	5%	Replacement for follow-on EU R&D – bilateral partnerships which generate co-funding opportunities to maximise value-for-money from Network Rail R&D. Medium-term R&D deployed second half of CP7 onwards, targeting productivity, safety and sustainability objectives.
UK Partnerships	3%	As for International Partnerships but with UK arms-length bodies. Medium-term R&D deployed second half of CP7 onwards.
Other Programmes follow-on	17%	R&D component of other CP7 programmes (e.g. IM Fleet upgrade, II follow-up, digital signalling), for deployment in CP7.
Remaining 'core' R&D	25%	R&D between RIRL 1-6 aligned to Regional and functional priorities captured during stakeholder engagement.