Innovation In Railway Construction

Industry Demonstration Event

20th March 2025

GCRE
Global Centre of Rail Excellence

Department for Business & Trade

UKRI Innovate UK

Llywodraeth Cymru
Welsh Government

Innovation in Railway Construction

Team Summaries

1. Focus Sensors
2. Ingram Networks
3. Universal Signalling
4. Furrer+Frey (CODES)
5. Furrer+Frey (ICAGE)
6. Mimicrete
7. Concreatene
8. AUS Ltd
9. RoBoK
10. Drone Evolution
11. Silicon MicroGravity
12. Enerail

1

Attaining Ubiquitous Railway Analysis (AURA)
Weaving a golden thread of insight at GCRE
Focus Sensors Limited

Summary

- Optical fibres already next to the track as the backbone of S&T systems can be used to monitor the railway
- Focus Sensors developed three fibre sensing use cases:
  - Intruder detection, though precisely locating footsteps
  - Rolling stock arrival time estimation
  - Detecting and tracking maintenance equipment

Potential Benefits

- Enhanced safety : intruder detection at large site reducing need or reliance on physical barriers and cameras
- Cost reduction : reducing theft and vandalism
- Construction efficiency : optimized flow of materials arriving at GCRE site by accurate prediction of arrival time
- Operational efficiency : monitoring track maintenance, construction vehicles and trains through the GCRE track layout

Exploitation

Many opportunities for exploitation beyond GCRE:

- Intruder and trespass monitoring on the railway and for any border
- Maintenance activity monitoring
- User-worked level crossing management

Additional Information

Focus Sensors offer a range of use cases based on fibre sensing including:

- Embankment slip, geotechnical changes and track stability
- Water saturation detection and water leaks
- Wheel impacts

Contact Details

- www.focus-sensors.com

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2

Delivering Telecommunications innovations in railway construction at the GCRE

Reducing the costs and increasing the benefits of trackside networks

Ingram Networks Ltd

Summary

- The innovation seeks to half the deployment time for trackside networks, reduce carbon footprint and add benefits.
- Measures include blown fibre, Wavelength Division Multiplexing, 'Screw in' Anchors and Smart power features.
- Added benefits include HD Cameras and RADARs to detect trespassers, improve safety and reduce railway operating costs.

Potential Benefits

- The primary problem the innovation solves is poor passenger connectivity, which is holding UK productivity back.
- UK Train Passengers spent 495 million hours on trains last year.
- With consistent, high-speed WiFi / 5G connectivity we can turn journey time into productive time.
- Making train travel more attractive will enable reduced subsidy.
- Attracting more travelers to rail will reduce CO2 emissions.
- Additional sensors improve the Business Case for adoption.#

Exploitation

- We are in active discussions with Transport for Wales, and intend to use the GCRE facility to showcase our solution to other operators in the UK and worldwide.

Additional Information

- For additional information on performance, cost and capabilities, please contact Steve Morris, Ingram Networks.
- This GCRE installation is also being used to trial our TRIG24

Research funded by the Department for Transport through the Connected Places Catapult, and research into increasing the resilience of railway infrastructure in the face of natural events as part of Innovate UK's International Rail Innovation Challenges programme.

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GCRE

Universal Worksite Protection
By Universal Signalling Ltd:
Reinventing railway signalling and delivering it for a fraction of the cost

Universal Signalling

SkyBlue Engineering

University of Birmingham

Summary

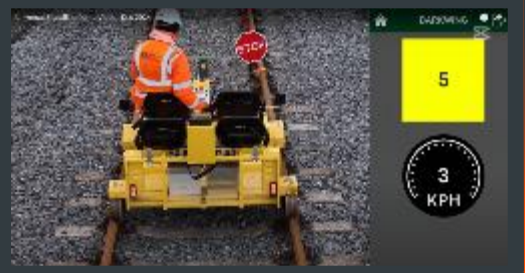
- Our company's goal is to radically reduce the installation time of signalling systems from decades to days, in turn reducing costs to a small fraction of what the industry has become used to.
- Here, we are demonstrating our worksite supervision system. It controls, monitors and records the speed and position of all vehicles within a possession.
- Speed and movement limits can be applied remotely and are fed to the cab of each vehicle.
- It uses the same technology stack as our full signalling system.
- It was fitted to track and vehicles in 1 hour, with no prior knowledge of the track layout.

Potential Benefits

- Currently, vehicle movements in possessions are managed by whiteboards and magnets. This system provides automation, and a more accurate view of the state of the site.
- There are frequent safety incidents which can also lead to expensive possession overruns, for instance points run throughs.
- The system can be used to play back all vehicle movements, showing where there are opportunities for efficiency improvements.

Exploitation

- We are pursuing worldwide opportunities with this technology, and other products using the same hardware.
- It is likely our first mainline demo will be right here in South Wales.



Additional Information

- Other products have been developed using same hardware:
  - User Worked Crossing Warning System
  - Continuous Speed Supervision for Light & Heavy Rail
  - An Alternative to Conventional Signalling Systems

Contact Details

Website: https://www.universalsignalling.com

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Cost-Reducing Dynamic Electrification gradient System (CODES)
Lowering Cost of Electrification
Furrer+Frey

Summary

Cost-Reducing Dynamic Electrification gradient System (CODES), is a system of modified masts. It allows for dynamic height adjustment to replicate any possible planned electrification on the real rail network, and for that to be easily & safely tested.

Potential Benefits

By creating adjustable height masts and electrification equipment

we can model real world scenarios saving:

- **Time,**
- **Budget,**
- **Resources**

Moreover, a permanent change to electrification standards is possible through empirical data.

Exploitation

- **Network Rail a primary customer for testing new electrification projects and renewals**
- **Rolling stock manufacturers can test their equipment's limits in a real-world, safe environment.**
- **Other potential uses where OLE needs to be moved temporarily out of the way (e.g., high load HGV, double-stacked freight containers etc.)**

Additional Information

- **Centralized Control System allows for unlimited scalability**
- **Remote Access allows for one-button setup from anywhere in the world**

Contact Details

- **https://www.furrerfrey.ch/en/**

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Innovative CAntilever for Greener Electrification (ICAGE)
Reducing the Cost of Railway Electrification
Furrer+Frey

Summary

Electrification infrastructure has largely remained unchanged for decades, still relying on designs from the 1950s. Heavy steel cantilevers require frequent maintenance, are prone to corrosion, and necessitate large, costly foundations.

I-CAGE harnesses innovative composite materials to address the challenges associated with steel components, using a patented design.

Potential Benefits

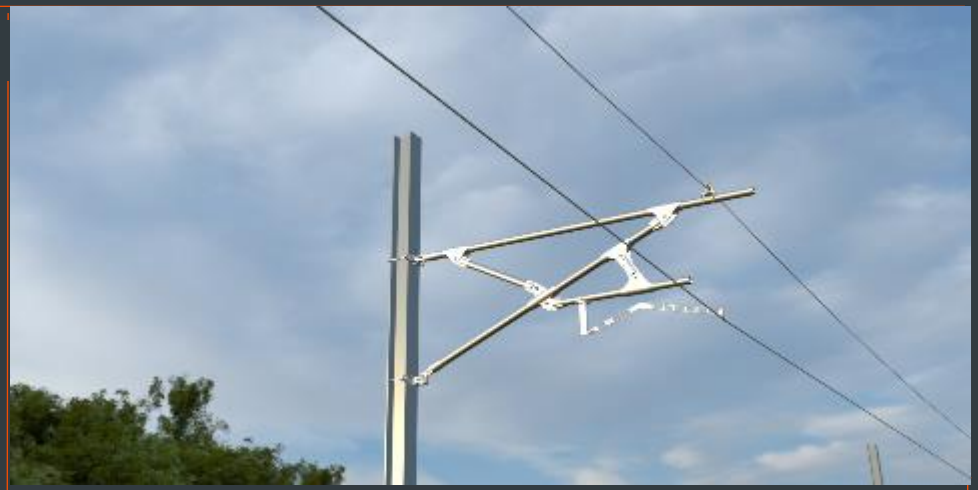
I CAGE offers a refined approach to railway electrification that is:

- **easier to install,**
- **more cost effective,**
- **inherently safer.**

By reducing construction costs, embodied carbon, and energy demands, this solution establishes a new benchmark for rail infrastructure.

Exploitation

- **The UK market presents a strong opportunity for I-CAGE exploitation, with a conservative estimate of 1% cantilever replacements across 120,270 existing electrification structures ensuring ROI, alongside 70,000 new cantilevers from planned electrification (13,000 STK by 2050) and HS2 expansion.**



Additional Information

- **Modular design allows to create any length cantilever with 4 standard parts and different GFRP tube length.**

Contact Details

- **https://www.furrerfrey.ch/en/**

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10093817 – Mimicrete Vascular Self-healing Solution in Railway Practice – Phase 2 Demonstration

Demonstrate Self-healing concrete in the railway practice for a sustainable future

Mimicrete Ltd (Lead) | Cardiff University (Partner)

Summary

Mimicrete is pioneering self-healing concrete technology to enhance the durability and sustainability of retaining walls in railway infrastructure. This project, in collaboration with GCRE construction team, Cardiff University, Walters Group, Arup, and Mott MacDonald, focuses on the acceleration stage of self-healing technology, integrating a vascular network that releases a healing agent upon cracking, extending structural lifespan and reducing maintenance costs. Key Achievements includes:

- On-Site Demonstration at GCRE – Self-healing retaining walls installed for real-world performance tracking.
- Accelerated Crack Testing – Hydraulic jacks used to create cracks, validating rapid healing and mechanical recovery.
- Long-Term Monitoring – Embedded sensors track crack formation, permeability, and corrosion resistance over time.
- Optimised Manufacturing – Improved vascular network resilience during casting for large-scale production.

Potential Benefits

- Enhanced Structural Integrity: The vascular network enables real-time crack healing, reducing risks of structural failure.
- Increased Safety: Minimising crack propagation helps prevent sudden failures, improving railway infrastructure reliability.
- Maintenance Reduction: Crack healing minimises repair interventions by up to 70%, reducing labour and material costs.
- Estimated Carbon Savings: Implementation of this technology contributes to significant carbon footprint reduction across the infrastructure lifecycle

Exploitation

- Rail Infrastructure Deployment – Scaling self-healing retaining walls for railway networks, reducing maintenance and carbon footprint.
- Strategic Partnerships – Engaging with rail operators, construction firms, and policymakers for industry-wide adoption.
- Regulatory Compliance – Aligning with Eurocode & BS EN standards to accelerate market readiness.

Additional Information

The GCRE trial has become a key milestone for Mimicrete:

- Attracted International Investment – Showcasing our innovation to global stakeholders.
- Increased Global Recognition – Generating interest from infrastructure leaders worldwide.
- Opened Export Opportunities – Positioning Mimicrete for opportunities and expansion into global market.

Contact Details

- www.mimicrete.com

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Low-Carbon Concrete Sleeper
Reducing embodied carbon in rail infrastructure
Concretene

Summary

- Low-carbon concrete sleeper using graphene nanotechnology
- Graphene-enhanced admixture optimised for pre-cast concrete chemistry
- Compliant with sleeper standards BS EN13230 & NR/L2/TRK/030

Potential Benefits

- Helping to achieve Network Rail's 2045 & 2050 net-zero emissions targets
- Increased durability for a longer service life
- Non-disruptive – handled and installed like standard sleepers

Exploitation

- A direct replacement for any type of concrete sleeper
- Procured through Cemex like other concrete sleepers

Additional Information

- UK's 20,000 miles of railways includes 50 million sleepers
- Sleepers account for 30% of rail infrastructure embodied carbon
- Concretene sleepers will play a significant contribution in reducing these emissions

Contact Details

- www.concretene.co.uk

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Composite Twin Track Cantilever (CTTC) for Smarter Rail Electrification

Revolutionising Rail: Smarter, Lighter, Greener Electrification

AUS Ltd in partnership with the University of Huddersfield

Summary

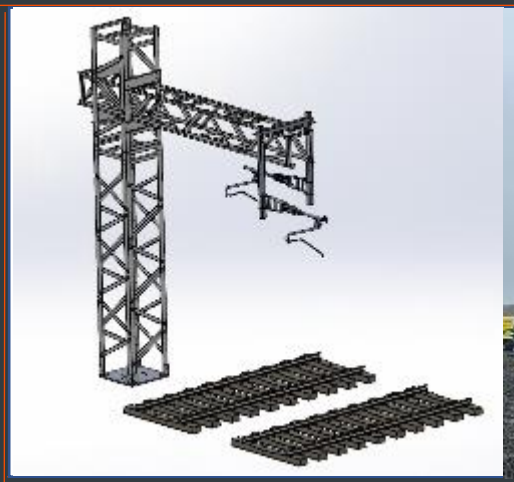
- The CTTC utilizes composite materials for a new and innovative take on the TTC
- Designed for versatility
  - Compatible with new & old infrastructure
- Optimised for use on rail OLE

Potential Benefits

- UK based manufacturer & supplier
- Overall weight reduction = 77.5% to the nearest alternative
  - Reduction in installation costs
- Help meet Network Rail's NetZero target
  - Reduced weight = Transportation carbon savings
  - 85% Saving compared to alternatives
- Lightweight, high strength solution to OLE structures

Exploitation

- Opportunity for CTTC to be tested on a live line at GCRE
- Further showcases and events
- Utilise enhanced corrosion resistance in highly corrosive environments



Additional Information

- AUS plan on installing sensors to monitor live data on the CTTC
- Lattice design to optimise FRP

Contact Details

- www.aus.co.uk

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INTElligent Real-time, MOnitoring & Detection video AnaLytics solution
Optimise rail construction with AI-powered CCTV
RoboK and Transport for Wales Rail

Summary

- Standalone, AI-powered video analytics system for rail construction monitoring
- Fully autonomous – solar-powered, 4G-connected, and independent of existing infrastructure
- Detection of safety hazards, vehicle dwell time, and operational efficiency

Potential Benefits

- Improves safety compliance by detecting PPE violations and unauthorised access
- Reduces project delays by optimising vehicle flow and equipment usage
- Enhances decision-making through AI-driven insights

Exploitation

Potential customers and opportunities

- Rail construction companies – Safety compliance and operational oversight
- Infrastructure agencies – Real-time monitoring for regulation enforcement
- Logistics and transport operators – Improved fleet and equipment tracking
- Smart city projects – Scalable AI monitoring for urban developments

Additional Information

- Scalable across multiple sites and industries
- Supports integration with existing CCTVs

Contact Details

- **www.robok.ai**

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Tethered Drones In Rail Security
Using drones to increase site security & routine maintenance
Drone Evolution

Summary

- Sentinel is a tethered drone designed to widen the footprint of security cameras on a rail site
- The tether provides a power to keep the drone in the air as long as it is needed
- Flexible payload options – different types of cameras or communications devices can be added
- No risk of "fly away"

Potential Benefits

- Reduces the need for as many expensive rail-side cameras
- Can be made responsive to potential intruders
- Can be used to assess fenceline or track issues on a planned basis

Exploitation

- Network Rail
- Rolling stock maintenance providers
- Utilities Asset Owners
- National Highways

Additional Information

- Sentinel is part of a suite of drone products being developed by Drone Evolution
- Drone Evolution's HQ is Caerphilly, South Wales

Contact Details

- www.dronevolution.co.uk

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Gravity Sensing for Rail Construction

Ruggedised gravity measurements for subsurface detection

SILICONMICROGRAVITY

sensing the world

Summary

- Successful detection of approx. 12 m deep subsurface tunnel
- < 5μGal resolution measurements achieved in <90 seconds per location
- GAIA Field is a Cost effective, Ruggedised, Field-deployable MEMS solution for Gravity Surveys

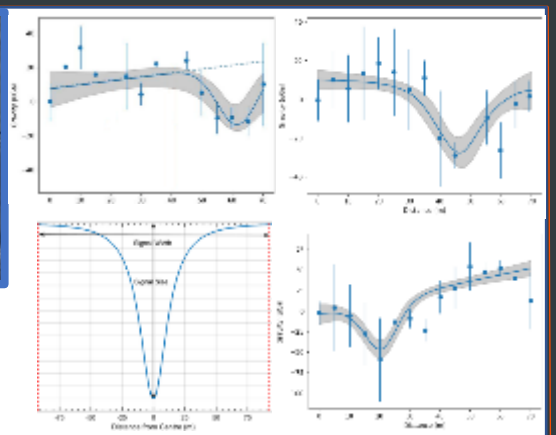
Potential Benefits

- Gravity sensing provides non-invasive, efficient alternative for sub surface analysis where other technologies struggle
- Enhances rail construction planning and safety pre-excavation
- Offers early anomaly detection in a highly scalable instrument suitable for widespread assessments

Exploitation

- Efficient detection of subsurface voids and tunnels for;
  - Rail infrastructure developers
  - Engineering consultancies
  - Geotechnical survey teams
  - Government agencies
- Pre-construction surveys
- Existing network monitoring
- Future potential for UAV (Drone) based measurements

GAIA Field Portable Gravity System



Successful underground anomaly detection in line with predictive modelling

Additional Information

- Borehole data suggested 12 m depth cavity
- Modelling predicted 14 microGal signal
- GAIA Field detected 20-30 microGal
- Full site survey also completed

Contact Details

- www.silicong.com
- Waterbeach, Cambridgeshire, UK

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Energy Control System for Energy Storage and Renewables
Accelerating Rail towards Net-Zero
EneRail Ltd, Riding Sunbeams, University of Birmingham
Aartech Solonics UK Ltd

Summary

Development of a traction power management system combining:

- Renewables
- Energy storage
- Regenerative braking
- Grid supply

The project establishes proof-of-concept for the system

Potential Benefits

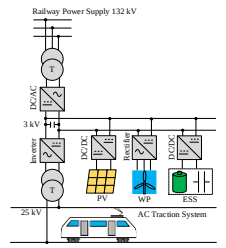
- Improved energy efficiency and traction power decarbonisation
- Uses energy storage and renewables to remove
- Reduce reliance grid energy
- Increase use of clean renewable energy
- Reduce overall energy costs

Exploitation

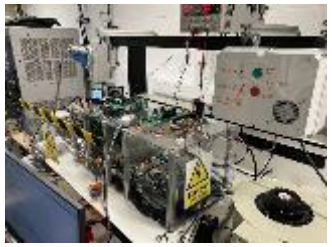
Next development stage:

- Develop lineside demonstrator with tram network
- Interest from tram networks already gained
- Seeking further partners to assist in delivery of next phase project

First of development towards larger scale system for heavy rail applications



Renewable railway power network


AC-DC-AC power converter


Grid emulator


Control board


Supercapacitor


DC/DC converter

Additional Information

- The system is modular and can utilise all types of energy storage as well as multiple renewable energy sources

Contact Information

EneRail

Aartech Solonics

Riding Sunbeams

University of Birmingham

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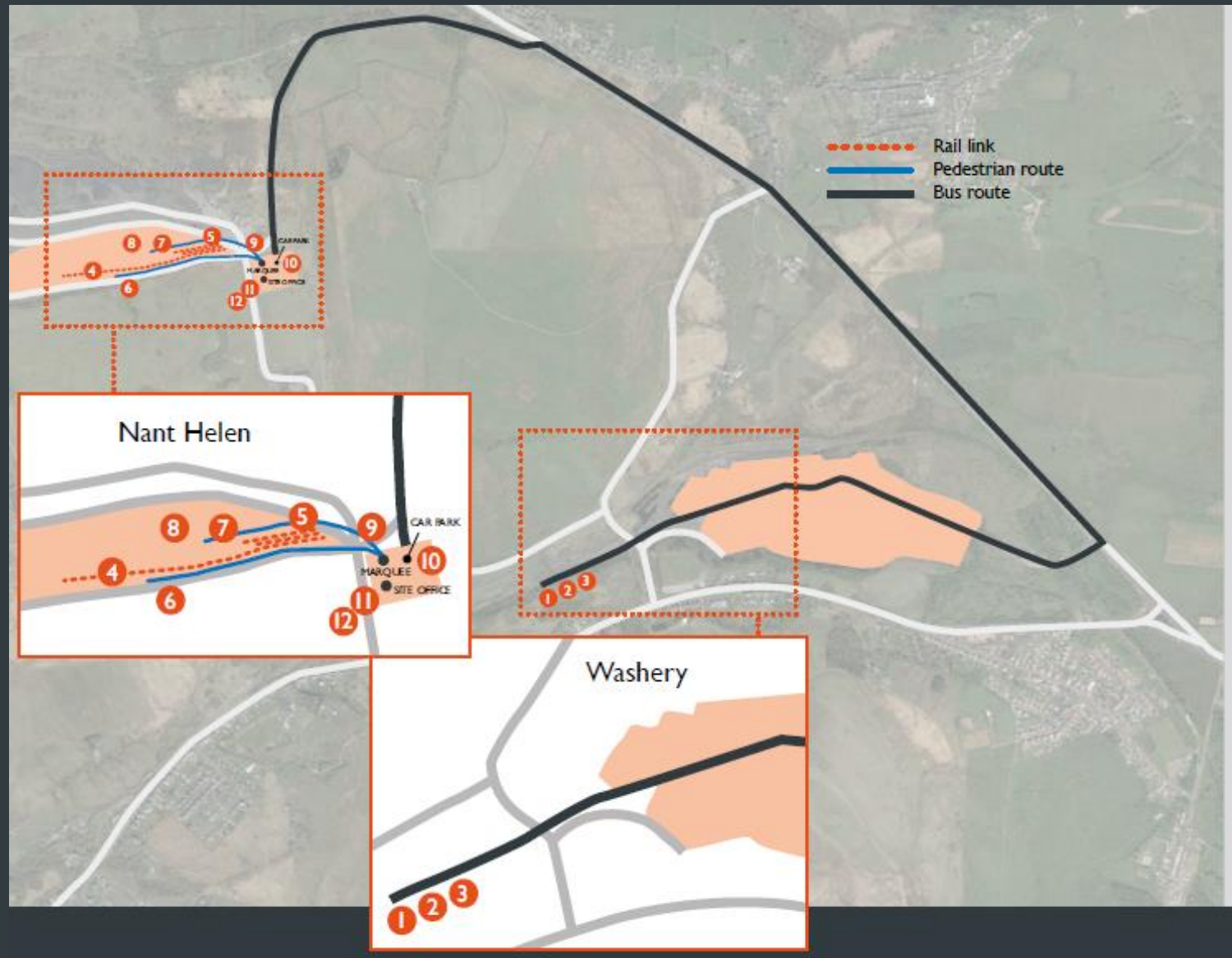
Demonstration Locations



Down in the Washery *(take the coach)*

1. **Focus Sensors Ltd** – AURA 2 – Attaining Ubiquitous Railway Analysis Phase 2
2. **Ingram Networks Ltd** – Delivering telecommunications innovations in Railway construction at the GCRE
3. **Universal Signalling Ltd** – Universal Interlocking: Next generation digital signalling as overlay

On Line 4

4. **Furrer & Frey** – CODES (Cost-Reducing Dynamic Electrification gradient System)
5. **Furrer & Frey** – ICAGE (Innovative CAntilever for Greener Electrification at the Global Centre of Rail Excellence)
6. **Mimicrete** – Mimicrete Vascular Self-healing Solution in Railway Practice
7. **Concretene** – Graphene enhanced concrete sleeper for lower embodied carbon
8. **AUS** – Composite Twin Track Cantilever (CTTC) for Smarter Rail Electrification
9. **RoboK** – INTElligent Real-time, MOnitoring & Detection video AnaLytics solution for rail construction

Site building

10. *(Outside)* **Drone Evolution** – Use of tethered drones in rail security
11. *(Inside)* **Silicone Microgravity** – Gravity sensing for rail construction
12. *(Inside)* **Enerail Ltd** – Energy control system for energy storage and renewables

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Thanks

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