The First of a Kind Rail Innovation Directory

2017-2020

UKRI Innovate UK

HM Government

Introduction

First of a Kind (FOAK) is a competition series funded by the Department for Transport (DfT) and delivered by Innovate UK (IUK) to develop demonstrators of innovative solutions to rail challenges.

Along with the Accelerating Innovation in Rail series of competitions, the programme has funded projects aimed at addressing the key challenges for the railway identified by the industry, in partnership with DfT. Competition themes have included low-cost high-value rail, customer experience in stations, minimising disruption to services, intelligent trains, demonstrating tomorrow's trains and stations, a greener railway, infrastructure and operational resilience, freight, and noise and environment.

This booklet is a showcase of projects funded through the First of a Kind and Accelerating Innovation in Rail competitions from 2017-2020, and aims to highlight innovative technologies which have been successfully demonstrated, for potential customers within the UK rail sector. From 2017-2020, the total offered to industry on these programmes was in excess of £30 million, representing significant government investment in rail innovation and an opportunity for rail stakeholders to engage with proven solutions.

We would encourage you to contact any of these innovators for further information or to take up with their products and services.

Contents

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Designing Future Infrastructure

Composite Cable Sleeper (CoCaSl)

Lead Partner: Haydale Composite Solutions Ltd
Participants: Oxford Plastic Systems Ltd, Testsure Technology Ltd

The market opportunity addressed by this project is the delivery of a novel means of routing and protecting cables in the ballast bed. Cables are required to cross rail lines as part of signalling and power systems. However, existing cable crossing methods can be a weak link in the system, and where cables are damaged, this may cause signalling failures and network delays. This affects the customer experience and results in lost productivity for the UK workforce. Other cable-protection methods can also hamper track maintenance engineering, including tamping. This project developed and tested a novel thermoplastic, non-conducting, recyclable sleeper through which cables can be routed. This lightweight and low-cost solution is available for mass-production and helps to protect cables in the ballast bed.

info@haydale.com

Track Inspection by Autonomous System (TrakSys)

Lead Partner: Technical Software Consultants Ltd
Participants: Centre for Advanced Transport Engineering

TrakSys is an autonomous vehicle with state-of-the-art inspection capability to generate information, which, combined with position data forms a map of the scanned area. This provides a richer and more accurate depiction of the condition of track sections, supporting defect and damage management, improved safety and a more productive rail network. The project has led to a capability to deliver rail volumetric inspection coupled wwith electromagnetic surface inspection on an autonomous platform. CATER-EU and TWI are building on this technology, developing advanced ultrasonic inspection which is enhanced by state of the art signal processing applications. This development work will enable more rapid and effective rail defect detection and interpretation.

traksysrail.co.uk

TrackWater: Supporting High-Value, Low-Cost Rail Network Drainage Asset Management

Lead Partner: In Touch Ltd
Participants: Lancaster University, Transport Systems Catapult, Network Rail Infrastructure Ltd

The TrackWater project looked at deploying remote sensing and real time alerting for drainage in order to improve maintenance efficiency, reduce the incidence of flooding and its associated costs, as well as providing an improved journey experience for the traveller.

Since the original project completion, Network Rail have directly commissioned a follow on project which is currently trialling equipment in the live rail environment across three routes.

admin@intouch-ltd.com

ON-TRACS: Rapid Rail Tension Measurement System

Lead Partner: TTI Testing Ltd
Participants: TraXion-NDT Ltd

The ON-TRACS project successfully demonstrated, in a laboratory environment, the ability to non-destructively and rapidly measure the axial tension in a rail sample. This method of measuring tension, or compression, is significantly more flexible, non-invasive and practical than existing methods which require cutting or un-clipping of significant lengths of rail.

testing@tensiontech.com

Delivering Future Stations

Stations AR Digital Twin

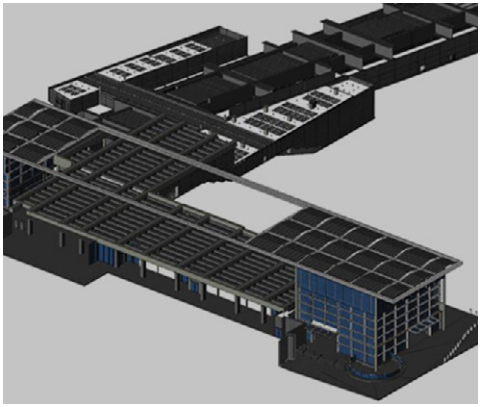
Lead Partner: PAULEY Group Ltd
Participants: HS2, the National College for Advanced Transport & Infrastructure, WSP (lead developer of two HS2 stations) and Inventya

The project team demonstrates the unique capabilities of an Augmented Reality (AR) digital twin platform for use within a station environment. The project focused on the potential for AR technology to revolutionise the way in which rail station staff are trained and upskilled. The immersive environment was modelled on HS2's Old Oak Common station. The digital twin platform has been designed to enhance asset management, security, train dispatch and communication. With real-time updates and the ability to simulate scenarios for training purposes including emergency procedures and "what if" situations, the solution minimises disruption and maximises customer and client experience.

info@pauley.co.uk

OpenSpace Thameslink

OpenSpace Group Ltd



OpenSpace has deployed a first-of-a-kind data-fusion platform and supporting infrastructure to monitor and predict the performance of the Kings Cross, St Pancras Station. The OpenSpace Platform provides station management and network operation teams with a set of next-generation tools to track the movement of people to better understand and manage the situations that cause disruptions and detract from passengers having a good end-to-end customer experience. The platform makes use of cutting-edge data to understand how people move through stations and the wider railway network, to ensure that passengers are put at the heart of the decision making process. OpenSpace Platform is a new product that forms the cornerstone of a commercial offering in the rail sector, and is now field-tested and ready for use by end customers.

✉ **hello@open-space.io**

PAWS (Personalised Accessibility and Wayfinding)

DW Windsor Ltd

PAWS integrates dynamic lighting technology with a vision system to create an autonomous solution for improving customer experience at stations. PAWS alerts staff when customers requiring assistance enter the station, and helps customers with heavy luggage or a pushchair to find a lift. It uses intuitive, temporary light projection to show customers the route through the station, or to find the correct carriage. PAWS helps to improve the part of the door-to-door journey that has the lowest level of customer satisfaction by supporting them in accessing train services, and through improving accessibility, wayfinding, passenger flow, and boarding times.

✉ **info@dwwindsor.com**

COINS - Customer-Operational INformation System for Railway Stations

Liverpool John Moores University

COINS is a new intelligent rail passenger information system that aims to improve information at railway stations by offering a real-time train-tracker, quicker and better data about disruptions and precise platform details. The system gathers all the information coming into the station from a range of sources and make it immediately available to passengers and staff, using machine learning to interpret the information and translate it into simple tailored messages.

The result is that passengers get much faster information that is specific to their particular journey. The system also makes information flow much more resilient in challenging times, for instance, when there is a major incident or flooding on the line. The system went live at Liverpool South Parkway station, Liverpool's major multimodal hub in November 2019. Accessible to around 100,000 passengers each month, the system received plaudits from both passengers and station staff, and was rated 10 out of 10 by staff who work in the location and eight out of 10 by passengers. Although the project ended in early 2020, Merseyrail elected to keep the system for at least another year.

ris@ljmu.ac.uk

NavSta App

Calvium Ltd

NavSta is a mobile wayfinding application, enabling individuals with impairments and accessibility needs to navigate stations independently and confidently. By providing information that passengers need when they need it, NavSta aims to reduce the causes of anxiety when travelling through stations, or when thinking about travelling through them. The NavSta Passenger App provides practical assistance to people when they plan a journey, undertake a journey and manage uncertainty during a journey through a station. NavSta has clearly demonstrated its value in user trials at Transport for London's (TFL) Canada Water Station and now provides a foundation for future development and deployment.

hello@calvium.com

Interactive Locations and Intelligent Digital Signage (iLIDS)

Lead Partner: Arriva UK Trains Ltd
Participants: Enable International Ltd, Rail Safety and Standards Board Ltd, University of Surrey

The iLIDS project produced a prototype to positively influence passenger flows at the platform-train interface (PTI), thereby easing congestion. It uses real-time data and information relays, including station infrastructure and signage, as a 'responsive user-interface', intelligently guiding passengers along the PTI to achieve more optimal boarding and alighting operations.

enquiries@arriva.co.uk

Dynamic Light for Wayfinding and Management of Passenger Flows at Stations

Lead Partner: DW Windsor Ltd
Participants: Urban Control Ltd, University of Nottingham

This project developed dynamic lighting to improve wayfinding and management of passenger flows at stations, thereby improving the customer experience, increasing capacity and making efficiency savings, with estimated benefits of £258m. The project undertook research, trials and evaluation of the benefits to demonstrate the return on investment.

New lighting products were developed to improve passenger flows on staircases and improve boarding of trains on the platform. The lighting was controlled wirelessly using Bluetooth Mesh and Wi-Fi sniffers developed to create heatmaps to track customer movements. Dynamic lighting was shown to be effective in getting attention of customers at the trial station in Chippenham. The technology is ideal for stations that are busy in the peak periods and can help with capacity, operational performance, customer experience and safety.

info@dwwindsor.com

Improving Card Tap Compliance

Lead Partner: Cubic Transportation Systems Ltd
Participants: Maynard Design Consultancy Ltd, University of Portsmouth

Incomplete journeys, where passengers do not touch their card on a ticket validator at the start or end of journey is an issue for passengers and operators alike, leading to passenger frustration, revenue loss and additional administration costs for the operator. A product was trialled in a live station, addressing this issue by taking a human-centred approach in designing and implementing an innovative reminder system which prompted individual passengers who were identified as being at risk of having missed a tap. Improved passenger experience will be an immediate benefit of this system, however, indirect benefits such as increased uptake of smart ticketing and capacity improvements are also foreseen. Combining cutting edge vision based tracking technologies with existing validator systems and novel feedback mechanisms the project outcomes are applicable in a much wider scope, in particular around innovation in gateline technology and future ticket detection systems.

www.cubic.com/about/contact

Designing Vehicles for the Future

Adaptable Carriage

42 Technology Ltd

The Adaptable Carriage project demonstrated a novel train seat mounting technology, which enables seats to be automatically folded and slid along the carriage sides. This offers new revenue opportunities from the transport of cargo, and passenger-friendly on-demand provision for wheelchairs, buggies and bikes. Analysis has shown that the UK rail industry could generate over £20bn, and reduce carbon emissions by over 120 MTCO2e, per year though moving goods by excess passenger seat capacity instead of road. Opportunities to demonstrate and trial the technology towards licencing it for commercial deployment are welcomed by 42 Technology, developers of the Adaptable Carriage concept.

answers@42technology.com

New Seating Approach to Maximise Train Passenger Capacity

Transcal Engineering Ltd

This project integrated three new seating types onto a single demonstration carriage for customers to experience and review. All three seating approaches increase capacity on trains, with more seats and standing space per carriage, providing a high-density seating solution, adaptable across vehicle types, and potentially configurable with demand.

info@transcal.co.uk

BRAIded Novel Beam STructures with Opportunities in Railcar Manufacture - BRAINSTORM

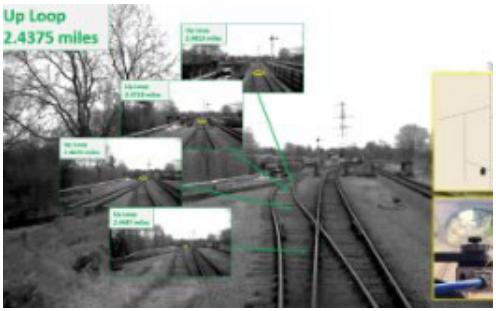
Lead Partner: Far-UK Ltd
Participants: Composite Braiding Ltd, TDI (Europe) Ltd

Project BRAINSTORM developed and demonstrated the applicability of braided composite structures to a novel, lightweight, modular railcar solution. This provides a radical approach to rail vehicle lightweighting, as well as offering significant opportunities for exploitation and the creation of a UK-centric supply chain in this industry. Project BRAINSTORM achieved a novel design of a light rail carriage in a braided composite tubular space frame configuration. Significant weight saving reduces wear on the tracks and lowers carbon emissions, whilst the modular structure assists repair of any damaged parts and the materials used are inherently recyclable at end of life.

office@far-uk.com

VALISE - The 'Video Balise' for Precise Low-Cost Train Positioning

Lead Partner: Reliable Data Systems International Ltd
Participants: Balfour Beatty Rail Ltd, First Rail Holdings Ltd, Network Rail Infrastructure Ltd, Nottingham Scientific



This project replaces track transponders and balises with a "Video Balise" (or Valise) stored in a windscreen mounted forward-facing camera, to locate a train. The Valise is 'read' as the camera recognises that the train is passing a stored location and will better enable condition-based infrastructure monitoring from trains.

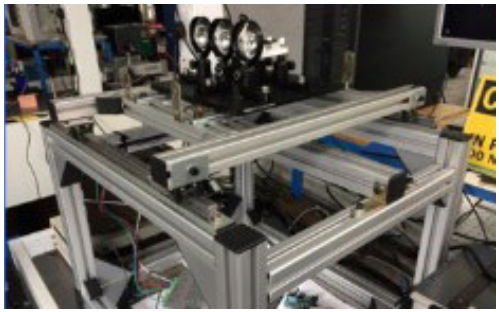
VALISE has shown the viability of using a train's forward-facing CCTV camera to detect 'virtual balises' in place of track mounted balises or transponders.

Applications demonstrated in the project include the in-cab display of speed restrictions, eliminating the need for track teams to deploy physical boards at the lineside. The demonstrator comprised a low-cost video positioning system with in-cab display showing the track-precise position and virtual balise information. The next step is to take the technology forward to operational trials with industry partners.

✉ **rdsintl@rdsintl.com**

Vehicle Internet Links Using Infra-Red Transmission of Information (VILIRI)

Lead Partner: Tethir Ltd
Participants: Broadband Access Strategies LLP, Network Rail Infrastructure Ltd, Northumbria University



VILIRI's approach uses Optical Wireless Communications (OWC) at Infra-Red (IR) frequencies to send data between train and trackside at 10 Gigabits per second. Data is transferred by line of sight from each transceiver on the train and along the track, while advanced signal processing and multiple channels enhance the optical links.

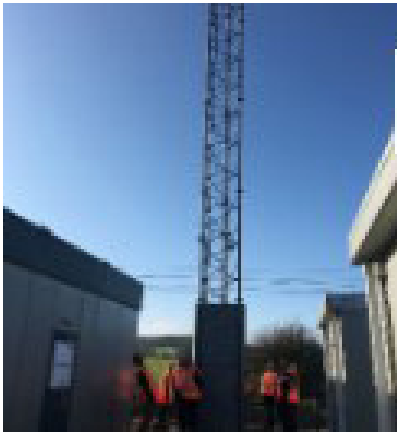
The VILIRI Project has allowed Tethir Ltd to investigate the potential of Free Space Optics (FSO) as a high bandwidth technology that could bring about much improved internet connectivity between trains and trackside. Advanced micro-engineering techniques have been applied to prove that the known limitations of FSO can be overcome without the need for tracking or other moving parts.

This positions Tethir to find partners that will win investment for the large scale production of the new components that will drive down the price and make FSO competitive for the railways and other markets over the next few years.

www.tethir.co.uk

SAFRON: Safe Operational Radio Network for Mixed-Priority Communications to Trains Using a Shared Architecture

Lead Partner: Apollo Rail Ltd
Participants: Network Rail Infrastructure Ltd, Telerail



SAFRON is a prototype for a shared communications architecture so that any data-centric system can use the same connection from train to trackside at an assured level of priority, safety and security. This will reduce duplicate connections, support closer integration of train and trackside, and enable better use of data.

hello@apollorail.com

IoT-Enabled Platform for Rail Assets Monitoring and Predictive Maintenance (i-RAMP)

Lead Partner: Mobibiz Ltd
Participants: Costain Ltd, University of the West of England

The i-RAMP system employs techniques in artificial intelligence, Internet of Things and Augmented Reality to enable predictive and preventive maintenance. The artificial intelligence based Simulation IoT Platform provides an interactive simulation platform to virtually evaluate the entire railway station, while the AR Toolkit, supports rail station maintenance regimes.

sjain@mobibizlive.com

MONAXLE - Live Monitoring of Train Axles with Autonomous Wireless Systems

Lead Partner: Perpetuum Ltd
Participants: TWI Ltd, University of Southampton

MONAXLE developed advanced self-powered wireless signal processing and sensing techniques, suitable for use in Perpetuum's harvester-powered sensor platform, to provide continuous live monitoring and detection of axle cracks on trains.

This method will eliminate current expensive Non-Destructive Testing (NDT) and disruptive manual axle inspections, and enable significant safety improvements. Providing an alternative solution to this industry-wide problem will help to significantly reduce rolling stock maintenance costs and improve train availability.

The next stage is to install the measurement onto a passenger train, upgrading Perpetuum's Wireless Sensor Node (WSN) using the microprocessor and sensor platform that was also developed in the project. Train operating companies and ROSCOs have already expressed interest in participating in this next stage.

info@perpetuum.com

Feonic Hybrid Powercell

Lead Partner: Feonic Technology Ltd
Participants: Active-Pcb Solutions Ltd

A Feonic Hybrid Powercell harvests and stores power from vibration frequencies. This project produced a small, lightweight power generator that harvests and stores energy from the train's mechanical vibrations, sufficient to create a maintenance-free autonomous power generator for wirelessly connected sensors monitoring a range of vehicle parameters, including the condition of wheel bearings.

The Feonic Powercell generates its own power from the vibration of the wagon using patented energy harvesting technology. There are several innovations within the product however the key feature is the ability of the sensor to be fully autonomous enabling it to be installed on any freight wagon without the need for an additional data hub either in the locomotive, or solar powered.

The project adapts existing technologies and techniques to create a world first with a known and accessible global market to monitor in excess of 19 million axle bearings. The same technology may also be used to monitor wheels and axle bearings on passenger fleets as well as traction motor bearings.

info@feonic.com

Reducing Carbon and Improving Air Quality

Green Rail - Exhaust After Treatment System (“GR-EATS”)

Lead Partner: Porterbrook Leasing Company Ltd
Participants: SWR and Eminox

GR-EATS implements Eminox’s proven on-road after-treatment system, already widely fitted to heavy duty vehicles such as buses, in a railway operating environment for the first time.

Responding to concerns around diesel engine exhaust emissions and air quality, the trial is deploying SCRT© (Selective Continuously Regenerating Technology) for the first time in a retrofit rail vehicle application. The trial equipment has been installed on the middle vehicle of a three-car Class 159 unit.

The aim of the trial is to reduce nitrogen oxide (NOx) emissions by up to 75% and particulate matter and carbon emissions by up to 90%. The SCRT comprises four components – a diesel oxidation catalyst (for carbon emissions), diesel particulate filter (for particulate matter), selective catalytic reduction (for NOx emissions) and a clean-up catalyst (which controls ammonia from any excess urea). Results to date demonstrate a reduction in NOx emissions of approximately 80%.

GR-EATS has established the technical and commercial viability of after-treatment for rail vehicles, so it can be offered for widespread fitment to ‘second generation’ diesel multiple units across the UK, thus significantly reducing emissions from industry rolling stock.

✉ **enquiries@porterbrook.co.uk**

Riding Sunbeams: First Light

Riding Sunbeams Ltd

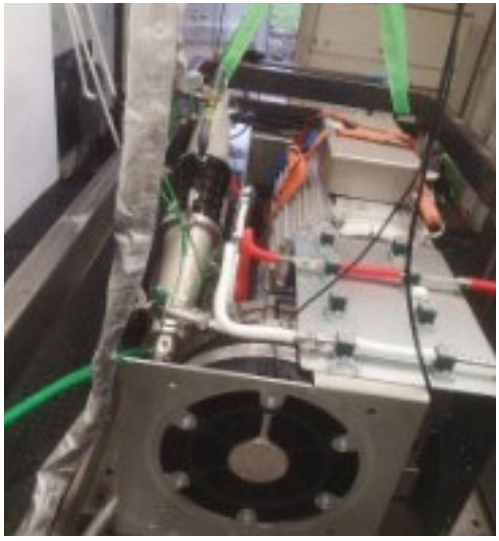
Electrified railways and solar power are key technologies for tackling climate change, moving Britain away from fossil fuels. The Riding Sunbeams First Light demonstrator will make it possible to locate solar traction farms alongside DC electrified routes, connecting solar generation directly to rail traction networks to power Britain's trains with clean, renewable energy.

press@wearepossible.org

W2W Zero Emissions Power System

Steamology Motion Ltd

Steamology is an energy technology company with a land speed record-breaking heritage. This project applies its hydrogen-based technology to decarbonising the railway using a compact energydense steam generator that drives a turbine to generate electricity. This provides a zero emission hydrogen power train for Vivarail Class 230 rolling stock. In the tight nine month programme Steamology developed a 100kW 'range extender' working demonstrator in collaboration with Vivarail.



Vivarail are re-tractioning the ex the London Underground district line class 230 rolling stock with innovative low and zero emission power systems. The Steamology Water to Water zero emission turbine and electrical generator along with ancillary equipment have been integrated within the Vivarail modular power raft system. The system has been tested using a Vivarail load bank. The teams are investigating the next steps to install the power raft onto a mule test train.

kirsty@newtownpark.org.uk | **matt.candy@steamology.co.uk**

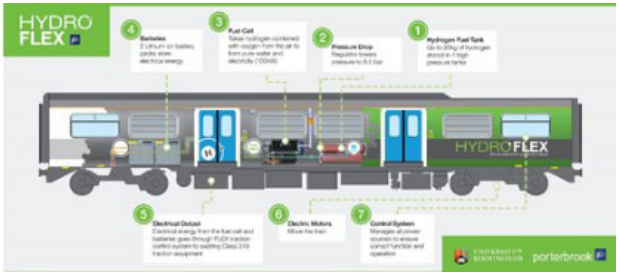
Towards Realising Accelerated Innovation in Novel (TRAIN) Battery Technologies

Lead Partner: Vivarail Ltd
Participants: Valence Technology, Petalite Ltd

The TRAIN project developed an innovative patented, fast charging system and static energy storage to exploit low-rate cheap energy for high-rate charging. With a charge time of only 10 minutes the solution provides significant operational savings, as well as reductions in CO2 and noise, and maintenance demands, minimising time out-of-service.

info@vivarail.co.uk

HydroFLEX Mainline Testing



Lead Partner: Birmingham Centre for Railway Research and Education
Participants: Porterbook

This project undertook the first UK mainline operational testing of a train equipped with hydrogen fuel cell technology. The testing programme gathered evidence to inform on going development of hydrogen fuel cell and battery technology deployed on a converted electric train, as an alternative to diesel engines and network electrification. HydroFLEX is the UK's first full sized Hydrogen powered train, which was developed in partnership by the University of Birmingham and Porterbrook and was demonstrated at Rail Live in 2019. DfT/Innovate UK First of a Kind funding helped to further develop the train operating systems and to achieve appropriate approvals to run the vehicle on the Mainline. This demonstrated the feasibility of Hydrogen power for mainline applications to the industry and this technology provides a significant contribution to the decarbonisation of the railway, particularly for routes that are not economic to electrify or it will not be possible to electrify for some time to come. Adoption of this clean traction power could happen quite quickly with retrofitted vehicles coming in the next few years and new build following on shortly afterward.

railway@contacts.bham.ac.uk

Retrofit EURO 6 Diesel Hybrid System for Shunters & Other Freight Applications

Meteor Power Ltd

This project resurrects a 1959 shunting locomotive by replacing the 92 litre diesel engine with a modern battery pack and a small diesel range extender to charge the batteries. Sophisticated control electronics are used to integrate the modern technology with the old electric traction motors.

This solution allows the battery pack to provide the power, allowing the much more efficient EURO 6 diesel engine to simply top up the battery as required. The aim of this project is to save these highly effective locomotives from the scrap yard, reduce their running costs and significantly reduce their emissions. The technology can be rolled out to other much larger engines to offer an affordable upgrade path to extend the life of existing locomotives, offer fuel efficiency and emission improvements and save the capital expenditure of buying replacements.

mike.edwards@meteorpower.com

Decarbonising Freight Locomotives

G-volution Ltd

This project demonstrates dual-fuelling in the rail freight market using proven technology from the road freight sector. From a technical perspective the key innovations within the project are the design of the fuelling and onboard fuel storage systems to minimise the space taken up on the vehicle; the configuration of the dual fuel optimiser software, to maximise the substitution of 'green' Bio LPG for diesel; and the integration and packaging of the optimiser and fuelling systems with the existing Class 73 vehicle architecture. This project has developed the business case for dual-fuelling and demonstrates the carbon and cost savings, enabling operators to move away from diesel to alternative sustainable fuel types, thereby improving emissions and air quality.

sales@g-volution.com

Ultra Light Rail Smart Transport Innovations

Ultra Light Rail Partners Ltd

This project used a low carbon / zero particulate emissions Parry People Mover Class 139 Light Railcar. The driveline and powertrain have been redesigned, and replaced by a hybrid powertrain combining a methane engine and flywheel within a conventional bogie frame, characterised by zero carbon and particulate emissions, and ultra-low noise emission.

info@ulrpartners.com

Building a Resilient Railway

SPECTRAIL - Low Cost Intelligent Infrastructure Through Fibre Acoustic Transmission

AP Sensing UK Ltd

SPECTRAIL allows data to be collected at sites previously inaccessible to power or connectivity. It combines the existing Network Rail fibre optic network with fibre optic acoustic sensing, piezo-electric acoustic transducers and high efficiency photovoltaic panels. This facilitates collecting actionable asset condition information, enabling a predict-and-prevent maintenance strategy across assets.

info@apsensing.com

Predict and Prevent Switch Failures

Smart Component Technologies Ltd

Severe impacts, voiding and track stability issues at railway switches and crossings (S&Cs) result in significant degradation of the asset and are the root cause of most component failure. To address this, Smart Component Technologies Ltd have developed SWIX: an end-to-end remote condition monitoring solution for measuring track displacement and critical switch components. The technology ultimately enables infrastructure owners to predict and prevent S&C failures. Trials are now being conducted with Network Rail, HS2 and Transport for London, with network wide roll out planned to begin in 2021.

info@smartcomptech.com

INFRAMONIT Test Vehicle

Railview Ltd

INFRAMONIT develops the next generation of Rail Subsurface Transport Infrastructure Inspection Radar that scans below the track surface, into the track bed and produces 3D images of subsurface infrastructure assets. This test vehicle reveals defects, failures and technical issues in the assets, with 3D images used to plan preventative maintenance. INFRAMONIT Test Vehicle has built and demonstrated radar equipment capable of forming 3D images of the subsurface using rotating antennae whose translational motions are not restricted to a single curve on the ground surface.

This is beyond the current state of-the-art which suffers from poor lateral resolution. Current ground penetrating radar for rail scanning employ arrays of vertically fixed antennae that direct radiation vertically into the ground; these systems are expensive to acquire due to the large number of independent transceivers required (29 in advanced units). This technology has been successfully demonstrated in the rail environment.

andrew.wilson@railview.co.uk

BVLOS Aerial Robotics

AmeyVTOL Ltd

This project has demonstrated how drones can be operated beyond visual line of sight (BVLOS) above an operational railway. This is a breakthrough capability, enabled by a number of unique elements including an innovative long range hybrid drone, and a bespoke ground control station (BVLOS Operations Centre) for planning, simulating, validating and operating along an automated flight path. The next stage of development will be the integration of appropriate sensors to undertake precision topographical surveys and automated asset condition monitoring. It is estimated that these BVLOS capabilities, once adopted can deliver recurrent saving to Network Rail of in excess of £150m pa.

Alternative Gauging Methodology (Probabilistic Gauging)

DGauge Ltd

DGauge developed probabilistic methods of gauging in order to maximise space on the rail network. The demonstrator, assessing areas in Scotland, allowed rail staff to review the traditional gauging approach against this probabilistic approach, and illustrate the saving that can be achieved in terms of clearance, stepping and intervention.

The project set about trialling new analysis technology (probabilistic gauging) to help reduce cost and disruption when introducing new trains. Through this software, the project demonstrated significant cost savings for a theoretical study (over 80%) and achieved a technology readiness level which allows probabilistic gauging to be applied on future active vehicle introduction projects (on a case by case basis with Network Rail).

Next for the project is a commercial roll-out to support a freight vehicle introduction and finalise the product approval, ensuring this can be deployed over the UK.

info@dgauge.co.uk

Delivering Freight Services for the Future

Fast Frequent Fulfilment (F3) by Rail/Intermodal

Lead Partner: Trucktrain Industries Ltd
Participants: Newcastle University, The Railway Consultancy Ltd, Preston Solutions Ltd, Inno4less Ltd

The Fast, Frequent Fulfilment Project (F3) carried out operational and financial modelling of intermodal rail operations along with interviewing key suppliers. The objective was to see if a short train concept was financially viable (including activities to make it viable), and whether that was attractive to the logistics industry in UK. The outcome is that a train carrying 12 to 14 containers can be financially viable compared to road transport if it is intensively managed.

The F3 Project has now branded itself as “FreightArranger” and is setting up its initial intermodal freight service between Manchester and Thameside. On the basis of this, the intention is to create a network of short freight train services. FreightArranger has the potential to catalyse modal shift from road to rail and substantially increase tonne/miles of freight on the UK rail network.

✉ **nick.radcliffe@trucktrain.org**

iPort Rail App: Ecoloco

Hive Logic Ltd

Ecoloco™ delivers flexible freight in the rail sector through the development of a digital platform, enabling rail-connected logistics services to be sourced easily and cost-effectively. The collaborative platform enables more efficient linkage between rail-freight arriving at an inland port and its onward journey by road to the end-customer.

Ecoloco was tested in 'live' traffic at Doncaster's iPort Rail facility over a two-week period in January 2020. The aim was to provide a more flexible interface between Road and Rail for the movement of intermodal containers. Over 20 containers were moved, demonstrating benefits including the ability for HGV's to pre-book an arrival slot at iPort Rail and exchange intermodal container data in a paperless environment, the provision of real-time data for iPort Rail, creating improvements in efficiency and productivity at the inland port, and frictionless handover of containers between freight train and HGV, demonstrating a reduction in waiting time of HGVs by 75%; from 20 minutes to less than five minutes.

info@hivelogicgroup.com

NR+: UK's First Integrated Digitised Rail Infrastructure Platform for Planning

University of Hull

In the UK, the required information for planning and scheduling is very fragmented. The NR+ digital platform for rail planning is a data platform that consolidates, and links various data sources required for rail planning in an accessible, digital format. On this platform various applications have been created to support rail freight planning and expose the data used by third party applications. NR+ will form the basis of a unique eco-system of integrated applications to generate more efficient, resilient and safer plans and schedules for freight and passenger trains, to better manage disturbances and delays and for dissemination of information.

logistics@hull.ac.uk

Reducing Noise & Benefitting the Environment

Improved Braking Through Controlled Water Addition

CoCatalyst Ltd

The rail industry spends over £50m per year trying to resolve the effects of low adhesion, particularly in autumn when “leaves on the line” make rails slippery. This project identified a solution, already proven to work on test trains, in which a small amount of water is sprayed from the train onto the tracks when a slippery rail is detected. This project has now demonstrated the solution on a passenger service train to prove the benefits in a live rail environment.

info@water-trak.com

Emissions as a Service for the Rail Industry

Emission Solutions Ltd

The EMSOL platform focuses on mitigating air and noise pollution incidents initiated by private and public service vehicles, including construction machinery. It provides real-time information on local air quality conditions through multiple sensors. Data analytics and identifying mitigations are provided with a mobile and web dashboard structure for multiple users.

info@emsol.io

Railway Works Noise Visualisation and Management (RaW-NoViMa)

Eartex Ltd (Eave)

Hearing damage caused by exposure to noise at work is permanent and incurable and the long-term risks are increasingly well understood. Occupational noise induced deafness is today still a widespread issue linked to increased accidents on site and early onset dementia. Eave has developed a noise management platform which gathers noise data via digital sensors embedded in ear defenders, and transmits it to a cloud-based platform which analyses and displays the data in an interactive format.

Through a demonstration on HS2 enabling works, the team has delivered an innovation in noise control and hearing health management for stakeholders at both HS2 and Costain-Skanska Joint Venture (CSjv). This offers health and safety managers, occupational hygienists, noise specialists and project managers insight on noise location and the wear-rate of hearing protection.

In addition the technology enables a simple approach to tackling noise at source, plus an ability to assess the effectiveness of noise management interventions. HS2, CSjv and their subcontractors have now adopted the Eave system to help manage noise exposures as a critical step to improving the hearing health of those working in the rail sector.

info@eave.io

Hubble

Hack Partners Ltd

Hubble is a vegetation management tool. The tool uses artificial intelligence to detect overgrown vegetation and what type of issue that can cause along the rail network. This provides Network Rail engineers the data-driven insight they need to manage vegetation at the right place and right time.

By using Hubble, Network Rail is reducing vegetation related incidents from occurring, such as: leaves on the track, overhead line failures, obscured signs and speed restrictions – all of which cause significant infrastructure, economic, and reputation damage to the railway. The software also enables Network Rail to take a more targeted approach to vegetation management and focus on problematic areas.

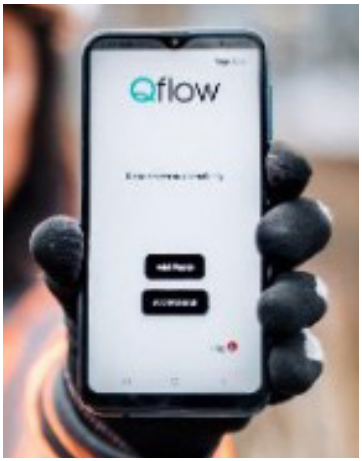
This helps prevent cutting down large amounts of trees unnecessarily, reduces train delays and could save millions of pounds in potential damages to rail equipment. Hubble is currently being adopted by Network Rail Anglia and Southern regions with the support of train operators such as Arriva Rail London, MTR and Southeastern Rail. It is also being trialled in other regions across the UK.

hello@hackpartners.com

Intelligent Data & Environmental Analytics (IDEA)

Qualis Flow Ltd

Qflow is a machine learning powered tool for predicting environmental impacts, including inefficient resource consumption and disruption to passengers and stakeholders during engineering and operational works. This project focuses on creating a real-time platform for gathering and analysing data to predict critical environmental risks. This project has led to the creation of a new way to forecast environmental risk, and generate new data insights from automating waste and material workflows. Qflow has identified direct commercial savings of approximately £80,000 and potential carbon savings of 149,000 kg CO2e per year during the site trials. The next phase will look at closing the construction-design loop, and look at optimising carbon output for future projects.



✉ **info@qualisflow.com**

WHIS®Wall

4Silence BV

The project trailed a new innovative method for reducing railway noise by changing the direction of the noise upwards. By using the WHIS®wall (one metre high) a noise reduction of seven decibels is achieved, comparable to a three metre high noise barrier. In this project approva for use with the Transport for London and Network Rail environment was initiated.

✉ **info@4silence.com**

Keeping Services Running

Smart Oil Plug

Lead Partner: JR Dynamics Ltd
Participants: Unipart Rail Ltd

Project Smart Oil Plug aims to provide real-time data analysis and reporting, to enable train operating companies to move away from excessive precautionary gearbox maintenance regimes to schedule informed predictive and preventative gearbox maintenance. This will reduce costs and increase the reliability of railway operations nationally. The Smart Oil Plug® project has delivered a step-change in rail gearbox monitoring, providing gearbox health information to operators, owners, and maintenance staff without the train leaving service. The demonstrator project through the First of a Kind funding highlighted gearbox running outside expected parameters, and the operator is taking action to monitor this vehicle proactively in response to the data. The project partners are now taking decisive steps to scale up volume production to cater for the growing demand of rail industry globally.

wsupport@jrdltd.com

Optimising the Flow of Information in the Rail Industry

Lead Partner: Bellvedi Ltd
Participants: Tracsis PLC, TransPennine Express Ltd

This project has developed a fully integrated and automated cloud-based solution for planning, managing and reviewing resources across the entire train planning and operations process - providing a single source of real-time updated information for controllers from rolling stock diagrams to optimal staffing, resource planning and work allocation.

info@bellvedi.com

RAPPORT – Real-Time Accurate Positioning and Protection of Rail Transport

Lead Partner: Incremental Solutions Ltd
Participants: Network Rail Infrastructure Ltd, Arriva Rail North Ltd, Icomera UK Ltd, Leeds University

RAPPORT is a suite of tools for improved awareness of train locations and movements to reduce the effects of disruptions and delays. By exploiting location information and interactive mapping it will accelerate accident and emergency response times, improve service recovery to rail incidents, and aid signallers' decision-making at User Worked Crossings.

The RAPPORT (Real-Time Accurate Position and Protection of Rail Transport) experimental prototype system delivered as part of the AIiR4 DfT/IUK funded project, provided locational information on trains and incidents to Network Rail and Arriva Rail North to expedite incident response and reduce disruption and delays on a low-speed line (2017). Since proving the benefits, Network Rail have subsequently funded an extension to RAPPORT use on high speed lines on the East Coast Mainline and Wales and Western Route (totalling seven train operating companies' fleets), enabling Network Rail to accelerate their response to incidents.

contact@incrementalsolutions.co.uk

Robotic Autonomous System for Train Fluid Servicing

Lead Partner: TBG Solutions Ltd
Participants: Brunel University London, The Chiltern Railway Company Ltd

This project delivered a proof-of-concept for the development of a robotic autonomous system (RAS) for fluid servicing of passenger trains, thereby improving the service to the passenger. As part of normal servicing, fluids need to be added to and removed from trains, for instance to replenish water supplies, and to extract waste. The project was based on a 6-axis robotic system and demonstrated an automated system to complete this task during train servicing. This approach has the potential to expedite servicing, to minimise spillage, and also relieves staff from this hazardous and unpleasant task. The application of robotic technology in this area will improve the service provided for the consumer by ensuring that servicing is completed rapidly, and will contribute to greater acceptance of RAS in the railway working environment with consequent economic benefits.

info@tbg-solutions.com

RODIO: Railway Optical Detection of Intrusions and Obstacles

Lead Partner: Iotics Ltd
Participants: Fincore Ltd, Network Rail Infrastructure Ltd, Tata Steel UK Ltd, Vortex IoT Ltda

RODIO addresses the complex challenges of remote condition monitoring of railway tracks and infrastructure. The project developed a system for near real-time detection and identification of intrusions and obstructions (such as tree and rock fall, people and animal trespass, and landslide and subsidence) through the deployment of low-power Internet of Things, artificial intelligence and edge computing.

info@iotics.co.uk

Multi-Sensor Condition Monitoring for Predictive Maintenance of Rail Infrastructure Using Optical Fibre Sensors (OptRail)

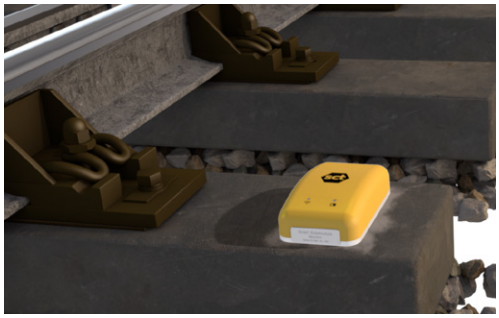
Lead Partner: rcm2 Ltd
Participants: Brunel University London, Surrey Advanced Control Ltd, TWI Ltd, Yeltech Ltd

This project developed an automated system for planning of track maintenance, using a combination of optical fibre sensors, coupled with new generation Internet of Things communications technology and artificial intelligence. It provided automated decision support tools for optimisation of maintenance programmes based on continuous real-time monitoring of track condition. The OptRail project established that optical fibre multisensing of temperature, strain and vibration can accurately detect the potential growth of cracks in the rail track and voids in the track bed. This was achieved through modelling, extensive lab tests and a field trial in an operational light rail environment in London.

✉ **ceo@rcm2.co.uk**

Smart-X: A Remote-Condition Monitoring Technology for Voids, Nose Impact and Switch Movement at S&Cs

Lead Partner: Smart Component Technologies Ltd
Participants: CHG Electrical Ltd, Network Rail



This project developed a technology to detect track voids and measure noise impact at switches and crossings (S&Cs), as well as the condition of the switch mechanism/drive. The project outputs improve automated inspection methods, help predictive maintenance, whilst furthering understanding of the precursors to switch wear and damage. Severe impacts, voiding and track stability issues at railway S&Cs result in significant degradation of the asset and are the root cause of most component failures. To address this problem, SCT have developed the Smart Substructure Monitor: a novel condition monitoring technology that measures substructure condition around critical assets. Trials are now being conducted with Transport for London, HS2 and Network Rail.

✉ **info@smartcomptech.com**

TRIKCL

Lead Partner: Gettrik Ltd
Participants: Clicks and Links Ltd

TRIKCL offers a revolution to the rail industry by providing an automatic drone-based asset mapping and a 3D location based reporting system, that will enable mapping, review and maintenance of assets, thereby removing the requirement for intensive manual work. The TRIKCL platform generates, stores, visualises and utilises 3D data online in real time. It can generate a 3D model from camera, drone or satellite images, integrate with monitoring sensors, and enable multiple users to search, compare, and annotate the model and data. This a faster and more accurate way to track and compare changes on the rail network. The system makes it easier to survey, inspect, maintain and repair rail assets, and provides a more accurate way to track and compare changes in 3D. With accurate positional data, the system also assists in decision making for predictive and preventive maintenance.

contact@gettrik.com

Pantograph Carbon Strip Wear Detection System

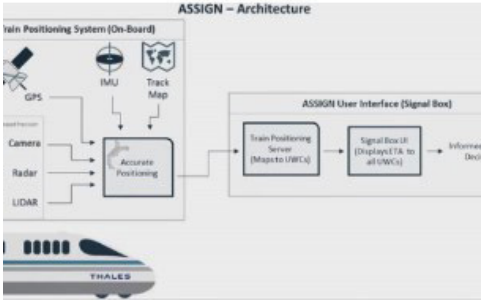
Lead Partner: JR Dynamics Ltd
Participants: Unipart Rail Ltd

Damage to overhead lines due to worn pantograph carbon contact strips can cause catastrophic failures that can lead to de-wirements, costing millions of pounds and causing significant disruption. Currently there are few methods for detecting the wear on the carbon strip on a real time basis and because of this, the carbon strip may be replaced on periodic basis, often prematurely, causing unnecessary expense, and added maintenance time and cost. This project delivered technology to detect the wear on the carbon strip in real time. Equipping pantographs with this low cost carbon strip wear monitoring system automatically conveys to the train operator the state of wear, helping to prevent damage to the infrastructure, and ensuring that the carbon strip is only replaced when required. This intelligent low cost system can be supplied and retrofitted to existing pantographs with little disruption or costs. The technology easily integrates with existing pantographs with minimal modifications and disruption, while meeting legislation and rail regulations to ensure that the product is readily accepted and approved by the rail authority.

wsupport@jrdltd.com

ASSIGN: Advisory System for SIGNallers for Improved User Worked Crossing Resilience

Thales Ground Transportation Systems UK Ltd



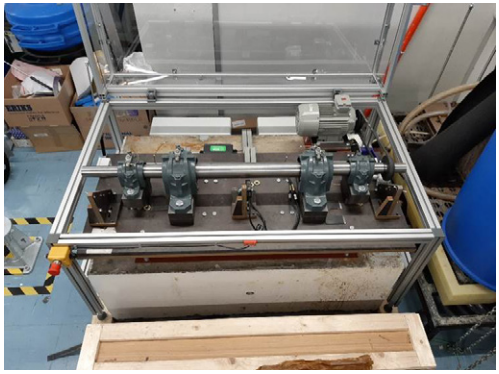
Level crossings remain the biggest source of risk on the rail network. ASSIGN combines robust positioning technology with an existing rail cloud-based system to create an application providing signallers with train arrival time information at user worked crossings. Signallers can quickly validate the decisions they make, giving greater resilience to the infrastructure they control.

ASSIGN has now completed its first trial installation on the Exeter-Barnstaple line in the south west. ASSIGN brings together next generation on-board positioning technology and communications to provide signallers in rural and long block sections accurate train position, in areas where the position of the train is often unknown. ASSIGN will significantly improve safety at User Worked Crossings without a requirement for complex and costly trackside installations.

quadrant@uk.thalesgroup.com

Wireless Condition Monitoring of Freight Locomotives

Perpetuum Ltd



Although the reliability of rolling stock is excellent, key elements, including the axles and wheelsets, are still prone to progressive degradation, requiring maintenance and safety management. Axle failures have been responsible for very serious rail accidents, and train operators perform annual ultrasonic axle testing on every axle.

The project has delivered a new technology to monitor the condition of rail axles whilst a train is running, reporting on axle load and the presence of any fatigue cracks. The technology incorporates a single energy-harvester powered wireless sensor node that requires minimal installation. As a bonus, the system also delivers wheel quality and bearing condition monitoring.

Routine testing is difficult, expensive and disruptive to other maintenance programmes. Providing an alternative solution to this industry-wide problem will help to significantly reduce rolling stock maintenance costs and improve train availability. The technology has already been demonstrated on a Class 66 freight locomotive, as well as on passenger vehicles. When in service, wheel condition is displayed on a mobile device compatible website, and the vehicle maintainer can receive email alerts of wheel condition and when maintenance is required.

info@perpetuum.com

OLErt (Overhead Line Equipment in Real-Time)

Incremental Solutions Ltd

OLErt will dramatically reduce the incidence of failures to electrified infrastructure and fleets through continuous and dynamic monitoring and alerting on service trains. This is achieved by leveraging imagery from existing roof-mounted equipment and integrating visual measurement algorithms with analytic platforms and precise positional certainty, to highlight abnormal infrastructure events. OLErt integrates visual measurement algorithms (from Oxford University academics) with Incremental's analytics platforms and precise positional certainty data, to prevent dewirements and other overheadline issues. By continually monitoring and evaluating train infrastructure in real time (in this case, the Overhead Line Equipment), the system analyses data to highlight abnormal events – before they happen. Following the delivery of the OLErt project, GWR and Network Rail have committed to the extension of implementation from one to six Class 387 units.

contact@incrementalsolutions.co.uk

An Automated Operations Decision Support Tool for Disruption Management

Artonezero Ltd (T/A JNCTION)

JNCTION's decision support tool uses artificial intelligence and machine learning techniques to assist control teams to plan train operations. During a disruption, the system suggests the quickest and most effective way to return services to the timetable; limiting any impact caused by disruption and helping to maintain high customer satisfaction. This project uses innovative artificial intelligence and machine learning techniques to automatically plan new train operations. In the event of disruption, this will save train operating companies time and money.

hello@artonezero.com

VPVision: Development of Remote Monitoring for Automatically Controlled Trains

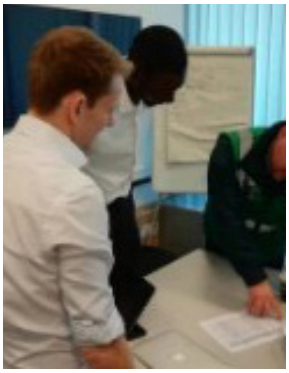
CPC Systems Ltd

VPVision improves the operational resilience of the railway. Data is transmitted and stored in a cloud database. Fault diagnosis is made quickly, trends identified and preventative maintenance schedules implemented. Fitted trains can be removed from service before a failure becomes critical, thereby minimising the impact on operations.

london@cpcprojectservices.com

TiPA: Transreport Intelligent Passenger Assist for Resilience During Disruption

Transreport Ltd



The Transreport Passenger Assist System enables rail passengers requiring assistance to request help when travelling on the rail network and operators to better respond to the impacts of disruption on disabled passengers. It facilitates an immersive experience for passengers by improving safety, enhancing the reliability of assistance, and reducing anxiety. TiPA: Transreport intelligent Passenger Assist for resilience during disruption will assist train operating companies to improve service to 14 million disabled rail passengers in the UK. This new and innovative technology will enable better information, better communication and better operation for train operating companies.

www.transreport.co.uk

Delivering A Better Customer Experience

CloseRFIT

Unipart Rail Ltd

CloseRFIT is a trial of the CloseR system which allows operators to engage with each customer, enhancing the customer's journey experience, and improving the efficiency of on-train operations. Inseat technology identifies individual passengers, allows automated validation of the ticket and reservation, and removes pressure on train crew from undertaking revenue protection activities. The CloseR system is a next-generation seat reservation system, which enables the personalisation of the customer travelling experience through the utilisation of three distinct technologies – Dynamic Seat Reservation Technology (on train hardware), mobile apps (Customer Mobile and Train Crew) and Customer Engagement Platform (back office systems).

✉ **enquiries@unipartrail.com**

First of a Kind – Demonstrating Tomorrow's Trains Today

Virtuosys Ltd

This project developed a platform for train operator and passenger applications, including a mobile Public Address service, a messaging service and a local Content Delivery Network. A 'CCTV Live Feed' application would enable operators to ensure doors are clear before departure, luggage is secure and passengers are distributed through the train.

✉ **info@veea.com**

AR & Fantasia Express

Meyouandus Ltd

"Fantasia Express" is all about imagination - seeing how a train journey can be turned into an immersive adventure. It is a showcase for making landmarks come alive – imagine looking out of the window to view a sea monster off the coast of Holy Island or Viking villages in the countryside near York. The project focused on making use of the 3D immersive capability of the passengers' phones, presenting a series of experiences that can be tailored to suit the train operator, the location, and the customer. This project demonstrated what is possible to help improve the passenger experience and the wealth of local and historical content flashing by outside the windows of a moving train. After the public trial the team has continued development and has had interest from a number of train operating companies alongside non-rail sector customers.

info@meyouandus.co.uk

Transreport Passenger Assist System

Transreport Ltd

The Transreport Passenger Assist System enables rail passengers with specific needs to request in advance, at station, or in-carriage, any assistance they may require in a sensitive and considerate manner, reducing anxiety and increasing confidence. Nearby staff receive the request on their smartphone, which automatically navigates them to the passenger.

www.transreport.co.uk

TRAFFIC – TRAin Footfall from Intelligent Counters

Block Dox Ltd

TRAFFIC continuously monitors how people use trains. It counts the number of people entering and existing rail vehicles, providing rail operators with precise information on where customers board and alight from their services, all day and every day. This data can be used to accurately assess and predict passenger flows, to assess loading during peak and off-peak services across the entire journey, and to inform the provision of more space on trains. This enables train and station staff to dynamically and proactively manage crowding situations, thereby making journeys better, simpler and more reliable, and improving the customer experience. The technology has been demonstrated on board live services, with information on loading immediately available to railway staff.

info@blockdox.com

Journeys Unlimited: Inclusive On-Board Experiences Through Digital Augmentation

Guide Dogs for the Blind Association

This project facilitates end-to-end train journeys for visually impaired customers. It brings together a number of transformative innovations - 3D soundscape technology, indoor navigation, and intelligent sensors - combining real-time information to enable a person to intuitively map their position and to successfully navigate a station, facilitating a richer experience and alleviating moments of anxiety.

guidedogs@guidedogs.org.uk

Wayscout: Real Time Onward Journey Platform for Rail Passengers on the Train

Proxad Ltd

This project deployed new real-time onward journey ride matching technology on Gatwick Express train carriages to provide a novel, personalised, end-to-end journey experience for rail passengers. Through the technology, passengers can define their travel requirements from their destination station. Wayscout then combines these responses to identify passengers with similar or compatible onward travel needs and offers taxi-sharing options to take customers to their destination. The activity demonstrated how travellers can expect rail to form the backbone of future journeys in the emerging Mobility-as-a-Service paradigm.

terry@proxad.com

Smart-Train - A Responsive Passenger Management System

You. Smart. Thing. (An Enable Group Company)

The 'Smart-Train Responsive Passenger Management System' project leveraged digital imaging and analytics technologies, commonly used in retail environments, to enable automatic passenger counting and real-time information to be captured for business-critical rail operations and to improve rail customer experience. It delivered a technical solution for rail service consist detection and an API schema for vehicle capacity management. If adopted alongside investment in the data capture systems that were tested, the project showed the Smart-Train system could deliver over £258m of immediate benefits to the rail industry, whilst enabling dynamic yield management in the future. The Smart-Train software now forms part of the 'You. Smart. Thing.' Travel Assistant service, an easily-embedded tool to guide people to venues and events.

hello@yousmartthing.com

Onward Journey Planner Assistant

Lead Partner: Proxad Ltd
Participants: Snap Out Ltd, ManagePlaces Ltd, University of Surrey

The Onward Journey Planner Assistant provides personalised onward journey transport options to rail customers in advance of arrival at the station. The project tested a software prototype, interacting with different components of the rail system and existing and live data, in a realistic, simulated environment to develop the new technology.

Passenger Experience and Innovation Infrastructure to Make the UK Rail the Best in the World

Lead Partner: Milne Research Ltd
Participants: Costain Ltd, IBM United Kingdom Ltd, IfM Education and Consultancy Services Ltd

The project pioneered a digital and physical innovation infrastructure for passenger engagement and innovation – Passenger Engagement and Innovation Infrastructure (PEII). Innovation hubs will be built and kitted out with interactive touchscreens, virtual reality booths and headsets, enabling passengers to input ideas, and trail and test innovations in a digital environment.

www.milneresearch.com

Real Time Train Occupancy Service

Lead Partner: Citi Logik Ltd
Participants: Buzz Radar Ltd, Transport Systems Catapult

This project aimed to better inform passengers regarding the on-board occupancy conditions of incoming trains and to equip train operating companies and station staff with real-time capacity information. It used a cloud-based solution to demonstrate that cell-phone movement on a cell-phone network could be used to report on train occupancy in real-time. This approach requires no supporting infrastructure and can therefore be made available very easily and at low-cost.

enquiries@citilogik.com

COUNTER: Computing Train Occupants Using Novel Sensing Techniques to Enhance Rail

Lead Partner: Block Dox Ltd
Participants: Loughborough University

COUNTER delivers an accurate and reliable measurement of real-time and predictive passenger flow and demand, thereby reducing delays and station platform accidents. It consists of a platform interoperable with existing train management systems, combining a patent-pending sensor fusion method, using WI-FI fingerprinting and lo-fi infrared sensors, with machine learning algorithms.

info@blockdox.com

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