Very Light Rail (VLR) as a means of delivering low-cost railways

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Traditional Rail & Trams

- Typically heavy (vehicles and infrastructure)
- Expensive
- Highly regulated and standards driven
- Slow to innovate
- Efficient mass transit solution
- Rapid on purpose-built alignments

- In 2014, RSSB asked WMG to be ‘disruptive innovators’ in rail, maximising technology transfer from the automotive sector
- DfT asked WMG to focus initially on making branch line services more affordable and sustainable
Very Light Rail

- A potential enabler of lower-cost connectivity of urban, suburban and rural areas, including replacement of traditional tram solutions, the revitalisation of unprofitable branch lines and reopening of previously closed ‘Beeching’ lines
- A possible element in ‘last mile’ public transport journeys
What is VLR?

• Very light weight vehicles (less than 1 tonne per linear metre) which can operate on less substantial track and infrastructure (lower costs of construction, operation and maintenance)
• Transfer of technology from the automotive sector (proven solutions, high quality, low cost, reduced risk)
• Self-propelled to eliminate expensive overhead electrification
• Vehicles designed for low cost manufacture allowing lower prices and bigger fleets
• Light weight slab track enabling fast installation and reduced maintenance costs
• Digital control to eliminate track side signals; autonomy to eliminate the cost of drivers

*BUT....VLR vehicles do not have ‘mainline crashworthiness’*
Revolution VLR Project

• Consortium awarded £1.1m by RSSB from the Radical Train Competition in 2014 to create a very light-weight railcar with novel hybrid-drive self-propelled bogies

• Phase 1 completed in September 2016 - detailed vehicle concept design and propulsion solution submitted to RSSB

• Phase 2 commenced January 2018, with £2.75m funding from DfT/RSSB. The £5.5m project will deliver a fully functional vehicle demonstrator by April 2020

• Eversholt Rail has made a significant investment in Phase 2 and is working to identify the first routes for operation
Modular Vehicle Architecture

- 18 tonnes tare (50% less than traditional DMU vehicle)
- 100kph+ top speed

High efficiency Cummins diesel-electric hybrid drives, using 2.8l engine, with Euro 6 exhaust after-treatment, mounted in a power-cassette under the vehicle body.

Electric regenerative braking to zero mph; all electric operation in stations; electric launch from stations.
Initial Routes and Future Mainline Operation

Segregated Routes

• RSSB has identified more than 30 routes in the UK where VLR technology could be used to transform uneconomic rural lines or enable lines closed in the Beeching era to be reopened and operated at much reduced cost.
• Train operating companies such as Northern, Arriva and Abellio have identified additional mothballed alignments that they would like to see re-opened.
• Rolling stock company, Eversholt Rail, intends to be the first mover in the introduction of VLR

Mainline Operation

• For more widespread applications, a collaborative forum is to be set up with representatives from ORR, RSSB, Network Rail, ROSCOs and TOCs to work towards appropriate safety standards and operating protocols.
Coventry Very Light Rail Project

Coventry is growing rapidly
• as are many medium sized cities in the UK

Significant road congestion and emissions
• urgent need for an improved public transport system which encourages modal shift from cars

Affordable long-term public transport solution required
• trams are too expensive but rail based solutions offer permanence not provided by buses
The Quest for Low Cost Urban Rail

In 2017, Coventry City Council commissioned WMG to carry out 2 feasibility studies:

- A study focussed on low cost ‘tram’ vehicles
- A study focussed on low-cost utility-friendly track solutions

In early 2018 Coventry City Council awarded an £8.0m contract to WMG to oversee the development of a battery powered vehicle (to be ‘autonomous ready’) and associated track solution which will be delivered by mid 2020.
Coventry VLR Shuttle Dimensions

- 10 m long
- 2.7m wide
- 2.95m high
- 4 doors
Coventry VLR Research & Development

The aim is to achieve a total whole-system target cost of around £7m per kilometre.

Note traditional tram solutions typically cost between £35m to £60m per kilometre.

The R&D programme is split into four work streams:

- **Vehicle – (led by WMG)** design and construction of a lightweight vehicle prototype, including a battery propulsion system.
- **Track – (led by WMG)** creation of an innovative low-cost track form which can be installed into roads with minimal disruption to utilities’ equipment.
- **Route Selection – (Coventry City Council)** route development, business case and Transport & Works Act Order.
- **Operations – (Transport for West Midlands)**: system operation (control, security, ticketing), passenger information and communications.
Route Aspirations

A clover leaf network covering high density housing and commercial areas of the city

Future shuttle line from city centre to HS2 station at Birmingham Airport
Vehicle Workstream

Main features:

• Bi-directional car
• Low floor, 2 bogies
• 15m radius cornering capability
• 6.8 tonnes tare
• Capacity 50+ (18 seats plus standees)
• Composite construction
• Battery powered (no overhead catenary)
• Charging of batteries via contacts on vehicle roof – electric bus chargers to be used
• Control system to SIL 3
• Autonomous ready
• Cooling via 2 x 6kW roof mounted units; heating from scavenged heat from vehicle systems
Vehicle Components
Vehicle Interior – Standard Mode
Passenger Capacity

With Wheelchair in use

Seats - 18
Standing Capacity @4pax/m² (Shown below) - 32
Standing Capacity @8pax/m² (Crush Loading) - 64
Total Capacity = 50
Total Capacity = 82
Track Solution Technical Challenges

The construction cost of new tram routes is dominated by the relocation costs of utilities – therefore ways to minimise the need for utility diversions offer opportunities for savings – ideally the track should be:

- Manufactured off-site, low cost, readily transportable
- Thin, durable, but able to support HGV loads
- Minimal disruption when laying
- Short timescales
- Few utilities diversions
- Minimal excavation
- Fast removal and reinstatement when access required by utilities
- Low noise and vibration emissions
- Safe for pedestrians and cyclists
Track Work Stream

Requirements of novel track form:

- no thicker than tarmac layer on surface of the road
- subsoil loads no greater than with existing road traffic
- modular construction with off-site manufacture
- Rapid easy removal and reinstatement
- Acceptance from utilities that relocation is not generally required
- 6m to 8m long sections manufactured off-site
Coventry VLR high level plan

- Vehicle supplier contracted
- Vehicle design sign off
- Vehicle ready for track testing
- Vehicle ready
- Autonomous vehicle test start
- R&D track build
- R&D track available
- City of Culture Exhibition
- Coventry VLR First Route start of construction

- Transport Works Act for Coventry Very Light Rail
- Low cost trackform research
- low cost trackform prove out

Track research project
‘Hub-to-Home’: the Next Revolution

Our vision is that VLR trains and shuttles will be part of solutions to carry travellers the last few miles of a journey to their homes or work.

These journeys might begin or be completed by autonomous road “pods”, providing travellers with frictionless public transport from door-to-door.

The proposed VLR National Innovation Centre in Dudley will focus on this.
The Very Light Rail National Innovation Centre

Situated at Castle Hill, Dudley, on the site of the former Dudley Station alongside the mothballed South Staffordshire railway line

2.2km twin test tracks

1. Lightweight structures
2. Propulsion and energy storage
3. Dynamics
4. Civils & infrastructure
Questions?

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