Network RUS: Alternative Solutions

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Front cover image courtesy of Dr Robert Carroll (Stagecoach Supertram)

Foreword

Innovation is vital for the railway industry if it is to maximise value for money and will form an important element of economic and environmental policy.

This Network RUS: Alternative Solutions complements and builds upon the Rail Technical Strategy published in 2012, to examine solutions to challenges in the regional and rural markets. It considers a number of areas where significantly different ways of doing things (the 'alternative solutions') could help the industry to achieve better outputs at lower cost. Equally importantly, the work has also established circumstances where the solutions would not be a helpful option. It will help focus thinking more sharply on solutions which could deliver benefit in a particular case whilst at the same time minimising effort devoted to evaluating inappropriate options

The following main areas have been looked at:

- can the application of tram and tram train technologies deliver savings in capital, operating and maintenance costs whilst at the same time improving the offer to the travelling customer?
- are there cheaper and more innovative ways of replacing diesel traction with electrically powered trains on low usage sections of track?
- what is the role of Bus Rapid Transit (BRT) and guided bus systems?
- does the Personal Rapid Transit (PRT) currently used in locations such as Heathrow Terminal 5 have wider applicability to increase access to the network?
- to what extent could further development of community rail initiatives bring added value to local rail operations?

Recent developments have assisted the study from the viewpoint of generating practical experience in a UK environment, for example

- successful completion of the Paisley Canal electrification scheme, in which the use of extended neutral sections beneath bridges has substantially reduced cost and complexity
- successful introduction of Class 139 vehicles on the Stourbridge Town branch
- Government authority to proceed with the Rotherham – Sheffield tram train pilot, development of which is now under way.

However, this RUS is not prescriptive. Each locality has its unique circumstances and solutions must be developed to meet specific local needs, working with rail industry partners and stakeholders to achieve the most favourable outcome.

As with each RUS, this strategy has been developed with the full input of the wider rail industry, including train operators as well as government and passenger representatives. It underwent two 60-day public consultations and I thank all who responded. Network Rail looks forward to working with the wider community to implement the recommendations of this strategy wherever clear benefit can be gained.

Paul Plummer

Group Strategy Director

Executive summary

The Network Route Utilisation Strategy (RUS) forms an important part of the Long Term Planning Process. It considers issues which are railway network wide. Alongside the Network RUS: Alternative Solutions, four elements of the Network RUS have already been established, namely:

- Scenarios and Long Distance Forecasts
- Electrification
- Stations
- Passenger Rolling Stock.

A 'Refresh' of the Electrification Strategy is currently being developed.

The Network RUS: Alternative Solutions has followed a remit which allowed it to think imaginatively about cost effective solutions for accommodating growth and operating services more efficiently. The solutions which are considered are generally over and above the conventional solutions in the railway's toolbox, such as existing types of rolling stock and 25kV AC overhead line electrification.

The document complements the Rail Technical Strategy (RTS), and Network Rail's Technical Strategy, by looking at the market needs and economic case for emerging solutions.

The RUS has looked at how future innovations could lead to efficient and effective accommodation of growth in accordance with Network Rail's Licence. It has considered passenger needs, stakeholder aspirations and has examined a selection of emerging technologies. Manufacturers, and those who are actively considering the development of these technologies, have worked alongside Network Rail to make sure that delivery issues are fully understood.

A number of the solutions have been applied successfully on the rail network in other countries. That experience gives useful pointers to the circumstances in which they could usefully be applied on the network in Great Britain.

Tram train

A tram train vehicle is best defined as a tramcar capable of operating on both a street tramway and heavy rail networks. Tram trains share similar market characteristics with trams. They are best suited to a medium to high level of demand for passengers requiring frequent but relatively short distance services. Unlike trams they do, however, have the ability to operate on both heavy rail infrastructure and an on-street tramway. This enables them to operate through services onto the national rail network.

Although tram trains do not currently operate in Great Britain, their characteristics suggest that they have potential to provide a new opportunity to make better use of some existing heavy rail corridors which serve dense urban areas.

Tram trains share the advantage of trams of being able to penetrate city centres beyond the existing terminal stations using a suitably equipped road network. They also have the advantage that they can share tracks with other passenger and freight services. This avoids the need to segregate the services or sever through journeys.

A tram train pilot is being funded by the Government and will start operating in 2016 between Sheffield City Centre and Rotherham. It will seek to address questions about the engineering and cost of the technology in a UK situation. Subject to the outcome of that pilot, the technology may then become part of a tool-kit for planning for major urban areas.

Based on current technologies, tram train is not likely to have a good value-for-money business case when it does not serve urban areas. However, technological developments in this area should be monitored. The advantages come from the ability of tram trains to operate on both a tramway and heavy rail network, serving a number of stops within dense urban areas beyond the terminal stations whilst retaining through operation to the existing rail network.

Tram

Tram systems have experienced a resurgence over the last 20 years. There are six systems operating in Great Britain's cities, with one under construction. Many of these systems make use of, or have been converted from, former heavy rail alignments. In Croydon and Manchester, services formerly operated by heavy rail rolling stock have been converted to segregated tramways. Tram systems include an element of on-street running and it is this characteristic that has opened up new markets and increased ridership.

Trams operate most effectively in densely populated urban areas when passengers require frequent services to cover short distances with convenient frequent stopping patterns. Their ability to run on streets allows them to penetrate urban areas, bringing rail transport close to homes and work places. The vehicles' quick acceleration facilitates frequent stops without a significant reduction in overall journey time.

As such, they are most appropriate for providing connectivity to city centres. This enables the dispersal of passengers to their destinations beyond the city centre station by going on to an on-street tramway. Taking heavy rail trains out of city centre stations can release capacity, addressing urban transport problems by providing a frequent high quality public transport corridor. To maximise the benefits to passengers it is important that good interchange facilities are provided to the heavy rail services.

Conversion of heavy rail infrastructure or service to operation by tram is unlikely to have a good economic case when long distance passenger services, or rail freight use the corridor, or when severance of an existing rail service would cause inconvenience to a large number of through passengers. Based on current technology, tram conversion is not appropriate outside densely populated urban areas as the demand would be unlikely to sustain the service.

Battery-powered vehicles

Battery technology is currently not sufficient to enable like-for-like operation of current diesel services. However, a number of manufacturers suggest that the technology could be developed to the point when energy storage on trains will be viable for these routes to enable the operation of a train across a gap in electrification infrastructure.

The RUS presents a high level specification of what a train with on board energy storage would need to be able to achieve to operate passenger services on the network.

We understand from manufacturers that the technology is not capable of operating all of these distances with the required time to recharge at the moment. However, given the considerable investment of other sectors, notably the automotive sector, there is reason to believe that the technology is likely to improve over the 30 years of this strategy.

It is recommended that the rail industry works closely with manufacturers as the technology develops. The Network RUS: Electrification 'Refresh' will take forward the recommendations of this strategy for this technology in considering those areas of the network which may not have a case for conventional electrification.

Battery power will not be considered to be an appropriate option for operation of vehicles on the network until battery technology is developed to a sufficient degree to provide value for money as an option for replacement of diesel units.

Our current understanding of the technology suggests that it is unlikely that battery technology will be appropriate on parts of the network which have a strong case for conventional overhead wire electrification where vehicles operate at more than 100mph, for substantial distances or when there is limited recharge time available. The potential for 'last-mile' diesel operation by an electric locomotive to access unelectrified freight terminals or sidings will be considered by the Network RUS: Electrification 'Refresh'.

Hybrid light rail

A range of alternative light vehicles have been proposed to operate the less dense parts of the network at a lower cost than existing rolling stock. These include the use of flywheel or other energy saving technology.

Unlike battery technology, one example of flywheel technology is currently being operated on the network. The Class 139 operates the regular passenger service on the branch line between Stourbridge Junction and Stourbridge Town.

Hybrid light rail currently operates to serve a relatively small niche. As with the Class 139, any case for a larger vehicle would be predicated on low capital and operating costs. Their niche would be expected to be semi-urban or rural markets. For example, subject to business case, they could be considered for areas where current one-car or two-car Diesel Multiple Units (DMUs) operate. Existing one-car vehicles operate in multiple with other DMUs and are therefore able to serve a wider range of demand. This feature would be advantageous in any future vehicle that was developed.

Personal rapid transit

Personal rapid transit (PRT) systems have been developed to move passengers in driverless pods, using a guidance system to take passengers to their selected destination. This means that service frequency and destination can be tailored to passenger requirements.

PRT systems have the potential for widening the catchment area from which passengers can reach rail stations within 10-15 minutes. This may result in an increased mode share for rail (and therefore increased rail fare revenues) as well reduced traffic congestion and regeneration benefits for cities. Examples of developments that could be realised by such rail access include:

- provision of remote car parking and redevelopment of former central parking sites
- development of edge of city centre business zones with easy access to rail stations
- new sustainable residential developments
- access to airport sites from rail stations
- interchange between two or more nearby town or city centre rail stations.

PRT does not operate at high speeds and has a limited carrying capacity per vehicle so would not be an appropriate option for replacing heavy rail services. It would be less appropriate than a fixed transport link for serving high volumes if passengers are going to a single destination.

Bus rapid transit and guided bus

A bus rapid transit (BRT) system is essentially a conventional bus with interventions designed to optimise the whole journey experience. The only difference being that the buses run for part of their route on a dedicated road as well as on the main local and highway network. BRT is operated with the driver driving the vehicle in the normal way throughout. Guided bus is very similar, except that the buses operate on dedicated guided sections as well as on the highway.

As discussed above, tram train and tram have the potential for enhancing connectivity and increasing the access to some urban centres. However, not all cities have sufficient demand to provide a positive business case. Lower levels of demand may require a lower cost solution. The provision of high quality bus-type services either in the form of a BRT or guided bus on a former rail alignment may offer an attractive, alternative, high capacity service.

It is recommended that this solution is considered as an option for reopening former railway lines where there is a poor case for heavy rail or tram type operation. This is likely to be in medium sized urban areas or routes serving more dispersed populations than are generally served by rail or tram networks and where it is challenging for either heavy or light rail to penetrate a city centre. Outside a rail industry context, BRT and guided bus have a broader set of considerations as to their appropriateness and characteristics as a mode of transport.

Bus Rapid Transit is not the appropriate option on routes that are not segregated or separated from the rail network. Guided bus would not be appropriate in comparison to BRT when the costs of the guide way are greater than the benefits. Both BRT and guided bus are unlikely to be the most appropriate option for transport corridors which have sufficient demand to warrant a heavy rail, tram train or tram network.

Electrification for lightly used routes

If the cost of providing electrical clearance would otherwise be prohibitive to an electrification project, it is recommended that consideration is given to an option for vehicles to 'coast' under structures. Network Rail has recently introduced such a system on the Paisley Canal branch. Neutral sections with neutral contact wire allow electrically powered rolling stock to coast under structures where there is physical clearance for the train but insufficient clearance for the electrical system to operate live. The costs of introducing electrification on the Paisley Canal branch were reduced by approximately 50 per cent and early indications suggest that the system has not compromised service performance.

Whilst this is may be an attractive proposition to avoid gauge clearance costs, it is only recommended in those circumstances where there is a low risk that a train might come to a standstill and cause a problem to service performance, where line speeds are low and service frequency is low. As such, it is recommended that the solution is considered on branch lines rather than the core network where speeds, frequency and performance risk are higher and Technical Specifications for Interoperability (TSI) compliance is essential.

Community rail

The RUS recognises the value that community rail groups have added through their continued involvement in the railway. This involvement should be facilitated where the solutions are suitable as community engagement can deliver an improved rail experience. Options have been considered for the potential role of community rail in obtaining value for money for the railway and encouraging greater involvement of the local community in their local railway. These options recognise that the history of community rail's achievement has tended to focus on strategies to increase ridership and revenue and find cost effective solutions, rather than reducing costs directly.

The key factor which needs to be present for community rail to be appropriate is the desire from a local community to engage and form a partnership with the rail industry. Experience has shown that community rail can contribute to the development of the railway in a number of ways:

- promoting ridership through community rail marketing techniques has been a successful way to attract additional patronage and also increase rail's economic benefit
- promoting alternative methods of ticket retailing such as on the Settle and Carlisle line
- in some instances community rail partnerships (CRPs) have been an important facilitator in the ability to rebalance fare levels and service provision to meet community needs
- community engagement has delivered improvements in the way services are developed
- partnerships have been successful in providing a very local link into the communities the railway serves when services change or there is disruption to services
- partnerships and station friends groups have made a significant difference to stations and the environs of the railway, enhancing the environment for passengers and local people.

Community rail partnerships have worked successfully in a range of different circumstances from commuter lines in London and the South East (e.g. Sudbury to Marks Tey and the St Albans Abbey Line), inner cities services (e.g. Severn Beach line in Bristol) to rural locations (the Falmouth branch in Cornwall).

A range of solutions have been deployed on community rail lines to enhance the network. Examples of these lower cost enhancements examples have included:

- Penryn Passing Loop – an innovative installation of a passing loop avoided the need for a new platform and footbridge at the station
- Harrington Hump – low cost means of raising a section of a platform to improve accessibility on to the train
- Beauly and Conon Bridge – two new stations in Scotland with only 15 metre long platforms thereby reducing their capital cost.

It is recommended that the railway continues to facilitate Community Rail Partnerships (CRP) and work with those groups and partnerships that do emerge. Community rail plays a role in reducing the gap between the cost of operating and income from passengers on more lightly used rail lines. A successful CRP can provide a strong case for the investment of other alternative solutions to enhance rail services on these lines.

Next steps

This strategy provides guidance for the appropriateness of different solutions to support particular transport challenges. It provides a toolkit of solutions which can be assessed for business cases in different circumstances. This strategy is principally aimed at solutions when use of an existing rail line may be required (in part) to deliver the transport solutions but it can also be used to consider options for new transport corridors in urban areas.

As with any RUS, the strategy reflects our best understanding at this point in time. The Rail Technical Strategy is underpinned by the Rail Innovation Fund which will be used to develop technology further. The strategy recommends that allocation of the fund takes cognisance of the recommended links between network challenges outlined in this document.

Whilst some of the solutions are close to an appropriate stage of development (or adaption) for introduction onto the UK rail network, others will require more attention, for example on battery technology. It is important to be aware that, by definition, a process of innovation is a process of change and that some technologies that are not listed as appropriate at present may become appropriate after further development work. It is possible that over the next 30 years there may be some significant technological developments that could reshape the market for public transport and how it is powered.

The recommendations of this strategy have been developed by the rail industry and its key stakeholders. They will form an input into the strategic decisions made by the industry's funders and suppliers. It also provides support to transport authorities in developing new transport services that interact with the national rail network.

1 Background

Introduction

Following the Rail Review in 2004 and the Railways Act 2005, the Office of Rail Regulation (ORR) modified Network Rail's Licence in June 2005 (as further amended, in April 2009) to require the establishment of Route Utilisation Strategies (RUSs) across the network. Simultaneously, the ORR published guidelines on RUSs.

1.1 Context

Following the Rail Review in 2004 and the Railways Act 2005, the Office of Rail Regulation (ORR) modified Network Rail's Licence in June 2005 (as further amended, in April 2009) to require the establishment of Route Utilisation Strategies (RUSs) across the network. Simultaneously, the ORR published guidelines on RUSs. A RUS is defined in Condition 1 of the revised licence, in respect of the network or part of the network, as a strategy which will promote the route utilisation objective.

The route utilisation objective is defined as:

> **'the efficient and effective use and development of the capacity available, consistent with funding that is, or is likely to become, available.'**
>
> ***Extract from ORR guidelines on Route Utilisation Strategies, April 2009***

The ORR guidelines explain how Network Rail should consider the position of the railway funding authorities, their statements, key outputs and any options they would wish to see tested. Such strategies should:

> **'enable Network Rail and persons providing services relating to railways to better plan their businesses, and funders better plan their activities.'**
>
> ***Extract from ORR guidelines on Route Utilisation Strategies, April 2009***

The process is designed to be inclusive. Joint work is encouraged between industry parties, who share ownership of each RUS through its industry Stakeholder Management Group.

RUSs occupy a particular place in the planning activity for the rail industry. They use available input from Government Policy documents such as the Department for Transport's Rail White Papers and Rail Technical Strategy, the Wales Rail Planning Assessment, and Transport Scotland's Scottish Planning Assessment. The recommendations of a RUS, and the evidence revealed in the work to reach them, provides an input to decisions made by industry funders and suppliers on numerous issues. These include franchise specifications and investment plans or the High Level Output Specifications (HLOS). HLOS specifies strategic outputs that Governments want the railway to deliver for the public funds that have been made available.

Network Rail will take account of the recommendations from RUSs when carrying out its activities. The ORR will take account of established RUSs, when exercising its functions.

1.2 Long Term Planning Process

The programme of geographic RUSs was completed with the establishment of the West Coast Main Line Route Utilisation Strategy in August 2011. Licence Condition 1 requires Network Rail to both establish and maintain RUSs. Network Rail has worked with the rail industry to develop a Long Term Planning Process which discharges this responsibility to maintain RUSs. Endorsement to these proposals was given by the Office of Rail Regulation in April 2012.

The Long Term Planning Process is designed to facilitate the strategic planning of the rail network in a way which is flexible enough to encompass the views of the rail industry, funders, specifiers and customers on the requirements to develop the network to meet future demand through market studies, cross-boundary analysis and route studies.

The process will consider local stakeholder aspirations and incorporate their views on how the rail industry can drive and support economic growth, as well as giving passenger and freight operators the confidence they need to take their own strategic decisions in planning the future of their services. Market studies and route studies will be published on the Network Rail website as drafts for consultation, followed by a 90 day consultation period.

The consultation responses will help to form the final study and subject to any representations being upheld by the Office of Rail Regulation, each study will be established 60 days after publication. Further detail regarding how each constituent part of the Long Term Planning Process will operate can be found on the Network Rail website at www.networkrail.co.uk.

1.3 RUS structure

This document outlines the role of the Network RUS in Chapter 2. It summarises the scope of the Network RUS: Alternative Solutions workstream. This includes the key issues which have been considered and the time horizon that it examines. It summarises the policy context and the relationship between the RUS and related policy issues which are being considered by industry funders.

In Chapter 3, the drivers of change are outlined. These are the factors which could potentially drive a move to alternative solutions on the network, taking cognisance of railway industry stakeholder objectives.

Chapter 4 presents the baseline for the study. The chapter defines each of the alternative solutions considered in the RUS.

The baseline describes each of these solutions, identifies today's usage, and the costs and characteristics associated with the solution.

Chapter 5 highlights the key gaps which have been identified in relation to both today's and a future railway which could exploit the benefits of alternative solutions. A RUS gap is a gap between current system capability (supply) and what it is required to do (demand). These are summarised within the chapter for each of the alternative solutions.

Chapter 6 summarises the options which are proposed by the RUS to bridge the identified gaps.

Chapter 7 analyses the results of the two stage consultation process and the additional alternative solutions that consultees proposed.

Chapter 8 concludes the document by establishing a strategy for each of the alternative solutions.

2 Scope and policy context

Introduction

The Network Route Utilisation Strategy (RUS) is part of the Long Term Planning Process (LTPP) and considers issues which potentially affect the entire rail network of Great Britain.

2.1 The role of the Network Route Utilisation Strategy

The Network Route Utilisation Strategy (RUS) is part of the Long Term Planning Process (LTPP) and considers issues which potentially affect the entire rail network of Great Britain. Its network wide perspective is supported by a stakeholder group with wide expertise which enables the development of a consistent approach on a number of key strategic issues which underpin the future development of the network.

The Network RUS with its broad range of stakeholders has a number of interfaces with other key strategic workstreams. As a result, the Network RUS has developed a meeting structure, industry consultation and programme to make sure that it produces key, timely and thoroughly consulted deliverables.

There are currently five working groups of the Network RUS of which four have published strategies that have been established with the Office of Rail Regulation (ORR):

- Scenarios and long distance forecasts (published and established June 2009)
- Electrification (established October 2009 and currently being refreshed)
- Stations (established October 2011)
- Passenger Rolling Stock (established November 2011)
- Alternative Solutions (final strategy published July 2013).

2.1.1 Network wide perspective

The Network RUS enables strategies to be developed by the industry, its funders, users and suppliers which are underpinned by a network wide perspective of rail planning. The development of such strategies makes sure that key issues are dealt with consistently throughout the long term planning framework.

The Network RUS enables strategies to be developed which by their very nature cross geographic boundaries (for example the development of future rolling stock families and electrification strategy). It draws upon best practice for different sectors of the railway.

2.1.2 Organisation: Rail Industry Planning Group and Working Groups

The Network RUS is overseen by the Rail Industry Planning Group (RIPG). The RIPG is chaired by Network Rail. It draws members from:

- Association of Train Operating Companies (ATOC)
- Department for Transport (DfT)
- Freight Transport Association (FTA)
- London TravelWatch
- Office of Rail Regulation (ORR)
- Passenger Focus
- Passenger Transport Executive Group (PTEG)
- Rail Freight Group (RFG)
- Rail Freight Operators Association (RFOA)
- Rail Industry Association (RIA)
- Rolling Stock Companies (ROSCOs)
- Transport for London (TfL)
- Transport Scotland (TS)
- Welsh Government (WG).

The majority of the work and detailed stakeholder consultation, however, is undertaken within working groups which have been formed to steer each of the Network RUS workstreams. The groups vary in size, but are all small enough to provide effective levels of engagement between the participants. However, given that each is composed of individuals with relevant expertise or strategic locus for the specific subject matter, they play an important role in recommending a strategy for endorsement by the RIPG.

The RIPG is the endorsement body for the outputs of the individual workstreams. Its agenda concentrates on key decisions – from endorsement of the working group remits to approval of key documents and ultimately the resulting strategy.

If the RIPG has comments or questions on papers, these would be referred back to the working group, which contains each of the RIPG organisations' specialist representatives.

2.1.3 Network RUS working group

The RIPG identified those elements of strategy which it wished to include in the Network RUS. A working group was formed to develop each chosen element of strategy. The Network RUS: Alternative Solutions working group consists of members of the following organisations:

- ATOC
- DfT
- Eversholt Rail and Porterbrook (representatives of the ROSCOs)
- Network Rail
- PTEG
- RIA
- Transport for Greater Manchester (TfGM)
- Transport Scotland
- Welsh Government
- ORR (in the capacity of observer).

2.2 Time horizon

The Network RUS takes a 30 year perspective. This is consistent with the long term views of transport planning taken by UK Governments in their recent strategy documents, notably:

- England and Wales High Level Output Specification (HLOS) 2012
- Scottish Government's HLOS (2012)
- DfT 'Reforming our Railways: Putting the Customer First' – Command Paper (2012)
- DfT 'Rail Decentralisation: Devolving decision-making on passenger rail services in England' consultation paper (2012)
- Welsh Government's 'National Transport Plan' (2010)
- Transport Scotland's 'Strategic Transport Projects Review (STPR)' (2008)
- Network Rail's 'Strategic Business Plan' (2013).

2.3 Scope of the Network RUS: Alternative Solutions

The objective of this RUS, as agreed by the SMG, is to develop a strategy which presents alternative solutions for accommodating future rail passenger demand in a cost effective manner. The work follows the established RUS process of developing a baseline, identifying gaps, options and proposing strategic recommendations.

The remit of the Network RUS: Alternative Solutions anticipated that stakeholders would identify issues which will be expected to trigger the need for an alternative solution.

Possible examples may include:

- the replacement of self powered rolling stock
- aspirations for lighter vehicles on less heavily used parts of the network
- a desire to identify innovative lower cost forms of electric traction
- aspirations to operate more frequent services on routes currently limited by infrastructure constraints (e.g. single lines with passing loops)
- aspirations for greater connectivity through enhanced city centre penetration
- increased community involvement in operating the railway.

The geographic scope of the Network RUS: Alternative Solutions relates to those services which are neither long distance high speed, London and South East or interregional. It examines a range of alternative solutions in relation to the regional commuter, regional and rural passenger services.

The alternative solutions have been selected on the basis that they may have potential to address the issues being faced by the rail industry or because they have not, or are not planned to be considered as part of the existing railway industry planning process. In preparing this strategy, the industry acknowledges that it does not necessarily have direct experience of all of the solutions considered. It has worked closely with organisations that do.

The RUS has considered relevant findings from ongoing workstreams notably that of the tram train pilot between Rotherham and Sheffield and the Technical Strategy Leadership Group (TSLG). TSLG is a cross-industry body which has led the industry in developing a Rail Technical Strategy, the most recent version of which was published in 2012. This develops a vision in each key technology area, commissioning research and building understanding around implementation issues and their solutions.

2.4 Policy context

2.4.1 England

In July 2012, the HLOS for England and Wales was published. It sets out for the Office of Rail Regulation and the rail industry what the Secretary of State for Transport wants to be achieved by railway activities during railway Control Period 5 (CP5) which covers the period from April 2014 to March 2019. The HLOS details options for future electrification schemes, improvements to safety and reliability levels, increased network capacity, a continued drive to demonstrate improved financial sustainability, improved customer satisfaction and enhanced environmental performance of the railway. The Statement of Funds Available, published alongside the HLOS, determined the likely rail industry funding available for CP5.

In March 2012, the DfT published the Command Paper 'Reforming our Railways: Putting the Customer First'. The Command Paper outlined Government's overall objectives for the railways and proposed how it intends to work with industry and other parties to secure significant cost reductions in the overall cost base. This is at the same time as improving the railway for both passengers and freight users. A key challenge identified was to try to make sure that the two elements of the rail industry, track and train, would seek to work in a more aligned manner to lower costs and improve services for all users.

The Command Paper responded to the conclusions and recommendations outlined in Sir Roy McNulty's independent 'Realising the Potential of GB Rail: Report of the Rail Value for Money' Study published in September 2011. It included suggestions that the rail industry consider alternative solutions to conventional heavy rail approaches to provide lower whole life cost options. This RUS considers some of these areas, such as the potential for use of tram and tram train as a lower cost rolling stock solution. The report emphasised the benefits of increasing local engagement in the railway.

In March 2012, the DfT launched a consultation into Rail Decentralisation. This examined devolving decision making on passenger rail services in England. It sought to obtain industry views as to how Government could devolve more responsibility and budgets for rail passenger services in areas of England to local bodies. The responses to the consultation were published in November 2012 and the DfT restated its commitment to seeking to implement an appropriate form of decentralisation in those parts of England where it is sensible to do so.

In January 2012, the DfT initiated a consultation on 'Devolving local major transport schemes'. It specifically sought views on how a new system should be created for prioritising and funding local major schemes after the end of the current Spending Review period. The consultation outlined proposals which included: utilising a population based formula to allocate funding in contrast to a costly bidding process, a locally led scheme prioritisation evaluation process, reduction of the role of central Government in the process and placing Local Enterprise Partnerships (LEPs) in the lead role as to which transport schemes would be delivered. The consultation proposed various options in relation to:

- the nature of the role that LEPs would have in the local transport decision making process
- how to promote strategic investment
- provision of assurances on the appraisal of individual schemes.

The consultation ended in April 2012 and in September the DfT published its detailed proposals taking the consultation views into account.

This established a timetable which will see Local Transport Bodies being provided with funding directly from 2015 onwards. This devolution of funding will result in more local decision making on transport investment.

Community rail was the subject of a Community Rail Development Strategy published by the Strategic Rail Authority in 2004. This set out the concept of designated community rail routes with objectives of increasing ridership, freight use and net revenue, managing costs down, and greater involvement of the local community in those routes. The DfT has subsequently taken the concept forward and published a review of the Community Rail Development Strategy (2007). As of 2013, the DfT has now designated 34 community rail services or routes.

2.4.2 Wales

In March 2010, the Welsh Government published the 'National Transport Plan'. This document provides a transport strategy for Wales. Rail is an integral element of the overarching strategy for an integrated transport system. The National Transport Plan has five key strategic objectives which are:

- reducing greenhouse gas emissions and other environmental impacts
- integrating local transport
- improving access between key settlements and sites
- enhancing internal connectivity
- increasing safety and security[1]

The plan aims to take these strategic priorities forward in developing an integrated transport network. These strategic priorities have numerous links with the RUS scope, particularly in the context of improving access and reducing greenhouse gas emissions.

1 Source: Page 9, National Transport Plan, Welsh Assembly Government, March 2010

2.4.3 Scotland

In June 2012, the Scottish Minister's HLOS was published. This outlined plans for continued investment to support growth over the period 2014-2019. Specific commitments included:

- improvements to journey times
- carbon reduction of railway activities
- maintenance of existing capacity and capability of the rail network
- development of a high performing reliable network
- maintaining Scotland's railway stations
- support for cross-border rail services
- maintaining and enhancing safety on the railway
- increasing the capacity and capability of the Scottish network.

In December 2008, Transport Scotland published its Strategic Transport Projects Review (STPR). The STPR indicated the Scottish Government's 29 transport investment priorities for the next 20 years. The schemes described in the document include proposals for electrification and metro or light rapid transit.

3 Drivers of change

This chapter outlines factors which could drive a move to alternative solutions on the network given the objectives of the rail industry's stakeholders.

3.1 Introduction

The UK Government and devolved administrations continue to emphasise the importance of rail in delivering economic and environmental benefits. This chapter outlines factors which could drive a move to alternative solutions on the network given the objectives of the rail industry's stakeholders. These drivers of change include the need to:

- reduce industry costs, whilst accommodating passenger demand efficiently
- improve the product offered to passengers, with the associated revenue benefits
- increase connectivity to assist peripheral settlements and assist workforce mobility
- contribute to the localism agenda including facilitating economic growth
- provide a more environmentally friendly product
- be less reliant on potentially insecure energy sources
- comply with environmental legislation
- make best use of technological development
- replace diesel powered rolling stock.

The chapter considers how alternative solutions are potentially able to contribute to these objectives. The alternative solutions are:

- conversion of heavy rail infrastructure or services to tram operation
- tram train
- battery-powered vehicles
- hybrid light vehicles
- personal rapid transit
- bus rapid transit and guided bus
- electrification for lightly used routes
- community rail.

The drivers of change listed above and the potential contribution of each alternative solution, described in detail in Chapter 4, will be used to identify, in Chapter 5, the gaps.

3.2 Reducing whole industry whole life costs

A key consideration in selecting the alternative solutions presented within this RUS is their contribution to the minimisation of the whole industry whole life cost of railways. Whole industry whole life cost concerns the capital and operating cost of the railway system across the asset lives of the infrastructure and rolling stock. This emphasis on cost reduction has been reinforced by the publication in May 2011 of the McNulty report 'Realising the Potential of GB Rail, Final Independent Report of the Rail Value for Money Study, Detailed Report'. In section 19, it considers the 'Lower Cost Regional Railway'. The options that are being considered in this strategy complement these objectives in that the various proposed alternative solutions could potentially reduce the whole life whole industry cost of the railway by either reducing capital, or operating and maintenance costs.

The Rail Value for Money report included suggestions that the rail industry consider alternative solutions to conventional heavy rail approaches to provide lower whole life cost options. This RUS considers some of these areas.

3.2.1 Tram and tram train conversion of heavy rail infrastructure or services

Trams are passenger carrying rail vehicles which are able to stop within the distance the driver can see to be clear ahead. Tramways must be segregated from heavy rail train services because of their different principles of train control and levels of vehicle crashworthiness. A tram train is a tram vehicle which is capable of operating on both a street tramway and heavy rail networks.

Tram and tram train have been proposed as a method of reducing both rolling stock and operating costs. The McNulty Report stated that, 'The options for the provision of lower-cost trains could include a number of solutions: […] there may be opportunities in some areas to convert from heavy rail to trams, or tram trains'.[1] This might

1 Source: page 268, Realising the Potential of GB Rail, Final Independent Report of the Rail Value for Money Study, Detailed Report, May 2011

apply to reductions in both operating costs and the capital cost of enhancements.

3.2.2 Alternative methods of electrification on lower traffic density lines

The Network RUS: Electrification Strategy explored the potential for 25kV AC overhead line electrification (OHL) to enable more efficient operation of passenger services. The strategy recommended options for electrification, of which the following have committed funding for electrification:

- Crossrail (Heathrow Airport Junction to Maidenhead)
- Edinburgh Glasgow Improvement Programme (EGIP)
- Great Western Main Line
- North Transpennine
- North West.

As part of the High Level Output Specification (HLOS) in England and Wales the following electrification schemes were included:

- South Wales Electrification
- Electric Spine (electrification of routes from Southampton Port to the West Coast Main Line and the East Midlands, including the Midland Main Line)
- Micklefield – Selby
- Thames Valley branches
- Walsall – Rugeley Trent Valley.

Conventional OHL should remain the starting point when considering the case for electrifying a route. It is most likely to be suitable for busier routes, where the new infrastructure can be offset by the lower costs of running electric rolling stock (compared to diesels).

The Network RUS: Electrification Strategy acknowledged that lower cost forms of electrification could enable the use of electric traction on sections of the network that would otherwise not have a business case.

Alternative forms of electrification on lower traffic density lines could reduce the cost of infrastructure required to achieve the benefits of electric traction. The concepts considered in the RUS involve progressively larger gaps in the OHL as follows:

- coasting – extended neutral sections to avoid gauge clearance of challenging structures
- discontinuous electrification – longer gaps in the wires for example through tunnels with energy storage onboard the rolling stock to provide power
- discrete electrification – potentially no new OHL and trains powered by onboard energy storage away from the existing OHL for tens of kilometres.

It is possible that coasting, discontinuous and discrete electrification could result in reduced infrastructure costs. Theoretically electric traction could be more affordable for lower traffic density lines. If the type of innovative electrification requires energy storage to power the train through the gap in the OHL the infrastructure saving needs to be balanced against the cost of energy storage on the rolling stock.

3.2.3 Community rail

Community rail is a concept which involves local communities in the development and promotion of their local rail routes, services and stations. It has been considered in the RUS on the basis of the scope for community rail to improve value for money and increasing local community involvement in the delivery of rail services.

The Strategic Rail Authority Community Rail Development Strategy (2004) proposed that community rail would be able to reduce whole life whole industry costs. The strategy set out the concept of designated community rail routes with objectives of increasing ridership, freight use and net revenue, managing costs down, and greater involvement of the local community in those routes.

The DfT has subsequently taken the concept forward and published a review of the Community Rail Development Strategy (2007). As of 2013, the DfT has now designated 34 community rail services or routes.

There is little evidence, however, of cost savings being achieved through community rail initiatives. It has not been demonstrated on a wide scale that operations, maintenance and renewals costs have been influenced by the present application of the community rail concept. Other elements of this strategy such as tram conversion and energy storage on trains have more potential to impact on these costs.

3.3 Efficiently accommodating passenger growth

For many of the lower traffic density lines, considerable growth has been experienced in the last ten years with further growth forecast. However, because of the low yield per passenger and high subsidy requirements on many of these lines, it can be hard to demonstrate a good business case for investment to increase capacity. Geographical RUSs have not always been able to find viable options to address the gaps raised. Alternative, lower cost solutions to conventional rail, in these circumstances, would be desirable. Community rail has the potential to allow greater flexibility to incorporate local priorities and develop a service offering which meets the needs of the local community, suggesting service pattern and frequency changes. There may be an opportunity to progress community rail service change proposals during refranchising competitions. The vehicle for expressing proposals will be via local Rail User Groups and in turn the respective County Council(s) or local authorities. Service change proposals will need to demonstrate both financial and operational viability.

The use of trams and tram trains have been proposed as ways to enhance capacity or frequency at a lower cost than a heavy rail option where a tram style vehicle is appropriate for the market served.

In urban areas, the use of trams and tram trains may be a way of addressing capacity gaps at major city centre stations. An option is the diversion of existing heavy rail services which terminate at congested main line stations (through tram or tram train operation on adjacent city streets). It could lead to improved network performance or release capacity for more economically valuable services. This may represent better value for money than a conventional solution of expanding capacity at main line stations. It is only beneficial to address capacity gaps in this manner if the capacity released by tram train can be used in an economically viable manner.

3.4 Improving the passenger product

Alternative solutions may offer a more affordable means of improving rail's product offering to its passengers. Improvements could include:

- elimination of modal interchange
- reduced journey times
- new journey opportunities
- increased connectivity
- improved city centre penetration
- increased frequency
- distribution of passengers from heavy rail stations
- train services tailored to local requirements
- new rolling stock.

3.5 Bringing additional passenger revenue

Each of the factors outlined in Section 3.4 combine to improve the product offer to the passenger and, by attracting additional rail passengers, bring additional revenue to the railway.

This could be through a transformative system-wide change such as tram conversion and its impact on ridership and revenue. Equally, in other circumstances it could be achieved through community rail activities which have largely focused on increasing patronage and maximising revenue by marketing and promoting local rail services.

3.6 Contributing to the localism agenda

The Localism Act (2011) seeks to devolve certain powers from central government. Generally, the provisions in the Act are only relevant to England and to a lesser extent Wales. Its significance for the rail industry is twofold in that it potentially gives an increase in control of local public finances and seeks to increase community involvement in decision making. Both may contribute to an increased use of alternative solutions.

In England, the Act introduced the concept of Local Enterprise Partnerships (LEPs) replacing regional development agencies. LEPs are partnerships led by local authorities and local businesses. They play a central function in attempting to develop an appropriate local environment to encourage business and economic growth and are an integral mechanism for delivering Government objectives for decentralisation. As of 2013, there are 39 LEPs across England.

Further to the Localism Act, it was announced by the Government in July 2012 that six cities (Birmingham, Bristol, Leeds, Newcastle, Nottingham and Sheffield) had agreed devolved funding arrangements. Arrangements for Liverpool and Manchester have already been agreed. Under the arrangement the cities have been given powers to:

- administer funds which were previously held by central Government to pay for local infrastructure improvements which assist in economic growth and regeneration
- exercise powers of borrowing against the future income from business rates to pay for new local infrastructure to stimulate economic growth and regeneration.

In January 2012, the DfT initiated a consultation on 'Devolving local major transport schemes'. It specifically sought views on how a new system should be created for prioritising and funding local major schemes after the end of the current Spending Review period. The consultation outlined proposals which included a locally led scheme prioritisation evaluation process, reducing the role of central Government and placing Local Enterprise Partnerships (LEPs) in the lead role in determining which transport schemes would be delivered. The consultation proposed various options in relation to:

- the nature of the role that LEPs would have in the local transport decision making process
- how to promote strategic investment
- provision of assurances on the appraisal of individual schemes.

The consultation ended in April 2012 and in September the DfT published its detailed proposals taking the consultation views into account. This established a timetable which will see Local Transport Bodies being provided with funding directly from 2015 onwards. This devolution of funding will result in more local decision making on transport investment.

In March 2012, the DfT launched a consultation specifically into Rail Decentralisation. This examined devolving decision making on passenger rail services in England. It sought to obtain industry views as to how Government could devolve more responsibility and budgets for rail passenger services in areas of England to local bodies. The responses to the consultation were published in November 2012 at which point the DfT restated its commitment to seeking to implement an appropriate form of decentralisation in those parts of England where it is sensible to do so. The possible implications of this commitment are considered in more detail in Chapter 6.

The localism agenda is significant to this RUS strategy. The devolvement of funding is likely to see more local decision making on transport policy and investment. It may also promote an increase in locally developed and funded involvement in the rail industry. Consequentially, this may increase the use of alternative solutions which fit specifically local gaps, especially when they can demonstrate a clear contribution to economic growth. Proposals for tram and tram train schemes are particularly likely to develop out of local aspirations to address urban transport gaps because of their multimodal impact.

3.7 Delivering environmental benefits

Rail transport currently accounts for approximately two per cent of carbon dioxide emissions from the UK domestic transport sector[2]. It is generally a more environmentally friendly method of travel than its major competitor (road). It is important that rail improves its environmental credentials even further in the light of government targets to cut carbon emissions and improve air quality. The automotive sector in particular has delivered substantial improvements in the fuel efficiency and emissions performance of road vehicles in recent years and this is set to continue.

2 Source: Low Carbon Transport Innovation Strategy, DfT May 2007

In some circumstances alternative solutions potentially have an important role to play in reducing the carbon emissions of rail services.

European legislation controlling emissions from rail diesel engines came into force in two stages with the first part (Stage 3A) coming into force in 2009. The second part (Stage 3B) of the regulations came into force in 2012 and is likely to require an exhaust after treatment system to reduce levels of nitrogen oxides and diesel particulates. There is a general expectation that Stage 3B engines will consume more fuel than equivalent 3A engines unless further improvements are made to the engine design. The location, size and design of some Diesel Multiple Unit (DMU) engines may make engine replacement difficult or too expensive, in particular with Stage 3B engines. Instead, operators may seek to refurbish their existing engines and modify these where cost effective, to improve fuel efficiency. This issue is of particular relevance to regional and rural markets. In some circumstances an alternative solution may be able to contribute to addressing this issue.

The European emissions standards are not retrospective. An owner or operator is not incentivised to consider refitting with the latest engine design, especially when it would require the engine raft to be redesigned (incurring associated costs). The space envelope of a 3B compliant engine is larger than that of a 3A engine which creates added complications in Great Britain which has the smallest space envelope underneath a vehicle in Europe.

Electrically powered alternative solutions may be quieter in operation than diesel rolling stock. The difference in noise emissions between conventional electric and diesel traction is illustrated in the Rail Safety and Standards Board (RSSB) T633: Study on further electrification of Britain's railway network, published in 2007.

3.8 Addressing security of energy supply

Rail transport currently represents approximately two per cent of domestic oil consumption in the UK [3] The White Paper on Energy (Meeting the Energy Challenge, May 2007) was published by the Department of Trade and Industry (now Business Innovation and Skills). It recognised that the transport sector heavily relies upon oil. This is at a time when Great Britain will increasingly rely on imported oil which carries potential consequences for the security of energy supply. Electricity can be generated from a variety of primary sources. The greater flexibility in the sources of energy available (particularly the potential to source from within the UK) would enable electrification to contribute to fuel security. This could reduce the exposure to the risk of future scarcity and the volatility of oil prices. Alternative solutions may in some circumstances be able to reduce dependency on oil, as an ultimate source of traction power supply.

3.9 Making best usage of technological development

Rail transport has the opportunity to take advantage of technological development either from within the rail industry or learning from other industries. Such developments, if they can be made use of to improve aspects of service delivery, environmental benefits or whole life cost reductions, may be a reason that an alternative solution is considered and implemented. The solutions considered in this RUS are of varying levels of technological maturity.

3 Source: Energy consumption in the United Kingdom: 2008 data tables, BERR

3.10 Replacing diesel powered rolling stock

A significant driver of alternative solutions is the requirement to provide new and additional passenger rolling stock on the network. Of the non intercity diesel powered passenger rolling stock fleet, 66 per cent of vehicles on the network are over 20 years old. In the next few years decisions will need to be made on whether to replace them or extend their lives. This will influence the case for tram and tram train conversion of heavy rail infrastructure or services as well as alternative forms of electrification and shape the strategy for their potential implementation. The Network RUS: Passenger Rolling Stock Strategy provides more detail on this driver of change.

The committed electrification schemes in Great Britain will permit the cascade of DMU rolling stock to other locations. However, as the DMU fleet ages and the DMUs displaced by subsequent electrification become progressively older, there will come a point at which, for lines without a viable electrification case or diesel rolling stock replacement, an alternative solution is potentially required. The timing of this need will depend upon the extent of future electrification and the extent to which it is possible to affordably extend the life of existing DMUs.

3.11 Summary

The desire to achieve improved value for money drives a need to examine a range of alternative solutions for accommodating the expected growth demand for the railway. The key consideration in this RUS is to examine alternative solutions for lightly used lines where conventional heavy rail solutions may not provide value for money.

4 Baseline

This chapter defines each of the alternative solutions considered by the RUS.

Figure 4.1
Photograph of Nottingham Express Transit Hucknall tram and heavy rail station

4.1 Introduction

This chapter defines each of the alternative solutions considered by the RUS. For each one, the baseline establishes the concept, today's usage, and the costs and characteristics associated with it. The alternative solutions are:

- conversion of heavy rail infrastructure or services to tram operation
- tram train
- hybrid light vehicles
- personal rapid transit
- bus rapid transit and guided bus
- battery-powered vehicles
- electrification for lightly used routes
- community rail.

4.2 Conversion of heavy rail infrastructure or services to operation by tram and tram train

4.2.1 Definition

Conversion of heavy rail infrastructure or services to operation by tram

'Tram conversion' refers to the adaptation of heavy rail lines or services to be operated as a tramway. In its Guidance on Tramways (2006), the Office of Rail Regulation (ORR) defines a 'tramway' as being a rail based passenger carrying mode of transport where the public have access to the vehicle and the speed of operation mean that any such vehicle is able to stop within the distance the driver can see to be clear ahead. This is known as operation by line of sight. The guidance divides tramways into three separate categories:

1. integrated on street – a tramway operated by line of sight where the rails are laid in the highway which is capable of being used by other vehicles or by pedestrians
2. segregated on street tramways – a tramway operated by line of sight where the rails are laid within the boundaries of a highway, and may be crossed by pedestrians but other vehicles may only cross at designated crossing points
3. off street tramways – a tramway operated by line of sight or signalled, or by a combination of the two where the track is wholly segregated from any highway; and the alignment is wholly separate from any highway. [1]

Conversion of heavy rail infrastructure or services to tram operation has formed a part of the creation of new tram networks in England and for light rail has been a feature of the Docklands Light Railway and Tyne and Wear Metro. Once a line is converted from heavy rail it may or may not retain the original infrastructure and train control system, though the route will operate with tram vehicles. The range of circumstances of heavy rail to tram conversion can vary considerably, for example:

- full separation by taking over the entire former railway formation and services – for example the Manchester Metrolink Bury line or the London Tramlink between Wimbledon and West Croydon
- full separation but sharing the alignment with heavy rail – for example the parallel alignment with heavy rail between Wilkinson Street and Bulwell on Nottingham Express Transit, see Figure 4.1
- segregated operating but without on street running as was proposed for the Watford Junction – St Albans Abbey line.

Until 1992 when Metrolink opened in Manchester, Blackpool was the only urban tramway remaining in Great Britain. There is considerable variety between the tram systems in terms of platform design, tram length, voltage, maximum gradients and wheel profile. In recognition of this variety, ways of standardisation are being considered by the tram industry.

Appendix A – Tram and Tram Train in Great Britain provides details of the tram systems in Great Britain, including the tramway that is currently being constructed in Edinburgh. A light rail or metro service may share many of the same characteristics as a tramway. However the lack of line of sight operations means that they cannot be shared with pedestrians or highway vehicles and must be wholly separated from the highway.

1 Source: Page 3, Railway Safety Publication, Guidance on Tramways, (2006) ORR

Converting to a tramway means that signalling equipment can be reduced (line of sight) and level crossings become tramway crossings falling under the responsibility of the relevant highway department.

Using an existing heavy rail alignment potentially reduces the cost of a tramway as on street sections are minimised. This avoids disruption on affected highways and the need for complex utility diversions which can form a considerable proportion of the capital cost of the construction of a tramway. However, the nature of an on street tramway with more frequent stops compared to a former heavy rail alignment means that a direct comparison may not be relevant in reality. A convertible rail line and an on street tramway proposal will not necessarily serve the same markets.

Tram vehicles are typically less able to withstand impact than their heavy rail counterparts and need to be segregated from heavy rail. This can be achieved through the signalling system or through physical separation from one another. Tram conversion can potentially reduce the operating costs of existing services. For enhancements, tram may reduce the costs of infrastructure at potentially lower capital, maintenance and operating cost than heavy rail.

Tram train

A tram train vehicle is best defined as a tramcar capable of operating on both a street tramway and heavy rail networks. They are differentiated from other tramway vehicles through being equipped with technology to interface with heavy rail systems. This relates to signalling, power supply, control and telecommunications. Several definitions exist, but this document uses the definition from the city of Karlsruhe in Germany where the concept originated. Tram train operation is enabled by the linking up of tramways with conventional heavy rail networks and the operation of the resultant service by tram style vehicles on both tramway and heavy rail routes. For passengers, a tram train offers a single journey between tram stops and conventional rail stations.

The tram train pilot between Rotherham and Sheffield will be the first tram train service to operate in Great Britain. See Section 4.2.2 for details.

Figure 4.2 shows a tram train in Karlsruhe operating on street, on a segregated tram route and on a route shared with heavy rail infrastructure. Appendix B – Tram train in Europe provides further details of the origins of tram train and its deployment in Europe.

The tram train vehicle is recognisably a tram but is able to cross the interface between heavy rail and tram to enable greater connectivity and city centre penetration. It has the advantage of high acceleration on heavy rail routes in comparison with Diesel Multiple Units (DMUs).

Tram trains are high density articulated rail vehicles capable of operating over street tramways or line of sight signalled railways, as well as on a fully signalled heavy railway. They may have a lower axle weight than some heavy rail vehicles. Tram trains have high acceleration and braking rates. They are fitted with magnetic track brakes for use in emergency situations, particularly when operating on the highway, enabling them to stop in a similar distance to a bus.

The vehicles are typically powered by overhead electric line. Tram train vehicles can be dual voltage to be compatible with the national heavy rail network traction power. Although diesel electric bi-mode tram trains have been used in a small number of locations, their increased maintenance cost and fuel consumption makes them potentially more costly. Bi-mode tram trains are more bespoke vehicles which can increase procurement costs.

To enable compatibility with tramways, stations on the heavy rail route may have to include a low height platform section as most tramways operate low floor vehicles where the platform heights are around 300-380mm. However, tram style stops are significantly lower cost than conventional heavy rail stations to construct. The improved vehicle performance over DMUs and reduced dwell times achievable with tram style operation enable additional stops to be provided. This may avoid significant increase in journey time.

The introduction of tram train has produced benefits to the travelling public by increasing the availability of journey opportunities and crucially reducing the requirement for interchange. Typically tramways serve multiple locations within a city centre, rather than solely a main railway station. In some cities the main railway station is located some distance from areas of employment, education or leisure activities. By providing direct access to other locations the generalised cost of transport is reduced and this is anticipated to increase demand. Tram train vehicles are optimised for services with frequent stops and relatively short passenger journeys.

Tram train schemes have often been introduced along with a varied package of measures such as changes to other modes of transport and ticketing.

Figure 4.2 – Photographs of tram trains in Karlsruhe (left to right) on an on street tramway, in segregated operation, and on heavy rail

Consequentially it is not possible to generalise about the impact of conversion to tram train on passenger demand. Chapter 6 focuses on specific examples in Great Britain of proposed tram train schemes rather than generalising from the market conditions in a German city. Some of the factors which affect demand may be achievable using heavy rail or other public transport options. In developing a specific scheme, a range of options would need to be tested to make sure that tram train is the most appropriate and best value for money option to address transport gaps.

4.2.2 Tram train pilot

The tram train pilot between Rotherham and Sheffield will commence in 2016. The pilot will run for two years with a view to permanent operation. The seven new vehicles will provide three services an hour operating from Parkgate Retail Park in Rotherham, travelling through Rotherham Central station and joining up to the existing Supertram network at Meadowhall where the services will then continue onwards to Sheffield City Centre, as shown in Figure 4.3.

The tram train pilot is a partnership between the Department for Transport (DfT), Network Rail, Northern Rail, South Yorkshire Passenger Transport Executive (SYPTE) and Stagecoach Supertram. SYPTE will lead on delivery of the pilot. This includes the construction of a 400 metre line connecting the tramway to the heavy rail network, and of the 750V DC overhead line electrification (OHL) on the heavy rail network between Rotherham and the new link line to the Supertram network. Tickets will be fully integrated with Supertram.

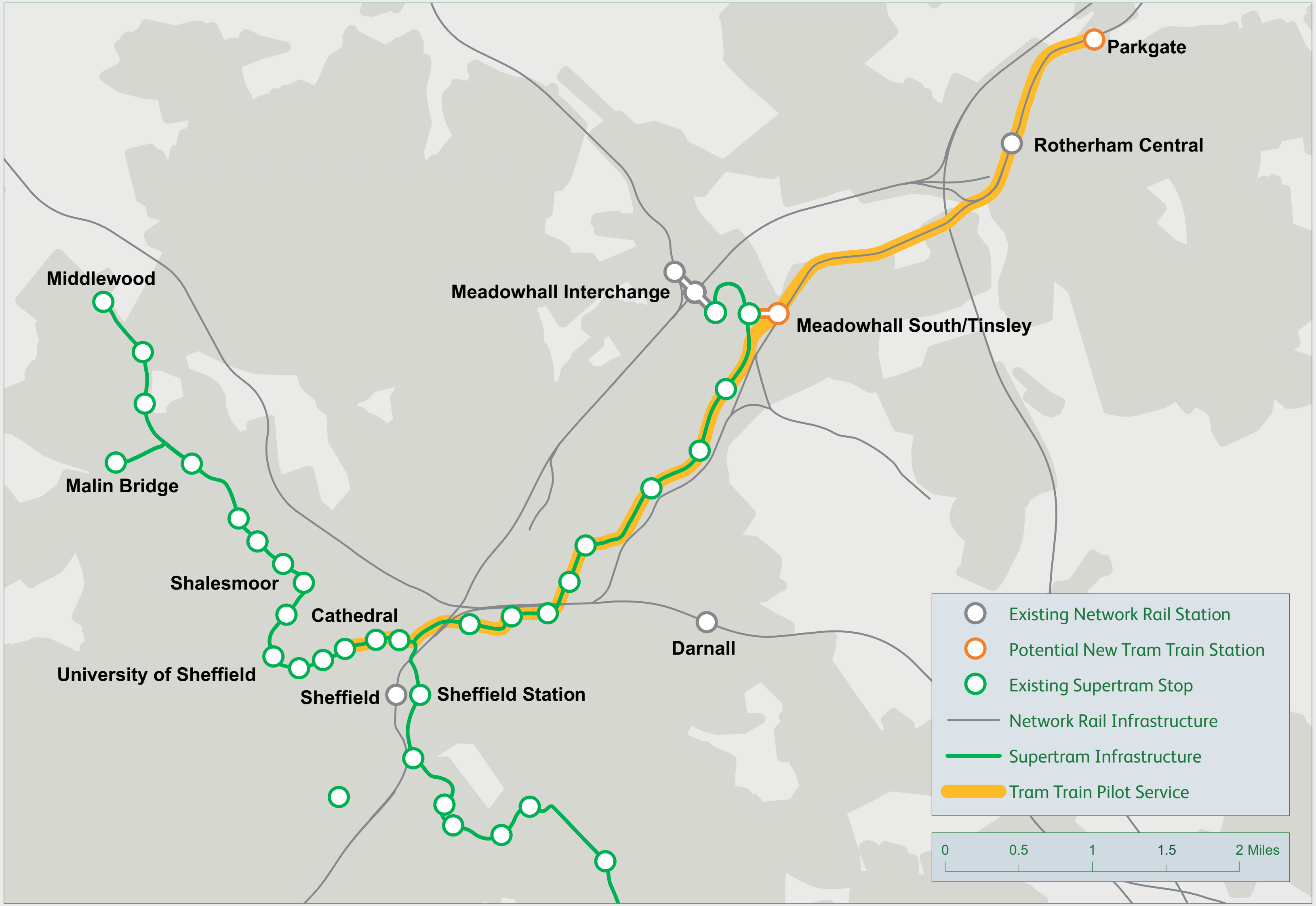
The pilot has the following objectives:

- ‘understand the changes to industry costs of operating a lighter weight vehicle, with track brakes, on the national rail network
- determine changes to technical standards required to allow inter running of light weight tram type vehicles with heavy rail passenger and freight traffic and to gain the maximum cost benefit from tram train operation
- gauge passenger perception and acceptance of tram train vehicles as a replacement for existing heavy rail services
- determine the practical and operational issues of extending tram trains from the national rail network to an on street tramway
- understand the technical and operational challenges involved in this project so that the concept can potentially be rolled out elsewhere.’ [2]

The trial will also increase rail connectivity between Rotherham and Sheffield centres. It will improve accessibility by sustainable means to new economic developments in the Lower Don Valley, with no increase in heavy rail capacity required at Sheffield station. This strategy builds upon the objectives of this pilot, by considering the extent of the market for the operation of tram train in Great Britain as a whole.

2 Source: Network Rail, Tram Train Trial Interim Learning Report (2010)

Figure 4.3 – Map of the Sheffield to Rotherham tram train pilot (source: Network Rail)



4.2.3 Tram and tram train capabilities

Rolling stock capacity

As with any rail service the maximum number of passengers that can be carried on a given service is a function of two basic factors:

- train capacity – the maximum numbers of passengers per train
- service frequency – the maximum numbers of services in a given direction on a particular route.

Table 4.1 presents the capacities of a range of trams, tram train, hybrid light rail and heavy rail vehicles. A two-car heavy rail train has approximately the same capacity as a tram or tram train.

However, because heavy rail vehicles can potentially operate in multiples of greater than two, and can be configured in higher density interior layouts, heavy rail vehicles have a greater range of capacities. Trams and tram trains are high density rolling stock with a low ratio of seating to standing passengers. This internal layout configuration is common for the kind of services on which they operate with frequent stops, with passengers travelling for a relatively short time.

Table 4.1 – Rolling stock seating and standing capacity (source: Network Rail)

Vehicle type	Vehicle type	Unit length (metres)	Total number of seats	Total passenger capacity including standing allowance	Total passenger per metre of rolling stock unit length
Hybrid light rail (1-car)	Class 139	8.7	20	60	6.9
Heavy rail DMU (1-car)	Class 153/1	23.21	73	98	4.2
Midland Metro tram	Ansaldo T69	24	56	152	6.3
Nottingham Express Transit tram	Bombardier Incentro	33	54	183	5.5
Manchester Metrolink tram	Bombardier M5000	28.4 (two trams =56.8)	60	206 (two trams =412)	7.3
London Tramlink tram	Bombardier C4000	30.1	70	208	6.9
Heavy rail DMU (2-car)	Class 170/2	47.22	122	210	4.4
Karlsruhe tram train	Vossloh Citylink	37.2 (two tram trains=74.4)	104	224 (two tram trains =448)	6.0
Mulhouse tram train	Siemens Avanto	36.68	85	231	6.3
Sheffield Supertram	Siemens	34.75	88	243	7.0
Heavy rail Electric Multiple Unit (EMU) (3-car)	Class 375/3	60.79	176	291	4.8
Heavy rail DMU (3-car)	Class 170/3	70.86	196	325	4.6
Heavy rail EMU (4-car)	Class 377/4	80.78	253	398	4.9
Heavy rail EMU (5-car)	Class 376/0	100.68	226	642	6.4

Both trams and tram trains can be operated in multiple on certain systems. In Great Britain, Manchester Metrolink is the only system where trams operate in multiple formation. Frequency of tram or tram train routes may also be constrained by the density of traffic on core on street sections as well as wider track capacity.

The maximum length of trams and tram trains is constrained by the need to operate on street. For most tramways, two 40 metre trams operating in multiple represent the upper limit.

Figure 4.4 shows the impact of two tram trains operating in multiple on the occupation of road junctions. Additionally, the building of 80m station platforms to accommodate such tram formations, in a densely urban environment may be challenging.

Figure 4.4 – Photograph of a tram train service in Karlsruhe

Table 4.2 illustrates the range of maximum numbers of passengers conveyed in a single direction for different frequencies by heavy rail and tram rolling stock. It has been assumed for this illustrative presentation, that a heavy rail vehicle carries a maximum of 100 passengers (both seated and standing capacity), a 30 metre tram carries 200 passengers and a 40 metre tram train carries 250 – 300 passengers. It concludes that there is a wide range of the maximum number of passengers that can be carried on a given route using heavy rail vehicles ranging from single car DMUs to 12-car EMUs.

Tram and tram train sit in a spectrum of public transport systems which range from the bus, to bus rapid transit and guided busways, to tram to heavy rail and then to metro. Tram and tram trains are lower capacity rolling stock tailored to providing a high frequency service, with frequent stops and shorter journeys where a higher percentage of standing passengers is appropriate. They cater for large volumes of passengers by enabling a high frequency through service.

By contrast,heavy rail services can accommodate similar volumes by lengthening services. The table does not suggest that it would be possible to have a 12-car service on all routes. It illustrates the likely flow of passengers and the frequency of services required to carry that volume of passengers for differing capacities of rolling stock.

The capacity of a tramway is less constrained by the capacity of the signalling system than a heavy rail service. Tramways, when operating on segregated alignments, can readily provide a service of over 30 trams per hour. Metrolink currently operates 25 trams per hour per direction through Cornbrook which could increase to 40 by the time the expanded Metrolink network has been completed. This would provide a theoretical maximum capacity of 16,000 passengers per hour per direction if all units operated in multiple through the core of the Metrolink network. Table 4.2 is most relevant to the individual corridors that form the network where the frequency would be likely to be lower than the city centre sections where routes combine.

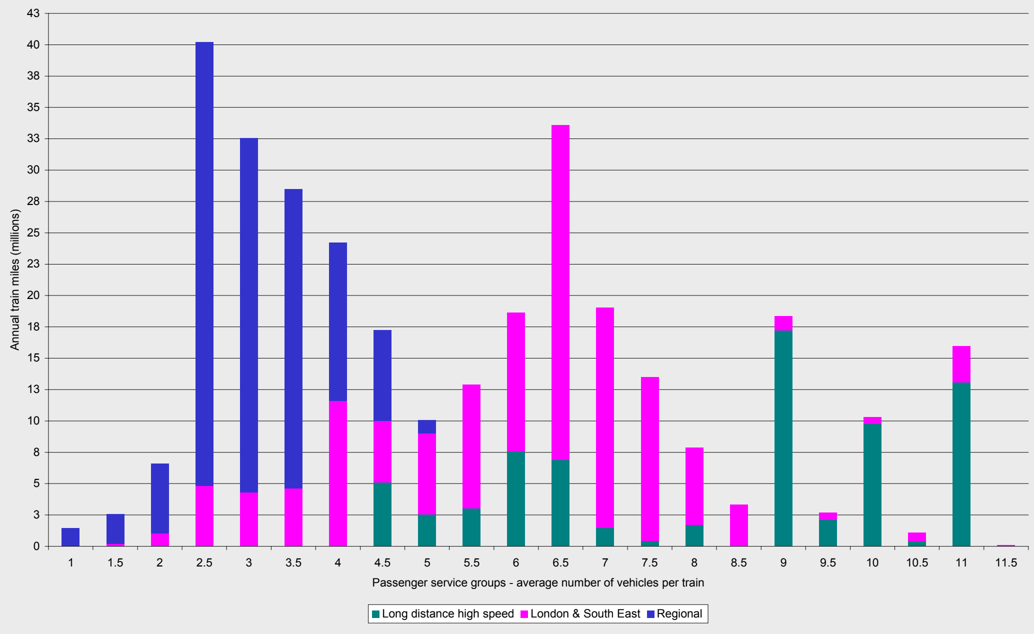
Table 4.2 – Illustrative passengers per hour per direction capacity for differing rolling stock and frequencies (source: Network Rail)

Rolling Stock	Maximum passenger per hour per direction capacity (approximate total seating and standing) services per hour											
	1	2	3	4	5	6	7	8	9	10	11	12
Hybrid light rail (Class 139)	60	120	180	240	300	360	420	480	540	600	660	720
1-car DMU	100	200	300	400	500	600	700	800	900	1000	1100	1200
Tram (30 metres)	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
2-car DMU	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
Tram train (40 metres)	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
3-car EMU	300	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600
Tram (2-units)	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800
4-car EMU	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800
Tram Train (2-units)	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
6-car EMU	600	1200	1800	2400	3000	3600	4200	4800	5400	6000	6600	7200
8-car EMU	800	1600	2400	3200	4000	4800	5600	6400	7200	8000	8800	9600
12-car EMU	1200	2400	3600	4800	6000	7200	8400	9600	10800	12000	13200	14400

Figure 4.5 shows the annual train miles for 2011-12 by the average numbers of vehicles per train service. This is broken down further to show the high level market sectors of regional, London and South East and long distance high speed train operators. This shows that most regional services operate as DMUs and therefore on average, have a lower number of vehicles per train.

The Network RUS: Passenger Rolling Stock Strategy notes that 59 per cent of DMUs were two-car units and 69 per cent of EMUs were four-car units. The market that is applicable to tram and tram train conversion is therefore the regional sector because of the volume of passengers per service.

Figure 4.5 – Annual train miles (millions) by average number of vehicles per train for regional, London and South East and long distance high speed passenger services (2011-12) (source: Network Rail)



Rolling stock acceleration

Figure 4.6 compares the performance of a Class 350 EMU, a Class 150 DMU and a Sheffield Supertram on a line with a maximum line speed of 120kmh. The graph demonstrates that up until 1.6 kilometres (km) the tram's acceleration means that although it has a lower top speed (80kmh) it is faster than both DMU and EMU.

The DMU's higher top speed means that after 3.12km it would overtake the tram. Tram trains, whilst likely to have similar acceleration and braking as a tram, can have a higher top speed of 100kmh. This would affect the point at which it was overtaken by the heavy rail rolling stock.

Figure 4.6 – Rolling stock speed and acceleration (EMU, DMU and Tram) on a line with a 120km speed limit (source: Network Rail)

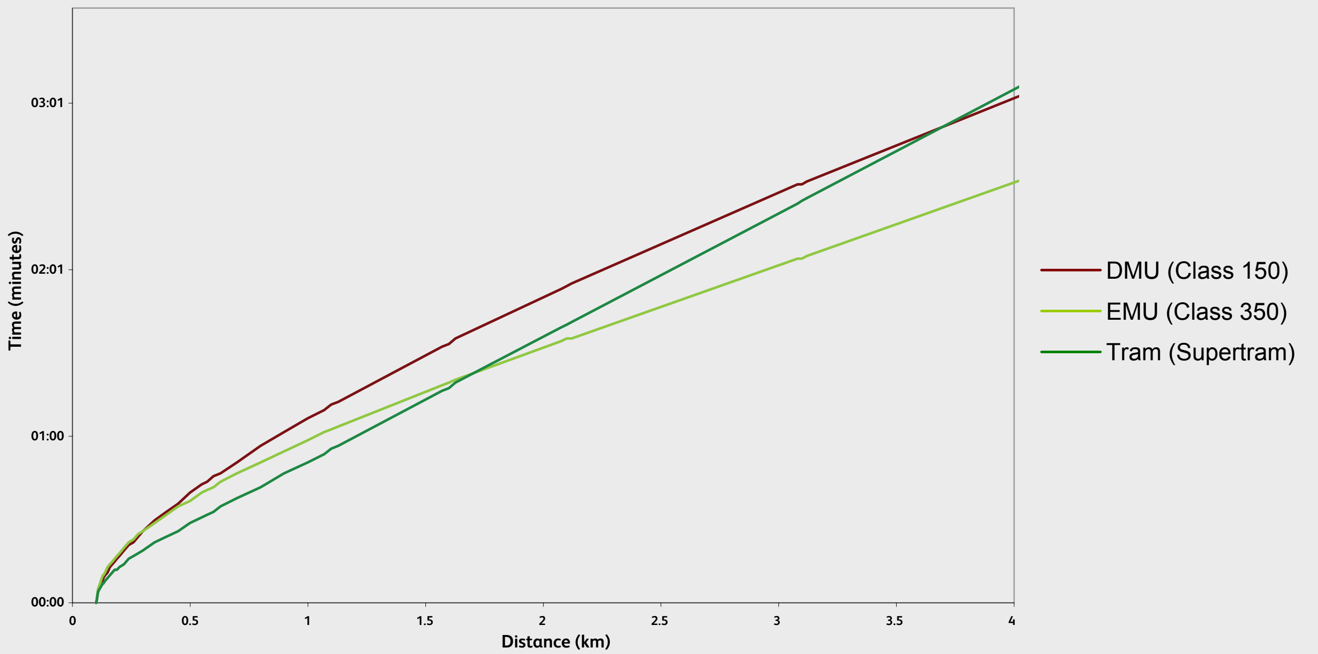


Table 4.3 shows a more pronounced advantage of tram style rolling stock which is able to use more rapid acceleration and braking to be able to maintain a higher average speed than either a DMU or an EMU where stops are close together. The results of the rolling stock modelling are for a line with a top speed of 120 kilometres per hour.

They compare a Class 350, Class 150 and Supertram. The time taken for a tram from start to stop is faster than both EMU and DMU at distances between stops of below three km. At distances below six km between stops, the tram is faster than a DMU.

Table 4.3 – Comparison of start to stop times for an EMU, a DMU and a Tram for varying distances between stops on a line with a 120km speed limit (source: Network Rail)

Rolling Stock	Distance between stops							
	500 metres (m)	1000m	1500m	2000m	3000m	4000m	5000m	6000m
Tram (Supertram)	00:44	01:07	01:29	01:52	02:37	03:22	04:08	04:52
Class 350 (EMU)	00:55	01:19	01:39	01:56	02:27	02:57	03:27	03:56
Class 150 (DMU)	01:03	01:34	01:59	02:22	03:03	03:39	04:15	04:46

Trams and tram trains are both used generally for shorter trips than heavy rail services. The statistics for average journey distances for the existing tramways in Great Britain are shown in Table 4.4. This shows that the average journeys are in general short. This matches the frequent stopping pattern of the tram services and configuration of the tram vehicles.

Manchester Metrolink has the longest average journey length. This reflects the fact that the conversions of the Bury and Altrincham line resulted in only a short section of on street running. Therefore the tram network retained much in common with the suburban rail network that it replaced.

Table 4.4 – Average length of journey on trams by system: England 2011-12[3]

System	Miles
London Tramlink	3.2
Nottingham Express Transit	2.8
Midland Metro	6.5
Sheffield Supertram	4.0
Manchester Metrolink	7.7
Blackpool Tramway	1.9

3 Source: DfT Light Rail Statistics 2011-12 (http://www.dft.gov.uk/statistics/series/light-rail-and-tram/)

4.2.4 Capital costs

There has been a difference in how tram schemes are funded in comparison with heavy rail. Typically for the creation of a new tram system, a central Government capital grant has been provided to cover a large portion of the cost of developing the infrastructure and purchasing the rolling stock. The funding of the tram scheme has generally been justified on the basis of the wider economic benefits that they will generate.

Tram systems are planned to generate revenue to cover the cost of operations and potentially a portion of the capital funding. They do not necessarily have provision for life cycle renewals. At the stage when a large scale renewal is required of either infrastructure or rolling stock, further central Government funding may be required. Renewals are not always funded by central Government. For example, Transport for Greater Manchester has funded the replacement of twelve life-expired trams through borrowing.

Tram train

The capital costs of construction of a tram train scheme consist of three elements:

1. the cost of conversion of the heavy rail existing infrastructure
2. the cost of connection to an existing tramway
3. the construction cost of a tramway (if one does not exist).

The extent of these cost components may be a determining factor in the viability of any scheme. These costs will be investigated in the tram train pilot. The estimates for the capital cost of the heavy rail infrastructure to enable the tram train pilot service to operate are:

- signalling and telecoms – 30 per cent of total cost
- electrification and plant (approximately 11.5 single track kilometers) – 40 per cent of total cost
- track (connection to tramway, modifications associated with tram train wheel profile)– 20 per cent of total cost
- stations (new platforms at Tinsley and Rotherham Central, as well as a new station at Parkgate) – six per cent of total cost
- structures – less than five per cent of the total cost.

The cost of track and a portion of the signalling and telecoms cost in the tram train pilot example relate to the provision of a 400 metre connection between the tram and the heavy rail networks which run in parallel. The cost of connection is less than half the infrastructure cost of the overall scheme. Where the connection is more complex and requires substantial new infrastructure, the cost of connection could form a larger percentage of the total. The connection cost and the extent of new infrastructure required to convert a section of heavy rail route would be important factors in a business case for a tram train scheme. As with the tram train pilot, there may also be enhancement costs to provide additional stations on the heavy rail network for increased service provision.

4.2.4.1. Conversion costs

Conversion costs comprise those capital works required to permit the operation of tram trains on existing heavy rail infrastructure. There are a range of conversion costs dependent on the extent of any infrastructure modification or enhancement which is required. Some of these items of conversion may not be applicable in all circumstances.

The cost of electrification is likely to be a significant element of the total cost of conversion. All British tramways are electrified with direct current (DC) overhead line electrification (OHL) to enable electric traction and on street running. DC OHL may be lower cost per single track kilometre than 25kV alternating current (AC) because it is a lighter system with smaller electrical clearances. Over a longer distance, with heavier trains, higher service frequencies, or higher speed the inherent inefficiency of DC as a result of transmission losses gives the requirement for additional substations. Therefore, DC electrification has not been selected for currently committed future heavy rail electrification. AC electrification can be of high voltage on the heavy rail network because the railway is separated from pedestrians and road vehicles.

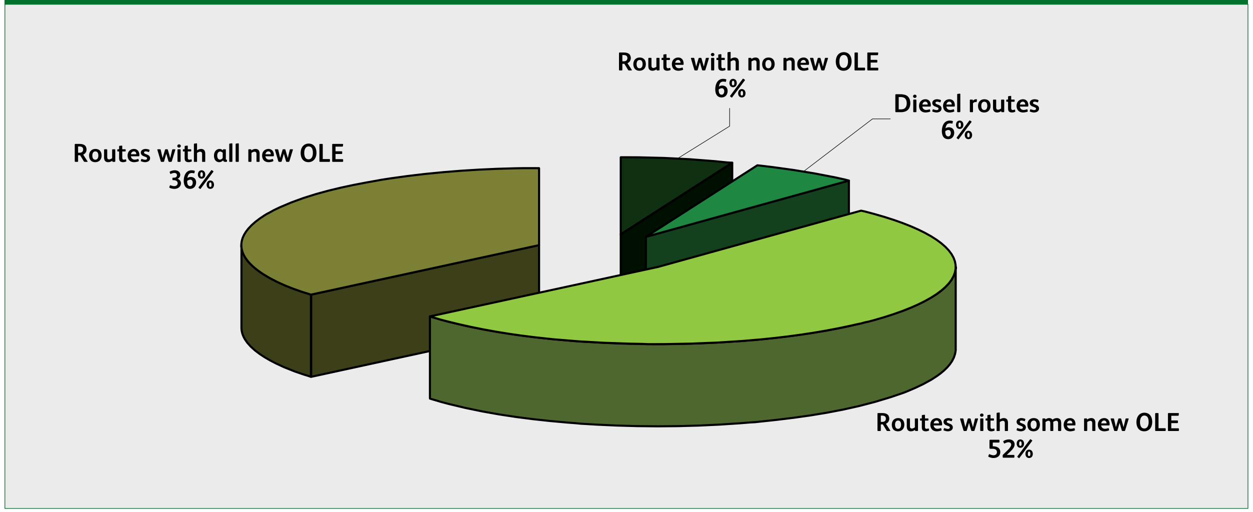
The main reason why 25kV AC OHL may be selected for a tram train scheme is that while operating on the heavy rail network it may be necessary for tram trains to be compatible with the heavy rail electrification network.

There are additional costs for dual voltage systems. These concern the provision of more complex rolling stock and infrastructure. Dual voltage tram trains require a transformer and rectifier which increase the weight of the rolling stock. This reduces potential operating and maintenance cost savings in comparison with a tram. The decision on electrification type would be a trade off between the strategic requirements of the heavy rail network and the most cost effective system in the context of the route.

For the tram train pilot, the structures component of the infrastructure cost is lower than would typically be seen for 25kV AC electrification because of the smaller electrical clearances required for 750V DC OHL. In a 25kV AC scheme, structures gauge clearance might result in 30 – 40 per cent of the capital cost of electrification (source: Network RUS: Electrification, 2009). These savings will be explored by the tram train pilot.

Figure 4.7 illustrates that the majority (88 per cent) of EU tram train projects have involved some degree of new electrification. In 36 per cent of cases the entire length of the route required electrification. There may be a cost to provide low floor platforms at existing stations in order to permit the usage of low floor trams. This cost only applies to low floor trams as heavy rail platforms are higher than the floors of most tram systems in Britain. Tram stops may be cheaper to construct than heavy rail stations but the potential for reduced station cost relates only to new, or substantially renewed stations, and not for existing stations. The lower costs for new stations relate only to the enhancement of the rail system. For the conversion of a route to tram train with low floor, there would be a cost to provide low floor platform arrangements.

Figure 4.7 – Percentage of European tram train routes by the extent of new or existing electrification and diesel operation[4]



4 Source: Axel Kühn 2012

Figure 4.8 shows the separate low platform extension to accommodate a tram train at a station in the Netherlands. This requires newly constructed low platforms, ramps to access the platform and fencing to make sure passenger safety is not compromised. Where low floor tram trains operate in conjunction with heavy rail vehicles or at former heavy rail stations, these kinds of solutions will be needed and represent a cost of conversion. Conversely a high floor city centre tramway will have higher tram stop costs than a low floor tramway. The issues of low floor rolling stock on the heavy rail network are being considered by the tram train pilot.

Tram trains do not have the same level of crashworthiness as heavy rail vehicles. Therefore they may need greater protection from the train control system to maintain safety.

On lines where capacity is not an issue, for example with only very limited heavy rail traffic, solutions which increase separation and reduce capacity may be appropriate mitigation. In areas where capacity is at a premium, more sophisticated signalling solutions may be required. These solutions will have varying capital costs.

Where the remaining heavy rail service is infrequent e.g. overnight freight traffic, it might be possible to avoid the need for tram train by the use of tram vehicles. It would need to be made certain that freight trains operate only after the last tram or before the first daytime service. The potential safety risks would need to be evaluated. The inherent inflexibility of this arrangement whereby heavy rail services could only be operated at night, thus removing the route's ability to serve as a diversionary route during the day, would need to be fully considered.

Figure 4.8 – Photograph of a low platform extension to accommodate a low floor tram train

If appropriate, this method of working could mean that the need for the cost and complexity of a full tram train approach could be avoided. A simpler tram solution might be possible. Consultation responses to the Scoping Document from Freightliner Group Ltd. raised concerns with this approach on the basis that:

- timing of freight trains may be relatively inflexible as a result of their passage through other parts of the network during their journey
- freight terminals may have planning restrictions on their hours of operation.

Modifications are required to the track to enable the tram train wheel profile to operate across switches and crossings. This is likely to involve the installation of raised check rails to compensate for the more tram like wheel profile. Equally, modifications may be required to the tramway in order to accept the tram train wheel profile. Modifications will be required in all circumstances where existing infrastructure is used. Where new segregated track is built it would be likely to be optimised to the tram train wheel profile.

The quality of track may need to be improved on the heavy rail route in order to maintain ride quality for the tram train. This is because as a lighter rail vehicle it may have less tolerance to lower maintenance standards of track. This is likely to be of particular relevance where tram trains convert freight only or secondary routes.

4.2.4.2 Connection costs

The tram train pilot connects to the tram network in Sheffield at a location where the heavy rail and tram lines run in parallel. This represents a simple and relatively straightforward connection.

In contrast, a connection that required substantial new on street running and where no available land was present for straightforward connection to the tramway would be more expensive. Connection costs will fit into a range depending upon the specific circumstances of the route assessed for conversion. This cost range is likely to be a function of the complexity of the connection and the technical and geographic challenges that need to be overcome to link a tramway with the railway.

Heavy rail to tram

Tram conversion results in similar considerations to tram train with the exception that the interface is not maintained with the heavy rail network and through running does not occur in passenger operation. Therefore there is no direct systems interface. The connection can be physically severed, but this may have costs as signalling, power supplies and track may need to be modified. However, tram conversion means that simplified train control can be implemented and potentially reduce costs further than is possible for those sections on which a tram train operates with heavy rail vehicles.

Tram vehicles are lighter than some heavy rail vehicles and may have associated cost savings. Where heavy rail traffic is limited, segregation may be effectively achieved through modification to the signalling system or potentially by only operating freight services at times when passenger services are not in operation. The extent of the arrangements to segregate traffic will depend entirely on the circumstances and frequency of any retained heavy rail services.

It is likely that a tram conversion from an existing tramway network would require a new depot. The Passenger Rolling Stock Depot Planning Guidance Document provides information and guidance on the construction of new rolling stock depots. The guidance is available on Network Rail's website at: www.networkrail.co.uk.

New routes

Tram has been used as an option to open new routes on former heavy rail lines e.g. the Midland Metro. However, the appropriateness of the route for tram is dependent upon whether a tram style vehicle would be suitable for the market served. Similar cost issues would exist as for a conversion except that the infrastructure can be tailored to the characteristics of the vehicles and is less constrained by existing assets.

The cost breakdown for the new heavy rail route between Airdrie and Bathgate is outlined in Table 4.5. It shows the comparative costs for each component of reopening. This is for illustration purposes and is not intended to suggest that the Airdrie to Bathgate line would have been appropriate for tram.

It is likely that cost savings would be possible using tram instead of heavy rail in a number of scenarios. These savings relate to the lower axle load of the vehicles and to the savings associated with being able to drive on line of sight, which may mean that there is no need for footbridges and lifts at stations.

Lower axle weight means that the track and formation can be designed to cater for lower weight vehicles reducing capital costs. Over the whole life of the assets, renewals and maintenance may also be lower.

The ability of trams to stop using magnetic track brakes in a similar distance to a bus means that the train control system is not a full signalling system. It relies on the driver and braking system rather than the signalling system alone.

If hybrid light rail vehicles such as the Class 139 were used, the extent of savings might be greater than for a heavier dual voltage tram train. The extent of any savings would be dependent on circumstances. A key difference in cost might be the use of a self powered hybrid light rail vehicle avoiding the cost of electrification infrastructure. However, any such decision on traction and rolling stock would need to be made considering the difference in whole life whole industry cost of self power and conventional electrification.

There may be additional costs of a depot and other facilities such as a control room which might not be required for a new line connected to a heavy rail system. These potential additional costs relate to the standalone nature of a light rail line separate from the rest of the heavy rail network.

The key question in terms of feasibility is whether the market conditions exist such that a tram style vehicle is appropriate and whether the market can be served without the substantial disadvantage of a segregated system.

Table 4.5 – Airdrie to Bathgate line capital costs range by type of asset (source: Network Rail)

Cost component	Lower range of total scheme cost	Upper range of total scheme cost
Depot	0%	10%
Electrification	10%	20%
Signalling & telecommunications	10%	20%
Stations	10%	20%
Track	10%	20%
Civils and structures	30%	40%

4.2.5 Operating cost

Currently there are no operational tram trains in Great Britain and the tram train pilot seeks to understand the impact of tram train on operating costs. It is assumed based on the experience of tram operators and the cost estimates of the tram train pilot, that operating costs may be affected as follows:

- lower track maintenance cost possible but dependent on circumstances
- electric tram train lower energy consumption than heavy rail EMU
- staff cost savings.

With trams, operating cost saving categories would be similar to tram train but potentially greater, as all heavy rail cost is eliminated. The lower tram costs stem from the lack of duplication of systems and the greater savings from the lighter weight vehicles.

It is important to note in the case of both tram and tram train that the loss of economies of scale, such as lower fleet utilisation resulting from smaller fleets (see Figure 4.11), might counter some of the lower operating costs.

The tram train pilot will investigate the detailed operational cost impact of tram train and any tram conversion will make an assessment of these issues on a case by case basis. This RUS has considered in detail the impact on rolling stock cost and the traction choice between electric and self powered vehicles.

Rolling stock costs

The Network RUS: Passenger Rolling Stock Strategy, asked the Rail Industry Association (RIA) and its rolling stock members two specific questions about procurement costs:

1. what is the variation in vehicle cost with order volume?
2. what is the cost of discontinuous rolling stock procurement?

The conclusions showed that a significant amount of non recurring cost investment, such as research and development, is required to produce a new type of rolling stock. This work is typically unique to each rolling stock fleet and there are few synergies between the research and development activities undertaken for different types of rolling stock. It is estimated by RIA that the cost of this work is, 'rarely less than £10 million, even for repeat orders of trains, and can reach as much as £100 million for substantially or completely new train specifications'.

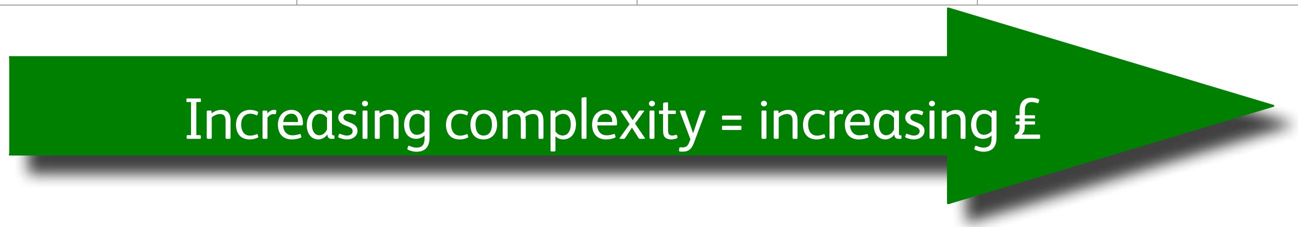
Further information from RIA suggests that a reduction in the number of variants, and an increase in the number of vehicles of each variant, would reduce both the one off research and development share of the total cost per vehicle and the average cost per vehicle. It is also estimated that this increases the cost of building rolling stock for the British market by approximately 20 per cent over what would have been possible against a scenario of continuous production. This figure is exclusive of any costs incurred in the bid process.

This research suggests that the highly bespoke nature of tram trains combined with a likely lack of continuity of orders means that the unit price for such rolling stock may be high in comparison with conventional heavy rail rolling stock where procurement economies of scale and continuity of orders can potentially be exploited. Tram and tram train orders may be able to be linked to those from other European countries in a way in which is generally more difficult for conventional heavy rail rolling stock because of the difference in platform height and gauge. This could be a means of achieving a more optimum order size to generate a lower unit cost.

There has been a difference in the way in which heavy rail and tram rolling stock is purchased. For tram schemes, rolling stock is typically purchased as part of a capital grant to build the tramway or renew the tramway. Heavy rail vehicles are for the most part leased from Rolling Stock Companies (ROSCOs).

This also reflects the wider market for heavy rail vehicles in Britain and consequently the possibility of re-use and subsequent residual value as a leased asset.This can make cost comparison less straight forward. Figure 4.9 shows the relative price comparison and the increasing capital cost with the complexity of the rolling stock.

Figure 4.9 – Cost of rolling stock assumptions, tram train (single voltage) tram train (dual voltage), tram train (diesel-electric bi-mode) (source: Network Rail)

<table>
<tr><th>Tram</th><th>Single voltage tram train</th><th>Dual voltage tram train</th><th>Bi-mode tram train</th></tr>
<tr><td>Capital costs range from slightly cheaper than two EMU vehicles to similar cost</td><td>More complex than equivalent tram</td><td>More expensive than a single voltage tram train</td><td>More expensive still and potentially higher cost than equivalent two-car DMU as a result of complexity</td></tr>
<tr><td colspan="4">
</td></tr>
<tr><td colspan="2">EMU vehicle lease per annum</td><td colspan="2">DMU vehicle lease per annum</td></tr>
<tr><td colspan="2">£90,000*</td><td colspan="2">£110,000*</td></tr>
<tr><td colspan="4">*Source: Network RUS: Electrification (2009)</td></tr>
</table>

Diesel tram trains

Diesel tram trains are in operation in a number of locations around Europe most notably in Germany where diesel electric hybrid tram trains are in operation in Kassel (Figure 4.10). The first phase of the tram train pilot planned to introduce diesel powered tram trains between Huddersfield and Sheffield. However, at the time no emissions compliant diesel engine was available for use in a tram train and so this phase of the pilot was put on hold. The tram train pilot project understands that there may now be bi-mode tram train products under development. The question of order size is likely to be an issue for any purchase of tram train vehicles as they are individually unlikely to be of a sufficient size to realise economies of scale or continuity of production.

Diesel tram trains represent only a percentage of an already small global market for tram train rolling stock. Compared to electric tram trains, diesel powered vehicles are heavier, due to having to carry their own engine and fuel. This strategy has therefore assumed because of the experience of the tram train pilot and the highly bespoke nature of the diesel tram train product that electric tram trains are the most likely option. Electric tram trains have therefore formed the starting point of the analysis.

Figure 4.10 - Photograph of a bi-mode tram train in Kassel

Fleet utilisation

For any alternative solution likely to be employed on a small scale in any location, fleet utilisation is a significant issue. Fleet utilisation is the maximum percentage of the traction units which are in operation each day. The Network RUS: Electrification (2009) said that a typical electric fleet had an availability of 91 per cent.

Figure 4.11 demonstrates that for a fleet size of less than 20 units, it is difficult to achieve this level of availability of rolling stock. This is because with a larger fleet, economies of scale mean that a smaller proportion of units are required to provide spare cover for maintenance.

The dip in percentage availability between five units with one spare, and six units with two spare, is because the latter has a greater percentage maintenance cover proportional to the total fleet size.

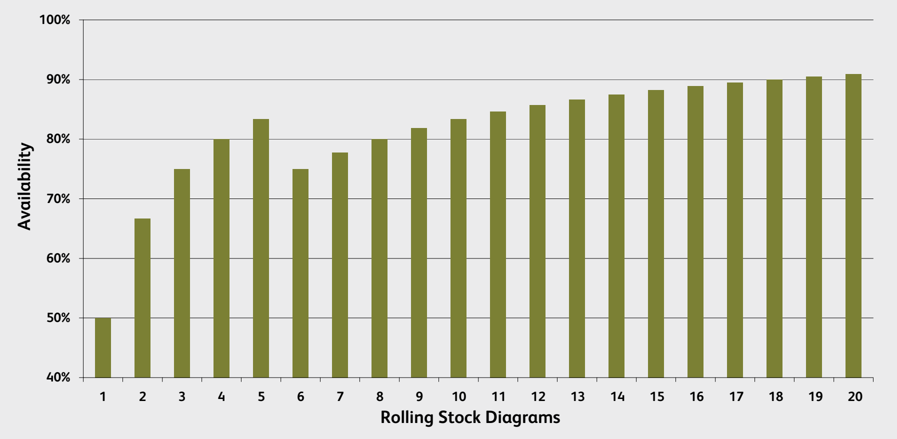
If an alternative solution results in small fleet, this may increase the total number of vehicles required to operate the service compared with a large standardised fleet. This conclusion applies to tram and tram train, as well as across the heavy rail industry.

4.2.6 Hybrid light rail

The term hybrid light rail refers to a number of differing solutions. The common features that these proposals share is the use of a lighter weight vehicle with potentially lower capacity and hence cost. The concept proposes relatively limited changes to existing infrastructure and may or may not be self powered. For new infrastructure it is contended by those promoting such schemes that substantially reduced costs might be seen.

Some of these solutions have been trialled but the only commercially operating service of this kind uses a Class 139 vehicle in segregated operation from the main line between Stourbridge Town and Stourbridge Junction. See Appendix C for further details of hybrid light rail operations on the Stourbridge Town branch.

Figure 4.11 – Typical fleet availability by number of rolling stock diagrams in a fleet (source: Network Rail)



4.2.7 Bus rapid transit and guided bus

Consideration of bus rapid transit (BRT) and guided bus by this strategy is only in the context of providing an alternative for re-opening a former railway line compared with either light or heavy rail technology. It is not seen as an alternative for existing operational railway lines.

A BRT system is essentially a conventional bus with interventions designed to optimise the whole journey experience. Appendix F has a case study of South Hampshire Bus Rapid Transit to illustrate the concept where the alignment of a former rail line has been used to create dedicated busway. The typical features of BRT are:

- a dedicated busway for the sole use of buses which in a number of instances has been formed from a former rail alignment to improve journey time and reliability
- traffic management measures and signal prioritisation at key network junctions across the route
- the in-vehicle environment will often be of a higher quality than other buses
- greater distance between stops than conventional bus services, to provide limited stopping pattern
- bus stop facilities of a higher quality, for example, with the provision of real time information
- high service frequency provision on the core of the route
- innovative ticketing systems to reduce boarding and dwell times
- BRT systems may have additional measures to maintain minimum standards such as service frequency and vehicle quality. This might be in the form of a Quality Bus Partnership which is an agreement between the local authority and operator.

A guided bus is very similar to the concept of BRT. The vehicles used are essentially conventional buses the only difference being that guided buses have the capability to run both on dedicated guided route sections and on the general public road network. BRT in contrast is operated by a bus with the driver fully controlling the vehicle throughout.

Appendix F has a case study of Cambridge Guided Busway to illustrate the concept. This busway was built on a former rail line for most of the guided sections.

The guided bus provides a very similar service offering to BRT, however, the use of guided bus differs in that:

- the additional fixed infrastructure gives a greater sense of permanence than a bus route and provides self-enforcing segregation (as other vehicles cannot use the guideway), assisting service reliability
- smoothness of the guided track improves ride quality
- guiding allows buses on the guided section to get closer to the kerb at stops to improve level boarding
- there are safety benefits on segregated sections
- buses can travel in opposite directions closer together as they are constrained within the two kerbs and therefore may require less land than a normal road.

In comparison with BRT, guided bus systems will have additional cost in relation to the construction of the guideway.

There are a variety of rubber-tyred tram and metro systems in existence around the world, with differing and often incompatible systems. While the specifics may vary, they all blend rail and road technology. Some are legally classified as buses (such as the Nancy rubber-tyred tram in France), whereas others such as the Mexico City Metro have more in common with a railway system. Globally they represent a small sub-set of urban light rapid transit systems. Rubber-tyred trams were suggested by the Isle of Wight Council on the basis that they could reduce the requirement for new fixed infrastructure to gain the benefits of a light rail system. This concept has therefore been assumed as having the same basic considerations as a guided bus scheme.

4.2.8 Personal rapid transit

Personal rapid Personal Rapid Transit (PRT) is automated transport by small vehicles on a dedicated guideway network with stations. In the future it may be possible for the guideway to be eliminated if autonomous guiding is used. At a pod station passengers are able to call a pod on demand and select a destination of their choice.

The benefits to passengers are that in comparison with other forms of public transport the waiting time is removed and the journey is shorter as the pod goes straight to the selected destination. A bus in contrast runs at a fixed interval and goes on a defined route.

Personal rapid transit is in operation at London Heathrow Terminal 5 linking the business car parks with the terminal. During its first year of service (2011-2012) carried 370,000 passengers[5]. Once full service was introduced on 7 May 2011, the Heathrow car park buses were removed from operation.

The pods themselves are capable of carrying up to four people. They are fully automated, battery-powered electric vehicles. The infrastructure that is required for the guideways is narrower than a conventional highway and is designed for the light axle loads of the pods.

In the railway context, PRT has the potential to meet passenger need for onward travel from rail stations in instances where demand is pulsed from a rail station to a number of locations within the local vicinity.

The pod in such a scenario affords an advantage over a conventional bus in that it goes direct to a specific user requested destination when it is requested. This reduces both waiting time and journey time to the passenger's desired destination. A bus in contrast runs at a given frequency and follows a predetermined circuit of bus stops.

5 Source: BAA

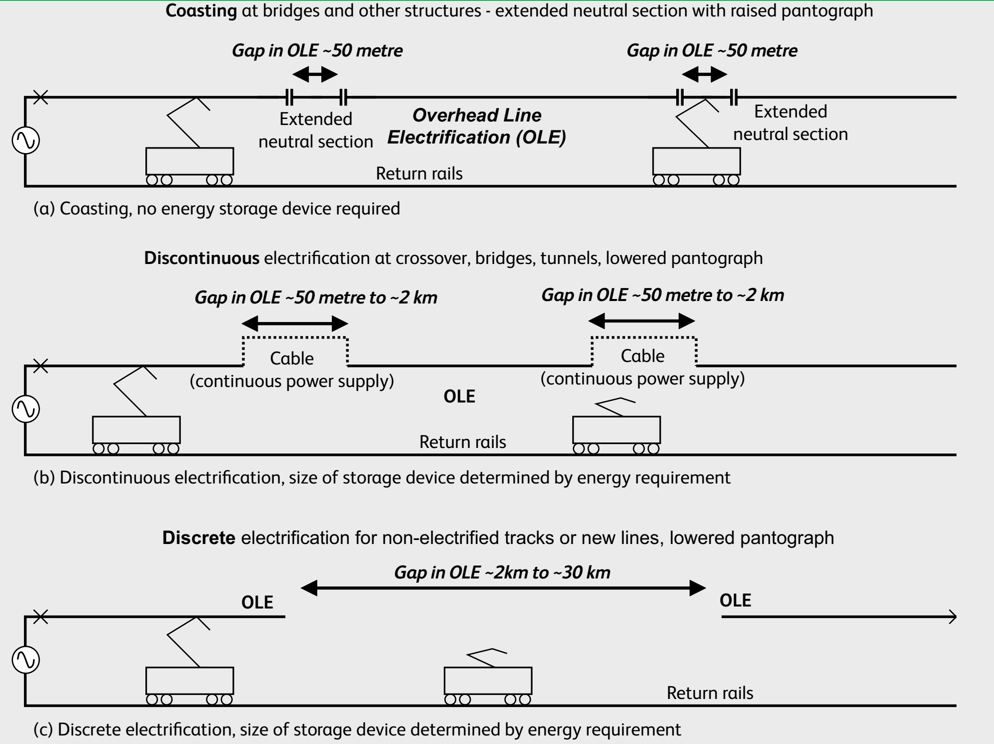
4.3 Alternative methods of delivery of electric traction on lower traffic density routes

4.3.1 Definitions of the alternative solution

To date a number of alternative solutions to conventional electrification have been proposed which potentially could contribute to reducing the infrastructure cost of electric traction. The solutions which have been considered in the RUS are described in Figure 4.12.

There are two aspects to alternative forms of electrification. Firstly, the shorter gaps in the Overhead Line Electrification (OHL) are aimed at reducing the cost of gauge clearing challenging structures Secondly, the longer gaps in the OHL aim to remove all of the additional OHL infrastructure capital and maintenance costs of providing electric traction, transferring some of those costs to energy storage onboard the rolling stock.

Figure 4.12 – Coasting, discontinuous and discrete electrification[6]



6 Source: RSSB, T777, Research Programme Engineering, Understanding the effect of 'gaps' in electrical continuity of the traction contact system Gaps in electrical conductivity of the overhead line AC traction system (2010)

The Network RUS: Electrification analysis suggests that the cost of gauge clearing structures and tunnels, depending on the route, accounts for between 30 to 40 per cent of the capital cost of an electrification scheme. An example of a challenging structure to electrify is the Farnworth Tunnels which are part of the North West Electrification scheme between Manchester and Blackpool North.[7]

Figure 4.13 shows a Class 185 emerging from one of the tunnels and illustrates some of the challenges of electric clearance.

The alternative solutions to conventional electrification considered in this strategy are coasting, discontinuous, and discrete electrification.

Coasting

This concept involves extended neutral sections in OHL of a few tens of metres through which a train can coast in order to avoid gauge clearance of complex structures. Gaps of this distance could be introduced without any trainborne energy storage device. Where sufficient physical clearance exists but there is insufficient electrical clearance a neutral contact wire is used through the extended neutral section. In locations with insufficient physical and electrical clearance an as yet undeveloped automated means of raising and lowering the pantograph could be used through a gap in the OHL.

Figure 4.13 – Farnworth Tunnels part of the North West electrification project between Farnworth and Kearsley

7 Source: RSSB, T777, Research Programme Engineering, Understanding the effect of 'gaps' in electrical continuity of the traction contact system Gaps in electrical conductivity of the overhead line AC traction system (2010)

While there would be gaps in the OHL, the power supply from the National Grid would be continuous through the use of underground cables which would link the two sections of OHL.

Discontinuous electrification
Discontinuous electrification refers to a situation where a route is electrified with gaps in the OHL of distances of a few hundred metres and an appropriate train borne energy storage device, e.g. supercapacitors, can be used to provide power for short durations through discontinuities in the OHL. This could be implemented to avoid the electrification of complex areas or structures, such as stations or tunnels. As with coasting, the power supply would be continuous.

Discrete electrification
Discrete electrification refers to an unelectrified route, or section of route, where a trainborne energy storage device is used to power a train for a distance of several kilometres. There would be a complete gap in the electrification infrastructure and each side of the gap would have entirely separate power supplies. Electrification or an external source of traction power would be required to charge the energy storage device, both at some point in the train's journey and at the rolling stock depot.

4.3.2 Existing and planned usage of the solutions

Coasting
There are three examples in Great Britain of extended neutral sections of gaps of tens of metres to avoid areas of insufficient gauge clearance for installation of 25kV AC OHL. These sites are:

- Paisley Canal – Scott's Road Bridge
- Romford - Upminster – Brentwood Road Bridge
- Romford - Upminster – Heath Park Road Bridge
- Ayr – 'Tam's Brig' on the A79.[8]

Coasting, while not widely used, is a conventional tool for avoiding the need to undertake substantial works to obtain sufficient clearances under structures.

8 Source: RSSB, 'Potential to reduce the cost for electrifying GB railways' (2011)

The key technical issue concerns the suitability of a location for having extended neutral sections and the risk of a train becoming stranded and unable to move. The choice of location for these sections needs to make sure that there are no signals, crossovers, level crossings, occupational crossings, speed restrictions, stations, significant gradients or tunnels. This ensures that there are no features which might reduce the speed of, or stop the traction unit traversing the gap. The use of EMUs formed of multiple sets would reduce the risk of becoming stranded, given that there is a pantograph on each unit.

Discontinuous electrification
There are currently no examples in Great Britain, or the rest of the world, of heavy rail discontinuous electrification. There are a number of technical and operational issues which would need to be overcome in order to implement the solutions:

- overhead line needs to be terminated at both ends of the discontinuity. This would require extra balance weights, anchor foundations and ties at both ends. Specifically designed rolling stock would be required with the ability to automatically raise and lower pantographs on the move with installed energy storage to bridge the gap
- electrical continuity needs to be maintained across the gap in the OHL, which would require high voltage cables for each section, terminations at both ends and cable routes to protect the cable mechanically
- a means of opening the circuit breaker on the traction unit and automatically lowering the pantograph before the discontinuity will be required. The opposite process is required as the train rejoins the OHL. In the future this could be automated to avoid the risk of human error in a manual process to raise and lower the pantograph. Examples of conventional requirements to raise and lower pantographs include voltage change over or bi-modes, both of which might only lower the pantograph once in a journey. Discontinuities could in theory be far more frequent and there is a technical challenge of switching between an internal and external power supply on the move

- energy storage devices will require time and the means to recharge the stored energy automatically in order to traverse the discontinuities along a route
- as a result of the large traction energy requirements, it is not thought to be currently feasible for high speed passenger and freight trains to make use of energy storage. The applicability of this solution is therefore likely to be limited to lower speed passenger routes.

Discrete electrification

There are currently no examples in Great Britain or the rest of the world of discrete electrification in heavy rail in commercial service using energy storage (such as batteries, flywheels or fuel cells). However, in the past there have been battery-powered rail cars.

There are battery-powered trains for use in specific circumstances e.g. London Underground infrastructure trains that operate in tunnel sections when the power system is isolated. Heavy rail vehicles have been hybridised, but the energy storage is not the sole prime mover.

For example, the Class 139 vehicles have a steel flywheel which acts as an energy store to provide power for acceleration.

A liquefied petroleum gas (LPG) engine is used once initial acceleration has been completed to maintain speed, and while stationary in order to 'charge' the flywheel. There are a number of examples in Europe in which urban tram systems have trialled energy storage devices (batteries, flywheels and supercapacitors) to allow self powered operation through the centre of cities. This removes the need for OHL to be provided over relatively short sections in order to protect the visual impact of architecturally sensitive and historic streetscapes. Nice tramway line 1 is operated in commercial service with battery storage.

A number of other lines are planned in cities such as Seville and Seattle. The alternative is to use an under street electrification system. This is potentially expensive to construct since it must never expose a street user to a live power supply.

Tram line 1 in Nice uses nickel metal hydride batteries to go through some of the central sections of the city under its own power avoiding the more expensive under street electrification and preserving an uncluttered visual environment. The trams use batteries in day-to-day operations and entered commercial service in 2007. Figure 4.14 shows two trams operating under battery power through one of the two gaps in the OHL. The gaps are several hundred metres in length and the trams operate at 30kmh.

Figure 4.14 – Photograph of Nice line 1 trams in battery mode

The reasons for implementing energy storage in the on street tram context are very different from those in heavy rail, where the main aim is to minimise infrastructure costs for the implementation of OHL. In a tram on street context, aesthetics of the urban streetscape and the cost of utility diversions are the primary drivers.

All of the points outlined for discontinuous electrification also apply to discrete electrification. The only exception are the issues around maintaining continuity of power supply. As a result of the longer gap in electrical supply, issues about change over between internal and external power may be simpler as they can be aligned to station stops.

With greater length of gaps in the OHL, reinforcement of existing power supply points might be required to allow trains to charge up either on the move, or when stationary in a depot or platform. If new electrification infrastructure is needed to make gaps feasible for the range of energy storage powered trains, these may be remote from existing OHL and power supply adding to cost and complexity.

In comparison with the shorter discontinuous gaps, the increased distance of the gap in OHL for discrete electrification will require a larger amount of energy storage to traverse the gap. In turn, this will impact on vehicle weight and therefore track maintenance. It may also reduce the available space for passengers if there is insufficient space underneath individual vehicles to install the energy storage systems. The number of stations at which a service calls, as well as overall line speed and gradient will have a considerable impact on the size of the required energy storage device.

It is not thought currently feasible for high speed passenger and freight trains to make use of energy storage because of the peak energy requirements. The applicability of this solution is therefore likely to be limited to lower speed passenger routes.

Energy storage

The energy storage technology required for a heavy rail context in the way described has not yet been employed in commercial operation. Historically rail cars have been used in some circumstances with lead acid batteries. The weight and charge time of such batteries is high. The use of batteries in Nice tram line 1 is for two sections of approximately 450 metres, rather than tens of kilometres. For this reason, this strategy focuses on the potential specification of suitable energy storage devices up to 30 years in the future. Energy storage technologies that have been considered include (not an exhaustive list):

- batteries
  - lead acid batteries
  - nickel metal hydride and nickel cadmium batteries
  - lithium ion batteries
  - lithium ferrous phosphate batteries
  - sodium salt batteries
- electrical
  - supercapacitor
- mechanical
  - flywheels
  - range extenders, where a gas turbine or internal combustion engine charges an energy store thereby reducing the peak power demand on the motive power source.

Conventional electric trains have batteries to provide backup power in the event of OHL or 3rd rail power failure. This energy storage provides onboard power for a period of time to the onboard auxiliary systems for the train's non traction electrical systems such as lighting and heating.

Energy storage may also have other applications which are not directly being considered by this strategy. These might include:

- hybridising diesel trains to reduce fuel consumption by capturing and storing energy from braking
- storing energy onboard the train or beside the track to reduce the peak power consumption, avoiding the need for power supply strengthening
- reducing the peak load of an internal combustion engine or enabling that engine to be 'down sized' by charging an energy store which is used for peak power consumption. An example is the Class 139 flywheel vehicle.

This strategy focuses on the potential for energy storage in its application to reduce the need for fixed infrastructure rather than these broader applications.

Based on previous studies, Table 4.6 shows a high level comparison of the three main types of energy storage that have been proposed. This illustrates both strengths and weaknesses when compared to diesel internal combustion engines. In the analysis that has been conducted to develop this strategy, batteries have been assumed to be the most viable technology for discrete electrification.

This is because while they are slower to charge than flywheels or supercapacitors and are not able to provide the same specific power for acceleration, they may have the specific energy range to power a train through a gap of kilometres in distance.

It is noted that the flywheels referred to in the table below have a small diameter and high rotation speed. This is very different from the type of flywheel used by the Class 139 which has a large diameter and lower rotation speed. The latter is a fully developed technology and does not have the same uncertainties.

Table 4.6 – Indicative capability of batteries, flywheels and supercapcitors [9]

	Batteries	Flywheels - small diameter and high rpm	Supercapacitors
Specific energy (range)	Good	OK	Poor
Specific power (acceleration)	Good	Very good	Very good
Useful life	~2-5 yrs	~10 yrs	~20yrs
Maintenance	Little maintenance	Some maintenance	Maintenance free
Environmental impact	Depends on type; some use scarce materials and are difficult to recycle	Good – readily available materials	Uses scarce materials
Safety	Low risk but dependent on type	Uncertain	Possible risk of electrical discharge
Reliability	Very reliable	Uncertain	Very reliable
Electrical efficiency	~90%	>95%	>90%
Charging & discharging time	Reasonable	Fast	Very fast
Self discharge	Days	Minutes	Hours

9 Source: RSSB, T779, Energy storage systems for railway applications (2010)

This is not to suggest that batteries are appropriate for all circumstances. For shorter gaps associated with discontinuous electrification the acceleration and rapid charging of supercapacitors or flywheels may be more applicable. No energy storage technology currently available, matches diesel fuel and an internal combustion engine for its combination of range, acceleration, and charging time. The storage technologies have different niches and are appropriate in different circumstances.

Hydrogen fuel cells have not been considered for two reasons. The first is the lack of a hydrogen distribution network and the energy cost associated with its production. The second is that rail is unlikely to lead the development of hydrogen fuel cell technology and is more likely to draw on developments in the automotive sector. The Rail Safety and Standards Board (RSSB) is considering this subject with the potential for trialling the technology if and when it becomes viable for use in heavy rail.

Energy storage has also been used to hybridise a number of types of heavy rail vehicles to improve energy efficiency:

- flywheel:
  - Class 139 – LPG powered internal combustion engine hybridised with a flywheel
- batteries:
  - Japanese Railways East diesel lithium ion battery hybrid diesel multiple unit (DMU) trial
  - Class 43 ‘Hayabusa’ trial undertaken in order to test the energy efficiency gains of installation of lithium ion battery storage on a diesel train
  - a number of trials in Europe, Japan and North America of hybrid diesel freight and shunting locomotives.

To date, energy storage has been used in heavy rail to improve energy efficiency by recovering energy from braking or for restricted environments such as the London Underground tunnels. It has not primarily been used in order to bridge gaps in electrification. In commercial service, only in a tram context have energy storage devices been used to bridge gaps in OHL.

However, the reason for its use in these contexts has been to avoid OHL having to be erected in historic city centre locations. The alternative is to use an under street electrification system which is an expensive and complex technology. In this context, energy storage may be a lower cost alternative to allow a small area of a city centre to be wire free. These considerations do not usually apply to the heavy rail market as issues of aesthetics of visual intrusion are generally not so relevant except in specific historic locations.

Energy storage is being developed for a number of market uses, for example, renewable power generation, uninterruptable power sources for telecommunications and data centres and in the automotive industry. Hybrid technology is most widely in use in cars and in buses and is designed to capture the energy of braking to reduce fuel consumption used for acceleration, reduce emissions, and particularly in the case of buses to reduce noise. Whilst a small market in comparison, the rail industry may be able to make use of the lower unit cost and longer asset life which may develop as a result of deployment of energy storage in the automotive, power, and telecoms sectors.

Bi-mode (electro diesel) trains

Bi-mode trains exist in Great Britain in the form of the Class 73 locomotive, and are planned as part of the Intercity Express Programme (IEP). In France EMUs are in service which have a bi-mode capability. Developments have been proposed to enable 25kV AC powered locomotives to have a bi-mode capability to travel the ‘last mile’ to an unelectrified freight terminal.

Initiatives to reduce the whole life cost of conventional electrification

A number of initiatives are under way to reduce the cost of conventional electrification on some routes. The two main examples under way are trolley wire on routes with an operating speed below 60mph and the potential to convert existing 3rd rail DC electrification to 25kV AC OHL.

Trolley wire OHL provides a lower cost overhead line arrangement by eliminating catenary wire. One or two contact wires are suspended from OHL masts without a supporting catenary wire. This reduces the weight of the overhead wires and the required strength and height of masts. It offers the potential for lower installation and material costs when compared to a conventional OHL system. It is only suitable for line speeds up to 60mph because of limitations on the ability for current collection to be maintained at higher speeds. If the route has tight radius curves this solution might be more advantageous as the longer span lengths possible with conventional OHL would not be feasible. On straight track the extra masts required by trolley wire might negate the costs of simpler wire as they have a significant per mast cost, regardless of size. The major potential benefit is a reduced requirement for physical clearances when compared to a conventional OHL system because of the lack of the catenary wire and size of the mast construction.

The DfT's research 'Low Cost Electrification for Branch Lines' Delta Rail (2010) looked at the potential for electrification on these routes. It explored the case for DC tram style electrification for self contained branch lines.

Following an initial study by the Technical Strategy Leadership Group (TSLG), the results of the study were published in 'Investigating the economics of the 3rd rail DC system compared to other electrification systems, T950 - August 2011'. As part of the Network RUS: Electrification 'Refresh' Network Rail is considering the case to convert elements of the 3rd rail DC network to 25kV AC.

The High Level Output Specification (HLOS) said that the Secretary of State for Transport wished the industry to treat Southampton to Basingstoke as a pilot scheme for such a potential modernisation programme of the wider DC network

4.3.3 Discrete electrification energy storage assumptions

The energy storage technology to allow operation in a heavy rail context in the way described has not yet been developed in commercial operation or tested in a trial for the size of gaps that have been considered. The RUS has a 30-year view and has, therefore, taken a forward looking stance in order to establish the market if the supply industry is able to develop these capabilities and the price at which it would be value for money. For this reason the RUS concentrates on the potential specification of suitable energy storage devices. The primary focus of the RUS is the capabilities that would be needed for energy storage to be able to be economically useful to the rail industry. Table 4.7 presents the cost differentials between DMU, EMU and EMU with battery storage operation. The table uses the values and costs for electrification in the Network RUS: Electrification workstream. Assumptions have then been made based on discussions with suppliers, previous research and engineering advice about the impact on these values that using battery storage would potentially have.

Table 4.7 – Assumptions of cost differential between, DMUs, EMUs and battery storage

	Diesel (£)	Electric (£)	Battery storage (£)
Fuel or electricity – per vehicle mile	0.47	0.26	0.31
Variable Track Access Charges (VTAC) – per vehicle mile	0.10	0.085	0.094
Maintenance – per vehicle mile	0.60	0.40	0.40
Variable cost track access per vehicle mile	1.22	0.76	0.82
Vehicle leasing per year	110,000	90,000	90,000
Capital expenditure per single track km	n/a	Capital expenditure for OHL and financing costs	Potential additional capital costs
Vehicle energy storage per annum	n/a	n/a	26,000 to 281,000

The key assumptions for an EMU with battery storage are as follows:

- electricity consumption is assumed to be 20 per cent higher over its total journey than an EMU due to the inefficiency of the battery and the additional weight of the vehicle
- variable track access charge (VTAC) is estimated based on increased battery weight added to an EMU which is detailed in Table 4.8
- maintenance per vehicle mile is assumed to be the same as an EMU at this stage, but this assumption would need to be confirmed in operation
- capital costs for discrete electrification have not been included at this stage. There are potential costs for power supply strengthening or for example, wiring bay platforms
- the battery cost is based on a 300 kWh requirement per vehicle which is detailed in Table 4.8. Due to the uncertainty about cost per kWh and battery life, a range of costs have been used. This cost range would also need to cover the cost of additional electrical and pantograph control equipment
- journey time savings of EMUs compared to DMUs may still be possible with discrete electrification, but acceleration consumes energy which reduces battery range.

Table 4.8 – Specific assumptions about batteries

Factor	
Batteries per vehicle	300 kWh central estimate: could vary according to service
Cost per battery kWh	£400 - £2,500
Battery life	3 – 5 years (a mid point of 4 years has therefore been assumed)
Financing costs	2.1% – 6% per annum
Installation costs	Unknown
Additional maintenance	Unknown
Disposal costs	Unknown but particularly for some kinds of batteries (for example Lithium Ion) there is currently not a recycling market
Other operation	Unknown
Battery mass per vehicle	~3 tonnes and ~1 tonne casing
Voltage	AC & DC
Efficiency	~+20% electricity consumption
Range (mileage)	Up to 75 miles depending upon the following:
Charge to discharge ratio	Ratio of OHL exposure time to total route distance is key
Speed (mph)	Speed increases power consumption and reduces range
Number of stops	Each station stop reduces range
Acceleration (m/s)	Match normal EMU, will consume more energy and reduce range
Gradient (+%)	Gradients add to power consumption and decrease range
Unit mass (tonnes)	Greater mass increases power consumption and reduces range
Auxiliary power (kw)	Heating, ventilation, air conditioning and other auxiliary systems power reduce range

For the basis of this analysis the costs have been kept at a high level and have not included the costs of additional complexity of rolling stock. An example of this is the additional systems relating to the battery. In effect it has been assumed that these would be included as part of the fixed cost of the battery. Table 4.8 presents the assumptions that underpin the battery specific figures in Table 4.7 and the selection of routes for analysis for the potential use of energy storage vehicles.

The key issues for the economics of the solution are the capital cost and life expectancy of energy storage devices and any ongoing maintenance. Life expectancy depends on the specific technology and its duty cycles. Batteries become less efficient over a period of time. Where they represent the prime form of power, the point at which they fail is more critical than for circumstances in which they are used as a hybrid to reduce fuel consumption since they are not the prime mover. Battery life affects the periodicity of the replacement cost which critically impacts upon whole life costs.

The cost per kWh of batteries has a very wide range of current and future cost estimates.

Therefore, the wide range has been used in order to establish the sensitivity of the market to price. The range has also been used due to uncertainty about battery life affecting the whole life costs. The range is expressed as a range of costs per annum which addresses uncertainty about both factors.

Ranges of batteries are not an easy issue to summarise since range depends upon a number of dynamic factors described in Table 4.8. This RUS, in its analysis has tested a range of capabilities for the distance that a battery can power a train away from the OHL. This more straightforward assessment of the network and the services operated has been made on the basis that a given range can be achieved with a charging time which allows the current timetable to be operated with the same number of trains. A more complex expression of the capabilities of a battery requires modelling of both battery and rolling stock to establish the energy required and the charging and discharging cycle for each route.

The 75 mile range has been used not because this is technically possible today, but to understand the impact of increased range on the number of routes on which it might be applicable as the technology develops over the 30 year life of the strategy.

4.4 Community rail

4.4.1 Definition of community rail

Community rail involves local people in the development and promotion of local rail routes, services and stations. Since its inception, community rail has encouraged communities to become directly involved in improving the railway environment through the reuse of redundant buildings, provision of additional services and the improvement of railway land. It has introduced strategies for increasing patronage and economic benefit to local communities. It delivers a flexibility to local routes and services that would be difficult to achieve through other rail industry mechanisms. Community rail enables local people both to influence and directly provide the service that meets their priorities. This RUS aims to assess if there is greater scope for community rail to improve value for money and whether local community involvement in the delivery of rail services through alternative solutions can be increased.

Community rail has developed in guises which range from DfT formal designation of community rail lines and station adoption schemes to more informal partnerships and interest groups. The Association of Community Rail Partnerships (ACoRP) represents a wide range of these community rail groups.

The RUS notes that some of the effects of community rail initiatives can be achieved by other means, for example in the devolution of powers to more local bodies such as Passenger Transport Executives. Train operators may be able to achieve similar outcomes without necessarily entering into a partnership with a community. An example without an explicit partnership is Southern Railway's Safer Travel Team which seeks to combat low level crime affecting passengers across its franchise. The unique factor relating to community rail is the involvement of the local community in partnership with the railway.

In this RUS, community refers to a reasonably cohesive geographic area such that its interests can be represented within a partnership. Community rail initiatives tend not to encompass the whole length of a main line or routes crossing multiple boundaries.

This is because such routes are unlikely to be sufficiently self contained to allow genuine partnership. However, there are exceptions. One such example is the Sussex CRP which covers sizeable sections of main line routes and crosses multiple boundaries.

It is accepted that a partnership cannot be imposed upon a community by the rail industry or its funders. The stimulus for developing such an initiative should come from within the community itself.

The DfT's definition of community rail starts from the premise that route closure is not a policy option and that conventional means of reducing costs or improving the sustainability of local railways are not possible. Community rail seeks to be a locally appropriate way forward to address the challenges that the routes face in delivering value for money whilst also providing a socially inclusive transport service.

The term 'community rail' relates to the involvement of the local community and the rail industry in partnership.

4.4.2 Community Rail Partnerships and Station Adoption

4.4.2.1 Community Rail Partnerships

Recognising the potential benefits of the community rail approach, the former Strategic Rail Authority (SRA) developed a Community Rail Development Strategy (November 2004) which was subsequently adopted by the DfT when it succeeded the SRA. The key aim of this strategy is to 'improve the financial performance, value for money and social value of local and rural railways' (Community Rail Development Strategy, SRA 2004).

The strategy states that 'the objectives of this approach to the development of community railways are based on providing a strategic framework for local routes, services and stations, within which they can develop and be put on a sustainable basis:

- increasing patronage, freight use and net revenue
- managing costs down; and
- greater involvement of the local community[10].

10 Source: page 5, Community Rail Development Strategy, 2004

DfT subsequently added a fourth objective of:

- enabling local rail to play a larger role in economic and social regeneration.

Table 4.9 details the 34 Community Rail Partnerships (CRPs) in England. The numbering of the route corresponds to the lines shown in Figure 4.15. There are currently no designated community rail lines or services in Scotland or Wales. However, in both instances informal community groups exist for some lines. In England there are also CRPs that are not on designated lines and services.

There are two levels of DfT designation. Where a service is the sole service operating over a line, both the service and the infrastructure are designated in a 'line designation'. Where a service also operates in part over the wider network, a 'service designation' is made which excludes the infrastructure on more widely used routes. Line and service designations are distinguished in Figure 4.15.

The potential benefits of community rail have also been recognised in Scotland. A consultation into the future of Scottish rail passenger services was held in late 2011 and early 2012 to inform Scottish Ministers' decisions in relation to the future of the ScotRail passenger franchise from 2014 and the High Level Output Specification (HLOS) for Control Period 5.

The consultation covered a wide range of issues including:

- achieving reliability, performance and service quality
- train service provision
- rail fares
- location and management of stations
- cross-border services
- rolling stock requirements
- passenger requirements
- sleeper services
- environmental issues.

The Ministerial Statement that accompanied the publication of the Scottish HLOS outlined the importance of community rail in future strategy development, stating that 'The response to the Rail 2014 consultation demonstrated the importance communities place on the railway and their willingness to play a part in their railway.

We want to see this enthusiasm harnessed and promoted.

Therefore we will encourage the creation of local Community Rail Partnerships and require the industry to work with these to establish facilities and services that address local needs.'[11]

Community Rail lines usually share typical characteristics. They generally operate over local or rural routes which have a single passenger operator and limited freight. DfT criteria state that Community Rail lines generally:

- are low speed – less than 75mph, single or double track (not multiple track)
- have one train operator providing most services
- do not provide major conurbations with commuter services, have no major freight flows and are not part of Trans European Networks (TENs).

There are exceptions to the above criteria. For example, the Severnside CRP is largely urban, providing local services in and around central Bristol. Appendix D provides an overview of its activities. The Mid Cheshire CRP between Chester and Manchester via Northwich provides a similar urban function.

Community Rail Partnerships are generally not for profit organisations working in partnership with the rail industry and incorporating a range of local groups including local authorities, rail user groups and community groups. The activities undertaken by a CRP will vary according to the available budget, size of the CRP, market area served and the route network profile. They may include marketing of different types of train tickets, special offers etc, the development of promotional line guides, organising and holding special events to engage with the local community, or retailing of guides, books or souvenirs relating to the line and the local area.

Funding sources for CRPs are potentially wide ranging. They will be subject to continuous change in response to financial, policy and political factors influencing funding bodies. It is inevitable that some funding sources will have very specific pre-qualification and bidding requirements.

Therefore, it will be highly likely that a CRP will need to bid in partnership with another local partner, typically a local authority. This usually will be as part of a larger transport scheme funding bid.

The benefits of CRPs are diverse. They might include the ability to stimulate passenger growth, to address urban area issues such as crime and/or the fear of crime, and to provide an independent view of local issues involving the railway network. Each partnership has individual objectives which relate to the specific circumstances of the locality in which the CRP route or service operates. By providing a focus for involving local people, CRPs can potentially make the most effective use of available resources to meet these local needs and identify opportunities for improvements at marginal cost.

CRPs play an important role in helping to develop ticketing, marketing and retail strategies for community rail lines in their area, in partnership with the rail industry. They add significant value to the industry by possessing an in depth and comprehensive understanding of the local transport market. With this understanding and through regular dialogue with the local community they are able to acquire information at an early stage to make sure that local needs are being met as fully as possible. A fuller discussion as to the different options available for implementation regarding marketing, retailing and ticketing strategies can be seen in Chapter 6.

It is recognised that not one strategy will fit all lines with community rail partnerships. Ultimately the mix of strategic interventions will vary according to the specific local market requirements. For example, a highly tourist orientated line would focus predominantly on the leisure market. In contrast, a largely urban community rail line would focus both on the leisure and commuter markets.

11 Source: Transport Scotland, Rail 2014 Minister's statement to Parliament

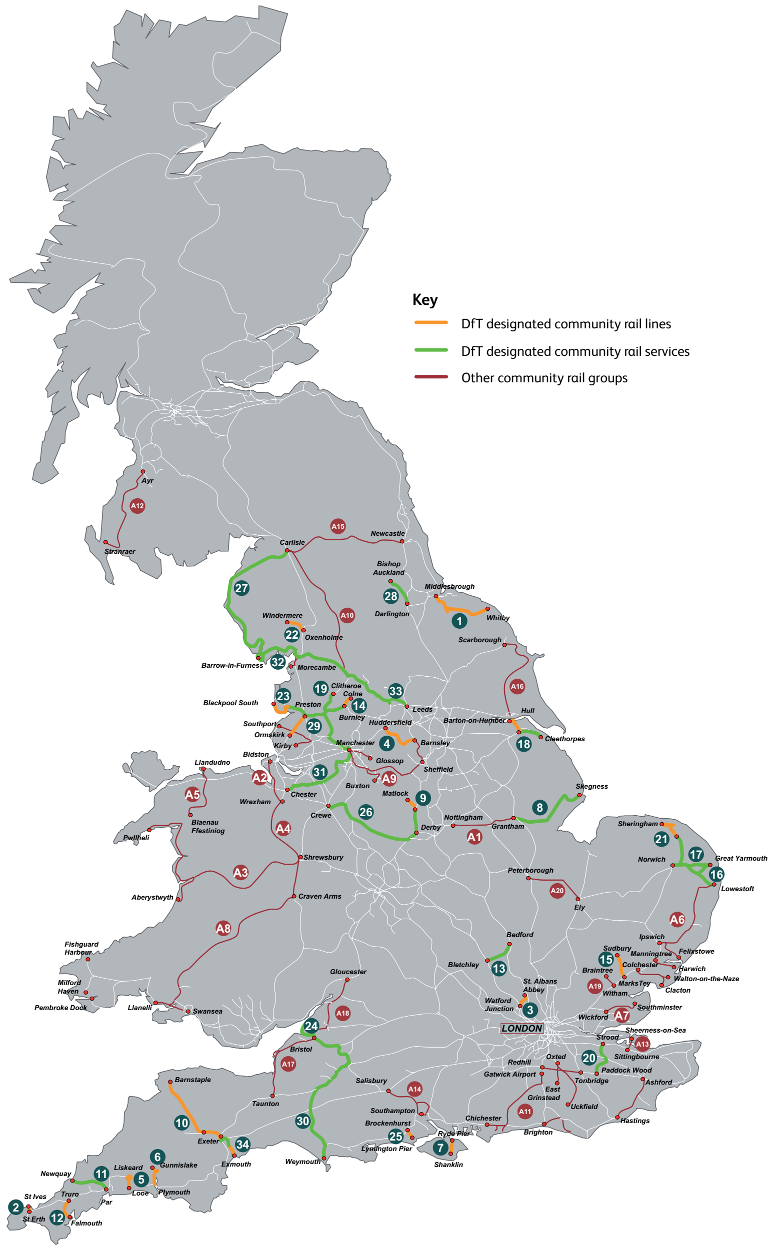


Figure 4.15
Map of community rail partnerships in Great Britain (source: Network Rail)

Table 4.9 – Community rail partnerships in Great Britain

Number	Community rail partnerships	DfT designation	Date of designation
1	Esk Valley Line: Whitby to Middlesbrough	Line	Jul-05
2	Devon and Cornwall Community Rail Partnership: St Ives Bay: St Ives to St Erth	Line	Jul-05
3	Abbey Line Community Rail Partnership: St Albans Abbey to Watford Junction	Line	Jul-05
4	Penistone Line: Barnsley to Huddersfield	Line	Sep-05
5	Devon and Cornwall Community Rail Partnership: Looe Valley Line: Looe to Liskeard	Line	Sep-05
6	Devon and Cornwall Community Rail Partnership: Tamar Valley Line: Gunnislake to Plymouth	Line	Sep-05
7	Isle of Wight Community Rail Partnership: Ryde Pier Head to Shanklin	Line	Mar-06
8	Grantham to Skegness Community Rail Partnership: Poacher Line: Skegness to Grantham	Service	Jul-06
9	Derwent Valley Line: Matlock to Derby	Line and service	Jul-Sep-06
10	Devon and Cornwall Community Rail Partnership: Tarka Line: Exeter St David's to Barnstaple	Line	Sep-06
11	Devon and Cornwall Community Rail Partnership: Atlantic Coast Line: Newquay to Par	Service	Sep-06
12	Devon and Cornwall Community Rail Partnership: Maritime Line: Falmouth to Truro	Line	Sep-06
13	Marston Vale Community Rail Partnership: Bedford to Bletchley	Service	Nov-06
14	Community Rail Lancashire: East Lancashire Line: Preston to Colne	Line	Nov-06
15	Essex & South Suffolk Community Rail Partnership: Gainsborough Line: Sudbury to Marks Tey	Line	Nov-06
16	Wherry Lines Community Rail Partnership: Norwich to Lowestoft	Service	Feb-07
17	Wherry Lines Community Rail Partnership: Norwich to Great Yarmouth	Service	Feb-07
18	Barton Line: Barton-on-Humber to Cleethorpes	Line	Feb-07
19	Community Rail Lancashire: Clitheroe Line: Clitheroe to Manchester Victoria (via Blackburn)	Service	Mar-07
20	Kent Community Rail Partnership: Medway Valley Line: Paddock Wood to Strood	Service	Sep-07
21	Bittern Line Community Rail Partnership: Norwich to Sheringham	Line	Sep-07
22	Lakes Line Community Rail Partnership: Oxenholme (Lake District) to Windermere	Line	Apr-08
23	Community Rail Lancashire: South Fylde Line: Blackpool South to Preston	Line and service	Apr-08
24	Severnside Community Rail Partnership: Severn Beach Line: Bristol Temple Meads to Severn Beach	Service	Apr-08
25	Lymington-Brockenhurst Community Rail Partnership: Lymington Pier to Brockenhurst	Line	Jul-08
26	North Staffordshire Community Rail Partnership: Crewe to Derby via Stoke-on-Trent	Service	Nov-08
27	Cumbrian Coast Line Community Rail Partnership: Carlisle to Barrow-in-Furness	Service	Sep-09
28	Bishop Line Community Rail Partnership: Darlington to Bishop Auckland	Service	Jan-11
29	Community Rail Lancashire: West of Lancashire Community Rail Partnership: Preston to Ormskirk	Line and service	Sept-11

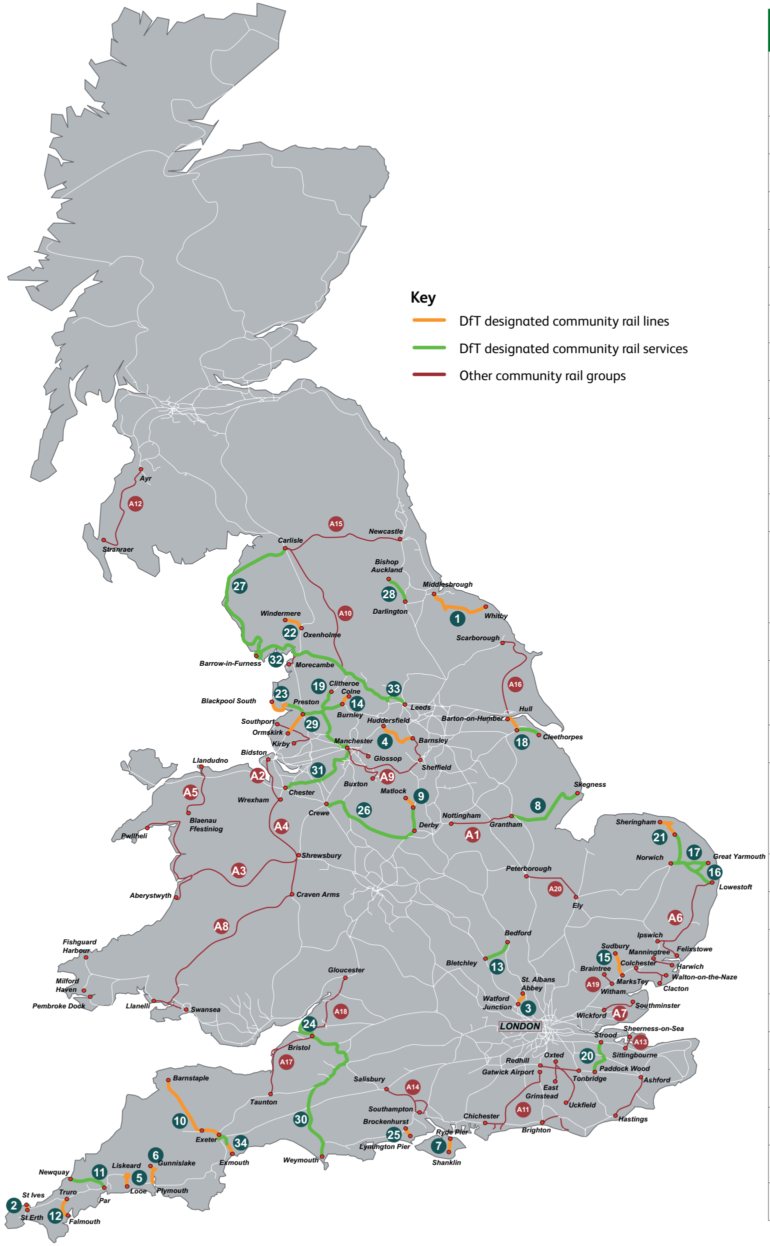


Figure 4.15
Map of community rail partnerships in Great Britain (source: Network Rail)

Table 4.9 – Community rail partnerships in Great Britain

Number	Community rail partnerships	DfT designation	Date of designation
30	Heart of Wessex Rail Partnership: Bristol Temple Meads to Weymouth	Service	Oct-11
31	Mid Cheshire Community Rail Partnership: Chester to Manchester via Northwich	Service	Jan-12
32	Furness Line Community Partnership: Barrow-in-Furness – Carnforth	Service	Jun-12
33	Community Rail Lancashire: Bentham Line: Leeds, Lancaster to Morecambe	Service	Oct-12
34	Devon and Cornwall Community Rail Partnership: Avocet Line: Exeter St David's to Exmouth	Line	Sep-12
A1	Nottingham – Skegness Community Rail Partnership: Nottingham to Grantham	n/a	n/a
A2	Borderlands Line Rail Partnership: Wrexham Central – Bidston	n/a	n/a
A3	Cambrian Rail Partnership: Shrewsbury – Aberystwyth and Dovey Junction – Pwllheli	n/a	n/a
A4	Chester to Shrewsbury Rail Partnership	n/a	n/a
A5	Conwy Valley Rail Initiative: Llandudno – Blaenau Ffestiniog	n/a	n/a
A6	East Suffolk Lines Community Rail Partnership: Ipswich - Lowestoft and Ipswich - Felixstowe	n/a	n/a
A7	Essex & South Suffolk Rail Partnership: Manningtree – Harwich Town, Colchester/Colchester Town –Thorpe-le-Soken – Walton-on-the-Naze and Clacton, Southminster – Wickford and Witham – Braintree	n/a	n/a
A8	Heart of Wales Line Forum: Swansea – Shrewsbury via Llandrindod	n/a	n/a
A9	Hope Valley & High Peak Transport Partnership: Manchester Piccadilly – Sheffield, Buxton and Glossop routes	n/a	n/a
A10	Settle-Carlisle Railway Development Company: Leeds – Settle – Carlisle	n/a	n/a
A11	Sussex Community Rail Partnership: Ashford – Hastings, Oxted – Uckfield, Hurst Green – East Grinstead, Reigate – Tonbridge, Chichester, Bognor Regis, Littlehampton – Gatwick Airport and Brighton – Seaford	n/a	n/a
A12	Stranraer- Ayr Line Support Association: Stranraer – Ayr	n/a	n/a
A13	Kent Community Rail Partnership: SwaleRail: Sittingbourne – Sheerness-on-Sea	n/a	n/a
A14	Three Rivers Rail Partnership: Salisbury –Romsey – Eastleigh – St Denys – Southampton Central – Redbridge – Romsey – Salisbury	n/a	n/a
A15	Tyne Valley Community Rail Partnership: Hadrian's Wall Line - Newcastle – Carlisle	n/a	n/a
A16	Hull - Scarborough Community Rail Partnership	n/a	n/a
A17	Severnside Community Rail Partnership: Bristol Temple Meads – Taunton	n/a	n/a
A18	Severnside Community Rail Partnership: Bristol Temple Meads – Gloucester	n/a	n/a
A19	Essex and Suffolk Community Rail Partnership: Witham – Braintree	n/a	n/a
A20	Hereward Community Rail Partnership: Ely – Peterborough	n/a	n/a

4.4.2.2 Station adoption

Stations can act as a focal point within communities and can be an important element in the local economy. Station adoption involves the community, or a specific local community group, contributing to the upkeep and management of local stations. Activities can include volunteers cleaning the station, renovating station buildings, installing flower tubs etc.

In some cases train operators, such as First Great Western, have supported station adoption schemes in repainting projects reinstating 'heritage' colour schemes and signage. In the UK, station adoption is most common at small and medium sized stations.

Station adoption can increase the property income of community rail routes by allowing community use of empty or derelict buildings. The reuse of buildings benefits both the local community and the railway by improving the station environment, providing a presence at the station, deterring trespass and vandalism and potentially attracting more passengers to visit the facility provided. In some cases buildings could be provided to community groups for a rent free period in exchange for renovation.

At Lostock Hall CCTV has been installed using Designated Community Rail Development Fund (DCRDF)[12] funding. This saw an almost instant decline in antisocial behaviour at the station.

More specific guidance from Network Rail, as to the use of redundant station buildings can be found within Section 2.5 of the Investment in stations: A guide for promoters and developers (May 2011 – Version 2.0) document:

http://www.networkrail.co.uk/browse%20documents/rus%20documents/route%20utilisation%20strategies/network/working%20group%202%20-%20stations/investmentinstations.pdf

Community groups involved in station adoption vary widely in nature – from District and Town Councils, Students' Unions and Rail Partnerships, through to groups of two to three local residents.

12 Source: Designated Community Rail Development Fund (DCRDF),fund established by the Department for Transport, Network Rail and ACoRP to support designated CRPs

The Community Scheme began in 2008. Since then around 90 schemes have been completed or are ongoing, with groups ranging from Station Friends to District Councils. More than 750 people have volunteered.

There are two types of scheme: 'One-off' is for a few days at most, with volunteers supervised throughout by Network Rail; 'Long-term' schemes (the great majority) continue on an annual basis.

Activities range from creating gardens and wildlife areas, to painting murals, or simply clearing litter and fly-tipping.

In the past 12 months there have been 11 'one off' short term community schemes, where work usually takes place for just a day, supervised by Network Rail. Two of these have involved cosmetic painting – of railings in Hungerford, Berkshire, and of a footbridge in Levenmouth, Fife.

The website of the Association of Community Rail Partnerships (ACoRP) lists 126 Station Adoption groups all of which look after train operating company leased land (some also have Network Rail Community Schemes). This number is almost certainly an underestimate, both because many groups are not members of ACoRP and because new Station Adopters are starting up frequently and would not necessarily have been recorded.

In Scotland the First ScotRail Adopt a Station scheme finds community or start up uses for vacant buildings at stations. Examples of adopters include Pitlochry Station Bookshop and a community meeting room at Maxwell Park (Pollokshields Heritage[13]). The railway contribution is to provide the space rent free but the adopters need to find the funds to make the space habitable for their purposes.

A practical source regarding advice and guidance on station adoption can be found on the ACORP website. The 'Station Adoption – A guide for the local community – 2010' toolkit document was developed by ACORP, Northern Rail and Transport for Greater Manchester (TfGM) http://www.acorp.uk.com/Assets/Acorp%20Station%20Adoption.pdf.

13 Source: http://www.scotrail.co.uk/content/adopt-station

4.4.2.3 Other forms of community rail

There are a wide range of other groups, many represented by ACoRP, who embody the concept of community rail, from community rail partnerships which are on undesignated lines, to rail user groups, and local authorities.

4.4.3 Infrastructure and rolling stock

4.4.3.1 Introduction

Community rail seeks to achieve cost reductions in infrastructure and train operation, to increase revenue generation and foster greater community engagement with the railway. It seeks to apply the recommendations of the 2011 McNulty Rail Value for Money Study.

Both future rolling stock and infrastructure network issues have been and are dealt with in the Network RUS, the geographic RUSs and the Long Term Planning Process(market studies). Therefore detailed analysis of rolling stock and infrastructure options is not included within this RUS. Furthermore, it is not within the remit of Network Rail to specify future rolling stock to be used on the network. However, it should be noted that a key recommendation in the Network RUS Rolling Stock Strategy (2011) was the future development of more generic rolling stock types to achieve financial economies of scale in procurement and operational efficiencies.

4.4.3.2 Rolling stock

The electrification programme for CP4/CP5 will release substantial amounts of modern diesel rolling stock suitable for cascade to community rail lines which are unlikely themselves to be electrified. It would be expected that prior to introduction on these routes rolling stock would, where necessary, be refreshed and/or re-furbished to make it fit for purpose.

4.4.3.3 Infrastructure

Community rail and local engagement has contributed to the development of lower cost innovative infrastructure interventions to meet existing passenger demand and also encourage greater rail usage. Involvement has included improvements to physical accessibility of train services and the provision of funding and input into the strategic development of infrastructure enhancements to facilitate service frequency enhancements on community rail lines. Key to successful delivery in both scenarios has been community stakeholders being engaged with the railway industry. This has resulted from making sure that all parties fully understand local passenger priorities, local transport planning policy priorities, the case for the required enhancement, and collaborative partnership working to have successful delivery of the scheme and to highlight the significance of such enhancements upon the local community's travel options.

An example of close community engagement with the rail industry to address physical accessibility issues at stations is the development of the Harrington Hump concept. In 2007, Cumbria County Council and Network Rail joined forces to develop a low cost accessibility solution to raise platform height at stations and thus reduce stepping distance between platform and rolling stock. Appendix E provides further details of the scheme which since initial development has begun to be introduced nationwide at other stations with significant stepping distances.

A further example of community involvement in developing infrastructure enhancements was to meet passenger aspirations for enhanced service frequency on the Maritime Line between Truro and Falmouth Docks. Cornwall Council had a long standing aspiration to increase service frequency on the line and encourage modal shift from road to rail between Truro and Falmouth. A partnership between Cornwall Council, Network Rail and First Great Western saw a low cost passing loop installed at Penryn in 2009 to permit an increased service frequency. Appendix E provides further details of the scheme.

The above examples have shown how close partnership between local community organisations and the rail industry can deliver low cost alternative solutions to meet passenger demand on community rail lines. Given the potentially diverse nature of infrastructure requirements and scenarios for community rail lines, specifications are not proposed in this document. Instead it is recommended that the devolved route teams of Network Rail, alongside TOC industry colleagues and in partnership with local stakeholders, work to formulate an optimum solution to meet local passenger demand in as cost effective a manner as possible.

4.4.3.4 Summary

The other alternative solutions under consideration in this strategy, namely tram train, tram conversion and energy storage, all have the potential to contribute directly or indirectly to the rolling stock and infrastructure cost of community rail routes. As part of this strategy, these aspects are being considered in parallel with the concept of community rail.

4.4.4 Passenger demand on community rail lines

4.4.4.1 Introduction to market characteristics

The designated community lines are diverse in their location and train service specification. Reflecting DfT's community rail criteria, they cover predominantly local train services which may have low service frequencies and comparatively slower journey times than other routes. Travel on designated community rail lines represents approximately two per cent of the national network with many of the journeys undertaken concentrated in the South West, North West and East of England as shown in Table 4.10. The community rail lines also tend to have a lower share of season tickets than the national average of 35 per cent, as shown in Table 4.10. This suggests that the majority of journeys are taken for leisure rather than commuting.

Table 4.10 – Usage of DfT designated community rail lines by area in England (source: Network Rail)

CRP by region	Total CRP journeys 2010-11 (000s)	Season ticket % (2010-11)
East Midlands	1045	17.2%
East of England	2185	13.4%
North East	185	10.0%
North West	2834	17.4%
South East	1879	24.1%
South West	2805	17.2%
West Midlands	539	15.8%
Yorkshire and the Humber	1350	10.7%
East Midlands	1045	17.2%

4.4.4.2 Rural and tourist lines demand

Much of the community rail market is for leisure purposes and is highly seasonal. Many of the localities served by community rail lines have stations at holiday locations. A number of the lines in Devon and Cornwall typify this substantial seasonal demand as a result of serving a tourist market, as shown in Figure 4.16. The corresponding low numbers of season ticket sales for these lines emphasise the seasonal nature of the demand experienced and the market that they serve.

Passenger demand on CRP lines has grown strongly over the period 2004/05 to 2010/11, as shown in Figure 4.17. The growth rates are shown in Figure 4.18 where growth is plotted against the percentage of journeys undertaken on season tickets. As a group, the lines have grown faster than the national average

Figure 4.16 – CRP seasonal fluctuations in passenger journeys (2010-11) on three routes (source: First Great Western)

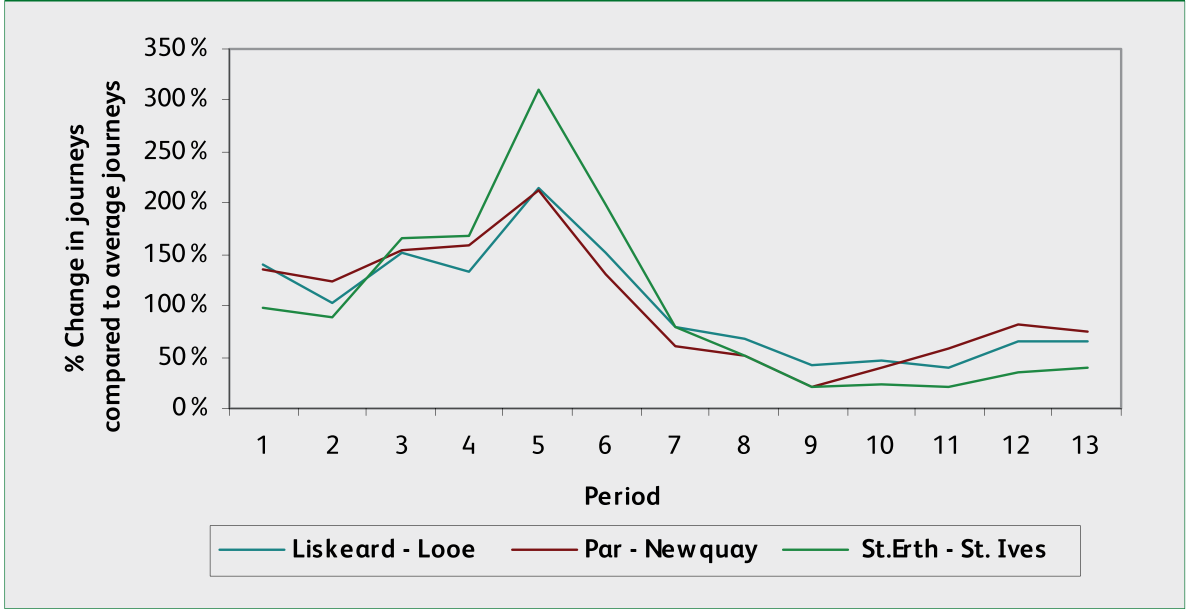


Figure 4.17 – Growth in CRP passenger journeys 2004-5 to 2010-11, indexed to 100 at 2004-5 (source: Network Rail)

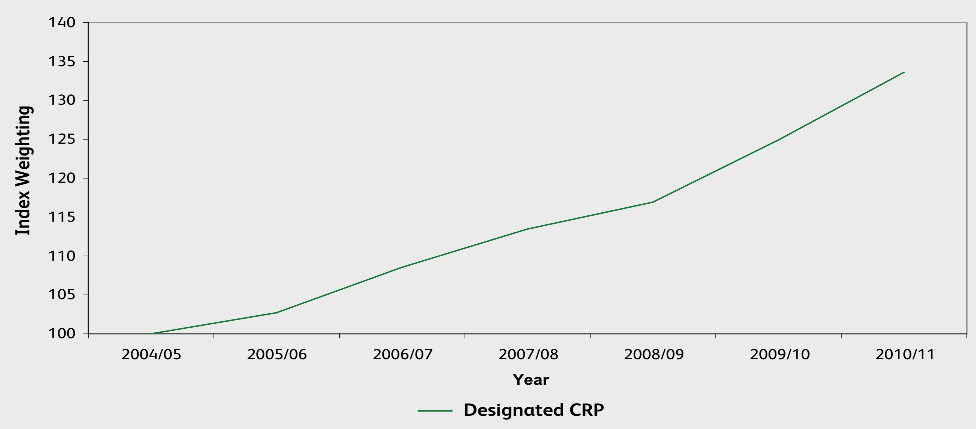
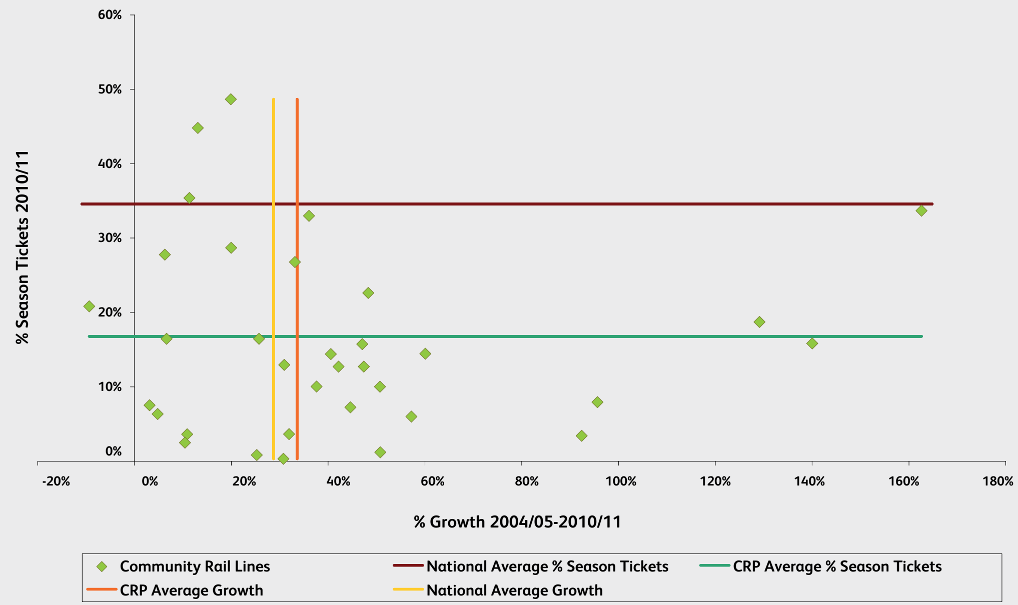


Figure 4.18 – Growth in CRP passenger journeys plotted against season ticket sales as a percentage of total sales (source: Network Rail)



4.4.4.3 Urban lines demand

There is substantial deviation in growth, with community rail lines that have a high proportion of season ticket travellers having experienced lower growth and only three lines above the national average. Lines with a high season ticket percentage have also grown slower than the average. Lines with fewer season tickets have grown relatively faster.

The percentage of season tickets has been illustrated in Figure 4.18 to make a high level assessment of the predominance of commuter markets on each route. It has been assumed that those lines with lower percentages of season ticket sales are serving primarily a leisure market. Leisure markets have different characteristics and demand drivers to those of business or commuter markets and have a greater level of discretionary travel. Therefore marketing initiatives may be more effective in influencing demand on such routes.

Lines with high season ticket sales would be assumed predominantly to be in urban areas where commuting by train would be an attractive alternative to the private motor car. Urban operations could fall into two broad categories. One, where a rural station is located at one end of a line and a major urban interchange/destination is located at the other. Alternatively, a route may cross a wholly urban area serving start and end points which are interchanges to the mainline national network.

4.4.4.4 Concentrated demand

Demand on CRP routes can experience periods of concentrated highs at any time of the year associated with special events occurring at a particular destination on the line. Subject to rolling stock and staff availability, and network capacity, the TOC will always endeavour to strengthen their services and/or provide enhanced service frequencies to cater for the spike in demand. For example, on the Heart of Wales line, between Swansea and Shrewsbury, the Royal Welsh Show at Builth Wells attracts a large number of visitors to the Llandrindod area each year. Wherever possible the local train operator introduces measures to cater for the increased demand on the line. In the past, subject to staff and rolling stock availability, loco hauled services with Mark 2 rolling stock have been used on scheduled and relief services to the event.

Additionally, on some CRP lines where off-peak train travel is discounted (typically a 50 per cent reduction or free as part of the national concessionary fares scheme) there can be heightened demand. This in turn can cause overcrowding which typically occurs on services departing stations immediately after the start of the off-peak period. It can be further exacerbated in the summer and/or holiday periods and where services are normally formed of only one or two coaches.

4.4.4.5 Growth trends

There have been five lines that have grown in excess of 80 per cent over the period and all have experienced major changes to the service provision to increase frequencies. These are the:

1. Severn Beach line
2. North Staffordshire line
3. Maritime line
4. Tarka Valley line
5. Matlock to Derby.

Some of the growth for the lines should be attributed to the changes in service provision.

A top down approach to drawing conclusions on the impact of CRP and community involvement on each of the lines is difficult given the nature of much of the community involvement in the railways. Furthermore, changes such as marketing and local awareness are hard to isolate from other changes such as increased passenger services and macro economic changes. Instead, the impact of the railways is examined by using case studies of the Devon and Cornwall Community Rail Partnership, the West of Lancashire Community Rail Partnership and examples of community rail from the Northern Rail franchise. These case studies can be found in Appendix D.

4.4.4.5 Revenue and ridership

Revenue issues concerning community rail lines are commercial decisions for the appropriate railway industry bodies, primarily the operator or Department for Transport. Such decisions will need to be made on a case by case basis.

Ticket sales data is the most readily available type of information which can be used to gain an understanding of line usage. It usually provides an indication of the origin and destination of individual journeys, although some rover or ranger tickets do not relate to a single route or journey. The Network RUS: Stations (2011) acknowledged the limitations of using ticket data as it does not directly translate into ridership on a line. As technology advances the rail industry is increasingly using in-vehicle passenger counting on rolling stock, to gain a more detailed picture of patronage. Such technology is not being used in new rolling stock, but also being retro-fitted to existing stock when undergoing refurbishment. Therefore it is likely that, over time, rolling stock which operates on community rail lines will be equipped with such technology.

4.5 Summary

This chapter has described the characteristics of each alternative solution, their usage, characteristics and cost comparisons.

Chapter 5 specifies the gaps based on the overarching drivers of change how the characteristics of each alternative solution enable them to contribute to addressing these objectives.

5 Gaps

This chapter outlines the key gaps which can be identified between today's railway and a future railway which could exploit the benefits of the alternative solutions outlined in Chapter 3.

5.1 Introduction

This chapter outlines the key gaps which can be identified between today's railway and a future railway which could exploit the benefits of the alternative solutions outlined in Chapter 3.

A Route Utilisation Strategy (RUS) gap is the gap between what the system can do now (supply) and what it needs to do (demand). This chapter develops gaps based on the drivers of change in Chapter 3 and on the baseline in Chapter 4.The gaps are summarised below for each alternative solution.

5.2 Alternative modes

The analysis of the gaps is not intended to suggest that these gaps would occur in isolation. As with any substantial change to the infrastructure and rolling stock, it is likely that there would be a number of gaps addressed by any tram or tram train scheme. The analysis attempts to isolate the specific circumstances in which tram or tram train is able to contribute to addressing gaps. The three gaps considered are:

- heavy rail gaps (Gap A)
- accessing new markets (Gap B)
- cost savings (Gap C).

In reality, a tram or tram train conversion of heavy rail infrastructure or services would address a range of gaps reflecting the package of changes to the whole public transport system that occur when such a service is introduced. The package of measures often includes:

- new journey opportunities
- reduced generalised journey time through improved connectivity and elimination of modal interchange
- increases in frequency
- fares changes
- changes in other public transport and to residual heavy rail services
- new stations.

The gaps have been tested in a step by step manner. Firstly, this is to attempt to isolate those specific factors which have been proposed as possible benefits of tram or tram train conversion of heavy rail infrastructure or services. Secondly, it is necessary to separate the specific contribution of the elements of the package of changes that a scheme would involve. This RUS starts from a heavy rail perspective, hence heavy rail capacity gaps represent Gap A.

However, in Gap B it is recognised that for the extension of an urban tramway, either by means of tram or tram train conversion of heavy rail infrastructure or services, wider public transport gaps are likely to be key. These gaps are not necessarily the direct role of the railway to address nor are they Network Rail's core area of competence. Instead they are more likely to be relevant to the aims of local authority Local Transport Plans and Passenger Transport Executives (PTEs) to provide the most cost effective transport offering for the given transport need. Nevertheless, using parts of the heavy rail network differently might help to address those gaps. The gaps that would be considered in a PTE and local transport planning perspective are multimodal in nature. Tram or tram train might be the most cost effective intervention of addressing such gaps.

Gap C relates to both the rail industry and local authority local transport planning aspirations to provide local rail services more cost effectively. It has been proposed that a range of alternative modes might be options to achieve this.

Gap A – city centre major station capacity and or capacity on inner suburban routes
As has been identified in Chapter 3, one reason for using tram or tram train conversion is in order to address major city centre station, or inner suburban route capacity. Therefore, a key gap is those locations in Great Britain where geographical RUSs have identified outstanding capacity gaps unresolved by conventional interventions. Additionally, there are scenarios where tram or tram train conversion might be able to release capacity by diverting certain services away from the constrained infrastructure.

Tram or tram train conversion of heavy rail infrastructure or services has been proposed as an option for capacity gaps at Leeds and Glasgow Central Station. Tram train conversion has been referenced in a number of other RUSs for consideration. In Leeds and Glasgow Central it was proposed for a specific option rather than as a more general concept.

Gap B – connectivity with city centres and their suburbs to create new journey opportunities, access new markets, and opportunities for new stations
The gap relates to a number of areas where existing areas of demand are currently not well served by train services. These areas include:

- current connectivity where location to location journey times by passenger services do not meet current or future needs
- journey times are not optimised, as modal interchange is required to complete journeys
- new journey opportunities and markets
- opportunities for new stations.

Typically, these gaps relate to situations where a city centre tramway already exists or where there are aspirations for one.

Gap C – cost effective ways of delivering services or new journey opportunities, access new markets, and opportunities for new stations

This is a gap where the cost of existing operations could be provided more efficiently in whole life, whole industry cost terms, if services were provided by trams or tram trains. It could also be where gaps exist in the capacity, connectivity and journey time on a particular route, as identified in geographical RUSs but the capital cost of capacity increases were not found to be possible with heavy rail. This gap does not necessarily relate to where an urban tramway exists. It could include conversion of routes where no such tramway exists. This might also include consideration of:

- light or hybrid light rail
- bus rapid transit and guided bus on a reopened rail corridor
- personal rapid transit.

5.3 Alternative methods of delivery of electric traction on lower traffic density routes

The gaps for the alternative methods of delivery of electric traction on lower density routes have been based upon established Network RUS: Electrification Strategy gaps. These gaps were:

- where electrification may enable more efficient operation of passenger services
- where electrification may enable more efficient operation of freight services
- where electrification could provide diversionary route capacity
- where electrification could enable a new service to operate.

Two of the four gaps in the strategy have been excluded, namely freight and diversionary routes. This is because the energy storage requirements for freight locomotives operating remotely from the existing electrified network are believed to be too large to be currently viable. Many diversionary routes proposed in the Network RUS: Electrification Strategy related to the operation of long distance high speed services which for the same reason, are not thought to be viable. Equally for diversionary routes, the infrequency of usage combined with the cost of energy storage make them inappropriate for consideration. Accordingly, the remaining two gaps have been adapted for relevance to the alternative solutions under consideration.

This RUS builds upon the gaps in the Network RUS: Electrification Strategy, by considering options for coasting, discontinuous and discrete electrification.

Gap D – coasting, discontinuous or discrete electrification which may enable more efficient operation of passenger services

The Network RUS: Electrification Strategy (2009) took as a threshold for conventional 25kV AC Overhead Line Electrification (OHL) to have a viable business case a greater efficiency than diesel train operation of one million passenger vehicle tonnes per annum per kilometre on single track routes. For double track routes the threshold was assumed to be two million tonnes per annum. The electrification strategy in its recommendations, acknowledged that if lower cost innovative forms of electrification were developed, this threshold might be lowered.

This is not to say that conventional 25kV AC OHL is not efficient, but it is unlikely to have a business case on the basis of greater efficiency unless it allows sufficient volumes of diesel train kilometres to be converted to electric traction.

This strategy develops the gap for the enabling of more efficient operation of passenger services from the Network RUS: Electrification Strategy. It targets lower traffic density lines, where conventional electrification may not be appropriate for achieving greater efficiency of operation of passenger services.

Two areas of consideration for Gap D have been identified. These are:

1. Avoiding the need for reconstruction of challenging structures e.g. bridges or tunnels

This element of Gap D relates to the gaps identified in the Network RUS: Electrification Strategy where, upon detailed investigation, it is found that there are considerable costs of reconstruction of difficult structures. In these cases alternative solutions may enable more efficient operation of passenger services.

2. Innovative low cost forms of electrification

The alternative solutions have different characteristics from conventional electrification. For example, through nodal electrification areas of the network which were not considered by the Network RUS: Electrification Strategy as within the threshold for conventional electrification can be considered. Nodal electrification refers to electrifying a service hub in order to enable a high proportion of traction units to switch to electric power for a relatively small conversion area.

Gap E – coasting, discontinuous or discrete electrification could enable a new service to operate

This gap includes passenger routes which extend beyond a currently electrified area. The use of energy storage would enable a corresponding extension of services at present operated by electric traction. This builds upon the gap in the Network RUS: Electrification Strategy.

While acknowledging that the Network RUS: Electrification Strategy also had a gap relating to new services, given that this is a national strategy no options have been assessed because none have been proposed. In implementing any electrification scheme the potential for new or modified services would probably be considered. As with the Network RUS: Electrification Strategy, this RUS does not propose any options of this nature as they would be considered at the point of implementation of any scheme.

5.4 Community rail

This section outlines two key gaps which can be identified between today's railway and a future railway which could realise the benefits outlined in the drivers of change from community rail initiatives.

The two gaps that have been identified are:

Gap F – the potential role of community rail in obtaining value for money in the local railway

Type F gaps concern the potential ability of community rail interventions to assist in developing any of the following:

- generate additional revenue
- minimise costs through greater operational efficiencies and innovation
- target investment to deliver maximum benefit to the local railway and community as a whole
- improve the deployment of resources, both financial and physical, based upon clearly defined local transport planning and community priorities
- secure third party funding to develop the railway.

Gap G – the potential role of community rail in encouraging greater involvement of the local community in the local railway.

Type G gaps concern the potential ability of community rail initiatives to encourage greater engagement by the community as a whole in their local railway.

The objectives of this activity would be to encourage usage of the railway and make sure that community needs are met as effectively as possible within the financial, operational and policy parameters of the railway network.

5.5 Summary

This chapter has presented gaps based on the drivers of change and baseline for the three groups of alternative solutions.

Following on from the gaps outlined in this chapter, Chapter 6 develops options to address these gaps.

6 Options

This chapter proposes options to address the gaps detailed in Chapter 5. The options that have been considered represent a subset of all the possible solutions.

6.1 Introduction

This chapter proposes options to address the gaps detailed in Chapter 5. This Route Utilisation Strategy (RUS) has considered the potential for technological options in the form of various modes of transport (trams, tram trains, hybrid light rail, personal rapid transit, bus rapid transit and guided bus), and innovative forms of electrification involving varying lengths of gaps in the overhead line infrastructure. Community rail as a concept of management philosophy involving the community in the development of the railway has also been examined. The options that have been considered represent a subset of all the possible solutions. These options have been selected on the basis that:

- they have not or are not planned to be considered as part of the existing railway industry planning process, and
- they have the ability to contribute to the gaps being considered.

Options have been labelled with the Gap letter (A to G) and then numbered for the individual option.

6.2 Trams and tram train conversion of heavy rail infrastructure or services

The options that have been considered address each of the gaps identified in Chapter 5 in turn. These gaps were:

- Gap A – city centre major station capacity and/or capacity on inner suburban routes
- Gap B – connectivity with city centres and their suburbs to create new journey opportunities, access new markets, and opportunities for new stations
- Gap C – cost effective ways of delivering services or new journey opportunities, access new markets, and opportunities for new stations.

Each option focuses on one gap. The reason for this approach is to understand the specific contribution of tram or tram train options in each area in which benefits have been proposed. In reality, any tram or tram train scheme would introduce a package of changes likely to address a range of gaps and deliver a wide range of benefits.

In particular, many of the transport gaps that the scheme related to would be outside of the direct responsibility of the railway industry. They would fall primarily within Local Authority Local Transport Plans and Passenger Transport Executives' areas of concern. The gaps and options start from the perspective of heavy rail capacity since this RUS is a rail industry strategy. It recognises that different uses of the railway network might be able to address wider public transport gaps at the same time as making the best use of the railway network.

The RUS examined the high level strategic issues relating to conversion to tram or tram train. Therefore, other options have not been considered. In reality, any project developing a scheme would evaluate the different public transport options in a particular corridor for addressing the gap, to secure the best value for money option. In addition to tram and tram train, these options might include a combination of heavy rail interventions as well as other public transport modes. This could include bus service changes or guided busways and bus rapid transit – see Appendix F for case studies of South Hampshire Bus Rapid Transit and the Cambridge Guided Busway.

Gap A – city centre major station capacity and / or capacity on inner suburban routes

The options considered in this section examine the potential for tram or tram train conversion of heavy rail services to address gaps in heavy rail capacity at stations in city centres. The range of options below consider the basic scenarios of conversion of heavy rail services to tram or tram train operation with or without an existing city centre tramway. It is unlikely that a scheme would contribute solely to heavy rail gaps. The examples cited in both Options A.1 and A.2 as part of tram or tram train conversion of heavy rail infrastructure or services would all have more substantial impacts on the wider public transport network. The conclusions to these options relate only to their impact on the heavy rail network and not their wider aims. The reason for considering the options in this way is to understand the case for heavy rail services or infrastructure to be converted to tram or tram train solely to address heavy rail gaps.

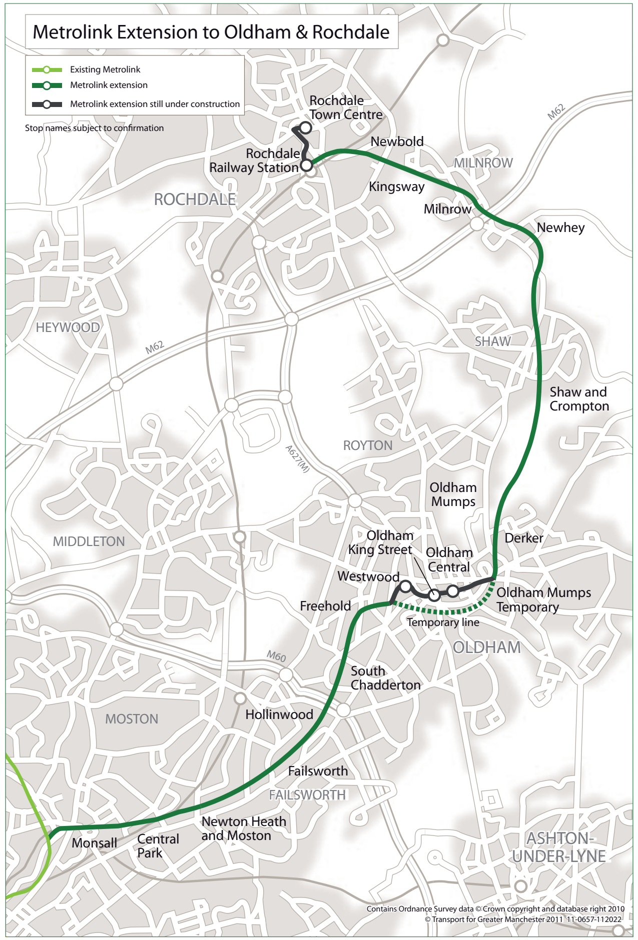


Figure 6.1
Map of the Rochdale via Oldham extension of Manchester Metrolink

Assessment of Option A.1: use of tram or tram train on some routes to take suburban services out of a heavy rail terminal where a city centre tramway exists	
Concept	Option A.1 is an example of the conversion of existing inner suburban train services to tram or tram train operation where there is an existing tramway in order to release capacity on the heavy rail network. An example of a conversion of former heavy rail services is the conversion of Rochdale to Manchester services (via the Oldham Loop) to Metrolink tram operations in Greater Manchester (see Figure 6.1). The conversion has released heavy rail capacity into the city centre terminal as services no longer travel between Manchester Victoria and Thorpes Bridge Junction. At Rochdale, heavy rail services which formerly terminated in the bay platform have been replaced by trams using a new stop adjacent to the railway station. The main aims of the scheme are to increase frequency of services and connectivity to both the city centre and the town centres of Oldham and Rochdale, not to release heavy rail capacity. While these impacts relate primarily to Gap B, the scheme is used here to illustrate the impact on Gap A.
Infrastructure and rolling stock requirements	• segregated connection to the existing tram network • electrification to 750V DC Overhead Line Electrification (OHL) • new rolling stock (trams) • track renewal • revised train control • refurbished structures • refurbished stations • new stations • new street running extensions into Oldham and Rochdale town centres.
Impact	• planned increased service frequency as tram type vehicles may have lower capacity than heavy rail • increased connectivity from new street running extensions and new stations • connectivity with the city centre by connecting into the existing tramway • the Diesel Multiple Unit (DMU) rolling stock released has been used to strengthen other existing services • the Northern Hub has proposals to increase the train service at both Manchester Victoria and Rochdale. Manchester Victoria is not currently used at full capacity. If the Northern Hub proposals are implemented this position would change and the capacity released by the Oldham Loop services could have a performance benefit • access to the bay platform at Rochdale for the Oldham Loop services was previously across the station throat, a capacity constraining move.

Assessment of Option A.1: use of tram or tram train on some routes to take suburban services out of a heavy rail terminal where a city centre tramway exists (Cont.)	
Feasibility	The key prerequisite for this option is the existence of services which can be segregated to allow tram operation and which can affordably be connected to an existing tramway. In the case of both tram train and tram an appropriate service length (route miles) and market demand are required for the concept to be feasible. Full segregation was possible on the Oldham - Rochdale line and conversion to operation has been implemented. However, if it had not been possible to segregate the services, then tram train could have been considered as an alternative.
Conclusion	Capacity benefits can result from tram or tram train conversion. However, capacity release is only one of the benefits and in this example it is not the main justification for the conversion of services to tram operation. The main immediate capacity benefit has been the release of DMUs to strengthen services elsewhere. Longer term, the released capacity may prove useful in terms of performance when the Northern Hub proposals are implemented. It is not always possible to envisage what released capacity will be useful for. For example, the original Metrolink conversions of the Altrincham line released considerable capacity through the Castlefield corridor in the centre of Manchester which has subsequently been used by interregional services. However, the extent of this benefit was not realised at the time and capacity release was not a main scheme objective. The capacity released by a tram conversion may not always be usable or relevant to identified route capacity gaps. The option is limited to where capacity gaps have been identified adjacent to an existing tramway, which are found in only seven cities in Great Britain (including Edinburgh which is currently under construction). Where connection to the tramway is relatively straightforward this option may be viable to address a capacity gap. However, based on the current planning horizon, no examples could be found in the geographical RUSs of tram or tram train conversions which would be justified solely on the basis of capacity released on the heavy rail network. Capacity release is likely therefore to be only a secondary benefit of future conversion. Only if the conventional solution for capacity enhancement was on too large a scale to be good value for money or affordable,could tram or tram train conversion become an option to address such a gap.

Assessment of Option A.2 convert some routes to tram or tram train operation to take suburban services out of a heavy rail terminal into a city centre without an existing tramway	
Concept	The Leeds tram train scheme was proposed to meet wide objectives. These include the provision of potential new stations and journey opportunities, to provide a link to Leeds Bradford International Airport, to facilitate housing growth, and to support economic growth. The RUS is concerned only with the heavy rail capacity benefits. The Northern RUS proposed tram train conversion of service groups into Leeds station as an alternative option to expensive and complex conventional solutions creating new lines into Leeds and potentially 'double decking' the station. There are two potential corridors that have been identified for tram train conversion to address potential performance and capacity gaps: 1. Harrogate services 2. Knottingley services. The current collective aspiration of West Yorkshire Passenger Transport Executive (WYPTE), North Yorkshire County Council, City of York Council and Harrogate Borough Council is to pursue full 25kV AC overhead electrification and heavy rail services for the entire route, with the possibility of tram train at either end of the route from Leeds to Leeds Bradford International Airport and from Poppleton into York.
Infrastructure and rolling stock requirements	On the Harrogate route, electrification is required to allow electric tram train operation from Leeds to a termination point. The termination point of the service could be the turnback at Horsforth which will be implemented during Control Period 4 (CP4 2009-2014), or beyond to either Leeds Bradford International Airport or Harrogate itself. An on street tramway is required with a connection to the heavy rail network to divert services from Leeds station. Dual voltage tram train rolling stock and associated depot facilities would be required. Changes would also need to be made to existing platform heights and to the heavy rail track alignment and geometry. On the Knottingley route electrification is required to support electric tram train operation from Leeds to Knottingley (via Castleford). An on street tramway is also required with a connection to the heavy rail network to divert services from Leeds station.
Impact	Harrogate – tram trains could run to Horsforth or could be extended to Leeds Bradford Airport or to Harrogate itself. Heavy rail services from Harrogate could then benefit from faster journey times into Leeds by no longer calling at stations between Horsforth and Leeds. Current heavy rail only infrastructure solutions to gaps on the Harrogate and Leeds North West corridors include a new platform face at Leeds. This might be avoided if tram train conversion reduced the volume of services calling at the station and only heavy rail services from Harrogate needed to be accommodated alongside longer trains on the Skipton and Ilkley corridor. Knottingley – this option has the potential to provide capacity and performance benefits by enabling the removal of services from Knottingley from the E and F lines into Leeds.
Feasibility	Harrogate – it is likely that the conventional option proposed to address the heavy rail gaps on this line and the Leeds – Skipton and Ilkley corridors would be feasible and less costly than a tram train solution. Knottingley – this option might address the gap at Leeds station but the cost and complexity of constructing a connection to the heavy rail network at Leeds is potentially significant. It is unlikely that the tram train option would be more cost efficient than a heavy rail solution.
Conclusion	Tram train options have the ability to contribute to heavy rail gaps at Leeds station. However, based solely on the benefits to the heavy rail service, they are unlikely to be justifiable. The cost of electrifying the route concerned and of providing a new alignment to divert tram trains away from the city centre station to a tram stop site are unlikely to offer value for money comparable with heavy rail only options. The RUS considered similar gaps in geographical RUSs across the network and has not found circumstances where tram train would be a viable option with a business case based solely on heavy rail gaps. It can be concluded that tram train conversion may have the potential to contribute to addressing heavy rail gaps but is unlikely to be the sole justification. This conclusion does not reflect the wider potential benefits of the Leeds tram train proposals such as accessing the airport and achieving better connectivity through an on street tramway penetrating the city centre. These relate to Gap B. Heavy rail capacity benefits might still be an element in a wider business case for tram train implementation in Leeds or other cities.

Gap B – Connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations

The options to address Type B gaps involve new markets and new opportunities, many of which would involve extension beyond the existing heavy rail network. The options consider the scenarios that are possible with or without a tramway.

<table>
<tr><th colspan="2">Assessment of Option B.1 conversion of heavy rail services to tram train operating onto an existing tramway system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations</th></tr>
<tr><td>Concept</td><td>This option involves the connection of an existing tram system to the heavy rail network with the objectives of providing connectivity with city centres and their suburbs. This would create new journey opportunities, allow access to new markets and provide opportunities for new stations.

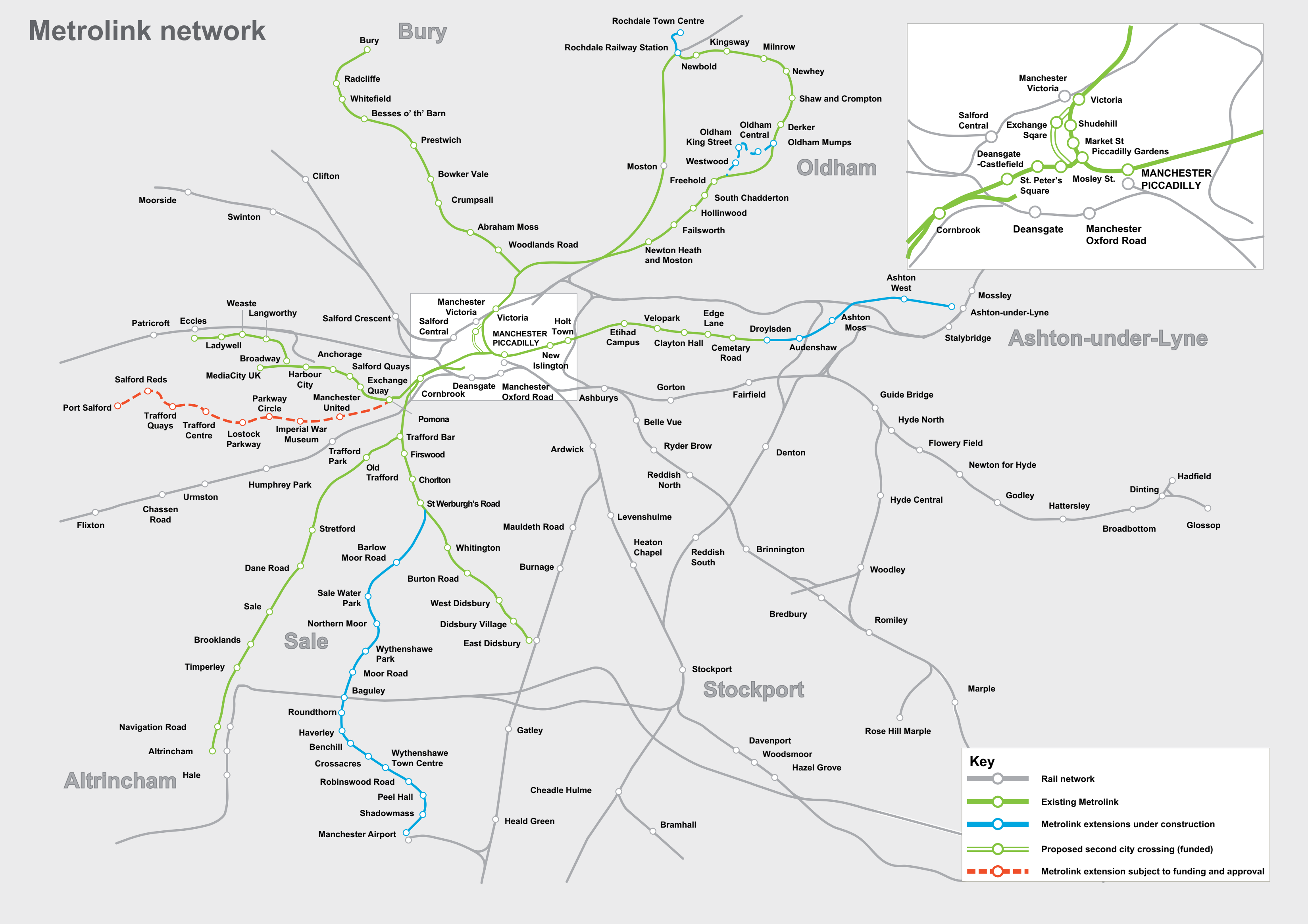
This option is illustrated with reference to modelling conducted by Transport for Greater Manchester (TfGM) of the proposed conversion of the Marple line in Manchester to tram train. The Manchester – Marple route is one of a number of potential tram train schemes in Greater Manchester.

Key aims of the proposal are to overcome the disadvantage of the location of Manchester Piccadilly station on the edge of the city centre and to allow higher service frequencies by avoiding the congested Northern Hub rail bottleneck. Both these aims could be achieved by connecting the heavy rail network with the Metrolink network in Manchester city centre. Figure 6.2 illustrates the Metrolink network along with the heavy rail network in Greater Manchester.

The TfGM modelled proposal is a tram train extension of the Metrolink Eccles to Manchester Piccadilly services running through to Marple at a 12-minute headway, with:

• all tram train services calling at all stations.
• the existing rail services modified as follows:
– all Manchester Piccadilly– Marple / New Mills via Bredbury services are withdrawn
– existing local services from Manchester Piccadilly – Marple Rose Hill via Guide Bridge service are retained
– existing local services from Manchester Piccadilly to Chinley and the Hope Valley (one train per hour) serving Ashburys and Maple are diverted to call at Guide Bridge and Hyde Central, continuing to Romiley, Marple, Strines, New Mills etc.</td></tr>
</table>

Figure 6.2 – Map of the Manchester Metrolink and Greater Manchester rail network (Source: TfGM adapted by Network Rail)



Assessment of Option B.1 conversion of heavy rail services to tram train operating onto an existing tramway system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations (Cont.)	
Infrastructure and rolling stock requirements	Specific Marple line infrastructure and rolling stock requirements include: • tram train rolling stock • connection to the Metrolink line • electrification of the Ashburys to Marple rail line for through running and track sharing by Metrolink services • new bay platform at Marple for terminating Metrolink services. The general infrastructure and rolling stock requirements which are not specific to the Marple line example are: • tram train rolling stock has to be procured because of the requirement to operate both on street and on the heavy rail network • depending on the location, the connection between the tramway and the heavy rail network may involve minor track work or considerable extension of the tramway. The cost will vary depending upon the length and complexity of the connection and what, if any, additional powers are required to build it • to provide a compatible traction system with 25kV AC OHL there needs to be a voltage change over to a lower voltage DC system for street running, or run DC throughout (which could restrict heavy rail network flexibility). An OHL system should be selected commensurate with the electrification strategy for the route. Dual or single voltage vehicles are readily available. The additional equipment required for dual voltage vehicles increases the capital cost as well as the added weight per vehicle. However, dual voltage vehicles may be a more cost effective way of future proofing a scheme for 25kV AC extensions as retro fitting may be more expensive • if the traction system is to be DC throughout, appropriate control and maintenance arrangements which minimise the safety interfaces are needed • wheel rail interface design that is compatible for both transport systems is needed. The increased flange back gap of tram wheels on heavy rail switches and crossings (S&C) requires special wheel profiles and additional guidance measures such as raised check rails or swing nosed crossings • if the tramway has low floor trams then existing heavy rail stations will need to be modified to accommodate tram trains • reduced level of crashworthiness of vehicles allowed under the relevant standards requires additional train control for crash mitigation to reduce the likelihood of a collision • effective radio communications for all the networks operated to all signallers and controllers must be provided – Network Rail is currently installing Global System for Mobile Communications – Railway (GSM-R), while tramway operators use other radio systems • consideration needs to be given to preventing wrong routeing from the railway to the tramway • track alignment and geometry on the heavy rail system may need to be improved to allow the lighter weight tram train vehicle to operate with sufficient ride quality due to the differences in vehicle body design • the operational model for the service needs to be defined, i.e. extension of tramway operation onto heavy rail network, or extension of franchised service onto tramway system, together with the creation and identification of a possibly new open access operator onto both • a new depot may be required if existing facilities have insufficient capacity.

Assessment of Option B.1 conversion of heavy rail services to tram train operating onto an existing tramway system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations (Cont.)	
Impact	The Marple line tram train proposals are expected to deliver the following changes: • improved journey times and network connectivity, with the creation of direct journey opportunities from stations on the Marple line to Manchester city centre and beyond, linking into the existing Metrolink network • extension of existing Metrolink services running through the city centre to Manchester Piccadilly and on to Marple, offering services every 12 minutes and thereby delivering a net increase in trains on the route, especially at inner suburban stations. Tram train services would replace some existing heavy rail services, whilst other existing services would be modified • a more balanced pattern of demand by time of day through attracting a less work dominated range of trip purposes. This is partly due to providing a much more attractive service from the inner urban area, which has a much higher trip rate to Manchester city centre for non-work purposes than the outer part of the route • adoption of Metrolink fares and ticketing on tram train services. Modelling developed by TfGM suggests the proposals would deliver a significant increase in patronage. Journeys to and from stations on the Marple line would increase by over sixty per cent. A significant proportion of this growth would be diverted from local bus services serving the suburbs of Manchester. The increased fares revenue would reduce or eliminate the need for an ongoing subsidy and facilitate some recovery of capital costs. The distribution of revenue would need to be rebalanced with the heavy rail franchise. Other benefits include lower operating costs and potentially less wear on the heavy rail network due to the lower axle weight of tram trains. The general benefits might include: • access to new markets • new stations potentially at lower cost than heavy rail • higher acceleration of tram trains compared to DMUs • lower unit operating costs • further frequency increases may be possible but would depend on available capacity, and the additional operating and capital costs required to achieve additional frequency • track access charges are likely to be cheaper due to the lower axle weight of tram vehicles. The demand forecasting undertaken for the tram train pilot between Rotherham and Sheffield has been used further to illustrate Option B.1. The tram train pilot service will operate from 2015 with a 20-minute frequency from Rotherham Parkgate all stations to the Sheffield Supertram Cathedral stop (see Chapter 4 Figure 4.3 for a map showing the tram train service). The pilot will provide a new transport link between the tram and heavy rail network, a new station at Parkgate and also increase the frequency of tram services on the Supertram network.

<table>
<tr><th colspan="2">Assessment of Option B.1 conversion of heavy rail services to tram train operating onto an existing tramway system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations (Cont.)</th></tr>
<tr><td>Impact</td><td>South Yorkshire Passenger Transport Executive's consultants used an elasticity based methodology to forecast the incremental change in demand caused by the tram train service from existing tram and train stations. For the wider transport area, demand associated with the new journey opportunities enabled by the tram train service and the new station at Parkgate was forecast using a logit model. It was based upon the city wide Sheffield and Rotherham Transport Model.
The relative split of overall demand forecast for tram train service in the year of its introduction is as follows:
• 67 per cent existing tram stops – demand forecast from existing tram journeys
• six per cent existing rail stations – demand forecast from existing rail journeys
• 27 per cent wider area – demand forecast from beyond the existing tram network from surrounding areas out towards Rotherham to both Sheffield and intermediate stations, and through the provision of a new station at Rotherham Parkgate.
The demand forecast for tram train services is primarily driven by the additional frequencies provided by the tram train within the existing tram network area. This is not unexpected because the tram train service will only operate to two stations on the heavy rail network. While rail may only represent six per cent of the overall forecast demand of the entire scheme, this hides significant percentage uplifts in demand on the existing rail corridor, which are as follows:
• Rotherham- Meadowhall 57 per cent
• Rotherham- Sheffield 21 per cent
• Sheffield- Meadowhall seven per cent.
The wider area demand associated with the new journey opportunities enabled by the tram train service and the new station at Parkgate represent 27 per cent of the forecast demand. Through the provision of a new station at Rotherham Parkgate in particular, tram train affects the attractiveness of using public transport in and around Rotherham and a proportion of current car and bus users will switch to the proposed new tram train service in these areas. These modal shift impacts are important for three main areas within the demand forecasting and appraisal:
• additional demands and revenues associated with modal switch in these areas
• loss of revenue from those who shift from bus to tram train, which must be recognised in the overall system revenue forecasts
• wider indirect taxation, decongestion and vehicle operating cost impacts that occur as a function of fewer vehicular trips on the road network.
The general operational and technical issues might include:
• potential delays to heavy rail services because of road congestion affecting the tram system
• limited potential to reduce complexity of the signalling system unless there are to be new sections of fully segregated operation
• if tram services operate a high frequency, they may be the busier operator than the heavy rail service and may need to take priority through appropriate timetable management.</td></tr>
<tr><td>Feasibility</td><td>• needs a tramway with sufficient capacity to be able to connect to, or a pre-existing tram service that can be extended
• analysis of tram acceleration characteristics in Chapter 4 suggests greater benefits would be likely converting from DMU operation to a tram train than from an Electric Multiple Unit (EMU)
• analysis of inner suburban services in Chapter 4 suggests that where these are operated by EMUs, the capacity provided in the high peak hour is higher than for DMU operated services, such as those presently operating the Manchester – Marple services. This is, in part, because EMUs are longer on average than DMUs and electrification has usually been provided on high traffic density routes. It may be likely that tram train conversion would have greater benefit on non electrified routes
• tram trains may permit an increase in the frequency on both the tramway and heavy rail network, where sufficient capacity exists. Tram train capacity is 250-300 passengers per vehicle which should be matched against current and optimum train capacity for the route using conventional vehicles. There would also be a cost for providing this additional frequency.</td></tr>
</table>

Assessment of Option B.1 conversion of heavy rail services to tram train operating onto an existing tramway system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations (Cont.)	
Feasibility	• tram train is useful where separate running is not practical due to the need to retain other heavy rail services (freight or passenger) on the converted route • provision must be made to integrate with other transport modes in line with both the heavy rail and local transport strategies • depending on the safety and performance strategies of the proposed system, the cost of construction and maintenance will affect the economics of the business case, i.e. alternative technology solutions on a small scale will drive up maintenance costs in comparison with heavy rail system components, which are easier and cheaper to source but over engineered relative to tram systems • the choice of 750V DC OHL or 25kV AC will depend upon the whole life cost and the strategy for heavy rail electrification for the area in question • the need to renew either the infrastructure or the rolling stock of either the heavy rail or the tram systems might trigger a value for money business case for the introduction of tram train to offset conversion costs against the renewal requirement • the need to invest in renewing rolling stock and/or infrastructure could be a catalyst for tram train conversion • small and discontinuous orders with bespoke requirements will raise the unit price of tram trains. Economies of scale should be sought as part of the procurement strategy • early consideration of the operational and maintenance costs of tram train specific infrastructure and compliance with applicable standards is needed. Consideration needs to be given to the relative costs of maintaining 'one off' or low population tram type components against the installation of heavy rail items for which there is an economy of scale • because safety systems for heavy rail are more stringent than for trams, there would be higher costs in integrating these features onto tram vehicles. Vehicle capital or leasing costs are likely to increase with the necessity to meet heavy rail safety standards and the need to cover higher insurance premiums due to higher operational risks; these need to be assessed at the start of the project. This may be mitigated through exemption by risk assessment • stops, where required, may have to satisfy existing heavy rail station platform dimensions or new bespoke stops would need to be provided. These should be done by a risk assessment which considers the amount of passing traffic, footfall etc.
Conclusion	• The factors affecting the appropriateness of the route for conversion are: • the level of existing train services not to be converted – if these services are too dense then tram trains will have insufficient capacity • if demand is too limited then tram trains will over supply the market and/or there will be insufficient demand and benefits to justify the capital costs • competition from other modes of transport • the potential benefits of city centre penetration • the potential benefits of new stops • the potential benefits of increased frequency • the principal factors driving the cost of a conversion to tram train are: – the complexity and scale of the connection to the tramway – the cost of conversion of the heavy rail infrastructure which, if it requires substantial electrification, may be considerable • conversion of DMU services would be likely to have the greatest benefits because EMU acceleration is nearer to that of a tram or tram train and EMU capacity is generally higher than DMU • whilst a whole life cost assessment would need to be undertaken for each option, it is likely to involve electrification because of the capital and operating costs of bi-mode trams or tram trains.

Assessment of Option B.2 operation of tram trains onto a new city centre system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations	
Concept	Construction of a new city centre tram system and successive connection to the existing heavy rail network. There are a number of examples across Great Britain, where tram train schemes have been proposed in cities that currently do not have a tramway.
Infrastructure and rolling stock requirements	As option B.1 plus: • creation of a new tramway plus associated vehicles • consideration needs to be given to the routeing of the tramway. This will be affected by the distance of the city centre from the heavy rail station. There may be the opportunity to have a form of interchange station for the tram services connected to the heavy rail station or to convert the existing heavy rail station itself to an interchange station to accommodate light and heavy rail, bus and taxi services • a new depot would be required for the fleet.
Impact	As option B.1 plus: • the converted element of the scheme would be similar to option B.1. However, a new tramway would also result in an impact which would need to be evaluated • significant disruption during construction to the existing transport network (e.g. road network for buses and city centre deliveries, taxis, emergency services etc) in the city centre area, and beyond if the heavy rail network is not in close proximity to the centre. However this is unlikely to be any greater than most significant transport improvement schemes • the cost of tram train conversion of an existing or former heavy rail route may be lower than construction of on street tramways and result in less disruption to road traffic during the construction phase due to there being fewer utility or other developed assets to overcome and third party interfaces to manage and compensate. Conversion of operational heavy rail routes could incur maintenance possession costs at a similar level to the current heavy rail network.

Feasibility	As option B.1 plus:
	• the creation of a new tramway would be dependent upon feasibility and a positive business case as it would have a considerable financial cost
	• land purchase or leasing costs will be incurred (no differential whether heavy rail or tram)
	• assuming the new tram track is to follow a previous rail corridor
	  – track installation and signalling costs will be incurred but may be increased if a tram train is used rather than a tram only system due to the potential requirement to comply with heavy rail safety standards. Exemptions may be possible through risk assessment
	  – a signal control centre for the tramway system must be budgeted for unless capacity exists within the Network Rail centre. This will require dedicated staff which may result in additional costs.

Conclusion	As option B.1 plus:
	• a business case would be required for the creation of an on street tramway. It is noted that the city centre infrastructure for the Manchester Metrolink was justified largely on the basis of converting the Bury and Altrincham lines. In this case the new city centre infrastructure was a relatively short section in the city centre. It has subsequently formed a part of the core network which brings far wider benefits than the original converted lines
	• however, heavy rail conversion to either tram or tram train is likely to be lower cost than new on street tramways because:
	  – most new tramways have made use of former railway alignments
	  – Manchester Metrolink and London Tramlink have both converted actual heavy rail services.

Gap C – Cost effective ways of delivering services or new journey

circumstances in which tram conversion is able to reduce the cost of services and enhancements on rural routes. This could include using tram or tram train as well as hybrid light rail vehicles such as the Class 139.

Assessment of Option B.3 convert to segregated tram system to provide connectivity with city centres and their suburbs to create new journey opportunities, tap new markets, opportunities for new stations	
Concept	Conversion from heavy rail to tram and separation from the existing heavy rail network, for example Nottingham Express Transit Phase 1 Hucknall-Nottingham City Centre. This conversion only applies to the infrastructure. Conversion can encompass converting heavy rail services, as seen with the London Tramlink's conversion of the Wimbledon to West Croydon services.
Infrastructure and rolling stock requirements	As option B.1 plus: • might be part of the creation of an entirely new tram system or as an extension to an existing tramway • tram vehicles only • change in infrastructure and train control systems to sever the new tram operation from the heavy rail network • possibility of simplifying the heavy rail signalling system • no requirement for any track, power or train control interfaces with the heavy rail network
Impact	As option B.1 plus: • might be part of the creation of an entirely new tram system or as an extension to an existing tramway • tram vehicles only • change in infrastructure and train control systems to sever the new tram operation from the heavy rail network. Closure powers would be required • possibility of simplifying the heavy rail signalling system • a new depot may be required for the fleet.
Feasibility	As option B.1 plus: • in some instances there may be a loss of passenger destination flexibility due to disaggregation from heavy rail network services leading to a requirement for a passenger interchange with onward heavy rail services • potentially lower cost than tram train because: – trams may be cheaper than tram trains – train control systems can be simplified throughout – heavy rail vehicles are no longer present. Therefore infrastructure maintenance costs may be lower.
Conclusion	As option B.1 plus: • tram conversion is only possible where the pattern of services and demand allows the removal of all other heavy rail services, including freight. The circumstances in which this applies may be constrained by requirements to retain significant numbers of heavy rail services on a route.

Assessment of Option C.1 cost effective ways of delivering services or new journey opportunities, tap new markets, opportunities for new stations - tram	
Concept	Conversion of heavy rail services outside urban areas to a tramway separated from the existing heavy rail network, for example as was considered for the Watford Junction to St Albans Abbey line (Appendix G provides a detailed case study of options that were considered for the Abbey Line).
Infrastructure and rolling stock requirements	• new electrification which, depending upon its strategic fit with the wider network and the whole life cost, might be 25kV AC or, more likely in the case of new electrification for segregated routes, 750V DC • for existing electrified routes 25kV AC tram vehicles would be needed. Otherwise alteration to the existing heavy rail power supply would be required. Segregation from the heavy rail network would be needed to make sure the entire system is independent. 3rd rail electrification is technically feasible but unlikely to be desirable due to the configuration of the vehicle design required to mitigate the imported risks of on street electrification running. Pantograph operation for on street running would be preferable • potential need to alter the signalling system, not only to ensure it is independent from the heavy rail network, but potentially also to alter the signage to be compatible with tramway operation • a new depot may be required for the small fleet created • more vehicles might be required than are being replaced because small fleets require a higher percentage of redundancy to cover maintenance spares • if low floor trams are used then existing heavy rail stations will need to be modified • track modifications to allow infrastructure compatibility with light weight vehicles and vehicle body design.

Figure 6.3
Photograph of St Albans Abbey station

Assessment of Option C.1 cost effective ways of delivering services or new journey opportunities, tap new markets, opportunities for new stations - tram (Cont.)	
Impact	• possible benefits – reduced operating costs – new stations may be able to be added without increasing journey time, due to the better braking and acceleration profiles of tram and tram train rolling stock compared to heavy rail stock – reduced capital costs for enhancements because: (a) passing loops built can be shorter for a tram or tram train than for heavy rail rolling stock due to improved braking capability of the former (b) the signalling system installed may be simplified in the case of tram conversion (c) new switches and crossings can be shorter for a tram or tram train than for heavy rail (d) new stations will potentially be cheaper for tram and tram train since they will require shorter length platforms than those required for heavy rail services. • possible costs – rolling stock – cost of conversion of track – cost of infrastructure enhancements – new depot – cost of segregation if required – cost of overhead line electrification (OHL) if not already provided or a self powered train is not feasible – cost of any new stations (albeit lower than heavy rail equivalent costs) • loss of passenger destination flexibility due to segregation from heavy rail network services leading to a requirement for a passenger interchange with onward heavy rail services.
Feasibility	• there is a capital cost to both conversion of the infrastructure and provision of tram rolling stock. As the cost of conversion of both is significant, a tram system value for money business case may be most feasible when renewal of either is scheduled • small and discontinuous vehicle orders with bespoke requirements will raise the unit price of trams. Economies of scale should be sought as part of the procurement strategy. Wherever possible, to maximise economies of scale in procurement, consideration should be given to the development of batch orders for stock across the country for different schemes. This would allow for standardisation of the vehicle type and reduce the number of rolling stock types operating on the national rail network (a key recommendation of the 2011 Network RUS: Rolling Stock) • it is only possible to segregate a limited number of services, as most existing service patterns interact with other heavy rail services, including freight. Only a small number have no interaction with any other passenger or freight service while in passenger operation. Most branches have some level of interaction either at their origin or destination, or with freight along some portion of the route • across the network there are even fewer examples of electrified branch lines which currently operate as fully segregated passenger services. This suggests a requirement for either electrification or diesel trams. Diesel trams may have a higher capital cost than an equivalent DMU • potentially lower cost than tram train because: – tram vehicles may be lower cost than tram trains – train control systems can be simplified throughout – heavy rail vehicles are no longer present therefore infrastructure maintenance costs may be lower.

Assessment of Option C.1 cost effective ways of delivering services or new journey opportunities, tap new markets, opportunities for new stations - tram (Cont.)	
Conclusion	• there are few fully segregated passenger services outside urban areas, as even most branch lines have a level of interaction with other trains either at a terminal station or with freight traffic • tram conversion is likely to involve electrification. This may involve 750V DC electrification. A business case will be required for this cost of conversion • the loss of flexibility in converting a route to trams would require passenger interchange to be addressed. Equally there may be additional flexibility arising from improved journey opportunities through the tram network • small scale operators may suffer from loss of economies of scale in terms of staffing, rolling stock utilisation and ticketing agreements • energy costs are likely to reduce, especially if the tram is electric • track access charges are likely to be lower due to the lower axle weight of tram vehicles • potentially would require more vehicles as a small fleet needs a higher ratio of spare vehicles than a larger fleet • signal control centre for tramway system must be budgeted for together with costs to decommission from the heavy rail control centre • operational costs (including vehicle refurbishment, carriage maintenance, mechanical maintenance, staffing, cleaning and breakdown systems) may be lower for tram than heavy rail.

Option C.2 provides a high level assessment of the impact of using trams as an alternative to heavy rail when reopening a route. The Midland Metro is one such example where trams have been used to reopen a former heavy rail service. The option sets out the considerations that will be relevant in selecting trams as opposed to heavy rail. This could include a range of solutions from a tram to hybrid light rail vehicles such as the Class 139.

Assessment of Option C.2 reopening of closed routes to tram, tram train or hybrid light rail operation	
Concept	Opening or reopening a corridor for tram use as an alternative to heavy rail. A number of openings or re-openings have been proposed but the capital and operating cost of a heavy rail solution means that there is a high cost hurdle to be overcome. Trams, tram trains or hybrid light rail might be a means to reduce the capital and operating costs of such schemes.
Infrastructure and rolling stock requirements	• The type of infrastructure and rolling stock that would be required is dependent on whether the reopening of the heavy rail corridor is planned for shared running or whether rail services are fully segregated • the infrastructure required for tram would potentially reduce the level of a number of cost s. However, electrification is still likely to be required and a number of costs would remain unaffected • a new depot would be required for the fleet.
Impact	• potential for disruption to existing transport networks (e.g. where it interfaces with the road network for buses, taxis, emergency services etc) during construction along the corridor and immediate area – although unlikely to be worse than any other major transport improvement project • potential for disruption of existing land uses depending on the location of the corridor in a rural or urban environment. This impact would be dependent on the extent to which new routes were required, whether the existing track bed could be utilised and how long it had been out of use.
Feasibility	• provision may be needed for integration with other modes, especially heavy rail, and would require passenger interchange to be addressed • the level of demand, linespeed, overall route length, and stopping frequency would determine whether tram, tram train or conventional heavy rail was appropriate for a particular route • tram would only be possible where it was acceptable not to integrate with heavy rail or limited time share operation was possible.
Conclusion	• If undertaken as a tramway, segregation needs to be possible and the disadvantages of the loss of network benefits need to be acceptable. • The suitability of a tram style vehicle depends upon: – market type – route length – passenger volumes • as with conversion of routes, diesel tram vehicles are more expensive while electrification has a capital cost to its installation • there may be a further benefit if there is some element of street running incorporated • may reduce the cost hurdle of a new or reopened line but the option will not be appropriate for all routes or markets.

Option C.3 considers the potential for bus rapid transit and guided bus for reopening former rail corridors.

It is not being considered as an option for replacing existing heavy rail train services.

Assessment of Option C.3 reopening of closed routes – bus rapid transit and guided bus	
Concept	For reopening heavy rail corridors both Bus Rapid Transit (BRT) and guided busways are an option for meeting demand. They offer the benefits of heavy rail, trams and buses combined. They have the ability to operate on track and guided rails with segregation and to serve areas radial from the fixed infrastructure. This broadens geographic coverage and gives the potential to penetrate town and city centres. In both the examples used as case studies in this RUS, South Hampshire and Cambridge, former rail routes have been reopened to passenger public transport using buses on segregated routes (see case studies in Appendix F).
Infrastructure and rolling stock requirements	Guided busways and bus rapid transit systems have a high degree of network adaptability and flexibility due to their ability to travel outside their busway or guideway (either for emergency deviations or to serve wider destinations) and thereby serve a greater area than fixed modal systems. In contrast, modes entirely dependent on fixed infrastructure such as heavy rail and light rail are constrained by the infrastructure they require. This may be an advantage over heavy or light rail options for reopening a former railway line as a smaller portion of fixed infrastructure in the form of a roadway, or guideway is required to serve the potential market.
Impact	The passenger benefits of the ability to serve dispersed locations and penetrate town and city centres is to reduce journey times and improve connectivity. For BRT the capital costs of the scheme are likely to be mainly for the construction of the dedicated roadway and stop facilities. Away from the segregated roadway traffic other highways measures might be taken to improve reliability and overall journey time. Guided bus differs from BRT because a dedicated guideway must be constructed rather than a road.
Feasibility	Bus rapid transit and guided bus have been used in circumstances where either a heavy or light rail service would not be practical on grounds of either cost, or constraints of space which preclude access to a city centre. They have generally been used over relatively short distances serving a dispersed catchment area which would not necessarily suit the fixed nature of heavy or light rail. They avoid the fixed costs to create the same extent of network, have lower cost vehicles and can make use of existing bus depots. The choice between modes will depend upon the characteristics of the markets that they serve and the specific geographic circumstances of the area.
Conclusion	Bus rapid transit and guided bus are further options for reopening a former rail route to public transport services. These technologies are an alternative to heavy and light rail options, particularly for routes serving more dispersed populations or where it is challenging for either heavy or light rail to penetrate a city centre. This is not to suggest that existing passenger rail services be replaced by a bus based mode, but rather to acknowledge the spectrum of public transport options which may be considered when proposing to use a former rail corridor to address a transport gap.

Personal Rapid Transit (PRT) has been assessed in Option C.4 to improve onward distribution of passengers from heavy rail stations.

Assessment of Option C.4 cost effective ways of onward distribution beyond heavy rail stations – personal rapid transit	
Concept	Personal rapid transit systems could be used to improve the onward distribution of passengers from heavy rail stations to remote locations such as car parking, business developments, airports or interchange between two or more proximate town or city centre rail stations. Personal rapid transit is a potential option for onward transport of passengers where demand is pulsed from a heavy rail station to a number of locations within the immediate vicinity. This is a similar scenario to the transport of passengers from an airport terminal to local car parks, for which PRT is employed at London Heathrow Terminal 5. The pod in such a scenario affords an advantage over a conventional bus in that it travels directly to a specific user requested destination.
Infrastructure and rolling stock requirements	Based on London Heathrow Terminal 5 the following infrastructure and vehicles would be required: • guideway • pod stations • automated battery-powered electric vehicles • control centre • maintenance facility.
Impact	PRT has the potential for widening the catchment area from which passengers can reach rail stations. This may result in an increased mode share for rail as well reduced traffic congestion and regeneration benefits for cities. The ability of the user to select both the time of departure and the destination reduces passengers waiting time and journey time in comparison to a bus service. Personal rapid transit has the potential to take the passenger right into the station rather than to a bus stop on the station forecourt.
Feasibility	The London Heathrow Terminal 5 pods which take passengers from the terminal to the car parks and is an example of this technology in practice in Britain. The relatively limited infrastructure which is required may make it practical to penetrate station buildings and find a route in a dense urban environment.
Conclusion	Personal rapid transit could be used to from rail stations to: • remote car parking, which could also enable redevelopment of former central parking sites • edge of city centre business zones developments to provide easy access to rail stations • new sustainable residential developments • access to airport sites from rail stations • interchange between two or more proximate town or city centre rail stations. Such measures for improved connectivity may not apply just to city centre stations. For example, there may also be an opportunity to enhance the role of the railway on the edge of towns by increasing station connectivity to business parks or park and ride sites. In the future, PRT could have a role in the expected development of new high speed rail stations to exploit local development opportunities.

6.3 Alternative methods of delivery of electric traction on lower traffic density routes

Gap D – coasting, discontinuous or discrete electrification may enable more efficient operation of passenger services

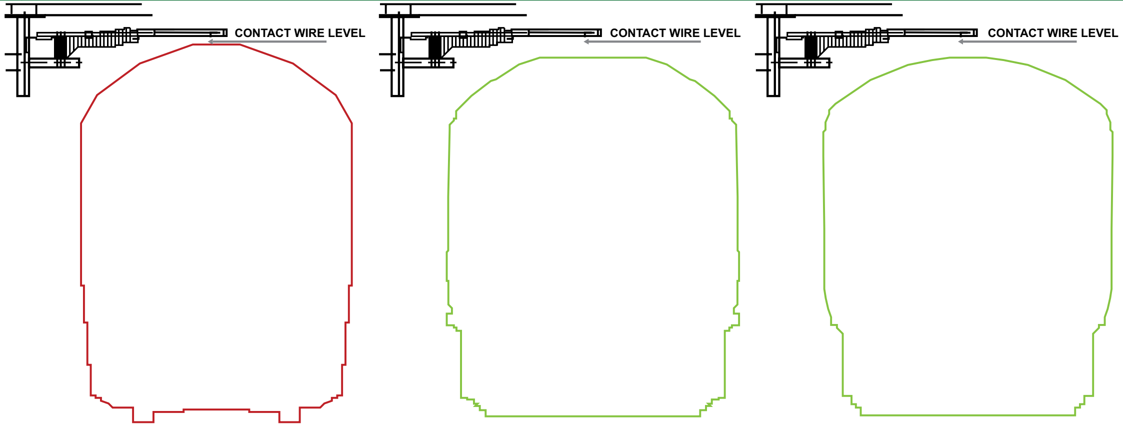
1 For avoiding reconstruction of challenging structures

These options relate to possible candidates already identified in the Network RUS: Electrification Strategy. Example options are considered as case studies.

Case study D1.1 – Paisley Canal extended neutral sections electrification (source: Network Rail)	
Concept	The Paisley Canal line was operated by three Class 156 DMUs in an area of otherwise electric traction. The route was 33 per cent electrified from Glasgow Central as far as Corkerhill Depot on the line to Paisley Canal. The aspiration was to be able to electrify the remainder of the route and operate the service using existing Class 314 and 380 EMUs. There are no freight services on the route but there is a currently disused oil terminal at Hawkhead to which there are aspirations to return freight traffic. A potential future requirement exists for freight on the route. Options were considered to electrify the route using conventional 25kV AC Overhead Line Equipment (OHL). The cost of achieving standard clearances for nine of the 12 overbridges meant the scheme did not achieve a positive business case. An alternative method using different approaches was used to reduce these costs. The scheme, costing £12 million, was completed and operational in December 2012.
Infrastructure and rolling stock requirements	The scope of the electrification scheme was to enable a half hourly First ScotRail EMU service to operate whilst maintaining the infrastructure capability for freight traffic to and from the currently disused Hawkhead oil terminal. The electrification scheme needs to maintain the capability for future aspirations for oil traffic as well as the Network Rail Track Recording Unit (TRU), Multipurpose Vehicle (MPV) and infrastructure trains. The proposed EMUs are the current vehicles operating in the area. Following the initial assessment, which showed the cost of providing standard clearance for structures would not be feasible, an alternative approach was to consider gauging the OHL around electric trains that use the route, rather than the Great Britain loading gauge. The alternative approach considered was to: • gauge around electric trains that use the route making use of reduced special clearances • make use of neutral sections under challenging bridges • remote earthing to address freight and infrastructure train gauge (innovation in Great Britain). This is not funded as part of the scheme but could be a future solution if freight services return to Hawkhead oil terminal. Figure 6.4 illustrates how different gauge clearances affect different types of rolling stock. Electrical clearances can be achieved for EMUs and the Track Recording Unit (TRU) at an OHL wire height which would allow mechanical clearance of a Class 66 freight locomotive but would not permit electrical clearance. It has been proposed to take isolations remotely, which would allow vehicles where mechanical clearance is possible to operate on the route, without the need for the isolation to be physically earthed locally each time such a train needed to use the line. Certification is needed for the earthing equipment. It is proposed to trial the equipment first to demonstrate the viability of remote isolation equipment and acquire full certification.

Case study – Paisley Canal extended neutral sections electrification (source: Network Rail)

Figure 6.4 - Mechanical and electrical gauge clearance of a Class 66, EMU and Track Recording Unit (source: Network Rail)



Class 66	
Dynamic height	3980 mm
Physical clearance	40 mm
Electrical clearance	Not clear

Scotrail EMU fleet	
Dynamic height	3853 mm
Physical clearance	187 mm
Electrical clearance	Special reduced

Track recording unit	
Dynamic height	3833 mm
Physical clearance	187 mm
Electrical clearance	Special reduced

Impacts

Initial work suggested an approximate infrastructure cost saving of between 20 and 45 per cent.
The table below shows the impact on the rolling stock of the various gauges ranging from full W6 freight gauge clearance (4165mm wire height) to progressively restricted gauges down to E1 (3925mm wire height).

	Full W6 Electrification gauge clearance	E3 Electrification gauge clearance	E2 Electrification gauge clearance	E1 Electrification gauge clearance
Rolling stock which can pass while current is live	Full range of W6 cleared rolling stock	All EMUs, loco gauge and some wagons	All EMUs, TRU, MPV and Class 15x	Low profile EMU (Class 314 and 380)
Rolling stock which can pass while current is neutral	n/a	Any locomotive gauge stock	Any locomotive gauge stock	All EMUs, TRU, MPV and Class 15x

There are also two proposed extended neutral sections which would be required to avoid track lowering. The pantograph of EMUs would remain raised but would be at a height that is too low for electrical clearance. This avoids the cost of interventions to change the infrastructure to achieve electrical clearance.

Case study D1.1 – Paisley Canal extended neutral sections electrification (source: Network Rail)	
Impact	The Paisley Canal line timetable under DMU operation often suffered from perturbation due to tight turnaround times associated with the DMU rolling stock diagrams operating on the route. Use of EMU rolling stock with faster acceleration gives the potential to improve performance without an increase in line speeds on the route. Electrification of the route has released three Class 156 DMU sets for use elsewhere within the ScotRail franchise on services where there is overcrowding due to increased patronage.
Feasibility	The remote isolations concept and equipment still needs to be trialled as it is innovative on railways in Great Britain. A draft operational procedure has been considered for remote isolations. This needs to be developed further at the next stage of the project. The infrequency of Network Rail infrastructure trains and absence of any current freight on the route at present means such a solution would potentially be acceptable. For lines where freight traffic is regular, remote earthing makes the network less flexible and therefore may not be appropriate. Extended neutral sections cannot be sited in locations where a train might come to halt such as at stations or signals. This restricts the applicability of this technique. Standards cover the circumstances under which extended neutral sections can be used.
Conclusion	The process that has been used to reduce the cost of the Paisley Canal electrification scheme is recommended for consideration to minimise the cost of gauge clearing challenging structures. The use of extended neutral sections or remote earthing needs to be in locations where it is technically and operationally feasible. The savings that the innovative solutions enable with the Paisley Canal route may not automatically apply to other routes. They are an example of how inventive solutions can save cost on tertiary routes where Technical Specification of Interoperability (TSI) compliance and full flexibility of operation is not a requirement.

Case study D1.2 – Discontinuous electrification – Crewe to Chester

The Railway Safety and Standards Board (RSSB) in conjunction with the Technical Strategy Leadership Group (TSLG) commissioned research to explore the potential to reduce whole life, whole system costs of alternative electrification technologies through case studies.

One such case study was the possibility of using discontinuous electrification on the Crewe-Chester route. This case study has been presented as an illustrative option.

The conclusions of this case study have been used in this RUS to assess the potential for discontinuous electrification on the network.

Case study D1.2 – Crewe - Chester discontinuous electrification (source: RSSB, 'Potential to reduce the cost for electrifying GB railways' (2011)	
Concept	The Network RUS: Electrification Strategy identified the electrification of the line from Crewe to Chester to enable electric traction on London Euston to Chester passenger services as a further option for which the business case might be improved by the usage of alternative solutions such as discontinuous electrification. This case study considers discontinuities in the OHL infrastructure on the Crewe-Chester route in the form of either: • extended neutral sections where there is insufficient electrical clearance • gaps in the OHL where there is also insufficient mechanical clearance. • To traverse these discontinuities the rolling stock might have to be adapted as follows: • more than one pantograph per train for short discontinuities less than 50 metres, which would mitigate the risk of gapping • an additional safety critical automatic control system to lower and raise pantographs where there is insufficient mechanical clearance (irrespective of gap length) • energy storage for longer discontinuities greater than 50 metres. This assumption was made to develop the case study. In reality a risk based approach would be taken to determining the maximum coasting distance based on the factors at the particular location.
Infrastructure and rolling stock requirements	Extended neutral sections and gaps greater than 50 metres in the OHL along the route for structures too complex to gauge clear. This scenario assumes: • no OHL in Chester station • pantograph lowering for gaps where there is also insufficient mechanical clearance • two pantographs per train • sufficient energy storage (supercapacitors) for trains to depart Chester station • bespoke rolling stock would be required.
Impact	The scenarios as they have been assessed do not include benefits to passengers. Only the differential whole life costs of operation, maintenance and capital expenditure are considered. There are no freight benefits.

Case study D1.2 – Crewe - Chester discontinuous electrification (source: RSSB, 'Potential to reduce the cost for electrifying GB railways' (2011) (Cont.)	
Feasibility	There is a potential reduction in the electrification infrastructure capital expenditure when compared to the base 25kV AC OHL case because of the assumed extended neutral sections and a large number of gaps. However, this cost reduction is exceeded by the energy storage costs. The average distance between discontinuities is short. Therefore, trains would have insufficient time under power to open and close the circuit breaker or lower and raise the pantograph to charge the energy storage. It is considered not to be operationally feasible.
Conclusion	The key drivers of the business case are the energy storage operating costs versus the avoided OHL infrastructure capital expenditure. Costs associated with the avoided OHL infrastructure include: • additional extended neutral sections • contact wire terminations • providing trains with more than one pantograph • pantograph control systems where there is insufficient mechanical clearance to raise pantographs. The concept could become financially feasible with longer life and a lower cost of energy storage. The point at which this occurs has been assessed through sensitivity analysis. The number and proximity of gaps in the OHL infrastructure mean that the scenario is not thought to be technically feasible over this route. While the number of gaps could have been reduced to make the solution technically feasible, this would have reduced the infrastructure savings and therefore any benefit of using discontinuous electrification.

Gap D – coasting, discontinuous or discrete electrification may enable more efficient operation of passenger services

2 Innovative low cost forms of electrification

These options expand beyond the Network RUS: Electrification Strategy to consider additional potential options which are facilitated by discrete electrification.

Option D.2.1 – Discrete electrification

For this option, a high level assessment of the market for operational cost viability of energy storage EMUs across the network has been undertaken. This analysis indentified the number of routes and vehicles which might be converted to include energy storage. This was based on a spread of prices of the energy storage and ranges of the energy storage technology away from the OHL. This analysis is intended to inform the rail industry and its suppliers in terms of the price and capability of energy storage which would be able to make a contribution to reducing the cost of operating the railway.

In Table 4.7 in Chapter 4 the general characteristics of a number of types of energy storage are presented. For the length of gaps involved in discrete electrification which are potentially in the order of tens of kilometres, only batteries have the necessary range to power a train for this distance. This option focuses on batteries as the assumed energy storage system which has the potential to develop to the extent they could be used in this application. Batteries have a wide variety of capabilities and differing characteristics. This analysis identifies the capabilities and price that would be needed by the rail industry for discrete electrification to be viable in the future.

Discrete electrification involves the deployment of new technology which is not in heavy rail commercial service in Great Britain or anywhere else in the world. This presents uncertainty over the capability, cost and operational impact. A reliable appraisal resulting in a specific benefit cost ratio (BCR) or net present value (NPV) cannot be generated. A market study was conducted to understand the indicative size of the potential market based on a range of prices and capabilities of battery technology. The energy storage technology is developing in both price and capability.

A range of capabilities and costs were considered in order to understand the point at which it could become viable.

The case for conventional electrification of a route rests on the volume of traffic per kilometre which generates the variable savings compared to the cost of running diesel trains. If enough traffic passes over a route, the variable cost savings (see Network RUS: Electrification Strategy Chapter 3) potentially offset the capital cost of the electrification infrastructure. Electrification is more likely to have a value for money business case in places where the volume of trains means that the infrastructure is highly utilised.

Similarly a discrete electrification business case would be positive if the rolling stock operates sufficient vehicle miles in order to generate a variable cost saving which exceeds the fixed cost. The fixed costs would be the battery over its lifetime and the cost of additional electrical and pantograph control equipment. In the same way as an electrification business case depends upon the utilisation of the infrastructure, a discrete electrification scheme value for money business case would depend upon the number of miles per vehicle per annum.

The additional weight of a battery in comparison to a conventional EMU would increase the track access charges and energy consumption of a battery power unit. Therefore, discrete electrification could potentially reduce the OHL infrastructure capital and maintenance costs, the variable savings of an EMU with batteries would be lower than for a conventional EMU. A trade is required between reduced OHL infrastructure capital and maintenance costs, and the fixed battery cost and lower variable cost savings in comparison with a conventional EMU.

Where conventional electrification has a value for money business case it is the more advantageous option. It is only on those lines where low traffic volumes and a likely absence of a viable electrification business case, combined with ageing self powered rolling stock that, in the future, an alternative solution such as discrete electrification would be desirable.

The factors that would reduce the favourability of a discrete electrification business case are those that:

- reduce the miles per vehicle
  - peak strengthening where additional units are used primarily to provide services during peak times but are not used in service in the off-peak
  - low speed of trains means that while they might be well utilised in terms of time in service, the average distance they cover each day is low
  - percentage of time as turn around time where a unit spends periods of the day in a terminating platform before forming its next service thereby reducing the miles operated each day
  - availability - island fleets particularly of less than ten units have a greater than optimal percentage of spare cover reducing the average miles operated per vehicle (see Figure 4.11 in Chapter 4)
  - additional time taken to recharge the battery which exceeds the available time in the current rolling stock diagrams.
- greater capital costs, which might for example include:
  - additional OHL to wire bay platforms or extend existing OHL
  - work to strengthen power supplies at charging locations
  - the need to replace batteries more frequently than expected.

Reductions in average vehicle mileages will reduce the variable cost saving per vehicle. Given the likely extent of the battery cost, it is unlikely that any increase in vehicle numbers over the current fleet could be supported as the variable cost savings per vehicle would reduce.

Capital costs to implement the discrete electrification scheme will increase the fixed cost of the proposal. This increases the cost hurdle that variable cost savings must overcome without necessarily increasing the benefits of the scheme.

The modelling that has been undertaken does not include any element of optimism bias, or additional capital expenditure that might be required. The assumptions do not include the cost of carbon. Carbon has been excluded because the modelling is for the assumed life time of the battery and not the rolling stock. In the period of the life of an individual battery, the cost of carbon may not be that significant at current prices. Over a longer appraisal period, carbon prices may have a more substantial impact on the business case.

The modelling has some assumptions on battery capability which go beyond the current ability of the technology. This is on the assumption of further improvements as wider industry efforts to improve battery capability continue.

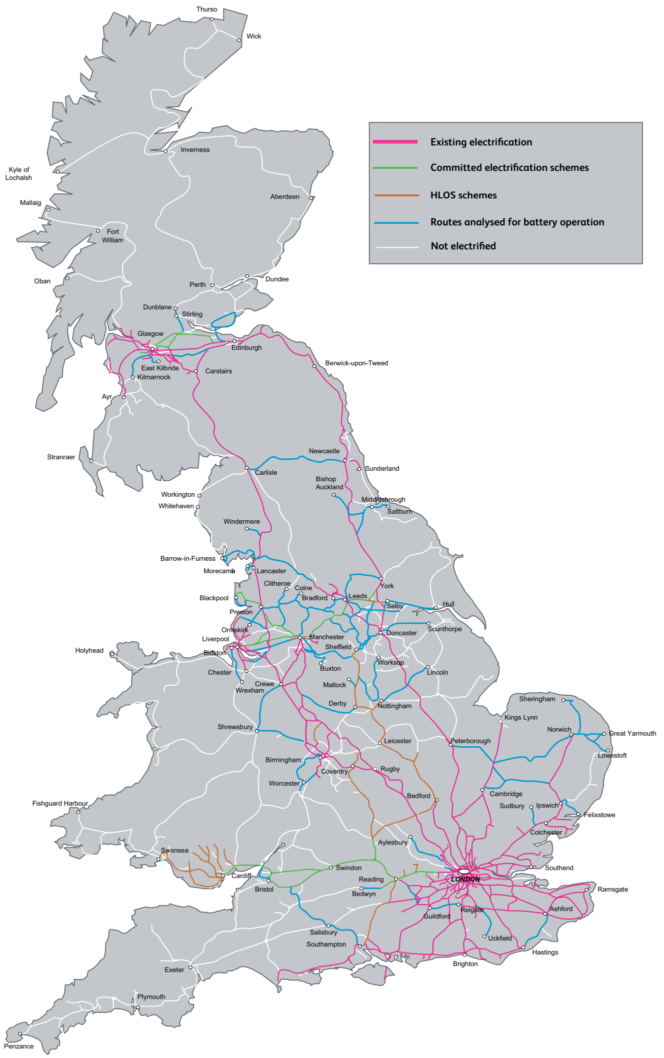


Figure 6.5
Routes analysed for battery-powered train operation (source: Network Rail)

The analysis includes elements of conventional operating and maintenance costs as well as battery costs. It does not include capital costs which might include:

- power supply strengthening
- additional electrification infrastructure at both platforms or depots.

The benefit of improved acceleration in comparison with a DMU has not been quantified. This is because faster acceleration would need to be traded off against a reduced battery range.

The modelling has used generic inputs and assumes a like-for-like conversion of service pattern and units. In reality, specific factors such as unit length and fleet availability may be affected by conversion. To develop the model, the work has assumed that high speed, freight, or current electrically operated services are not involved.

Figure 6.5 shows in blue the routes that were analysed for potential battery train operation.

These routes are those with diesel passenger services operating at speeds under 100 miles per hour, where:

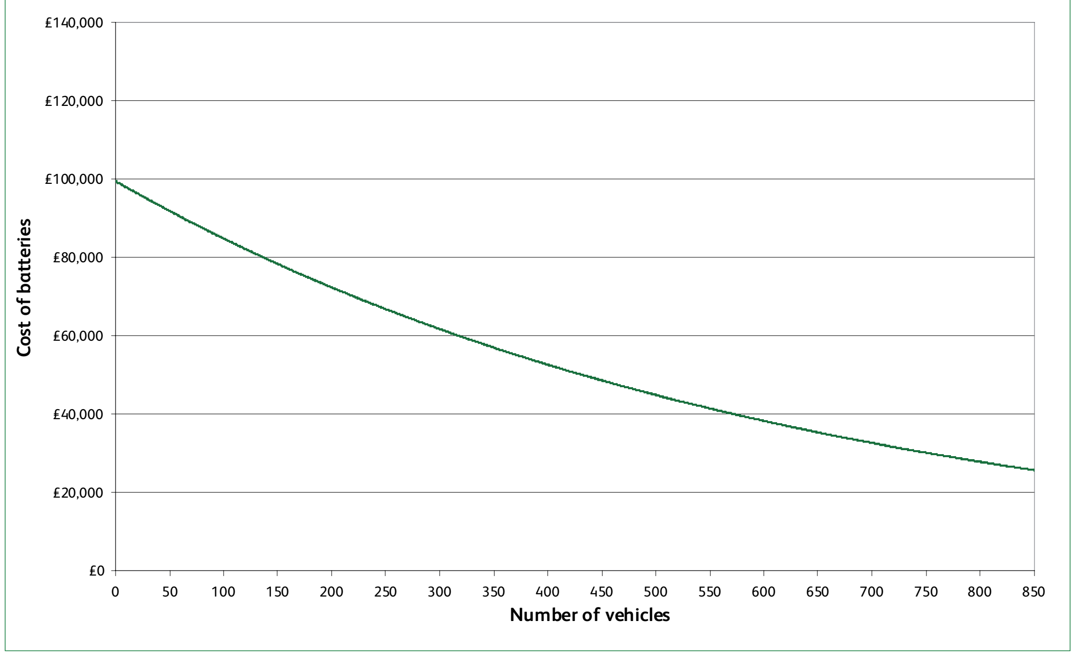
- a portion of the route is electrified (even if this is only a terminal platform)
- the non-electrified portion of the journey is less than 75 miles either between two points of electrification, or as a return journey
- the service is not on a route which forms part of a committed electrification scheme or an HLOS scheme.

The routes that have been analysed have been used to understand the railway industry's requirements for battery-powered trains.

An estimate of the number of vehicles per service group was made and the annual vehicle miles was calculated from billing data. The analysis considers current service groups. It does not consider the impact of uncommitted electrification schemes or changes in service patterns.

Figure 6.6 shows the demand curve for the potential passenger service groups modelled. The conclusion of the price analysis is that once the fixed cost of installation of the battery on an EMU falls below a sufficient level per vehicle, there is the potential for a cost saving in comparison with DMU operation. This does not indicate that these routes would necessarily be feasible with today's battery technology. As battery cost declines to below the differential cost between a DMU and an EMU any distance operated would result in a saving over DMUs.

Figure 6.6 – Potential number of vehicles: price of energy storage (£) (source: Network Rail)



A wide range of cost estimates were seen in previous studies. The upper end of these estimates is considerably above the threshold at which any vehicles in the graph would be viable. Some studies suggest that battery costs will fall substantially over time, driven largely by developments in the automotive sector. Uncertainty over the current and future prices means that this strategy presents potential battery costs as a range.

Figure 6.7 shows the potential market for vehicles based on a range of distances that the battery is capable of travelling away from the OHL, up to a maximum of 75 miles. This assumes that the range can be delivered by a charging time that requires no additional vehicles. Unless the charging time is capable of being accommodated within the existing number of units to operate a timetable, it is unlikely that variable cost savings could offset the fixed cost of rolling stock and batteries.

The market shows a linear relationship between distance travelled away from the OHL and the numbers of vehicles on routes which could potentially operate using an energy storage EMU. This suggests that there does not appear to be a cluster of routes around a common distance of gap in the OHL provision. The relationship is a simple one, suggesting the further a battery can power a train, the larger the potential market in terms of vehicle numbers.

Figure 6.7 – Potential number of vehicles: energy storage device range away from OHL (miles) (source: Network Rail)

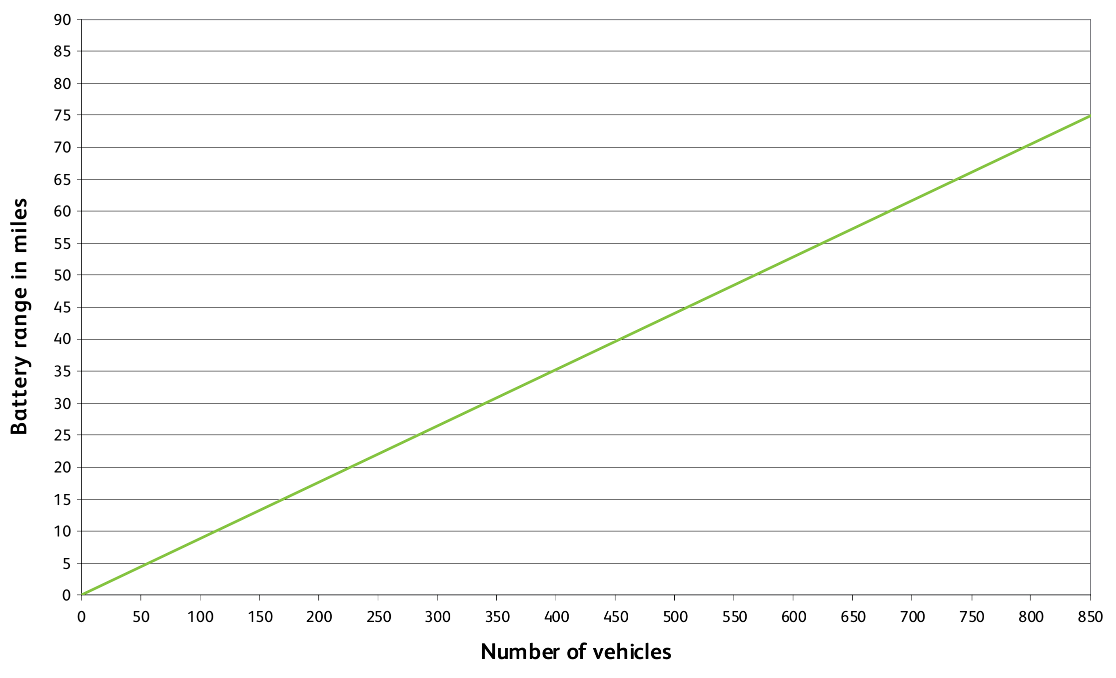
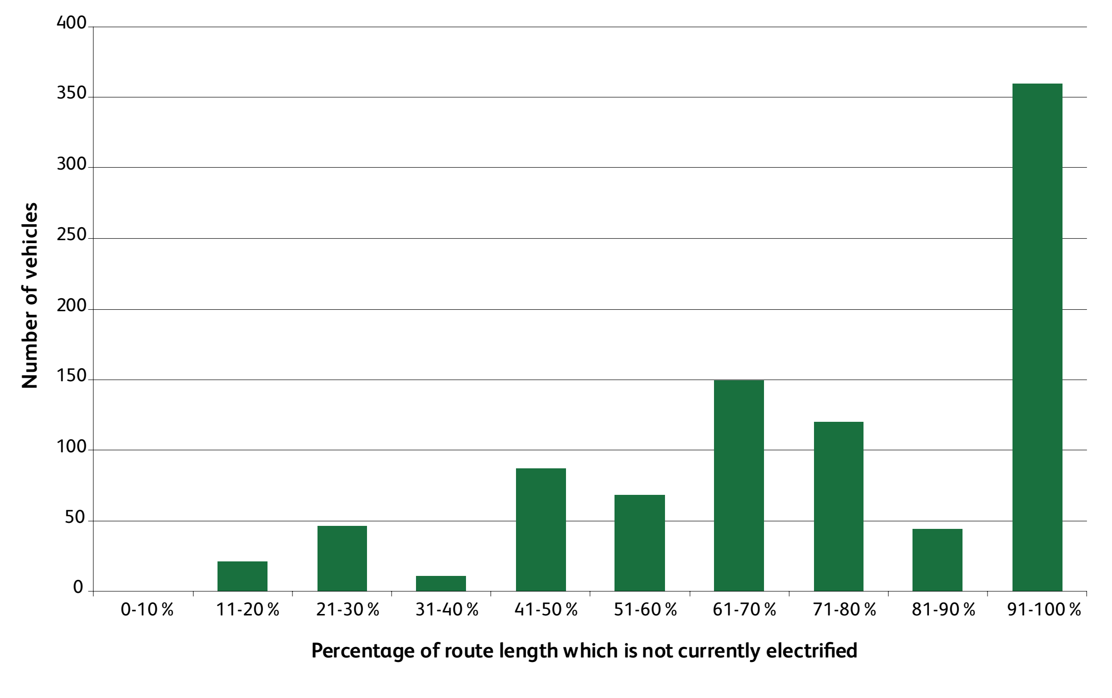


Figure 6.8 shows a summary of the extent of electrification on the passenger routes analysed. It identifies the percentage of electrification as a proportion of total route length. Of the vehicles in the analysis, only 20 per cent operate on routes with more than 50 per cent electrification. Of the remaining 80 per cent, the largest single group are in the category of routes with currently less than ten per cent electrification. Of these a number are reliant on charging entirely in a terminating platform.

It is clear from this that the ability for vehicles to charge quickly is essential if the number of vehicles and utilisation is to remain within the current fleet numbers required to deliver the timetable. If the current timetable cannot be operated with the same number of units, due to charging requirements, it is unlikely that a value for money business case would exist. The balance of variable cost savings depend upon vehicle utilisation.

Figure 6.8 – Potential number of vehicles: energy storage device range away from OHL (miles) (source: Network Rail)



It has been suggested that by electrifying a nodal location from which a number of services radiate and using discrete electrification, it might be possible to convert a substantial area of DMU operation to electric traction while minimising the infrastructure capital expenditure. This could expand the number of services that could be considered for conversion to battery-powered rolling stock.

If nodal electrification was undertaken, it would raise the fixed cost hurdle which variable cost savings based on the operation of energy storage EMUs would be required to overcome. This RUS did not consider the impact of additional OHL infrastructure or nodal electrification. It has also not compared the cost of conventional electrification with discrete electrification.

In conclusion, this option has found that there may be a may be a market for discrete electrification in terms of cost savings in comparison with DMUs. This is dependent upon the price of batteries and their capability to deliver a range off the wires at the same level of rolling stock efficiency as current DMUs.

6.4 Community rail

This section outlines the options to address the two key gaps which can be identified between today's railway and a future railway, which could realise the benefits outlined in the drivers of change from community rail initiatives. The two gaps are:

- **Gap F** – the potential role of community rail in obtaining value for money in the local railway
- **Gap G** – the potential role of community rail in encouraging greater involvement of the local community in the local railway.

Type F gaps concern the potential ability of community rail initiatives to generate either additional revenue, minimise costs, target spending, improve the deployment of resources based on local priorities and secure 3rd party funding.

Type G gaps concern the potential ability of community rail initiatives to encourage greater involvement in the local railway through increased local involvement either in volunteering or decision making.

Gap F – the role of community rail in obtaining improved value for money

Some parts of the rail network are focused on providing largely social benefits and much of this network operates away from the major conurbations. It is focused on rural counties such as Cornwall, Cumbria, Devon and Lincolnshire. Improved value for money could be realised by reductions in cost and increases revenue. Community engagement has been most successful in activities to increase patronage, with the aim to reduce subsidy by increasing revenue.

As highlighted in the Gaps chapter (Chapter 5), key to implementing any of the presented options will be to make sure that funding is made available to employ a Community Rail Partnership Officer (CRPO). The CRPO will then be able to oversee, subject to funding availability, local TOC and Network Rail support, implement through partnership with industry and the community, and promote interventions to mitigate gaps existing on the community rail line.

Options to address this gap are now summarised.

Option F.1: Additional community engagement

This option introduces additional community engagement in areas where there is currently no involvement at present, in order to increase revenue. It is recognised that many CRPOs already work very closely with Network Rail in developing community rail initiatives. Where this already occurs, thought should be given by all involved parties to potential options further to develop relationships. The underlying aim should be not only to strive for greater cost efficiencies but to use each others different skill sets to grow and develop the community rail market. Effective two way engagement will be critical to delivering success. Indicators of success will ultimately be levels of increase in patronage, revenue generation and passenger satisfaction.

It is important when considering additional community engagement that both industry and government recognise the costs and benefits of such activities.

The costs will primarily relate to industry personnel time in managing and providing any required input into the process. Further community involvement will offer the benefits of opportunities for an improved rail travel experience and increased awareness of the railways within communities. This would be achieved by:

- being able to consult with community partners to improve the rail service
- being able to focus investment, based on local priorities
- supporting volunteering to improve the railway environment.

It is also possible for non community rail routes or services to have a greater degree of community engagement. There is an established process by which involvement is facilitated through the relevant transport agency and the rail industry. The driver of the success of community rail is the degree of involvement from local stakeholders. The expansion of community rail or other forms of community engagement is contingent on a community having the willingness and enthusiasm to become involved in the local rail lines.

The line or service can also influence the success of the partnership. Some lines and services may not be appropriate for community involvement. These include long distance services which serve multiple communities and markets and routes with mixed traffic types. In such circumstances, station user groups or adoption groups may be appropriate.

Volunteer support cannot be seen as a substitute for paid staff or indeed taken for granted. Volunteer activities are limited by the level of engagement of volunteers and also by their own personal time available to give to a task.

In summary, it is recognised that it is unlikely that the rail industry can deliver the benefits associated with community rail without community engagement. Where groups and parties are interested in greater involvement, this should be facilitated where the solutions are suitable. Community engagement can deliver improved rail experience and increased awareness of the railways. Table 6.1 illustrates examples of community engagement options that have been applied.

Table 6.1: Option F.1 – Examples of additional community engagement

Organisation	Option(s) applied
Chester-Shrewsbury Rail Partnership	The Community Rail Partnership (CRP) in 2011-12 secured funding from the Regional Transport Consortia through Wrexham County Borough Council for £55,000 for CCTV at three stations. The partnership had worked with the British Transport Police and train operating company to identify the need.
Derwent Valley Line Community Rail Partnership	The partnership with local stakeholders secured over £700,000 of investment in station enhancements between Duffield and Matlock. The majority of funding came from the local authority Local Transport Plan and external grant funding.
Esk Valley Railway Development Company (EVRDC)	Whitby is an unmanned station. In order to deter anti-social behaviour, a partnership with local police and the CRP has been formed. The EVRDC opens and closes the station, reducing the operating costs associated with the station.
High Peak and Hope Valley Community Rail Partnership	The partnership has developed a small projects fund to give grants of up to £2,000 to fund local railway improvements. Examples of funded projects include: new running-in boards at Chapel-en-le-Frith, cycle stands at Middlewood station and New Mills Newtown station.
Mid Cheshire Community Rail Partnership	Friends of Stations are now present at individual stations along the line, with volunteers helping with gardening and litter picking.
Three Rivers Community Rail Partnership	The CRP in partnership with Sustrans organised for the installation of cycle gullies on Chandlers Ford station footbridge.

Option F.2: Wider adoption of community rail techniques

Community Rail has brought innovation to the ways in which some lines are managed. The option is to deploy these where there is no community engagement. For instance, the Rail Value for Money (RVfM) study published in May 2011 notes that operators of rural routes should be afforded greater flexibility than is currently allowed by franchise requirements to determine appropriate retail outlets. For analytical purposes the option is split into a three sub options:

1. ticketing
2. retailing
3. marketing.

Option F.2.1: Wider adoption of ticketing strategy

Community rail approaches to ticketing are seen as an effective strategy to attract additional passengers to rail and improve services. The option seeks to adopt some of these techniques elsewhere, even if a partner is not present.

Through community engagement, new ticketing types such as ranger and rover tickets have been introduced. These are designed to offer flexibility in the use of rail services. These ticket types are widely used on other parts of the network.

Increasing ticket prices has been used by communities as a way to raise funds to improve rail services, particularly in order to fund Sunday services. These increases are typically not designed to reduce the subsidy. Instead they are a way to try and fund improved services at minimal cost.

The effectiveness of alternate pricing strategies will vary by market. On largely commuting lines or stations, research indicates that a decrease in price would not generate sufficient additional demand to offset the reduction in revenue from existing customers. Outside the commuting market where travel is more discretionary there is greater potential in lowering fares to attract passengers.

The ability of train operating companies (TOCs) to set prices on many routes is restricted by the regulatory cap on prices and increasing prices involves a lengthy consultation process. The presence of the community partners makes it possible to raise fares, without necessarily having to go through the full consultation process.

TOCs are currently incentivised through the franchising process to lower prices where it represents an improved outcome. It is likely that the opportunities for changes exist around the margins where there are specific local circumstances.

In conclusion, community engagement in rail has in some instances been an important facilitator in the ability to adjust fare levels to meet community needs. While this could be done without community involvement, consultation costs could outweigh benefits. TOCs are currently able to price fares lower to manage demand and will do so where a value for money business case exists. Likewise, they can introduce ranger tickets if there is a value for money business case. Table 6.2 illustrates examples of wider adoption of ticketing strategy options that have been applied.

Table 6.2: Option F2.1 – Examples of the wider adoption of ticketing strategy

Organisation	Option(s) applied
Derwent Valley Line Community Rail Partnership	A summer evening bargain ticket was introduced on the line to encourage greater off-peak utilisation of the line.
Severnside Community Rail Partnership	Sponsorship in 2011 of the trial of basic ticket machines, developed from car park machines at three stations to facilitate easier purchase of tickets.
Local train operating company and community partners	In 2004 the local train operating company in partnership with local community partners introduced 'Ranger' tickets on the St Ives Bay Line at St Ives, St Erth, Lelant Saltings and Carbis Bay with a standard £4 fare for all local journeys.

Option F.2.2: Wider adoption of retailing strategy

Community rail approaches to ticket retailing are viewed as effective ways to attract additional passengers to rail. Ticket sales at local shops such as those on the Tamar Valley line are seen as a good way to address the lack of ticket offices. Likewise there are examples of community shops or commercial companies selling tickets at stations.

Research indicates that staffed ticket offices, retail facilities and the presence of staff at stations are all valued by the travelling public. If ticket retailing facilities can be provided using alternative methods of sale, it may be possible to increase patronage. There is a potential synergy that other retail facilities (café, shops etc) would also improve the station environment and improve security. The impact of these activities will be greater on business and leisure travellers in comparison to commuters. The extent of the additional patronage delivered by these services, iscapped at two per cent of starting (base) demand in appraisal guidance. Survey evidence and the changes in demand on the Tamar Valley line suggests higher demand may be experienced.

There have been some successes in providing alternate retailing. Table 6.3 presents a selection of initiatives that have been applied.

It is important to note that along with the benefits of alternative retailing strategies on an individual or small scale there are potential challenges and costs. This point is illustrated by the introduction of Carnets; the CRP is responsible for their distribution to retailers which would otherwise be a cost that could not be covered by the increased revenue.

Alternative methods of ticket retailing have been employed by community rail, indicating that it is feasible. Wider application will be best assessed on a case by case basis. Commercial and specific local factors will dictate the success of individual options. Alternative retailing strategies should be encouraged, where feasible. They should not necessarily be developed at the expense of existing ticket offices or other conventional retailing channels.

Table 6.3: Option F2.2 – Wider adoption of retailing strategy

Organisation	Option(s) applied
Severnside Community Rail Partnership	The CRP embarked on a programme of encouraging scholars to use the train, by promoting and issuing scholar season tickets on behalf of First Great Western for travel on the Severn Beach Line and to schools and colleges throughout the area.
Arriva Trains Wales (Gobowen station)	The booking office and waiting room is operated by a limited company. Severn Dee Travel is an independent rail agency which operates on a not for profit basis. It is almost wholly financed by the small commission obtained through ticket sales. It operates with 2 paid staff and 5 volunteers. It provides space in the waiting room for a café which is staffed 6 days per week.
Tamar Valley line	On the Tamar Valley line between Plymouth and Gunnislake carnet ticketing has been introduced. The scheme is managed by the local authority.
Merseyrail	M2GO is a concept which combines ticket sales and a shop environment. It is a way to improve retailing at stations and many commercial shops operate across the network.

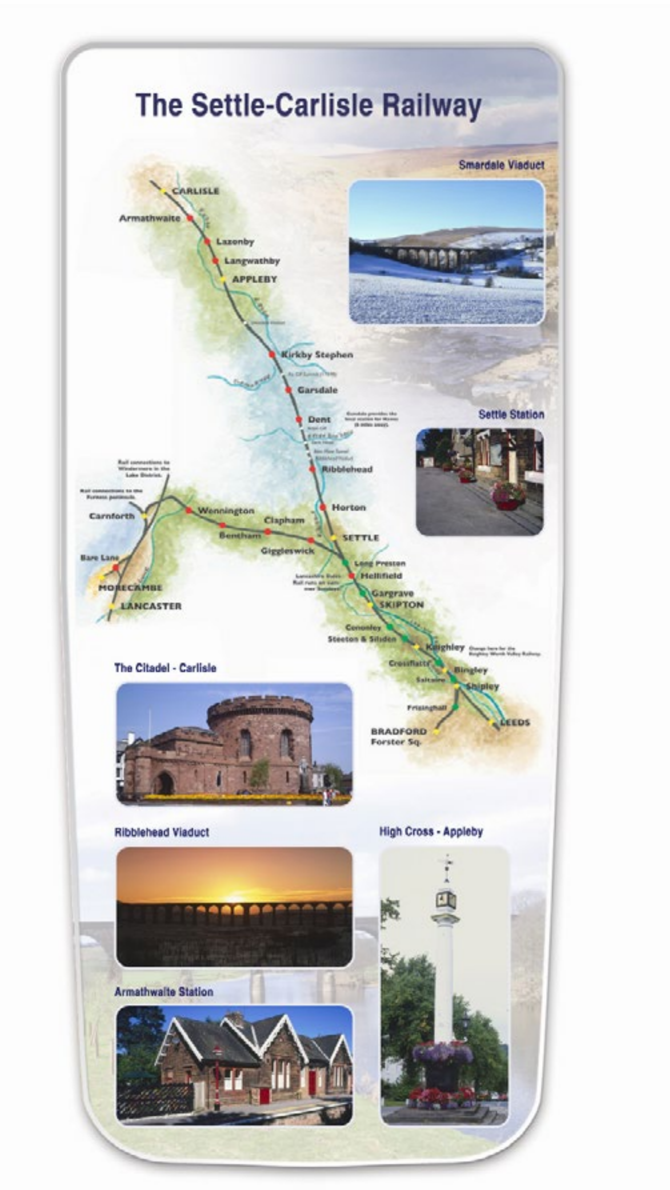


Figure 6.9
Marketing Material for the Settle and Carlisle line (source: Northern Rail)

Option F.2.3: Wider adoption of marketing strategy

Community railways have undertaken a wide range of marketing and promotional activities designed to increase patronage. Operators of visitor attractions, other tourism bodies and transport operators are likely to have shared interests in encouraging more visitors and sustainable access. Successful examples include the provision of cycle hire at Windermere and Brockenhurst stations. In Scotland, the Friends of the West Highlands lines have produced a series of postcards promoting their line and the local scenery, and have negotiated tree clearances from the line to allow for better views of the local area.

Increasing patronage will help to reduce subsidy as long as it is pursued with a value for money approach. TOCs are able to undertake commercial advertising. Therefore, additional advertising would be aimed at producing benefits for the wider community, for instance the increase in revenue experienced by local business that could result from increased rail patronage, or the reduction in road congestion. On this basis, much advertising is undertaken in partnership between TOCs and local communities in order to promote both rail and the communities' attractiveness to visitors.

TOCs currently invest in advertising with community rail partnerships as a commercial measure.

Figure 6.9 shows some illustrative marketing material for the Settle and Carlisle line that highlights the attractions along the route.

Initiatives can also extend to information provision in circumstances such as engineering blockades. For example, the renewal of the Arnside railway viaduct caused major changes to travel plans for passengers on the Barrow-in-Furness to Carnforth railway line in spring 2011. A team from TransPennine Express, First Rail Support, Northern Rail, Network Rail, and the Furness and Lakes Line CRP joined with rail user groups, the Furness Line Action Group and the Leeds Lancaster Rail User Group to make sure that posters and timetables reached all relevant stations and also offsite information outlets including libraries, Tourist Information Centres, Post Offices and village shops.

Advertising in conjunction with community rail partnerships, local tourism authorities and other parties appears to be a successful way to attract additional patronage. The incentive structures are such that where the opportunity to increase revenue through advertising exists it can be expected that TOCs would adopt it. Therefore, community advertising is likely to increase the economic benefits of the railway through its impact on the local economy.

Table 6.4 illustrates examples of wider adoption of marketing strategy options that have been applied.

Table 6.3: Option F2.2 – Wider adoption of retailing strategy

Organisation	Option(s) applied
Derwent Valley Line	The CRP developed a school trips guide to the line to encourage greater off-peak travel on the line.
Friends of the West Highlands Line (FWHL)	Free postcards of trains of the West Highland Line were distributed on the train. This was in partnership with FWHL, HITRANS and First ScotRail. A website promoting the line has been developed.
Kent Community Rail Partnership	In the Medway Valley, the CRP in partnership with the Valley of Visions Landscape Partnership produced a pack of 'Rail Trail' self-guided walk cards. They are available at local tourist information centres and local libraries to encourage greater usage of local rail services for journeys and access to local countryside.
Mid Cheshire Community Rail Partnership	The CRP has developed a short film about the Manchester – Chester line, filmed by volunteers, highlighting attractions at stations. The community rail officer successfully bid for lottery funding to develop a line guide to promote the local attractions of the line to encourage greater patronage.
Severnside Community Rail Partnership	During 2011, in partnership with South Gloucestershire Council and First Great Western, a leaflet was produced promoting commuting to Filton Abbey Wood station aimed at large employers located near the station to encourage workers to use local rail services.

Gap G – the role of community rail in encouraging greater involvement of the local community in the local railway

The second community rail gap identified in Chapter 5 concerns the role of community rail in encouraging greater involvement of the local community in the local railway. This gap explores the role that the local community can have in developing rail routes and services. Options to address the gap of the role of community rail in encouraging greater involvement of the local community in the local railway include:

1. local service decisions and fare levels to optimise capacity usage to local priorities
2. micro-franchising potentially to increase local control in line with local needs and priorities.

Option G.1: Local input into decision making

Community rail has enabled decisions to be made about social rail services with community engagement. Stakeholder engagement in the specification process on regional lines could permit improved timetables that meet the community needs.

Engagement through the community rail process has allowed communities to specify their needs clearly to the railway. In some cases this has led to improvements in the rail service pattern and at stations.

Timetabling driven by local needs could offer much more flexibility with services reflecting the peaks and troughs of the markets that are served. The Rail Value for Money report suggests that such an approach would give greater scope for integration with other modes of transport. This should include common timetables that link at key interchanges.

Community rail services are often resource constrained. They cannot be increased without a step change in costs. Community rail involvement has suggested timetable changes which have brought benefits to a line.

Industry has often sought advice from CRPs as to what they perceive to be priorities for expenditure when deciding upon how an allocation of funding from the station enhancements fund is spent in a particular area.

The purpose of this is to maximise local benefit from the limited available funding as much as possible. Community engagement has delivered improvements concerning development of services.

Local input into decision making can be seen in several devolved structures, such as Passenger Transport Executives, and is not unique to community rail. Community rail is one example of how to achieve greater local input, particularly where groups in a local area are interested in becoming more involved in decisions concerning their local rail services. The public accountability that this involvement in decision making has will depend upon the nature of the groups represented. For example, for designated community rail lines and services, Local Authorities are central to such partnerships. Therefore, there is likely to be clear local democratic accountability.

Table 6.5 illustrates examples of local input into decision making options that have been applied.

Option G.2: Micro franchising
Micro franchising has been proposed as an alternative method of procuring regional railway services.

It is a step further than community rail, with the operation of the railway taken over by the community, or by a concession smaller than the conventional franchise.

Micro franchising is intended to provide a more cost effective and better integrated service within a local area. The RUS has not developed an option as the Department for Transport (DfT) consulted in 2012 on devolution of rail powers in England. The document was entitled 'Rail decentralisation: devolving decision making on passenger rail services in England'.

Introduction of micro franchising or new powers for decentralisation of rail powers would require action from the existing franchising authority. The DfT consultation highlighted a number of possible options (including micro franchising). The document summarised the respective advantages and disadvantages of possible options.

6.5 Summary

This chapter has analysed the options for the three groups of alternative solutions. Chapter 6 will draw up the conclusions for the individual options to present an emerging conclusion.

Table 6.3: Option F2.2 – Wider adoption of retailing strategy

Organisation	Option(s) applied
Chester-Shrewsbury Rail Partnership	In 2006 a key priority was an hourly train service on the line. In order to establish the viability of the proposal a consultants report was commissioned in partnership with local stakeholders. This assisted in reaffirming rail priorities and subsequently fed these into relevant industry consultations.
Derwent Valley Line Community Rail Partnership	The CRP continued to undertake strategic level campaigning for improvements via the East Midlands Trains franchise in relation to maintaining an hourly service frequency at local stations and station enhancements. It successfully lobbied for the retention of hourly services at local stations.
Devon and Cornwall Community Rail Partnership	The CRP suggested various timetable changes on the Barnstaple line. They were considered by the rail industry, implemented and have brought benefits to the local community.
Heart of Wessex Community Rail Partnership	The CRP was engaged by the industry and asked specifically how an allocation from the station enhancements fund should be spent across its area.
Kent Community Rail Partnership	During March and April 2011, the CRP in partnership with Cuxton and Halling Parish Councils distributed questionnaires to local residents seeking their views on local public transport serving their community. The survey results were used to help formulate future strategy for working with rail and other public transport operators in developing service enhancements and inputting into the rail industry refranchising consultation processes.
Severnside Community Rail Partnership	The CRP worked in partnership with First Great Western to agree that additional services would call at Parson Street on a Saturday to cater for Bristol City football club matches. This would encourage greater rail use to and from sports events and greater use of smarter travel choices.

7 Consultation process

Network RUS: Alternative Solutions has involved a two stage consultation process.

All of the consultation responses (for both stages) that have been received are published on Network Rail's website www.networkrail.co.uk. This chapter highlights the key issues raised in the consultation responses at both stages.

7.1 Introduction

Uniquely, the Network RUS: Alternative Solutions has involved a two stage consultation process. The first part of the consultation was on the Network RUS: Alternative Solutions Scoping Document which was published on the 28 February 2012 along with a press release announcing its publication. This was followed by a 60-day consultation period which ended on 30 April 2012. A second consultation phase, consulting on the Draft for Consultation was undertaken. The document was published on 28 September 2012 and a 60-day consultation period concluded on 30 November 2012.

All of the consultation responses (for both stages) that have been received are published on Network Rail's website www.networkrail.co.uk.

This chapter highlights the key issues raised in the consultation responses at both stages.

7.2 Scoping Document and Draft for Consultation responses

During the course of the two stages of consultations a total of 122 responses were received, which represented responses from 92 separate organisations or individuals. A breakdown of the overall response trends across both stages and response profiles at each individual consultation stage can be seen in Table 7.1. The organisations who have been involved throughout the process in the Working Group are also detailed in the table.

Table 7.1 – Summary of all consultation responses to the Network RUS: Alternative Solutions

	Organisations represented on the Working Group	Number of responses to the Scoping Document	Number of responses to the Draft for Consultation
Government	3	1	
ATOC, train and freight operating companies	1	1	
Supplier	1	2	3
Rolling Stock Company (ROSCO)	2	1	
Personal Rapid Transit		1	
Hybrid light rail		1	3
User/Interest Group		16	8
Passenger transport executive, regional transport partnerships or transport alliance	2	8	7
Community Rail		11	14
Local Authority/Local Enterprise Partnership		12	15
Other		3	3
Individual		8	4
Total	**9**	**65**	**57**
Total Consultation Responses		**122**	
Total number of organisations and individuals who responded to both consultation stages		**92**	

7.3 Scoping Document key themes

A total of 65 responses to the Scoping Document were received from a range of organisations and individuals as shown in Table 7.1. A summary of the key issues raised within the Scoping Document consultation stage can be found in Appendix H. An additional element to the Scoping Document consultation phase saw Network Rail hold wider stakeholder briefings in 2012 with Community Rail organisations to seek their views on the proposed strategy. Results of these stakeholder briefings were influential in developing the Draft for Consultation and Final RUS strategy.

7.4 Draft for Consultation response themes

57 responses to the Draft for Consultation document were received, as summarised previously in Table 7.1. From the analysis of the responses, 26 additional respondents submitted a response to the Draft for Consultation who had not submitted a response at the Scoping Document consultation stage.

Consultation responses welcomed the railway industry's focus on innovation. There was broad support for the emerging conclusions around tram, tram train conversion of heavy rail infrastructure and services, electrification and community rail. A number of responses were very positive about the rigorous coverage of the diversity of subjects under consideration. Some responses provided general feedback in relation to a number of wider policy and strategy issues. There were concerns from some consultees that the RUS's consideration of community rail was focused too narrowly.

These concerns have been detailed in Section 7.4.4 along with the actions that have been taken to address them. A summary of the messages from the consultation and the actions which have followed are summarised as follows:

- policy and strategy – issues raised by consultees that were not specific to any one area of the RUS
- tram and tram train conversion of heavy rail infrastructure or services
- traction beyond the electrified network
- community rail.

7.4.1 Policy and strategy

A number of themes raised by consultees in their responses were not specific to any one particular area of the RUS. The issues raised were as follows:

7.4.1.1 Economic development and wider economic benefits

South Yorkshire Passenger Transport Executive (SYPTE) noted the need further to acknowledge within the document how the rail network can support economic development. This is particularly in relation to how alternative and lower cost solutions are required to unlock economic growth, which in turn demonstrates government policy. The potential contribution to economic development of the options considered has been detailed in the final strategy.

7.4.1.2 McNulty Report

Several consultation responses ranging from Passenger Transport Executive Group (PTEG) to the Esk Valley Community Rail Partnership, stressed the importance of exploring the issues raised within the McNulty report into reducing railway industry costs. Of particular interest was following up on a key recommendation of gaining a deeper understanding of how adoption of alternative solutions could possibly help to deliver cost savings to the regional and rural railway. In the final strategy, the potential contribution of the alternative solutions has been discussed.

7.4.1.3 Transport planning

Centro and PTEG in their responses raised the importance of rail in the local transport planning process and the role of Local Authorities and PTEs in assisting the railway industry in developing alternative solutions. While the RUS is a rail industry strategy, it is recognised that because some of the alternative solutions go beyond the current railway network, local transport planning may have a central role in their future development and usage

7.4.1.4 Industry guidance - processes

Several consultees expressed in their responses a desire for clear industry guidance as to how third parties wishing to invest and engage with the rail industry should proceed and how Network Rail should go about taking ideas forward in relation to initiatives such as community rail partnership development and station adoption. In the final RUS strategy, links to appropriate industry guidance documentation have been provided.

7.4.1.5 Environmental impact of alternative solutions

The environmental impact of alternative solutions was raised by the Light Rail Transit Association (LRTA) in the context of electrification. In its response it stressed the importance of the document acknowledging the environmental benefits of, and passenger preference for, electric operation of rail services at both a local and national level. This is acknowledged in the final document.

7.4.1.6 Rolling stock

A number of responses were received which raised issues relating to the future provision of self powered rolling stock. This concern related both to the future provision of rolling stock and to the appropriateness and age of stock used on rural lines. The Network RUS: Alternative Solutions strategy has investigated the potential for battery trains and innovative electrification technology for use on the self-powered network.

The Network RUS: Electrification 'Refresh' will evaluate the extent of the self-powered network in the future, which will then provide a scale of the issue in question.

7.4.2 Tram and tram train conversion of heavy rail infrastructure or services

There was general support by the majority of consultees for the conclusions in relation to tram and tram train conversion of heavy rail infrastructure and services.

A number of challenges and key considerations were identified by consultees in relation to the potential development and implementation of tram and tram train schemes. Table 7.3 summarises these. They are categorised by theme, applicability to tram and tram train scenarios.

Table 7.3 – Tram and tram train key considerations identified by consultees

Tram and tram train theme	Applicable to		Consideration	Proposed by
	Tram	Tram train		
1. Planning	✗	✓	**Tram train application** – tram trains are naturally constrained in capacity and performance by the light rail infrastructure that they operate over. They are produced in small batches creating risk in being able to procure specialist parts. There are additional costs to adhere to operational standards for main line operations. In the European light rail market, where batch sizes are often small, the market has developed to create a consistent group of technical standards allowing the supply market to deliver commonality through a product platform approach.	Bombardier Transportation
	✗	✓	**Tram train procurement** – since the potential volumes of tram trains will be very low, one agency should take the initiative in developing the specifications.	Various

Table 7.3 – Tram and tram train key considerations identified by consultees (Cont.)

Tram and tram train theme	Applicable to		Consideration	Proposed by
	Tram	Tram train		
1. Planning	✓	✓	**Tram and tram train infrastructure costs** – costs of infrastructure modification to increase overall line capacity for tram and tram trains are less than for heavy rail since (a) passing loops built are shorter for tram and tram trains than for heavy rail due to better braking capacity of the former, (b) signalling system may be simpler and (c) new switches and crossings can be shorter for tram and tram train than for heavy rail.	Systra
	✓	✓	**New station development** – conversion of a heavy rail line to tram and tram train operation allows new stations to be added without increasing journey times due to better braking and acceleration profiles of tram and tram train rolling stock.	
2. Operations	✗	✓	**Tram train operational scenarios** – although tram train is most appropriate for large urban areas, it has potential application in very sensitive rural areas such as national parks with very high numbers of visitors.	Cumbria County Council
	✗	✓	**Service continuity** – need to make sure that services do not become fragmented due to introduction of tram train and through services with minimal changes for as many passengers as possible are encouraged.	Leeds-Lancaster-Morecambe Community Rail Partnership and TravelWatch NorthWest
	✓	✓	**Tram train network integration** – substantial investment has been undertaken in the railway network to create a diversionary network for long distance services. Such investments may be rendered less optimal should tram and tram train conversion occur on such routes.	Strathclyde Partnership for Transport (SPT)
	✓	✓	**Passenger needs** passenger priorities from local transport services should be fully identified before seeking to convert heavy rail services to tram and tram train operations.	TravelWatch NorthWest
3. Technology	✓	✓	**Bi-mode tram and tram train vehicles** – such vehicles have to carry their own fuel and as such compromise the weight advantage that light rail typically has.	Blackpool Council

Table 7.3 – Tram and tram train key considerations identified by consultees (Cont.)

Tram and tram train theme	Applicable to		Consideration	Proposed by
	Tram	Tram train		
3. Technology	✗	✓	Hybrid light rail application – the RUS is a positive and far-sighted analysis of how rail capacity can be improved with the application of tram technology. Emerging tram technologies allow for a much more extensive expansion of capacity on branch lines, in the countryside and in smaller cities and towns. Hybrid light rail offers ways to address a number of problems identified in the RUS concerning: (a) the capacity required by energy storage systems, (b) cost of new rails, and the complexity of laying those rails in streets, (c) the cost of vehicles themselves, reduced carbon emissions and reduced risks when operating alongside other road users.	Lightweight Community Transport Ltd
	✗	✓	Ultra light rail definition – the term ultra light rail is inappropriate to describe Class 139 Railcars. The early versions of Parry People Mover rail vehicles were built to the size of a minibus, carrying 12 to 20 passengers and weighing about 5 tonnes. The mode has been lengthened to accommodate 60 people on Class 139 units at Stourbridge and is being lengthened again to accommodate 120 people in vehicles weighing up to 20 tonnes. The vehicles therefore should be referred to as 'light rail vehicles' and in order to differentiate between Supertrams and most tram trains a possible improved description would be hybrid light rail.	JPM Parry and Associates

7.4.3 Traction beyond the electrified network

There was broad support for the conclusions on innovative electrification.

A number of key considerations pertinent to innovative electrification technologies included were cited in consultation responses and are summarised in Table 7.4.

Table 7.4 – Innovative electrification key considerations identified by consultees

Innovative electrification theme	Consideration	Proposed by
General	**Energy storage technology** - there needs to be a watching brief on such technology.	Several consultees
	Low cost forms of conventional electrification - the application of such technology, e.g. trolley wire, should be further investigated.	Several consultees
	Innovative electrification technologies development – these are likely to develop considerably over the RUS lifetime. Solutions identified for accommodating gaps of varying lengths in overhead line electrification could create new opportunities for electrifying routes previously deemed impractical.	SYPTE
Discontinuous and discrete electrification	**Attractiveness of discrete electrification** – the core factor that reduces the attractiveness of discrete electrification is the additional time taken to recharge the battery. This is the unique point of difference in contrast to other electrification methods.	Bombardier Transportation
	Capital cost increases – potential capital cost increases would be relatively small reductions against the relatively large savings originating from not wiring 100 per cent of a route. Bombardier would expect an overall and substantial cost reduction for an optimised discrete electrification scheme.	
	Vehicle weight – vehicle weight and therefore track maintenance will increase. The cost increment in this area would be substantially lower than the cost saving from reduced electrification. Where 100 per cent electrification is not feasible, on-board storage for an EMU would see a vehicle no heavier than a DMU, but with lower operating costs.	
	Technology - it is relatively unproven and therefore should only be introduced if it can be demonstrated as having no potential adverse impact upon train journey reliability.	South Lanarkshire Council
	Pilot study - a robust pilot of new technology will need to be undertaken, to identify cost savings and operational issues prior to widespread introduction. A pilot project similar to that for the tram train study should be proposed.	Several consultees
	Gradients – this will be a problem in some locations for discontinuous electrification systems. Consideration would need to be given as to whether or not to provide emergency power for such situations.	The Bishop Line Community Rail Partnership
	Application - discrete electrification will be a worthwhile solution for many lines as technology improves. However, dwell times for units in electrified areas may necessitate major infrastructure modifications due to competing demands on the network.	

Table 7.4 – Innovative electrification key considerations identified by consultees (Cont.)

Innovative electrification theme	Consideration	Proposed by
Independently powered vehicles (battery)	**Battery-powered train technical features** – key technical features of battery-powered trains are: (a) energy loss in a battery storage EMU would be less than 10 per cent higher than in a conventional EMU, (b) passenger space would not be lost by on-board storage, (c) energy consumption (battery usage) increases with average speed (this is achieved with higher acceleration), (d) battery capability (typically capacity) rather than efficiency degrades with use, (e) charging time is a key parameter for delivering a cost-effective and operationally robust solution.	Bombardier Transportation
	Battery-powered operational constraints – in certain parts of the network, gradient and weather related issues and time and distance considerations might make the battery-powered solution less attractive.	Strathclyde Partnership for Transport (SPT)
	Battery power technological advances – reliance purely on battery power technological advances as a solution is unadvisable as it could delay the development of simplified and affordable overhead line electrification, e.g. tram and trolley systems developed to a 60mph maximum line speed.	Railfuture
	Electro-diesel and battery-powered trains costs – a comparison of the expected future whole life costs should be undertaken to identify the most cost-effective intervention for bridging gaps between electrified sections.	
	Business case development – the business case is impacted by a number of parameters, in relation to cost, revenue and other benefits.	

Several consultees proposed potential locations for the application of innovative electrification technologies.

7.4.4 Community rail

Network Rail held wider stakeholder briefings in April 2012 with community rail partnerships to seek their views on the proposed strategy. In autumn 2012, during the consultation phase of the Draft for Consultation document, Network Rail engaged with a diversity of stakeholders in relation to the document. The final RUS strategy has been written considering both the feedback that has been received from these briefings on community rail and the Scoping Document and Draft for Consultation responses received.

Key messages from the Draft for Consultation document consultation responses and how they have been addressed are now summarised.

7.4.4.1 Community rail engagement

A number of consultation responses highlighted several issues regarding the existing community rail engagement process. Cumbria County Council noted that the document did not recognise the various community rail initiatives that Network Rail itself has led on and delivered. The final strategy has been updated to include coverage of community rail initiatives such as the Harrington Hump on which Network Rail has led and continues to lead.

ACoRP expressed a number of general concerns, in relation to the development of community rail, which included:

- the intractability of the industry mitigating against innovative and cost effective ideas
- the fear of Health and Safety legislation upon railway staff and others wanting to develop projects
- industry needs to be less prescriptive when addressing rural lines with limited services
- the need of industry and government to realise the costs and benefits of community engagement.

The Bishop Line noted that community rail is currently not formally involved in any specific planning processes of Network Rail and that it relies upon public domain information, sometimes after the majority of planning has been undertaken. It is recognised that this is an issue and including community rail within the remit for the Network RUS: Alternative Solutions signifies effort to encourage greater engagement between Network Rail and community rail initiatives.

Several responses, such as that of Somerset County Council, outlined proposals as to how Network Rail should encourage community rail engagement by: (a) permitting lower cost secondary infrastructure where suitable for community rail projects, (b) providing procedures for volunteers working at stations that encourage and safeguard them and (c) developing a more effective approach to funding community rail schemes that benefit all interested parties. The value and importance of community engagement has been reiterated throughout the final strategy.

7.4.4.2 Community Rail Partnerships (CRPs)

A number of responses noted that the document largely covered holiday and rural areas in relation to Community Rail Partnerships (CRPs) and tended to overlook CRPs in an urban context. This concern was noted and in the final strategy, case studies of urban CRPs in operation have been provided. Examples used to demonstrate the work and problems faced by urban CRPs include the Severn Beach Line and the St Albans Abbey Line.

7.4.4.3 Funding and affordability

Financial issues were a common theme across many consultation responses. Several responses questioned the impact of the McNulty report upon lowering costs of the regional railway and how this impacts upon both costs and timescales taken forward by CRPs and how alternative solutions could help fulfil the McNulty objectives.

Funding of community rail partnerships was acknowledged as an important issue for consideration by some responses. For example, Lancashire County Council noted that a major difficulty facing community rail is acquiring adequate funding to employ a Community Rail Officer. The final strategy seeks to acknowledge the financial challenges that are faced by community rail in funding the initiative.

Some responses, such as that of the Lancaster and Skipton Rail User Group noted the need for the development of a simplified and lower cost process regime for projects on the infrastructure used wholly or mainly by Community Rail services. It was believed that this would contribute to significant cost reductions in this part of the railway.

7.4.4.5 Strategic policy

General policy issues were raised regarding community rail. The Association of Community Rail Partnerships (ACoRP) noted that solutions, particularly at a local level should not be too narrowly defined and require a wider more holistic cross-industry approach. Network Rail recognises this as an issue and accepts that this is an area that industry as a whole should take a more holistic cross-industry approach to seek greater cost efficiencies and passenger benefits.

7.4.4.6 Ticketing and patronage data

Several responses noted concerns regarding ticket data. It was considered that there were two primary problems, which included uncertainty as to exact ridership levels on community rail lines and revenue collection issues, particularly in peak periods. The uncertainty as to ridership levels related to a combination of existing ticket revenue allocation methods and the proportion of uncollected revenue on such lines. Revenue collection issues focused upon the ability of staff to be able to collect revenue on crowded trains and also undertake safety critical duties. These issues have been considered further in the Options Chapter.

7.5 Further alternative solutions

Consultation responses at both stages proposed additional alternatives which could be considered by the RUS. These have been raised by consultees in either the Scoping Document, Draft for Consultation or both consultation phases and have already been or are being examined or considered for examination by the rail industry.

As a result of comments by several consultees in the Scoping Document, bus rapid transit, guided bus and personalised rapid transit modes were investigated as potential alternative solutions. These were consulted upon in the Draft for Consultation document and subsequently included as further alternative solutions in the final RUS strategy. During the two consultation phases, a number of consultation responses identified several very innovative alternative solutions. Details of all the proposals raised in consultation responses can be found in Appendix I.

7.6 Suggested additional gaps

A number of generic gaps were suggested as part of the consultation responses at both stages. Gaps relating to regional self-powered rolling stock replacement, and the cost to enhance, maintain and operate the regional and rural railway system were the most frequently cited.

The final strategy recognises that there are contributions which can be made by alternative solutions. However, these gaps extend across the rail network and beyond the remit of this specific RUS. This is not to suggest that these are not significant issues for consideration by the railway industry. The RUS outlines the specific contribution of such options to these gaps. However, it cannot address them in their totality. They may be appropriate for consideration within the remit of future RUS workstreams.

7.7 Summary

Network Rail thanks all those who contributed to the consultation on both the Network RUS: Alternative Solutions Scoping Document and the Draft for Consultation. The responses have been invaluable in helping develop this final RUS strategy. The diverse subject themes in comparison with previous RUSs resulted in Network Rail opting uniquely for a two-stage consultation process. In this context, the responses of stakeholders are recognised as particularly vital to the development of the final strategy.

8 Strategy

The railway has experienced a decade of unprecedented growth. This growth is expected to continue and by 2020 another 400 million rail journeys per year are forecast. A major challenge is to accommodate this growth in a safe, cost effective manner that will continue to be attractive to the passengers of the future as their needs (and the offer of competing modes) change.

8.1 Introduction

The railway has experienced a decade of unprecedented growth. This growth is expected to continue and by 2020 another 400 million rail journeys per year are forecast. A major challenge is to accommodate this growth in a safe, cost effective manner that will continue to be attractive to the passengers of the future as their needs (and the offer of competing modes) change.

The industry is ambitious in addressing the demands that are being put upon it and is keen to innovate. It benefits from an extensive network which came about as a result of our Victorian forebears' vision. The demands of the passengers that followed inevitably are somewhat different from those of the Victorians and the railway industry has worked hard to make sure the network meets their needs.

We are currently in the midst of a period of considerable enhancement of the network. There is an extensive programme of further electrification, investment in capacity to run additional trains and the prospect of a new high speed line. The railway is planning major investment in technology in the next few years with new capabilities such as intelligent infrastructure changing the way we operate and maintain the railway. In 2012, the cross industry Transport Strategy Leadership Group launched a Rail Technical Strategy (RTS) which outlined the vision. Network Rail will shortly publish a Technical Strategy consistent with the RTS. The Network Rail Technical Strategy will identify opportunities for new technologies to be developed or transferred from other sectors and applied to the railway. This will form the framework for research and development investment which will create capabilities for Network Rail and the rail industry as a whole towards the long term vision for rail.

The Network RUS: Alternative Solutions has been prepared against this background with a remit which allowed it to think imaginatively about cost-effective solutions to accommodating growth and operating services more efficiently. The solutions being considered are generally over and above the conventional accepted solutions which are currently in the railway's toolbox, such as 25kV AC overhead line electrification (OHL) and existing types of rolling stock. It complements the RTS by looking at market needs and the economic case for the emerging solutions.

The RUS has looked at how future innovations could lead to efficient and effective accommodation of growth in accordance with Network Rail's Licence. It has considered passenger needs, stakeholder aspirations and has examined a selection of emerging technologies. Manufacturers and those who are actively considering the development of these technologies have worked alongside Network Rail to make sure that delivery issues are fully understood.

This chapter outlines the resulting strategy. It brings together the key strategic issues which could lend themselves to alternative solutions identified by Network Rail, its customers and stakeholders and identifies a strategy to take them forward. It then provides guidance on the circumstances in which the technologies or activities are likely to be most appropriate.

8.2 Strategy development

By definition, the alternative solutions considered in this RUS are those which have not been routinely considered by railway planners when addressing the challenges of accommodating growth in demand on the network or in seeking to increase the efficiency of services. A number of the solutions, however, have been applied successfully on the rail network in other countries and that experience gives useful pointers to the circumstances in which they could usefully be applied on the network in Great Britain.

The strategy builds upon that experience and outlines which solutions appear to be most relevant to the challenges that the rail industry faces. The aim is to be open to new ideas and to develop a toolkit for cost-effective solutions when conventional ones are unlikely to be value for money or feasible. The strategy does not claim to be exhaustive, not least because of the potential for change over the next 30 years, but it provides recommendations on the circumstances in which a number of alternative solutions may be appropriate.

Guidelines are presented for when each mode, approach or technology is likely to be appropriate and when it is not. Inevitably local circumstances will influence the applicability of options to specific issues.

Business cases should always underpin the ultimate choice of solution.

8.3 Alternative solutions to address network challenges

8.3.1 Tram train

A tram train vehicle is best defined as a tramcar capable of operating on both street tramways and heavy rail networks. However, tram trains differ from trams in several important respects. They:

- are installed with train control systems which enable operation on both rail infrastructure and on-street running
- can generally operate at speeds up to 100kph
- have a wheel profile to operate both on a tramway and on heavy rail infrastructure
- have crash-worthiness standards appropriate for both on-street and heavy rail situations
- can be fitted with dual voltage equipment (25kV AC and low voltage DC)
- can be bi-mode diesel and DC electric.

They share similar market characteristics with trams i.e. they are best suited to a medium to high level of demand for passengers requiring frequent but relatively short distance services. They do, however, have the ability to operate on both heavy rail infrastructure and an on-street tramway, thereby enabling them to operate through services onto the national rail network.

8.3.1.1 When conversion of railway infrastructure for use by tram train is an appropriate option

Although tram trains do not currently operate in Great Britain, their characteristics suggest that they have potential to provide a new opportunity to make better use of some existing heavy rail corridors which serve dense urban areas. Tram trains share the advantage of trams of being able to penetrate city centres beyond the existing terminal stations using a suitably equipped road network, but also have the advantage that they can share tracks with other passenger and freight services, thus avoiding the need to segregate the services or sever through journeys.

A tram train pilot is being funded by the Government and will start operating in 2016 between Sheffield city centre and Rotherham. It will seek to address questions about the engineering and cost of the technology in a UK situation. Subject to the outcome of that pilot, the technology may then become part of a tool-kit for planning for major urban areas.

The emerging costs from the trial would provide useful information to improve understanding of the overall business case for tram train. Our understanding of the market suggests that there is likely to be a stronger case in those cities which already have tramways but wish to extend the services onto the rail network since much of the infrastructure would already be available. The following examples meet the high level criteria for tram train introduction and have been raised as potential candidates. Subject to business case, this list includes:

- Greater Manchester
- Nottingham
- South Yorkshire
- West Midlands.

Transport for Greater Manchester (TfGM) is developing a tram train strategy for the conurbation which is consistent with this RUS. TfGM's strategy will build on their initial sift of tram train routes, demand forecasting and business cases to look at the corridors in detail along with the impact on the Metrolink and Network Rail networks.

The Welsh Government is developing proposals for a Metro style transport system in south east Wales and is considering tram trains as an option for inner suburban services and for new lines.

It is proposed that this recommendation is revisited when there is a greater understanding of technical issues and the emerging costs of the tram train trial. At that point it may be worth considering whether there is a business case for the use of tram train in cities which currently do not have an existing tram network but which have an extensive rail network and would be likely to generate the appropriate level of demand.

8.3.1.2 When conversion of heavy rail infrastructure for use by tram train is NOT an appropriate option

Based on current technologies tram train is not likely to have a good value-for-money business case when it does not serve urban areas. Technological developments in this area should be monitored. The advantages come from the ability of tram trains to operate on both a tramway and heavy rail network serving a number of stops within dense urban areas beyond the terminal stations whilst retaining through operation to the existing rail network.

8.3.2 Trams

Trams are light rail vehicles. Individual trams are up to 40 metres in length but can operate as multiple formations. They are designed to operate on streets shared with pedestrians and other road users. They operate on line of sight and are required to be able to stop within safe braking distances. This requirement drives many of their technical features and cost. They therefore operate at top speeds generally markedly lower than heavy rail systems but with high rates of braking and acceleration. Off street (in light rail mode) typically they are designed to operate at speeds up to 80kph. In their current form their train control system, wheel profile, and crash-worthiness characteristics prohibit their operation on the heavy rail system. They require their own fixed infrastructure with a tram control system and DC electrification at relatively low voltages. Thus if heavy rail lines are converted for tram operation, they would be used exclusively by the trams and severed from the rest of the national rail infrastructure.

If a conversion is to use the existing heavy rail platforms, the trams would need to be suitable for operation with high platforms (as is the case with Metrolink) rather than with low platforms as is more conventional for tram operation. Alternatively the existing platforms would have to be rebuilt as low platforms. Both solutions potentially have cost implications and should be considered carefully in any business case for conversion.

8.3.2.1 When conversion of railway infrastructure for use by trams is an appropriate option

Trams operate most effectively in densely populated urban areas when passengers require frequent services to cover short distances with convenient frequent stopping patterns. Their ability to run on streets allows them to penetrate urban areas, bringing rail transport close to homes and work places. The vehicles' quick acceleration facilitates frequent stops without a significant reduction in overall journey time. As such, they are most appropriate for providing connectivity to city centres. This enables the dispersal of passengers to their destinations beyond the city centre station by going on to an on-street tramway. By taking heavy rail trains out of city centre stations this can release capacity, addressing urban transport problems by providing a frequent high quality public transport corridor. To maximise the benefits to passengers it is important that good interchange facilities are provided to the heavy rail services.

To be commercially viable, trams require medium to high demand. For example, the Wimbledon to New Addington route on London Tramlink has a passenger capacity in one direction per hour of approximately 1,700, and Manchester Metrolink Bury line has a passenger capacity in one direction per hour of approximately 2,000. If a heavy rail corridor is to be considered for conversion it would need to serve at least part of a corridor which would generate this level of frequent short trips. This may involve the extension of an existing tramway, such as was the case with the Rochdale via Oldham Metrolink extension, or the creation of a new tramway, such as the former Wimbledon to West Croydon branch line which now forms part of London Tramlink.

If conversion is to provide a net benefit, the benefits of the tram service should outweigh any disadvantages of ceasing the operation of other services along the route when the infrastructure is severed from the national network. Similarly, the appraisal of a tram conversion scheme should take into account any loss of patronage from former through services to destinations beyond the extent of the new tram network. Careful consideration should be given to the ease of interchange and integration with the existing rail service.

When an on-street tramway does not feature as part of a proposal these requirements are not needed and it is likely that a conventional heavy rail solution may be more viable.

8.3.2.2 When conversion of heavy rail infrastructure for use by trams is NOT an appropriate option

Conversion of heavy rail infrastructure or service to operation by tram is unlikely to have a good economic case when long distance passenger services or rail freight use the corridor or when severance of an existing rail service would cause inconvenience to a large number of through passengers. Based on current technology tram conversion is not appropriate outside densely populated urban areas when the demand is unlikely to sustain the service.

8.3.3 Self Powered vehicles

The Network RUS: Electrification published in 2009 provided a map identifying a number of lines for which electrification was not proposed. It is currently under review but it is expected in the longer term that, even with a significant investment in electrification, there will still be a proportion of the rail network which will remain unelectrified and consideration of the traction policy for these lines will be important as the industry develops its long-term plans.

At present, approximately 66 per cent of the local service Diesel Multiple Unit (DMU) fleet is over 20 years old raising a question about the most efficient and sustainable life-extension and replacement of existing DMUs with self-powered vehicles in the future. The Long Term Passenger Rolling Stock Strategy for the Rail Industry (2013) gives a high level rolling stock strategy that is an indication of the numbers of self-powered vehicles that may be required.

8.3.4 Battery-Powered vehicles

8.3.4.1 When battery-powered trains would be considered as an appropriate option

Battery technology is currently not sufficient to enable like-for-like operation of current diesel services. However, a number of manufacturers suggest that the technology could be developed to the point when energy storage on trains will be viable for these routes to enable the operation of a train across a gap in electrification infrastructure of potentially tens of kilometres.

Table 8.1 presents a high level specification of what a train with on-board energy storage would need to be able to achieve to operate passenger services on the network.

Table 8.1 Energy storage powered train - rail industry requirements

Factor	Conclusion of analysis
Safety and environmental impact	The energy storage technology must be safe to operate in a rail environment and should minimise environmental impact of its manufacture, operation, and disposal.
Energy storage rolling stock vehicle whole life cost	The whole life, whole industry cost of an energy-storage-powered fleet must be lower than that of the conventional options of continued diesel operation, or electrification. Without this, energy-storage-powered rolling stock will not be the best value for money option for future traction power source.
Type of energy storage	Of the technologies considered for discrete electrification, research[1] suggests that batteries offer the best future prospect because of their balance of range and power. This conclusion does not exclude any developments in technologies other than batteries that might in the future be able to meet the demand of powering rail vehicles. Combinations of different technologies might also be possible in order to provide a balance of capabilities. A small engine or auxiliary power unit (APU) could also be considered in order to trickle-charge the energy storage system.
Energy storage weight	The heavier the energy storage per vehicle the less the net saving on infrastructure maintenance and the greater the energy consumption.

1 Reference: RSSB, T779, Energy storage systems for railway applications (2010)

Table 8.1 Energy storage powered train - rail industry requirements (Cont.)

Factor	Conclusion of analysis
Energy storage volume	The economic case would be stronger if the energy storage is able to fit within the space available on a vehicle and not impinge upon passenger accommodation.
Energy consumption and CO_2 emissions	The economic case would be stronger if the energy consumption per vehicle is efficient to give a cost and CO2 emission saving in comparison with a DMU.
Rolling stock availability	The economic case would be stronger if rolling stock availability is at least that of a DMU. Battery recharge time must not be such that additional units are required to operate the same level of service.
Rolling stock reliability	The economic case and operational feasibility of energy-storage-powered vehicles may be improved if the miles-between-rolling-stock failure-rate is at least comparable to that of future conventional rolling stock.
Energy storage range	The market for trains powered by energy storage is dependent on range while operating from onboard stored energy. With progressive increases in range, diesel vehicle miles could be converted to trains powered by energy storage.
Energy storage recharge or replacement time	Must be capable of recharge or replacement within the period that a train is exposed to the OHL or stationary at a terminating station. If more vehicles are required to operate a service than with DMUs in order to allow for recharge time, the benefits will be lessened in comparison to DMUs and conventional electrification.
Rolling stock duty cycle	Must be capable of conducting the same duty cycle as currently achieved by DMUs operating a given set of services. The benefits of energy storage will be lessened in comparison to DMUs and conventional electrification if more vehicles are required.
Energy storage life and performance	Energy storage asset life must be predictable. In addition to reliability: the main effect of the length of energy storage asset life is on the whole life energy storage cost.
Energy storage unit cost	The unit cost of batteries is uncertain. The RUS has shown that if the price of the battery installation per annum falls to a sufficient level, it is possible that a saving can result compared to DMUs.

The RUS has considered distances which we understand from manufacturers that the technology is not currently capable of achieving within the required time to recharge. However, given the considerable investment of other sectors, notably the automotive sector, there is reason to believe that the technology is likely to improve over the 30 years of this strategy.

It is recommended that the rail industry works closely with manufacturers as the technology develops. The Network RUS: Electrification ‘Refresh’ will take forward the recommendations of this strategy for this technology in considering those areas of the network which may not have a case for conventional electrification.

8.3.4.2 When battery-powered trains would NOT be considered as an appropriate option

Battery power will not be considered to be an appropriate option for operation of vehicles on the network until battery technology is developed to a sufficient degree to provide value for money as an option for replacement of diesel units.

Our current understanding of the technology suggests that it is unlikely that battery technology will be appropriate for those parts of the network which have a strong case for conventional overhead wire electrification and for vehicles that operate at more than 100mph, for substantial distances or when there is limited recharge time available.

The potential for 'last-mile' diesel operation by an electric locomotive to access unelectrified terminals or sidings will be considered by the Network RUS: Electrification 'Refresh'.

8.3.5 Hybrid light vehicles

A range of alternative light vehicles have been proposed to operate the less dense parts of the network at a lower cost than existing rolling stock. These include the use of flywheel or other energy-saving technology.

Unlike battery technology, one example of flywheel technology is currently being operated on the network. The Class 139 operates the regular passenger service on the branch line between Stourbridge Junction and Stourbridge Town.

8.3.5.1 When hybrid light vehicles would be considered as an appropriate option

The current Class 139 is a light vehicle which works well on a segregated section of the railway where its carrying capacity of approximately 60 passengers meets the needs of the market. Its relatively low capital and operating costs are appropriate for a low-volume low-revenue market.

The segregation of the operation means that the vehicle does not require the levels of crash-worthiness that would be required in the mixed use railway. It operates over a section of track which had to be improved to provide a smooth ride for passengers in a light vehicle.

The current Class 139 could be expected to work well on short segregated parts of the railway with low demand and track of at least similar quality to that on the Stourbridge branch. The developers of the vehicle are currently working on a bogie version which would have a higher carrying capacity and would provide a smoother ride on a variety of tracks. If such a vehicle were developed, it may have the potential to serve wider markets with higher patronage.

Hybrid light rail currently operates to serve a relatively small niche. As with the Class 139, any case for a larger vehicle would be predicated on low capital and operating costs. Their niche would be expected to be semi-urban or rural markets. For example, subject to business case, they could be considered for areas where current one-car or two-car Diesel Multiple Units (DMUs) operate. Existing one-car vehicles operate in multiple with other DMUs and are therefore able to serve a wider range of demand. This feature would be advantageous in any future vehicle that was developed.

8.3.5.2 When hybrid light vehicles would NOT be considered as an appropriate option

Hybrid light rail vehicles are unlikely to have a strong business case on interurban routes or areas of very high demand into city centres, such as the London commuting area. They will also not be appropriate in areas with too little demand to provide a positive business case, this applies to both existing and new alignments.

8.3.6 Personal Rapid Transit (PRT)

Personal rapid transit (PRT) systems have been developed to move passengers in driverless pods, using a guidance system to take passengers to their selected destination. This means that service frequency and destination can be tailored to passenger requirements.

8.3.6.1 When Personal Rapid Transit (PRT) would be considered as an appropriate option

PRT does not operate on any part of the existing or former British national rail network. It does, however, move passengers between Terminal 5 at Heathrow Airport and outlying business car parking. Driverless pods with a capacity of four passengers operate using a guidance system on segregated routes. With a five-bay pod station dispatching a vehicle from each bay every 30 seconds with a four-person vehicle, the maximum demand that could in theory be served is then 2,400 passengers per hour. Similar types of vehicles are being developed to operate to operate autonomously without a guideway. A trial is planned for their operation in Milton Keynes.

Whilst they are low capacity vehicles, they have the advantage that their frequency and destinations can be tailored to passenger requirements.

PRT systems have the potential for widening the catchment area from which passengers can reach rail stations within 10-15 minutes. This may result in an increased mode share for rail (and therefore increased rail fare revenues) as well reduced traffic congestion and regeneration benefits for cities.

Figure 8.1
London Heathrow Terminal 5 Pod

Examples of developments that could be realised by such rail access include:

- provision of remote car parking and redevelopment of former central parking sites
- development of edge-of-city-centre business zones with easy access to rail stations
- new sustainable residential developments
- access to airport sites from rail stations
- interchange between two or more nearby town or city centre rail stations.

Such measures for improved connectivity may not just apply to city centre stations. For example, there may also be an opportunity to enhance the role of the railway on the edge of towns, and station connectivity to business parks or park-and-ride sites. In the future, PRT could have a role in the expected development of new high speed rail stations to exploit local development opportunities.

8.3.6.2 When Personal Rapid Transit (PRT) would NOT be considered as an appropriate option

PRT does not operate at high speeds and has a limited carrying capacity per vehicle so would not be an appropriate option for replacing heavy rail services. It would be less appropriate than a fixed transport link for serving high volumes if passengers are going to a single destination.

8.3.7 Bus Rapid Transit (BRT) or Guided Bus

A BRT system is essentially a conventional bus with interventions designed to optimise the whole journey experience. The vehicles are conventional buses, the only difference being that they run for part of their route on a dedicated road as well as on the main local and highway network. BRT is operated with the driver driving the vehicle in the normal way throughout. Guided bus is very similar except that it operates on dedicated guided sections as well as on the highway.

8.3.7.1 When Bus Rapid Transit (BRT) or Guided Bus would be considered as an appropriate option

As discussed above, tram train and tram have the potential for enhancing connectivity and increasing the access to some urban centres. However, not all cities have sufficient demand to provide a positive business case. Lower levels of demand may require a lower cost solution. The provision of high quality bus-type services either in the form of a Bus Rapid Transit (BRT) or guided bus on a former rail alignment may offer an attractive, alternative, high-capacity service.

It is recommended that this solution is considered as an option for reopening former railway lines where there is a poor case for heavy rail or tram-type operation. This is likely to be in medium sized urban areas or routes serving more dispersed populations than are generally served by rail or tram networks and where it is challenging for either heavy or light rail to penetrate a city centre. Outside a railway industry context BRT, and guided bus have a broader set of considerations as to their appropriateness and characteristics as a mode of transport.

Former rail alignments in South Hampshire and between Cambridge and St Ives have been reopened to passenger public transport using buses on segregated routes (see case studies in Appendix F).

8.3.7.2 When Bus Rapid Transit (BRT) or Guided Bus would NOT be considered as an appropriate option

Bus Rapid Transit is not the appropriate option for conversion on routes that are not segregated or separated from the rail network. Guided bus would not be appropriate in comparison to BRT when the costs of the guide way are greater than the benefits. Both BRT and guided bus are unlikely to be the most appropriate option for transport corridors which have sufficient demand to warrant a heavy rail, tram train or tram network.

8.3.8 Electrification for lightly used routes

8.3.8.1 When 'coasting' and discontinuous electrification is considered as an appropriate option

If the cost of providing electrical clearance would otherwise be prohibitive to an electrification project, it is recommended that consideration is given to an option for vehicles to 'coast' under structures. It is recommended that the option identification process considers whether designing a system containing an option for vehicles to 'coast' under structures is appropriate.

Figure 8.2
Cambridge Guided Busway

Figure 8.3
Paisley Canal station following completion of electrification

This would apply if the cost of providing structural clearance for OHL would otherwise be prohibitive to an electrification project. Network Rail has recently introduced such a system on the Paisley Canal branch. Neutral sections with neutral contact wire allow electrically powered rolling stock to coast under structures where there is physical clearance for the train but insufficient clearance for the electrical system to operate live.

The costs of introducing electrification on the Paisley Canal branch were reduced by approximately 50 per cent by this means and early indications suggest that the system has not compromised service performance.

Whilst this is may be an attractive proposition to avoid gauge clearance costs, it is only recommended in those circumstances where there is a low risk that a train might come to a standstill (causing a problem to service performance) and where both line speeds and service frequency are low. As such, it is recommended that the solution is considered on branch lines rather than the core network where speeds, frequency and performance risk are higher and Technical Specifications for Interoperability (TSI) compliance is essential.

There are a number of other options for lower cost electrification which have not been considered in detail by this strategy. A pilot of tram train operation between Sheffield and Rotherham using 750V DC trolley wire is currently considering the practicalities and differential costs of using tram-style and conventional overhead line.

Tram style electrification involves one or two contact wires suspended from masts without a supporting catenary wire, which reduces the weight of the overhead wires and reduces the required strength and height of masts. The pilot will also assess whether the differing rail profiles on the tramway and the consequent compromise on wheel profile on the vehicle will adversely affect the maintenance regimes on either system or the vehicle.

Use of 25kV AC tram-style wire for low speed routes has not been implemented outside locations such as terminal stations, freight yards and depots. It is recommended that the results of the tram train trial are examined with a view to including the use of tram-style OHL as an option for low speed routes in the future.

8.3.8.2 Where 'coasting' and discontinuous electrification is NOT considered as an appropriate option

Whilst coasting may be feasible in certain circumstances outlined above for current rolling stock, it is not considered as appropriate for the core network.

Extended neutral sections require bespoke rolling stock with energy storage installed to allow trains to cross the gaps in the OHL. Recent research by the Technical Strategy Leadership Group suggests that this type of extended discontinuous electrification would appear not to have a value-for-money business case with current energy storage costs. The work indicates that savings in infrastructure costs may be exceeded by the cost of energy storage and more complex rolling stock. Additionally, operating a route with large numbers of small gaps in the OHL is challenging and may, above a certain number, not be operationally feasible due to the time required to raise and lower pantographs.

Whilst long sections of discontinuous electrification are not recommended in this strategy, it is recommended that the position is reviewed if there is a step change in energy storage technology on trains at some future date.

8.4 Community Rail

The strategy recognises the value that community rail groups have added through their continued involvement in the railway. This involvement should be facilitated wherever appropriate, since community engagement can lead to an improved rail experience. Options have been considered for the potential role of community rail in obtaining value for money for the railway and encouraging greater involvement of the local community in their local rail line. These options recognise that the history of community rail's achievement has tended to focus on strategies to increase ridership and revenue and find cost effective solutions, rather than reducing costs directly.

8.4.1.1 When community rail provides an appropriate alternative

The key factor which needs to be present for community rail to be appropriate is a desire from a local community to engage and form a partnership with the rail industry.

Experience has shown that community rail can contribute to the

Figure 8.4
The original Harrington Hump at Harrington Station

development of the railway in a number of ways:

- promoting ridership through community rail marketing techniques has been a successful way to attract additional patronage and also increase rail's economic benefit
- promoting alternative methods of ticket retailing such as on the Settle and Carlisle line
- In some instances community rail partnerships (CRPs) have been an important facilitator in the ability to rebalance fare levels and service provision to meet community needs
- community engagement has delivered improvements in the way services are developed
- partnerships have been successful in providing a very local link into the communities the railway serves when services change or there is disruption to services
- partnerships and station friends groups have made a significant difference to stations and the environs of the railway, enhancing the environment for passengers and local people.

Community rail partnerships have worked successfully in a range of different circumstances from commuter lines in London and the South East (e.g. Sudbury to Mark Tey and the St Albans Abbey line), inner cities services (e.g. the Severn Beach line in Bristol) to rural locations (e.g. the Falmouth branch in Cornwall).

A range of solutions have been deployed on community rail lines to enhance the network. Examples of these lower cost enhancements examples have included:

- Penryn Passing Loop – an innovative installation of a passing loop avoided the need for a new platform and footbridge at the station
- Harrington Hump – low cost means of raising a section of a platform to improve accessibility on to the train
- Beauly and Conon Bridge – two new stations in Scotland with only 15 metre long platforms thereby reducing their capital cost.

It is recommended that the rail industry continues to facilitate Community Rail Partnerships (CRP) and work with those groups and partnerships that do emerge. Community rail plays a role in reducing the gap between operating costs and income from passengers on more lightly used rail lines. A successful CRP can provide a strong case for the investment of other alternative solutions to enhance rail services on these lines.

8.1.1.1 When community rail DOES NOT provides an appropriate alternative

For a community rail partnership to be effective, commitment from local authorities and train operators is essential. Other groups, such as rail user groups, station friends, national parks authorities and tourist attractions can all make a valuable contribution but if those first two are not present it is doubtful the CRP will be successful.

It is also important that the CRP has a plan and realistic, if challenging, aspirations. If the plan or the aspirations are not realistic, partners will become frustrated and failure of the CRP is likely. Funding is a key issue and for any partnership a clear structure of accountabilities and responsibilities is also important. If these cannot be identified it is unlikely a CRP will deliver benefit to rail users, partners or the industry.

The appropriate community rail options will be dependent upon the circumstances of the local community and the characteristics of the railway. These characteristics include the market, the nature of the railway services and the potential to influence demand for rail travel.

8.5 Summary of appropriateness of alternative solutions

A range of modes of transport has been proposed and described throughout this strategy to meet a number of network challenges in the future.

Table 8.2 gives a high level summary of a guide to when each mode should be considered as part of the planning toolkit. The guide is not intended to indicate that the mode would necessarily be appropriate as all would be need to be subject to business cases.

Table 8.2 – Guide to when and where each mode should be considered

Mode	Range of typical characteristics	Where modes may be consider in applicable markets					Circumstances where mode is appropriate	Circumstances where mode is not appropriate	Examples
		Long distance high speed and interurban	London and South East suburban and regional	Suburban	Rural	Distribution beyond heavy rail stations			
New or reopened Heavy rail lines	• between 1 and 12 passenger vehicles as either multiple units or locomotive hauled coaches • maximum operating speeds between 120 and >300kph • fixed infrastructure with a full train control system • electrified 25kV AC or 750V DC 3rd rail, and self-powered • high platforms.	✓	✓	✓	✓	✗	When sufficient demand to support a strong business case: • new heavy rail lines • reopened former passenger rail routes • High Speed lines.	New heavy rail lines are not likely to be appropriate when there is low population density and/or a dispersed catchment area	• Ebbw Vale Line • Airdrie to Bathgate • future East West Rail • High Speed 1 and 2
Conversion of heavy rail infrastructure or services for operation by tram	• trams up to 40 metres long (can operate in multiple) • generally low platform (except Manchester Metrolink) • maximum operating speeds of up to 80kph • on-street tramway operation with other road users and track brakes • cannot operate with heavy rail services • fixed infrastructure with a tram control system • electrified 750V DC.	✗	✗	✓	✗	✓	• to access city centre stations via an on-street tramway from high demand passenger corridors • local high volume passenger demand to city centres • rail stations with a partial rail alignment or dedicated corridor available • the advantage of severance from the network outweighs the disadvantage to existing rail users.	• locations outside major urban areas and without appropriate corridors • when the disadvantage of severance from the heavy rail network outweighs the benefits	Manchester Metrolink conversion of Rochdale via Oldham route to tram operation

Table 8.2 – Guide to when and where each mode should be considered (Cont.)

Mode	Range of typical characteristics	Where modes may be consider in applicable markets					Circumstances where mode is appropriate	Circumstances where mode is not appropriate	Examples
		Long distance high speed and interurban	London and South East suburban and regional	Suburban	Rural	Distribution beyond heavy rail stations			
Tram-train	Similar characteristics to trams but can operate on both heavy rail systems and on-street tramways, and be dual 25kV AC and 750V DC capable	✗	✗	✓	✗	✓	• as with tram but when the operation of a passenger service on heavy rail lines is needed in addition to tramways • there is a need to operate alongside heavy rail passenger or freight trains.	• when a major urban area is not served with an existing or new tramway • long distance, outer suburban, regional or rural services.	• Sheffield to Rotherham tram train trial • possible future Manchester to Marple services
Hybrid light vehicles	There are a range of products which have been proposed but most involve lower cost rolling stock to operate on less dense parts of the network. They may not be able to interoperate with heavy rail vehicles. The only operating example is the Class 139 which is a hybrid flywheel vehicle with a 80kph maximum speed and capacity for approximately 60 passengers.	✗	✗	✗	✓	✓	• low demand for rail services • operating cost of services can be reduced • when it is unlikely that conventional electrification will be provided for DMU replacement.	• service cannot be segregated from the wider rail network • likely passenger demand is low or a dispersed catchment area • for high volume or long distance markets.	Stourbridge Town Branch
Bus Rapid Transit (BRT) or guided bus on a reopened rail corridor	BRT systems are conventional buses with interventions designed to optimise the whole journey experience. An example is the South Hampshire Bus Rapid Transit when the alignment of a former rail line has been used to create dedicated busway. A guided bus provides a very similar service offering to BRT, however, the use of guided bus differs in that there is additional fixed infrastructure on the guide way	✗	✗	✓	✗	✓	• for enhanced connectivity in smaller urban centres when there is insufficient demand to make the case for new light rail • when a former rail alignment is available with no long term strategic need for reopening	• not for replacement of heavy rail services • unlikely to be an option for corridors with sufficient demand for heavy rail or light rail • in comparison with BRT, guided bus is not appropriate when the benefits of a guide way are outweighed by the cost.	South Hampshire Bus Rapid Transit and Cambridge Guided Busway.

Table 8.2 – Guide to when and where each mode should be considered (Cont.)

Mode	Range of typical characteristics	Where modes may be consider in applicable markets: Long distance high speed and interurban	London and South East suburban and regional	Suburban	Rural	Distribution beyond heavy rail stations	Circumstances where mode is appropriate	Circumstances where mode is not appropriate	Examples
Personal Rapid Transit (PRT)	An electrically powered independent 'pod' vehicle able to transport generally up to 4 people to a range of dispersed locations on demand. This means that service frequency and destination can be tailored to passenger requirements	✗	✗	✗	✗	✓	• locations within approx 2 miles of existing rail hubs • support the case for enhancement of rail stations • when there is passenger demand to multiple destinations • variable levels of demand throughout the day • to unlock commercial development close to rail stations	• it would not be appropriate for high volumes to defined destinations over longer distances • not for replacement of heavy rail services.	Heathrow Terminal 5 to the business parking.

8.6 Next Steps

This strategy provides guidance for the appropriateness of different solutions to support particular transport challenges. It provides a toolkit of solutions which can be assessed for business cases in different circumstances. This strategy is principally aimed at solutions when use of an existing rail line may be required (in part) to deliver the transport solutions but it can also be used to consider options for new transport corridors in urban areas.

It is recommended that the guidance for the appropriateness of different modes to different planning situations is used to sift planning options in the rail industry's long term planning process. Future planning should use that guidance to expand the toolkit of potential solutions and, at least as importantly, use the guidance to avoid spending its resources on inappropriate solutions.

As with any RUS, the strategy reflects our best understanding at this point in time. The Rail Technical Strategy is underpinned by the Rail Innovation Fund which will be used to develop technology further. This strategy recommends that allocation of the fund takes cognisance of the recommended links between network challenges outlined in this document.

Whilst some of the solutions are close to an appropriate stage of development (or adaption) for introduction onto the UK rail network, others will require more attention, for example on-board energy storage. It is important to be aware that, by definition, a process of innovation is a process of change and that some technologies that are not listed as appropriate at present may become appropriate after further development work. It is possible that over the next 30 years there may be some significant technological developments that could reshape the market for public transport and how it is powered.

The recommendations of this strategy have been developed by the rail industry and its key stakeholders. They will form an input into the strategic decisions made by the industry's funders and suppliers. It also provides support to transport authorities in developing new transport services that interact with the national rail network.

This RUS will be reviewed periodically by the Network RUS Rail Industry Planning Group if there are any significant changes in circumstances or technological changes that impact upon the strategy proposed. It is recognised by the strategy that the nature of societal and technological change means that the conclusions may need to be revised in the future. It expected that this RUS will become established 60 days after publication unless the Office of Rail Regulation (ORR) issues a notice of objection within this period.

Appendix A – Tram and tram train in Great Britain

Table A.1 shows the operating tram systems in Great Britain. This includes the tramway that is currently being constructed in Edinburgh. Most of the tram systems constructed since 1990 have been created in part by converting heavy rail infrastructure. In Edinburgh, options considered included a heavy rail alignment. These have not formed part of the scheme as it is currently being constructed. In Croydon and Manchester, the tram conversion replaced previous heavy rail services.

There is considerable variety between the tram systems in terms of platform design, tram length, voltage, maximum gradients and wheel profile. In recognition of this variety, ways of standardisation are being considered by the tram industry.

No tram train services are currently in operation in Great Britain. The tram train pilot between Sheffield and Rotherham is funded to operate for two years, commencing in 2015. More details about the tram train pilot and its objectives can be found in Chapter 4 Section 4.2.2.

It was proposed to convert the 6½ mile long Watford Junction – St Albans Abbey heavy rail branch to operate using tram vehicles. The current rail service consists of a train every 45 minutes in each direction. Local stakeholders have long identified the need to increase the frequency and introduce a regular half hourly or 20 minute frequency service to this single track branch line. Assessments undertaken so far indicate that it should be possible to run a more frequent 20 or 30 minute tram service on the Abbey Line at approximately the same cost as the current heavy rail service operation, if an intermediate passing loop is provided. The proposed conversion to tram operation would take advantage of the lower operational costs of tram, compared to heavy rail.

Table A.1 – Data on existing tram systems in Great Britain 2011-12 [1]

	Blackpool Tramway	Manchester Metrolink	Sheffield Supertram	Midland Metro	London Tramlink	Nottingham Express Transit (NET)	Edinburgh Tram
Route length (miles)	11	25 (not including Metrolink expansion and second city crossing)	18 (plus tram train extension to Rotherham)	13 (to be extended into the centre of Birmingham)	17	9 (not including NET phase 2 and 3)	8
First section opened	1885	1992	1994	1999	2000	2004	Planned 2014
Number of trams or vehicles	16	74	25 (plus tram trains on order)	16 (to be replaced by new trams as part of expansion plans)	30	15 (not including NET phase 2 and 3)	27 to be delivered
Tram or vehicle lengths Metres	32.23	29 & 28.4	34.75	24	31.1	33	42.8
Street running	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Former railway alignments	No	Yes	Yes	Yes	Yes	Yes	No
Replaced 'heavy rail' service	No	Yes	No – but tram train pilot will operate on heavy rail infrastructure	Reopened on a former heavy rail route.	Yes	No	No
Platform height	Low	High	Low	Low	Low	Low	Low
Electricity supply	600V DC overhead line	750V DC overhead line	750V DC overhead line	750V DC overhead line	750V DC overhead line	750V DC overhead line	750V DC overhead line

1 Source: Green Light for Light Rail, Department for Transport, 2011 http://assets.dft.gov.uk/publications/light-rail/green-light-for-light-rail.pdf

Appendix B – Tram train in Europe

Origin of the tram train concept

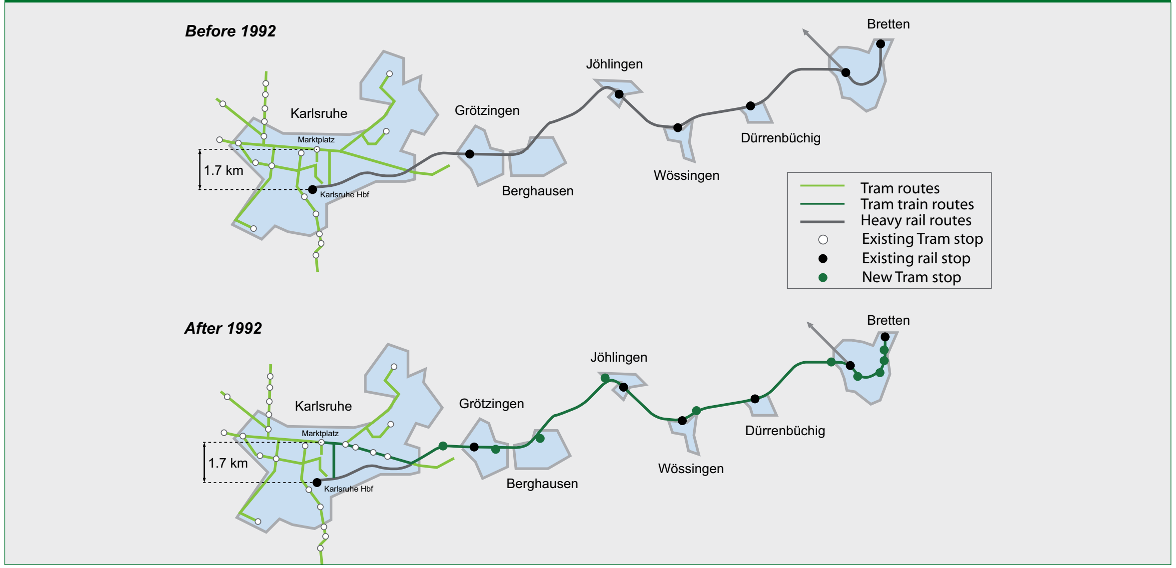
The first tram train was introduced, on a limited basis, in Karlsruhe, Germany, in the 1960s. It involved tram vehicles operating on heavy rail infrastructure with occasional freight services. The first true tram train anywhere in the world began operation between Karlsruhe and Bretten in 1992. It had an interface with both the tram and heavy rail network, as well as being dual voltage. The aim was to allow people to get directly into the city without having to change from one mode to the other at a station, a considerable distance away from the city centre. Other European cities and regions that have introduced tram train networks include Saarbrücken, Kassel, Mulhouse and The Hague.

Karlsruhe main station (Hauptbahnhof (Hbf)) is remote from the city centre. The walking distance between Karlsruhe Hbf and Karlsruhe Marktplatz is 1.7 kilometres, as illustrated in Figure B.1. Before 1992, a public transport journey from Bretten to the centre of Karlsruhe at the Marktplatz involved a rail journey and an interchange with the tram network.

After the tram train conversion this interchange was eliminated saving 15 minutes journey time. In addition, further stations were constructed along the line of route. This further decreased the generalised journey time by reducing the average distance between the nearest station and the passenger's place of origin or destination. Frequency on the route was increased, as was the length of the service day.

A connection between the tram network and the Deutsche Bahn (DB) heavy rail network was built with a voltage changeover. At the voltage changeover point between the 750V direct current (DC) tram network and the 15kV alternating current (AC) heavy rail electrification, the tram train switches automatically on the move from DC to AC or vice versa. Having developed the first corridor in 1992 a number of additional tram train conversions have followed. Currently there are now 12 routes. The extensions to the network have followed the same principles as the first tram train line. They have connected nearby city regions to the network.

Figure B.1 – Karlsruhe to Bretten before and after tram train introduction in 1992 (Source: Karlsruhe Transport Authority)



The corridors in Karlsruhe have experienced growth in patronage and modal shift following tram train introduction. These demand changes have been driven by a number of factors:

- city centre penetration
- new stations
- new electric rolling stock replacing older diesel multiple units (DMUs)
- increases in frequency
- reduction in some fares
- increased length of the service day
- integration of public transport.

Characteristics of European tram train routes

There are a wide variety of tram train routes in operation in Europe. Some systems follow the principles outlined in the Karlsruhe example. Others operate as express tramways (up to 100kph) and do not interwork with heavy rail infrastructure.

The routes in Europe have a variety of service and operational characteristics. Route length is generally relatively short, with 73 per cent of tram train routes being less than 40 kilometres in length from the city centre (Source: Axel Kühn 2012).

There are exceptions, such as the Karlsruhe-Freudenstad route which travels over 80km from Karlsruhe. However, even for those longer routes, it is unlikely that large numbers of passengers make the total journey. Instead, they link a number of centres with passengers making shorter journeys along the route.

The average distance between stops for the tram train routes in operation in Europe is approximately 2.1 kilometres (source: Axel Kühn 2012). This indicates that they have a dense stopping pattern consistent with the operating characteristics of a tram.

The average distance between stops is higher than a typical street tramway, reflecting in part the longer routes and higher average speeds of tram trains on heavy rail infrastructure.

Appendix C – Hybrid light rail

The term hybrid light rail refers to a number of differing solutions. The common features that these proposals share is the use of a lighter weight vehicle, with potentially lower capacity and hence cost. The concept proposes relatively limited changes to existing infrastructure. It may or may not be self powered. For new infrastructure it is contended by those promoting such schemes that substantially reduced costs might be seen.

Some of these solutions have been trialled. The only commercially operating service of this kind uses a Class 139 vehicle (see Figure C.1) in segregated operation from the main line between Stourbridge Town and Stourbridge Junction. This service has been operated since 2009. Two Class 139s are required to operate the service.

The branch is unique on the railway network in that it is only around ¾ mile long and segregated from other train services. The service is subcontracted from the London Midland franchise and the vehicles are owned by Porterbrook Leasing. The two Class 139 vehicles replaced one heavy rail single car Class 153 Diesel Multiple Unit (DMU). These are segregated from heavy rail trains and operate a ten minute frequency service with one vehicle in service at any one time.

The Class 139 is a light weight vehicle with a tare weight of 10.5 tonnes, two axles and a total capacity for 60 passengers. This compares to approximately 100 passengers per equivalent heavy rail 20 metre DMU vehicle. The vehicle has a flywheel energy storage system. This recovers braking energy and reduces peak power requirements from the liquefied petroleum gas powered internal combustion engine. This has the effect of reducing fuel consumption. Given the length of the branch line, the speed of the vehicle is necessarily low. The vehicle is designed for operating at up to 40 miles per hour.

The operation of the service has required the construction of a small maintenance facility and addition of a new buffer stop design at Stourbridge Town. Works were required to the infrastructure to address ride quality due to the vehicles' tolerance to the track conditions. On Network Rail's infrastructure, the Class 139 has been approved for operation only on the Stourbridge Town branch. Operation on the Stourbridge Town branch in this way is acceptable due to the self contained nature of the branch and the one train method of operation.

The Class 139 vehicle is not compliant to Railway Group Standards for compatibility with other Network Rail infrastructure. It is not compliant with standards for interoperability with other heavy rail vehicles. The personnel who operate the service are trained and assessed in accordance with only the relevant operating criteria for the branch line and rolling stock which complies with Railway Group Standards and the Safety Management System for this branch line operation.

Figure C.1
Photograph of a Class 139 approaching Stourbridge Junction

Appendix D – Community rail case studies

Devon and Cornwall Community Rail Partnership case study

The Devon and Cornwall Rail Partnership is a Community Rail Partnership (CRP) which consists of six community rail lines, all of which were granted designated status by the Department for Transport (DfT) by September 2006.

The CRP has existed in Devon and Cornwall since 1991. Its remit covers six routes across both counties:

- 'The Tarka Line' Exeter to Barnstaple
- 'The Tamar Valley Line' Plymouth to Gunnislake
- 'The Looe Valley Line' Liskeard to Looe
- 'The Atlantic Coast Line' Par to Newquay
- 'The Maritime Line' Truro to Falmouth
- 'The St Ives Bay Line' Penzance to St Ives.

The six lines can be seen in Figure D.1, which shows those designated community rail lines and services that form the wider CRP.

The Partnership comprises the counties, the train operator First Great Western, local government and the University of Plymouth. The CRP has a small team with two full time staff, one part time member of staff and volunteers. It is part funded by the franchisee.

The aims of the Devon and Cornwall CRP include:

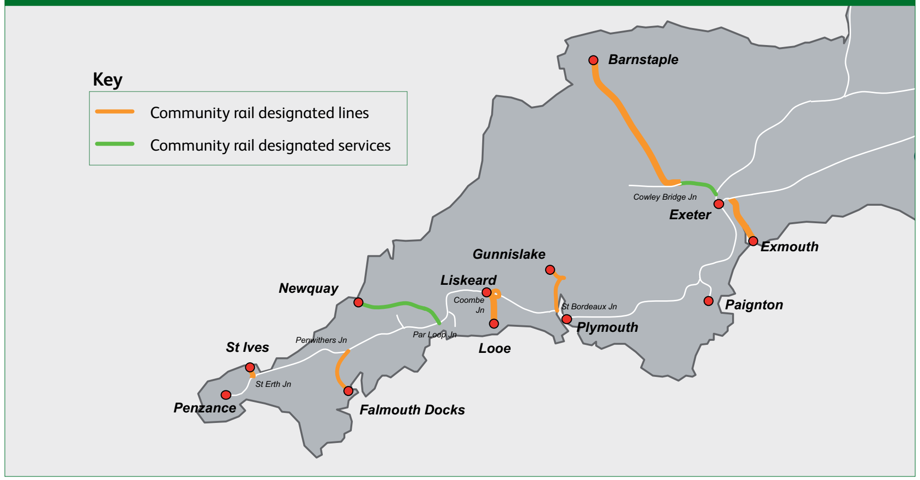
- increasing passenger numbers
- seeking improvements to the railway
- boosting the local economy
- linking the community to the railway.

Devon and Cornwall Community Rail Partnership activities

In order to achieve its aims, the CRP has undertaken activities which have focused on the following areas

- marketing
- fares and retailing
- service development
- volunteering.

Figure D.1 - Map of the Devon and Cornwall Community Rail Partnership routes



The Devon and Cornwall CRP has been active in introducing new ticket and retailing opportunities on the lines under their stewardship. It has also helped provide ticketing services on the Looe Valley Line in the height of summer. In order to increase the attractiveness of rail as a mode of transport, the CRP has worked to improve car parking facilities at six stations across all lines.

The Partnership has also been involved in developing train services. On the Barnstaple branch, the CRP undertook research and concluded that the wishes of the local community for journey time improvements outweighed the need for all services to call at all stations on the branch.

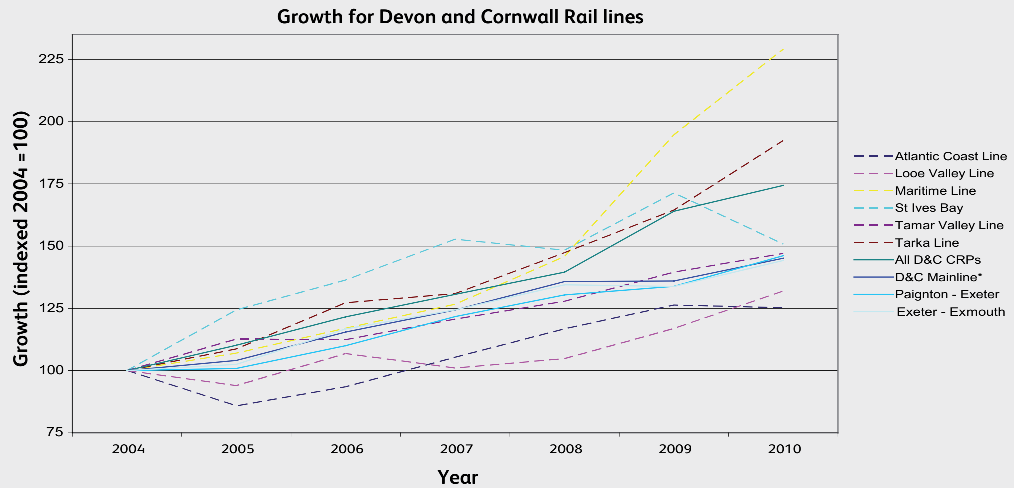
Services at the lightly used Portsmouth Arms station were reduced from seven to five a day from 2004. The time saved by excluding the station call resulted in journey time savings between Exeter St Davids and Barnstaple. The CRP, in consultation with the community and the train operator, was able to negotiate an increase in ticket prices in order to fund improved services.

The CRP has facilitated station adoptions and encouraged volunteering on the lines. Stations on the Tarka Line have volunteer groups, and 12 other stations are regularly maintained by the local community. Students from local universities regularly visit other stations to volunteer. This has resulted in the environment at a number of stations being improved significantly.

Devon and Cornwall Community Rail Partnership changes in passenger demand

The CRP's remit specifically aims to increase passenger numbers. Since 2004, the Devon and Cornwall community rail lines have been growing faster than the non community rail lines in the region. Overall, four of the six lines have outperformed the mainline and other regional branch lines in terms of growth. The relative growth in rail passenger demand is shown in Figure D.2.

Figure D.2 – Devon and Cornwall Community Rail Partnership line specific growth 2004-5 to 2010-11 (indexed to 2004-5)



*D&C Mainline – Devon and Cornwall Mainline services Penzance to Exeter and onwards to Bristol and London

Source: Devon and Cornwall Community Rail Partnership

A key driver of the strong CRP growth has been the increase in demand on the Maritime and the Tarka Lines, which are the busiest. The St Ives branch has also seen service improvements. The community partnership has been directly involved in many of these changes.

The Devon and Cornwall CRP has been particularly active in the area of ticketing and retailing. In 2004 'Ranger' tickets were introduced at St Ives, St Erth, Carbis Bay and Lelant Saltings with a standard £4 fare for all local journeys. In 2005, the partnership introduced the concept of 'Carnets' where tickets are sold as a group of single tickets in advance from local shops in the community. This was introduced on the Tamar Valley Line and the Tarka Lines in response to falling passenger numbers. The CRP found that this concept was particularly useful in areas where the local station had no ticket office. On the Tamar Valley Line 20 per cent of all journeys are now undertaken using carnet tickets

The impact of the additional marketing and station improvements are ongoing activities. They did not present themselves clearly in this data.

The partnership is actively marketing the routes that it covers. This includes a website, leafleting and advertising aimed at local residents, visitors to the area and the tourist industry. Marketing has been targeted on specific lines to reach target audiences.

Since the introduction of the Carnet tickets, the decline in growth on the Tamar Valley Line has been reversed. Demand is growing at a similar rate to the other lines in the region. Research suggests that passengers value the ability to buy tickets before travel from retail facilities. Therefore, it is reasonable to assume that these activities would have contributed to growth. The tickets are now used by 17.6 per cent of travellers on the line, despite no longer being sold at a discount to season tickets.

Northern Rail – community rail case study

Since commencing their franchise in 2004, Northern Rail have worked to encourage the development of Community Rail Partnerships within their operating area. There are currently 18 formal Community Rail organisations on Northern Rail's network across the North of England. A number of informal partnerships also exist, some of which are working towards formal Community Rail designation of lines or services.

Many of the 'Community Rail' organisations Northern Rail work with are not confined to Community Rail routes or services. Principles that have been developed on designated lines and services have been applied across the Northern Rail network. This includes the development of 'station adoption'. Station adoption takes place at varying levels as follows:

- 1st level – Station Adopter who will review and report back on the condition of the station waiting facilities, notice boards, etc and whether any repairs are required, in return for which they receive travel benefits from Northern Rail
- 2nd level – More formal Station Adoption by community groups to develop and look after station facilities, notice boards, planters, gardens etc, beyond that which would normally be provided by the rail industry
- 3rd level – Corporate adoption of station facilities by local companies.

There are a large number of level 1 and 2 station adoptions across the network. Take up of the 3rd level has yet to develop. Level 2 station adoptions are particularly strong around Greater Manchester where support has been forthcoming from Transport for Greater Manchester. This level of support for the stations provides the opportunity for Northern Rail to monitor the condition of assets and respond quickly where required. At a higher level, it enables Northern Rail to work much more closely with the community to improve the quality of the waiting environment for rail passengers.

Mid Cheshire Community Rail Partnership

An example of the work of Community Rail groups in the North is the Mid Cheshire Community Rail Partnership. The partnership was formed in 2004. It is made up of local authorities on the route, Transport for Greater Manchester, town and parish councils, Mid Cheshire Rail Users Association and the Forestry Commission. The services on the line were 'designated' as a Community Rail Service on 18 January 2012.

The Partnership has four key aims. These are: to work with the member organisations to improve the service, to promote and market the line, to improve stations, and to increase levels of community involvement. To fulfil these aims a diversity of activities have been undertaken. Initiatives include the promotion of Mid Cheshire attractions accessible by train through a rail walks booklet and Scenic Britain by Train publications, awareness raising exercises at community events, preparation of digital publicity material including social media such as YouTube, on train events such as a family ghost train, the heritage train and music trains.

The Partnership works with numerous local companies to use the time available through corporate social responsibility programmes to complete station garden and renovation projects. This has seen staff from Barclays Bank completing work on the Mid Cheshire Line while staff from Veolia Environmental Services have undertaken repainting and planting works at Ellesmere Port to create an improved station environment. As well as this work at stations, the Partnership works closely with Northern Rail to report and monitor the progress of station repairs. It encourages communities, schools and residents to become involved at stations. It is planning to create an outdoor art gallery at each of the 16 stations on the line.

The benefit of CRPs can be quantified through the external funding brought in and the number of volunteer hours given. The Mid Cheshire Community Rail Partnership estimates that as a minimum, 600 volunteer hours are given every quarter. This is roughly equivalent to an additional 1½ full time posts working to promote the line and to help develop the service.

Manchester - Clitheroe fares changes

The Clitheroe Line Development Group (CLDG) was formed in 2002 to market additional services which were introduced to the line in June of that year. A successful bid had been made to the Strategic Rail Authority (SRA) for funding to provide a year round hourly Sunday service between Manchester and Clitheroe, along with other minor service improvements. However, the additional services were due to cease following the expiry of their funding in 2007.

The formal designation of the Manchester to Clitheroe route as a Community Rail Service by the DfT on 27 March 2007 brought the opportunity to seek an innovative way to secure the future of the service. Designation allowed the CRP to examine new ways to develop the service and experiment with initiatives that would be difficult to achieve within the normal railway industry framework.

The first major challenge for the CRP was to seek a way to secure the future of the Sunday services. Surveys were carried out which showed they were very popular and seen as an integral part of the overall service package. Their loss would impact on usage of the service on other days of the week. The issue was discussed with Northern Rail and it was proposed to assess whether revisions to the fares package could generate sufficient additional revenue to provide the support required for the Sunday service. A fare yield analysis showed that by a series of fare adjustments could produce sufficient revenue.

This change needed agreement from the DfT as it required a derogation from the incremental revenue share agreement contained in Northern Rail's Franchise Agreement. The Community Rail line designation was a significant factor in securing this agreement. The DfT accepted that in this case a fare adjustment was an innovative way to secure the Sunday services and agreed to the proposed changes.

The final package agreed with Northern Rail was as follows:

- from May 2007 fares on the line were increased by one per cent with this being predicated to cover the funding gap for the Sunday services for the remainder of the Northern Rail franchise
- other fare adjustments were made including the ending of most Cheap Day Returns and Cheap Evening Returns on the line. Although minor, they also had the benefit of simplifying the fare structure as the difference between Standard Day and Cheap Day single and return tickets was minimal
- to make sure that the full additional revenue was predicated to fund the Sunday services, the CRP and Northern Rail obtained agreement from the DfT to a derogation from the Incremental Revenue share arrangements in the Franchise Agreement.

Esk Valley passenger information

Northern Rail operates trains across a large part of the network and uses a variety of often old systems to disseminate passenger information. Northern Rail wished to improve passenger information. It approached the Esk Valley Rail Development Company with a plan to use the Esk Valley Line as a pilot for using Global Positioning System (GPS) satellite and 3G mobile phone technology to deliver passenger information to stations on the route.

The Esk Valley Railway Development Company (EVRDC), set up in 2003 to promote the Esk Valley Railway, has given financial support to contribute towards some of the costs of implementing the new technology.

The GPS and 3G technology has proved to be a reliable method of providing information to passengers. It is particularly useful when a ticket office is closed, or when there is a disruption to the services, and to give general reassurance of the service pattern. It is also used to provide information on the timetabled arrival and departures of the heritage services on the North Yorkshire Moors Railway.

For the Esk Valley Line, the information system is absolutely essential to encourage customer loyalty. The details it provides are important for all passengers and particularly for school traffic which provides much of the demand for the services. The EVRDC is keen for further schemes to be introduced across the Northern network to other lines with limited service provision. Northern Rail are interested in developing a similar scheme on the Cumbrian coast line.

Preston-Ormskirk Line - community rail line designation case study

The Preston to Ormskirk Line is a 15 mile branch with 12 trains a day Monday to Saturday. The current timetable is irregular and the West of Lancashire Community Rail Partnership (CRP), along with Lancashire County Council and West Lancashire Borough Council, has the improvement of the service as a key objective. Ideally the partnership would like to see a standard service pattern introduced, in common with most Northern Rail services operating in Lancashire.

The West of Lancashire CRP was the first CRP to be established in Lancashire and brings together a range of partners including the County Council, West Lancashire Borough Council, Sefton Metropolitan Borough Council (MBC), Wigan MBC, Transport for Greater Manchester, Merseytravel, Northern Rail, Network Rail and Ormskirk Preston Southport Travellers' Association (OPSTA).

Objectives of the CRP

A key issue for the CRP is the low level of passenger traffic using the line as illustrated by Table D.1. As can be seen over the five years to 2010-11 the number of passengers using the service has increased by a very modest 6,000 or just three per cent. This is lower than for other regional services operating in Lancashire or nationally.

Market research into passenger needs

As a prelude to seeking the formal designation of the line the West of Lancashire CRP commissioned detailed market research in 2009. The main aim was to determine what the issues were for passengers and whether formal designation could add value to those aspirations. Following face to face interviews with passengers the report concluded that 'The frequency of the train service was not only a main source of customer dissatisfaction it was rated as the highest priority for improvement – by a significant margin' (source: 2009 market research commissioned by the CRP). The study highlighted that whilst there were other issues that passengers wanted to be addressed, the timetable was the significant factor affecting their perception of the service and its usefulness.

Table D.1 – Preston to Ormskirk Line annual passenger journeys 2006-7 to 2011-12 (source: Lancashire County Council)

Year	Journeys	Annual growth
2006-07	192,990	
2007-08	185,983	-4%
2008-09	194,887	5%
2009-10	188,070	-3%
2010-11	199,011	6%
2011-12	216,327	8.5%

The opportunity

The Lancashire and Cumbria RUS in August 2008 presented a series of options for the Preston to Ormskirk Line. The recommended option was line speed improvement to enable an hourly service to be introduced. The option involves the removal of a passing loop. Whilst this might appear counter intuitive, the time savings associated with not entering and leaving the loop, along with other measures, will enable a reduction in journey time. While this had the disadvantage of reducing the flexibility of the line, the RUS concluded that this scheme should be taken forward. The County Council, along with the West of Lancashire CRP, also supported the option.

Line speed improvements should enable a regular timetable to be introduced. A key issue for the CRP is whether this will result in an increase in the quantum of services. Northern Rail were willing to see what could be done to improve the existing timetable but wanted to do this on the understanding that the CRP would seek the formal designation of the line.

DfT community rail line designation

Following the Lancashire and Cumbria RUS, the West of Lancashire CRP saw the formal community rail designation of the line as a further way to make sure the industry focuses on the line.

Designation has taken some time to achieve. One of the CRP's constituents, OPSTA, objected to the designation because of the perception that it would bring a focus on incremental and short term measures, rather than the more significant infrastructure improvements the group sought. Only after a series of meetings and a ballot of OPSTA members was sufficient common ground established to enable OPSTA to withdraw its objection to designation. Designation was formally announced at the Community Rail Awards held in Sheffield on 23 September 2011.

The Route Prospectus includes a section unique to the line: 'Unlike earlier designations, it is intended to actively change the route capacity to reduce the costs of operation in order to improve the service and the long term viability of the route' (source: Preston to Ormskirk Route Prospectus, 2011).

Conclusion

Designation of the Preston to Ormskirk Line will bring benefits to the local CRP as it pursues its objectives through:

- working with industry partners to see if a standard pattern timetable can be introduced and pursuing its implementation
- using the formal Community Rail designation to speed up the introduction of revised timetables for the line and develop a funded marketing strategy for it
- working with Northern Rail to develop a robust business case for the enhancement of the service once line speed improvements have taken place
- managing the expectations of stakeholders so that they continue to support the changes.

Urban Community Rail Partnership (CRP) – Severnside CRP

Introduction

The purpose of this case study is to illustrate the typical activities undertaken and the challenges faced by community rail partnerships in an urban environment. For this purpose the Severnside Community Rail Partnership which covers routes radiating out of Bristol Temple Meads is used as the case study.

CRP background

The Severnside CRP was formed in 2004. It was the first largely urban CRP. The main aim of the partnership is to identify and implement interventions to encourage the use of local rail services radiating from Bristol, and making sure that local station access is easy and that stations offer a safe and welcoming environment. The coverage of the CRP from Bristol is bounded by Gloucester, Bath/Freshford, Weston-Super-Mare, Taunton and Severn Beach/Avonmouth.

The partnership's running costs are funded by a grant from First Great Western and five local authorities. Projects are funded separately, including from commission on scholar season ticket sales.

Challenges faced by an urban CRP

The CRP has been faced with challenges typical to any urban CRP. These include issues around unstaffed local stations which were considered as being unwelcoming and potentially unsafe locations. Problems included:

- stations as crime hotspots (including drug dealing)
- meeting places for local youths
- tired, overgrown foliage and a maintenance backlog
- existing buildings were a target for graffiti.

Such problems constituted substantial challenges for the CRP and rail industry to tackle.

Strategy

The CRP has sought to address the challenges and encourage greater rail travel usage by undertaking various initiatives. The Severnside Community Stations Programme encompassed:

- involving the local community in their station
- developing station work plans and priorities with First Great Western and Network Rail and with strong support from the British Transport Police
- 'heavier' work undertaken by offenders as part of the Community Payback Scheme
- engagement with local schools and community groups.

The CRP has been working with the Probation Service as part of the national Community Payback Scheme. Activities undertaken as part of the scheme include gardening, removal of litter and debris and basic painting and maintenance (both indoors and outdoors). This does not replace the TOC's requirement to maintain the station.

Specific improvement projects overseen by the CRP are summarised in Table D.2.

Table D.2. – Schemes overseen by Severnside CRP

Location	Scheme detail
Bedminster	A substantial community backed improvement scheme, including new artwork, subway lighting, CIS, CCTV, platform improvements, notice board and garden
Clifton Down and Redland	School artwork
Montpelier	Graffiti art
Patchway	Creation of a new station garden
Stapleton Road	Disused track bed transformed into a community garden centre
Weston Milton	School gardening

Initiatives to encourage greater rail usage have been diverse and are summarised in Table D.3.

Summary

The Severnside CRP shows that through constructive partnership between the local community, local government and the rail industry, urban challenges can be addressed and rail travel usage increased.

This is reflected by patronage figures for the Severn Beach Community Rail Line which over the last 5 years (2008-2012) has grown by over 100 per cent.

Table D.3. – Strategies to encourage greater rail usage

Intervention	Strategy
Marketing	Develop a dedicated Severn Beach Line web site
	Work with the Heart of Wessex Rail Partnership to promote the Heart of Wessex Day Ranger ticket which covers the Severn Beach Line
Patronage	Worked with Friends of Suburban Bristol Railways on a summer weekday count of passengers using the Severn Beach Line and on various promotional activities
Travel planning	Work with employers on the north Bristol area to encourage rail commuting via Bristol Parkway or Filton Abbey Wood
	Encourage scholars to use the train by promoting and issuing on behalf of First Great Western scholar season tickets for the Severn Beach Line and to schools and colleges throughout the area

Appendix E – Community rail line infrastructure enhancement case studies

Figure E.1
Harrington Hump at Harrington station

Harrington Hump – low cost accessibility improvements

Introduction

The purpose of this case study is to showcase a low cost alternative solution to improving accessibility to trains at stations with low platforms and therefore sizeable stepping distances. Additionally this case study highlights how a partnership approach between different rail industry parties, railway industry stakeholders and the construction industry has helped to deliver a tangible, sustainable, low-cost and long term infrastructure solution.

Scheme background

In 2007, Cumbria County Council, DfT, Northern Rail and Network Rail joined forces to develop an innovative low cost accessibility solution to raising platform heights and reducing the stepping distance between platforms and rolling stock. It was agreed that any innovative system would need to possess the following:

- safe and providing standard height access to the train
- low cost
- not require possession access to be installed
- capable of assembly without using large power tools
- capable of being used across the network
- long design life (50 years)
- meeting network standards or provide justification for variation
- capable of installation over a short time period by a small team.

The innovative system for raising platform height was developed for and trialled at Harrington on the Cumbrian Coast Line. Consequently it is known as the 'Harrington Hump'.

Technical features

The hump is made of glass reinforced polymer and is designed in sections which are able to be built to any specific length. It is variable in height and length, so will fit with any platform, irrespective of how large the stepping distance or how long the train. The hump is equipped with ramps which make it fully accessible to all users.

Costs and Implementation

Harrington is a small village; its station is not heavily used and would not qualify for conventional funding sources. Platform raising for stations such as Harrington would typically cost approximately £250,000 per platform and would almost certainly require a closure during installation.

The development costs for the alternative solution, funded by Network Rail, DfT and Cumbria County Council, were approximately £60,000. Future production costs could be as little as £25,000 per installation. This is only a tenth of the cost of a typical platform rebuilding scheme. Such potential cost savings highlight the value of the low cost alternative solution. The hump took just over 12 months from initial concept development to introduction into service and was brought into service on 15 December 2008. Figure E.1 shows the Harrington Hump in situ.

Future application

Since the initial trial installation in 2008 at Harrington, other stations on the network to adopt the Harrington Hump include Aberdovey, Northwich and Seascale and St Albans Abbey. It is considered that this low-cost intervention could be applied to more than 300 platforms at stations across the network. In 2011, as part of the Department for Transport Access for All Mid-Tier bidding competition, £5 million was awarded to Network Rail to develop the Harrington Hump concept at a further 100 platforms across the network.

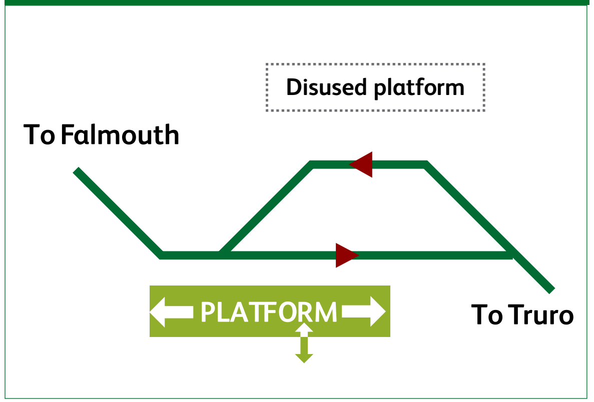
Conclusions

This case study shows that through close partnership working between the railway industry, stakeholders and external industry innovative and cost effective solutions can be delivered. The potential financial benefits and cost savings that can be accrued from implementation of the Harrington Hump are significant;. There is a potential of saving up to 90 per cent of the cost of a conventional platform rebuilding scheme.

The potential for widespread application of the Harrington Hump at more than 300 platforms across the network illustrates the long term impact that this alternative solution could have in addressing an inherent railway infrastructure challenge.

Figure E.2 Maritime Line

Figure E.3. – Penryn passing loopPartnership routes



Maritime Line - Penryn station innovative passing loop

Introduction

At Penryn station in Cornwall, on the Truro – Falmouth Docks (Maritime Line) community rail line, an innovative infrastructure upgrade solution has been developed to enable a doubling of train frequency from 13 to 29 trains per day (Monday to Saturday) to meet passenger demand. Since May 2009, a half hourly service frequency has been provided. Previously, service intervals were as much as two hourly.

Options considered

A number of options were initially considered by Network Rail to enhance service frequency on the line. Following a study in 2005 two options were shortlisted for further consideration:

- Option A: Passing loop at Penryn station – extending the existing platform to provide standage for two trains
- Option B: Passing loop at Penryn station – provision of two platforms at Penryn Station bringing the disused platform back into operational use.

Option B was a conventional solution costing approximately £9 million. It involved the reinstatement of the disused platform, with a new Disability Discrimination Act (DDA) compliant footbridge. Extensive vegetation clearance and repairs to the existing disused platform were needed. Additionally, bank stabilisation and additional trackwork might have been required.

Option A was an alternative solution costing £1 million less than option B. It allowed both Up and Down trains to call at a single face extended platform by installing a loop commencing half way along the platform. The total platform length would be 202m long with a middle section of approximately 60m adjacent to the new platform of the loop not being useable for passenger access to a train. The operation would see a northbound train arrive first and wait at the northern end of a platform (adjacent to the loop).

A southbound train would call via the new loop, passing the stationary northbound train and cross to the southern section of the extended platform.

The choice of Option A as the preferred option was as a result of it being a lower cost option which afforded the same operational benefits as Option B. The key cost differentials were the removal of the need to install a DDA compliant footbridge and reinstate a disused platform.

In addition to the infrastructure upgrade adjacent to Penryn station, the station has seen a number of enhancements to cater for additional traffic. This has included new platform surfaces, waiting shelters, a ramp access and a new car park.

Funding sources

The service frequency enhancement was made possible by the provision of the new passing loop and associated signalling at Penryn costing £7.8 million. The scheme was led by Cornwall Council. Cornwall Council contributed £2.5 million, the European Regional Development Fund (ERDF) provided £4.7 million, and support from Network Rail (£600,000) and from First Great Western.

Conclusions

Use of the line has more than doubled since the passing loop was installed and the train service improvements introduced. The Maritime Line ended 2012 on 613,058 journeys, up 6.3% on 2011 and more than double the 293,026 journeys seen in 2008, the year before the improved service was introduced.

The Maritime Line case study demonstrates a relatively 'low cost' alternative solution to increasing service frequency on a predominantly single track community rail line. Securing funding from a diversity of funding streams and partnership between third parties and the railway industry were key to the success of this initiative. Its wider application would potentially be feasible on other lines with a low service frequency.

Appendix F – Bus rapid transit and guided bus case study

Case study 1: South East Hampshire (Fareham – Gosport) Bus Rapid Transit system

Case study aims

The case study provides a synopsis of the rationale behind the decision by Hampshire County Council to develop a bus rapid transit scheme between Fareham and Gosport.

As has been explained in Chapter 4 of this document the purpose of considering this case study of bus rapid transit is restricted to its use of a former heavy rail alignment between Fareham and Gosport. It is in this limited context of reopening a former rail route that the case study is presented.

Scheme background

The passenger rail connection to Gosport was closed in 1953 leaving the Gosport peninsular reliant upon the A32 as a transport link. During the 1990s, proposals were put forward to use the old railway line to develop a tram line from Fareham via Gosport and onwards to Portsmouth, known as the South Hampshire Light Rapid Transit Scheme.

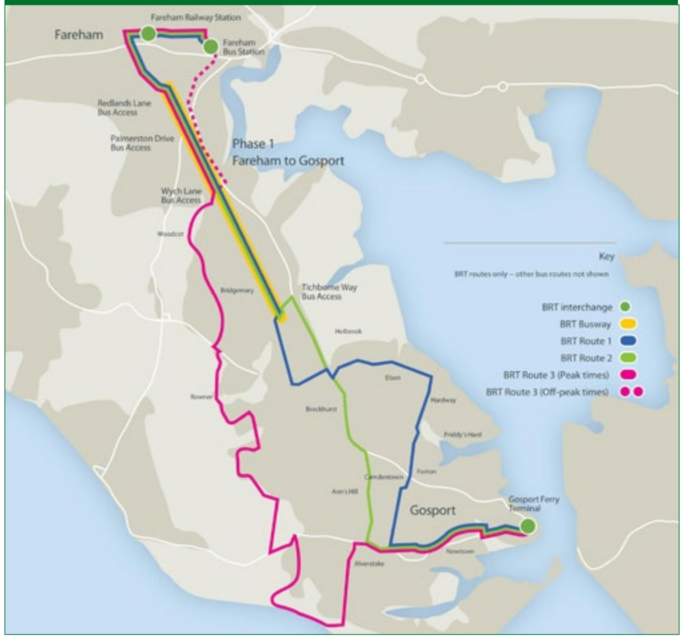
In 2004 central government refused the funding for the scheme. As a consequence, attention was refocussed on developing a smaller scheme to address transport issues across the Gosport peninsular. In 2009, a £20 million government grant was offered for part of the railway alignment to be converted for operation by bus rapid transit.

Introduction to the network

The South East Hampshire Bus Rapid Transit (BRT) system operates between Fareham and Gosport (see Figure F.1) with 3.4 kilometres of dedicated segregated busway which opened in April 2012. The dedicated busway section has been built on a section of former railway line.

Service frequency across the network is high frequency, typically every seven to ten minutes (Monday-Saturday) and at 15 to 20 minute intervals in the evening and on Sundays. Access to the section of dedicated busway is restricted to buses and emergency service vehicles only.

Figure F.1: South East Hampshire Bus Rapid Transit network (source: Hampshire County Council)



Gaps in meeting passenger demand (existing and longer term)

At an early stage in the development of the scheme, a number of gaps were identified in public transport service provision across the Fareham-Gosport peninsula. Consequentially, these represented defined scheme objectives which formed the Community Infrastructure Fund (CIF) bid. The Community Infrastructure Fund supports transport schemes that would promote new housing and community growth.

These are summarised in Table F.1 which outlines the individual scheme objectives and some contextual background to each of the individual objectives.

Table F.1 – South East Hampshire BRT scheme objectives and contextual background*

Scheme objective	Contextual details
1. To improve access to future and existing employment sites by public transport.	Improve access to major employment areas, primarily North Fareham and Gosport Waterfront. Improvements to be measured in relation to journey time enhancements for public transport users and the proportion of population experiencing the journey time improvements.
2. To improve access to public health services at both local and sub-regional levels by public transport.	Improve access to local health facilities. Improvements to be measured in relation to journey time enhancements for public transport users and the proportion of population experiencing the journey time improvements.
3. To improve public transport access to tertiary education by public transport.	Make sure that all students can arrive at tertiary education establishments before their start times, usually 09:00.
4. To improve public transport access to and from the North Fareham Strategic Development Area (SDA) to local employment, education and health services.	Improve journey times to and from the SDA location.
5. To improve the overall quality of public transport provision.	Improve public transport service provision quality by enhanced vehicle quality, integrated ticketing provision, real time information, improved bus stop environments, ease of interchange, marketing, safety and security. The objective will be measured against qualitative user surveys highlighting user changes in perception concerning service quality (both public transport and non public transport users) and patronage data from the key bus operator.
6. To assist in meeting the requirements of the Air Quality Management Areas (AQMAs) Plans.	Assist in reductions of NOx levels, in line with the targets and timescales outlined within the AQMA plans.

***Source:** Hampshire County Council (2008): South East Hampshire Bus Rapid Transit – Phase 1 Fareham – Gosport, Community Infrastructure Fund 2: Full Business Case Submission – Volume 1.

Option development and appraisal

During the option development and appraisal process, a diversity of public transport base options were considered, which would enhance travel choices within the South East Hampshire sub-region. These are summarised in Table F.2. The shortlisted options (Quality Bus Partnerships (QBP), on-street bus priority and off-street bus corridor) were subsequently evaluated against the scheme objectives.

Table F.2 – South East Hampshire BRT scheme objectives and contextual background*

Option	Public transport intervention	Intervention proposal	Shortlisted (yes/no)	Reason(s) for option being discounted
O1	Improved conventional bus services	Development of QBPs and interlinked improvements in service standards.	Yes	
O2	On-street bus priority	Priority measures at or on the approaches to junctions, combined with bus lanes.	Yes	
O3	Guided buses	Buses steered on a majority of/or the entire route, by external means, normally on a dedicated track. All other traffic is excluded, enabling maintenance of reliable schedules. Some on-street running would be required.	No	Deliverability – cost and risk
O4	Trolley buses	Electric power buses by overhead wires on-street.	No	Deliverability – cost and risk
O5	Trams/Light-Rapid Transit	Urban rail transportation using electric rail cars operating primarily or mostly on routes separated from all other traffic.	No	Deliverability – cost and risk
O6	Heavy Rail	Connection to the national railway network.	No	Deliverability – cost and risk

Source: Hampshire County Council (2008): South East Hampshire Bus Rapid Transit – Phase 1 Fareham – Gosport, Community Infrastructure Fund 2: Full Business Case Submission – Volume 1

The conclusions of the evaluation were:

- on-street bus priority scored better against the scheme objectives when compared against a QBP alone
- off-street bus priority affords significant possibility for enhanced access, an improved public transport image and reduction in traffic flows on existing routes
- on street bus priority can provide similar benefits to off-street running, but at a lower cost level due to the constraints and limitations on the existing road network
- in practice, a comprehensive off-street bus priority area wide network would be unfeasible. Therefore an off-street bus corridor option would need to be supplemented with on-street bus priority measures to achieve a comprehensive area-wide network.

During the CIF bid process, the Fareham – Gosport peninsula was deemed an early priority. Off-street bus corridor measures were seen as the option likely to more fully fulfil the scheme objectives and consequentially stimulate a step change in public transport service provision in the peninsula. Therefore, it was concluded that an off-road busway, along the disused railway corridor was the preferred option for the CIF bid.

Scheme implementation

Implementation

The main element of construction encompassed the conversion of 3.4 kilometres of disused railway line between Redlands Lane in Fareham and Tichborne Way in Gosport. The core activities included:

- installation of environmental measures to mitigate the impact upon existing ecology near to/on the route
- site clearance and where necessary, track removal
- earthworks:
  - removal of existing track ballast material which was unsuitable for re-use within the scheme
  - lowering of the disused rail corridor at junctions, to join with adjacent roads
- demolition of existing structures where necessary
- statutory service works – diversions and protection works of water and gas mains, to accommodate the BRT
- drainage and ducting – provision of new surface water drainage and plastic ducting
- new structures where appropriate
- busway construction – provision of busway carriageways and footways, bus platforms, CCTV provision, new bus shelters and new traffic signals at selected interchanges.

Funding

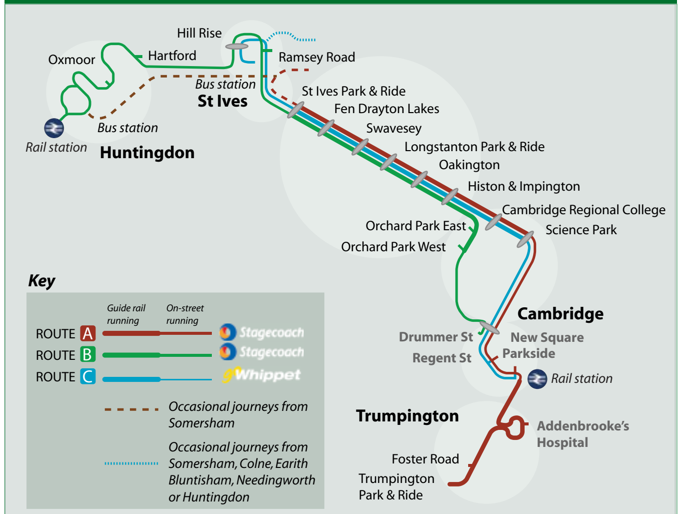
Funding requirement for the scheme was £24 million, with £20 million from the Government's CIF, and £4 million from Hampshire County Council's capital programme.

Conclusions

At this stage, it is too early to provide any definitive conclusions as to the performance of the new BRT. However, as stated in the original business case, there are a number of key determinants of the scheme which were:

- distribution and equity: the impact of the busway would be neutral in that it would not disadvantage any specific areas or communities
- affordability and financial sustainability: the scheme demonstrated both affordability and financial sustainability via CIF funding, availability of resources from Hampshire County Council and investment by the major bus operator
- practicality and public acceptability: the scheme represented a practical proposal and had local Council Executive Member political support.

Figure F.2 – Cambridgeshire Guided Busway network overview (source: Cambridgeshire County Council)



Case study 2: Cambridgeshire Guided Busway

Case study aims

The purpose of this case study is to provide an overview of the rationale behind the decision by Cambridgeshire County Council to develop a guided busway between Huntingdon, St Ives and Trumpington via Cambridge city centre.

As with the South Hampshire example the guided busway in Cambridge uses a former rail line and options were considered for both light and heavy rail services on the same alignment as some of the guided busway sections.

Introduction to the network

The guided bus network opened in August 2011 and operates between Huntingdon, St Ives, central Cambridge, Cambridge railway station and Trumpington. The guided busway sections operate in two sections, from St Ives Park and Ride to Cambridge Science Park, a distance of 12 miles.

The second section is between Trumpington Park and Ride and Cambridge railway station to Addenbrooke's Hospital, a distance of four miles. Figure F.2 shows an overview of the network.

The guided busway has two bus operators serving the network, Stagecoach and Whippet Coaches. Stagecoach operates services on Route A between St Ives and Addenbrooke's and Trumpington. Route B is operated also by Stagecoach between Huntingdon and Cambridge using the northern busway from St Ives. Whippet Coaches operates Route C services from St Ives.

Operators pay the council an access charge to use the busway between 07:00 and 19:00, Mondays to Saturdays. The charge is not applied at other times, in order to encourage operators to run services at less busy times of the day. The charge consists of two elements, a flat entry fee and a mileage fee. This covers costs such as staff wages and maintenance of the system.

Ticketing on the system sees several options, including specific operator day passes. Inter-operator ticketing has been difficult to achieve, due to the need to allocate revenue between the operators. However, Cambridgeshire County Council has developed a smartcard that is based on carnets of tickets.

Ten trip carnet tickets are sold for use on all operators which can be purchased online and topped up by the driver. Ticket machines are provided at all stops and drivers will not sell tickets at stops on the guideway. This minimises dwell time at individual stops on the guideway.

On sections of the network with guide rails, a parallel bridleway and cycle route is provided. This improves accessibility for pedestrians, cyclists and horse riders.

Gaps in meeting passenger demand (existing and longer term)

In developing the case for the guided busway, a number of 'gaps' in transport infrastructure/service provision were identified within the Cambridgeshire Sub-Region (A14 Cambridge-Huntingdon corridor), initially by the Cambridge to Huntingdon Multi Modal study (CHUMMS). CHUMMS was one of a series of multimodal transport studies requested by the Department for Transport, Local Government and the Regions. These studies were as a result of a review of the Trunk Roads programme that was undertaken in 1998 in 'A New Deal for Trunk Roads in England.' The CHUMMS report was published in 2000.

CHUMMS recommended a comprehensive package of interventions, which included the upgrading of the A14 core trunk road, between Cambridge and Huntingdon, demand management and creation of a rapid transit system. The CHUMMS report and Cambridgeshire County Council Local Transport Plan (LTP 1) identified several key transport gaps, which are summarised in Table F.3.

Any intervention that would be adopted would need not only to mitigate or solve issues at a Sub-Region level across the corridor but also demonstrate applicability in meeting transport policy objectives at a national and local level.

Option development and appraisal

The Cambridgeshire County Council Local Transport Plan (LTP 1) Annual Progress Report 2002 provided a detailed appraisal of alternative improvements to public transport along the A14 corridor. The purpose of this was to see whether or not any other intervention could offer better value for money than a guided bus system. The two options considered were:

- low cost alternatives which could be implemented using LTP block allocation funding
- higher cost options using light or heavy rail rather than a guided bus.

Details of each of the options appraised are summarised.

Option 1: Low cost alternative
The low cost alternative proposed, consisted of:

- 500 metre bus lane and signal prioritisation measures at the A10/A14 grade separated junction to enhance access to the Science Park area during peak periods
- dedicated 300 metre bus turning lane from the B1050 to the A14 in order to improve access to the A14 for buses leaving Longstanton for Cambridge
- 2.5 kilometre segregated bus lane on the A14 between Oakington and Girton, in the Cambridge direction only, to reduce journey times in the peak, for buses travelling towards Cambridge.

It was concluded that the package of low cost alternative interventions were limited in terms of benefits that they could provide in rectifying the identified subregional transport infrastructure and service provision gaps.

Option 2: light and heavy rail instead of a guided bus
The CHUMMS report considered appraised options for guided bus, and light or heavy rail along the route.

The report concluded that a guided bus system offers greater benefits at a lesser cost than either light or heavy rail.

It avoided a number of shortcomings associated with light or heavy rail such as:

- constraints of a historical city like Cambridge would make it very difficult to accommodate a light rail option within the city centre and impossible for a heavy rail option
- lack of flexibility of routes and network in contrast to a guided bus. Both heavy and light rail are constrained by their fixed infrastructure making it harder to serve communities remote from the line of route.

Table F.3 – Transport Gaps identified in the Cambridge Sub Region by CHUMMS and the Cambridgeshire Local Transport Plan 1 (2001-2006)

Gap	Detail
1. Demand for public transport	Greater pressure placed upon the network as it seeks to serve a more dispersed population.
2. Road network congestion	The A14 is the core road route in the area. Highways Agency statistics showed it to be one of the two most congested dual carriageways in the UK.
3. Imbalance of housing and jobs within the city of Cambridge	An increase in commuting into Cambridge has occurred and consequential increased peak time road congestion has been experienced. A lack of affordable housing in and near to Cambridge has contributed to increased commuting.
4. Increasing levels of car use	An expanding population, economic prosperity and insufficient alternatives to the private car. The Sub-Region has 20% higher levels of car ownership than the national average.
5. Traffic noise and fumes	A specific problem adjacent to the A14.
6. Rat running	Increased numbers of cars travelling through villages has resulted in congestion, pollution and road safety in such villages.
7. A14 and M11 being used as local roads	Motorists using these roads as local roads to access Cambridge.
8. Peak hour congestion	Peak hour congestion blocks the A14 Milton Junction and access to Cambridge Science Park.
9. Social exclusion	Unemployment levels are variable across the Sub-Region.

Selection of the guided bus option as the preferred option
From the appraisal of both the low cost alternatives (highways and traffic management interventions package) and light or heavy rail options the rationale for choosing a guided busway was that:

- the low cost alternative failed to mitigate or resolve the majority of identified transport infrastructure or service problems within the Sub-Region. Consequentially its benefits were deemed to be limited
- overall the low cost alternative would not offer good value for money; any benefits that it might afford could be overshadowed by the disruption it would create and such a package of interventions could only operate on a short term time scale
- the heavy rail/light rail scheme would help to mitigate or resolve many of the identified transport gaps but was seen as significantly more expensive than the guided bus option and afforded lesser overall benefits.

Further significant benefits of adopting a guided busway network include:

- modern vehicles with enhanced ride quality on the guideway sections
- greater journey time reliability because of the segregation from other vehicular traffic
- enhanced waiting areas and onboard facilities
- guiding allows greater ease of access at stops as the bus can get closer to the bus stop
- clear differentiated branding of services and a sense of permanence given by the fixed infrastructure
- creation of new journey opportunities
- introduction of bus and multimodal integrated ticketing
- a safer operational environment, similar to that of light rail or heavy rail due to operating on dedicated and segregated guideway free from other vehicular traffic
- the ability of the driver to drive on sight and respond to obstructions or adverse operational circumstances
- guidance technology to provide a physical fail safe lateral support mechanism
- rubber tyres on concrete which enhances stopping performance in contrast to steel wheels on steel rails of trains
- improved communications and security systems, including a central control room to monitor bus progress via Global Positioning System (GPS).

A public inquiry was held during 2004 into the proposals. The inquiry considered heavy rail, light rail as well as a guided bus only road option. The guided busway scheme was approved by Government in December 2005.

Conclusions

The Cambridgeshire Guided Busway is still relatively new, having opened in August 2011. Almost 225,000 passenger trips were made during the first month of operation and the two bus operators have already had to increase service frequency to meet passenger demand. During the first year of operation 2.5 million trips were undertaken on the busway. This represented 40 per cent above the initial first year forecast.

From the case study, the key determinants for the adoption of a guided busway by Cambridgeshire County Council as a solution to meet present and future demand on the Cambridge – Huntingdon corridor were:

- the strategic benefits of network flexibility and adaptability that a guided busway system offered as opposed to fixed base heavy or light rail options neither of which could effectively penetrate the city centre
- the greater value for money and consequential associated benefits that a guided busway system afforded
- the ability of a guided busway system option to fulfill, Government transport policy objectives to a greater extent than other modal options at both a national and local level (national shared priorities for transport and consequentially Local Transport Plan objective.

Appendix G – St Albans Abbey- Watford Junction: Abbey Line case study

Introduction

The purpose of this case study is to provide an overview of the options considered by Hertfordshire County Council (HCC) to increase train service frequency on the Abbey Line in a cost effective manner. It identifies a number of general lessons that can be learnt from evaluating different service provision scenarios when considering innovative options.

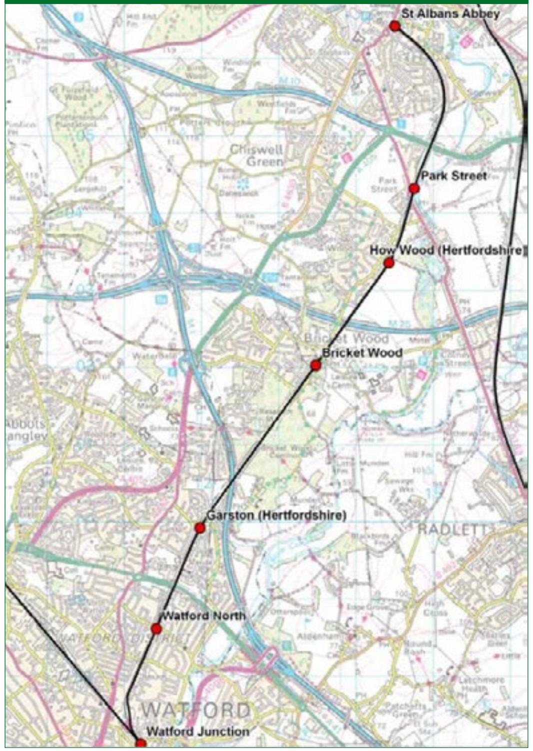
Background

The single track Abbey Line runs 6 ½ miles between Watford Junction and St Albans Abbey, located on the western side of St Albans. Figure G.1 shows a map of the line. The line is electrified with 25kV overhead line electrification.

The service is currently operated using a four-car EMU. The frequency of service is one train every 45 minutes in each direction. There are no freight services operating on the line. The line is currently operationally segregated from the national rail network. There is no opportunity to operate through services to London Euston without extensive upgrading of existing infrastructure. Current depot and stabling arrangements see the unit operating the service stabled remotely and maintained at the franchisee's depots. Since 2005, the line has had an active Community Rail Partnership (CRP), known as the Abbey Line CRP.

The road corridor between St Albans and Watford is severely congested. The proposals are intended to encourage modal shift and allow improved mobility.

Figure G.1 – St Albans Abbey – Watford Junction – Abbey Line route map (Soutce: DfT)



Project objectives

The primary objectives of the project as identified by Hertfordshire County Council were to:

- increase the passenger train service frequency from 45 minute to 30 minute intervals within existing funding constraints
- deliver a long term legacy for users of the Abbey Line.

Wider objectives included:

- continue to provide through ticketing
- pilot a different model of operation (including possible transfer to light rail)
- investigate whether or not this could reduce costs and maintain a robust service and infrastructure
- investigate simplification of the railway system (i.e. reduction in the number of parties interfacing in the management and operation of the line) as the route is largely segregated from the rest of the railway network
- if a light rail solution was adopted, allow for possible future extensions to the line on street
- learn lessons for future schemes which are potentially applicable at similar locations.

Scenarios

Hertfordshire County Council identified and evaluated five options to fulfill the project objectives, ranging from retaining the existing service type to the conversion of the line to a light rail system. Characteristics of each scenario are summarised below.

Scenario 1: Retain the existing heavy rail service and service pattern within the franchise
This proposal envisaged no material change to existing arrangements. It would require no additional funding and meet existing passenger needs. There would be no service improvements.

Scenario 2: Heavy rail service within a renewed franchise but with the requirement to operate an increased frequency
Funding would be required for a passing loop at Bricket Wood, associated infrastructure enhancements and provision of an additional train set and crew to operate a half hourly service. The station facilities at Bricket Wood would need to meet the requirements for disabled access, which in practical terms would mean a substantial bridge and ramps or lifts. Previous studies concluded that the infrastructure upgrade did not provide value for money. The scenario would provide a greater frequency and capacity than is required to meet passenger needs.

Scenario 3: Light rail service with increased frequency within a renewed franchise
This scenario would see the line remain in its current form until the West Midlands franchise is re-let. The new franchise might have an option to increase service frequency by using light rail. A passing loop, a fleet of light rail vehicles and a new depot would be required. The train operating company could sub-contract the service or operate it directly. This scenario could be similar to the operating arrangements for the Stourbridge Town branch line.

Scenario 4: Light rail service with increased frequency as a micro-franchise

The line would be separated from the West Midlands franchise and the DfT would award a microfranchise with a requirement to increase service frequency using light rail. The same infrastructure and rolling stock would be needed as the previous scenario. The line would remain part of the national network and Network Rail would remain infrastructure owner.

Scenario 5: Light rail with increased frequency let as a concession with (a) Network Rail or (b) Hertfordshire County Council as infrastructure manager
The line would be separated from the West Midlands franchise. The county council would tender the operation as a light rail concession. The line would operate externally to the franchised railway, with the county council acting both as fare regulator and contract manager. The same infrastructure and rolling stock would be needed as the previous scenario. Infrastructure maintenance would either remain with Network Rail or be transferred to the county council. The county council could manage the infrastructure or transfer that responsibility to the concession.

The line might cease to be part of Network Rail's regulated asset base. If this occurred, the county council would require a Transport and Works Act Order to acquire powers of operation to operate the railway and to manage the level crossing. The operator could apply to be exempt from licence by the Office of Rail Regulation (ORR) since it would be a light rail operation outside the franchised railway. The ORR would still undertake safety inspections.

Evaluation criteria

The criteria used by Hertfordshire County Council (HCC) for evaluating the scenarios reflected the primary objectives and covered:

- affordability
- project (implementation) complexity
- passenger needs
- local influence
- long term legacy.

1. Affordability

Affordability varied widely across the different scenarios:

- Scenario 1 (no change) required no additional funding
- Scenario 2 (heavy rail with increased frequency) required additional funding for a passing loop and an additional train and staff
- Scenario 3 (light rail within the next franchise) would require subsidy increase but capital and overhead costs could be absorbed in a larger franchise
- Scenario 4 (light rail as a micro franchise) would require additional subsidy to support overhead costs and some capital investment. Management overheads for both the DfT and county council would be incurred. Existing rail systems and costs would be retained
- Scenario 5 (light rail as a concession) involves all overheads for contract management. Assuming the line was no longer part of Network Rail's regulated asset base, long term liabilities for renewals would be the responsibility of the local authority.

2. Project (Implementation) complexity

- Scenario 1 would involve no changes
- Scenario 2 would see Network Rail and the TOC managing implementation applying standard methods
- Scenario 3 would see Network Rail, the TOC and sub-contractor overseeing implementation with a similar approach to the Stourbridge Town branch
- Scenario 4 would be managed by the county council, Network Rail and operator within industry rules
- Scenario 5 could be the most complex, depending upon which party takes responsibility for structures and bridges. Separation of the line from the national rail network could become complicated. The scenario might involve new standards and rules being developed. It would be managed by the county council and additional resources would be required.

3. Passenger needs

All scenarios would meet existing passenger needs. Scenario 1 would not encourage the modal shift required by local authorities to address congestion on the road corridor between Watford and St Albans. The increased frequency with heavy rail scenario (2) could potentially represent provision of over-capacity. The light rail Scenarios (3, 4 and 5) would appear to be a better balance in meeting demand and capacity. All scenarios, with the exception of Scenario 5 (light rail as a concession) would be able to retain through ticketing. Scenario 5 might not permit the provision of all national rail ticket types.

4. Local influence

All scenarios provide a varying degree of local influence. Scenarios 1-3 where jurisdiction of the line remains with the operator and/or infrastructure provider see limited or no change to existing local influence on the line. In contrast, Scenarios 4 and 5 where the county council is directly involved in the management and/or operation of the line see greater local influence in the service provision.

Lessons learnt

1. Economies of scale
In the existing franchise arrangement the branch line's overheads are incorporated into the costs of the wider franchise and so benefit from economies of scale inherent within a larger operation. A much smaller, stand-alone franchise would lose these efficiencies, potentially increasing the cost of the operation of the line. Other more infrequent expenses, for example franchising costs, would also be increased.

Risks concerning bridges and earthworks on the railway are currently borne by Network Rail who are able to generate economies of scale by spreading risk and maintenance costs across the network. For the risks associated with the branch line to be borne separately would increase costs. Network Rail's funding in five year control periods allows it to plan several years ahead while the county council is funded annually. For the council to fund any unforeseen remedial bridge repairs quickly could be extremely difficult and additional central funding might have to be applied for.

2. Revenue allocation
Removal of a branch line from the franchised railway would create difficulty in apportioning revenue currently allocated to the branch line from the main line. If the branch line was separated from the franchised railway, revenue allocation from the main line would no longer be automatic. It would have to be commercially negotiated. It might also not prove possible to maintain through ticketing which would be detrimental to passengers.

3. Project complexity (implementation)

The different options, in particular those to convert to light rail operation involve a number of sources of complexity. These include: the number of parties involved, determining arrangements to remove the line from the franchised railway, making appropriate funding arrangements, retaining through ticketing, ensuring compliance with industry regulatory requirements such as Station Access Agreements, and any changes required in relation to electricity provision and control.

Some of the scenarios could result in complex contractual agreements, require a statutory instrument or a Transport and Works Act Order, involve planning permission risk or the disruption of existing third party leases.

Conclusions

The Abbey Line case study provides an example of where the railway industry and its funders and stakeholders have considered a range of alternative solutions to meet passenger needs.

Where it is proven that a solution has a positive business case, delivering real benefit, then Network Rail and the industry is supportive of such an initiative. The case study highlights the potential range of options that an alternative solution will encompass. This will vary from little or no change to more complex, extensive change.

A number of high level considerations have been identified within the case study which may be relevant when developing and evaluating potential alternative solutions. These relate to financial, commercial, project management, logistical and user needs considerations. They are potentially applicable across the full scope of the RUS scenarios, whether it be community rail, tram train or self powered battery vehicles.

In May 2013, DfT and HCC announced that plans to convert the line to light rail operation have been dropped. They cited that the proposal had turned out to be substantially more complex than initially anticipated and that it would not be feasible to deliver light rail within existing funding streams.

HCC has stated that it is still committed to enhancing service frequency on the line. It will consider whether a case for conversion to light rail can be made if the redevelopment of Watford Junction station and the potential for extension at either end of the line into towns are incorporated into proposals.

Appendix H – Scoping Document Consultation Summary

Table 7.2 – Summary of issues raised by consultees in the Scoping Document consultation phase	
Issue(s) raised	**How issues were dealt with in the Draft for Consultation and/or the final RUS strategy**
1. Tram train	
Broad support for the consideration of tram and tram train conversion of heavy rail infrastructure and services by the Network RUS: Alternative Solutions.	No further action required.
Concerns were expressed regarding tram trains perceived limited application and issue of adapting technology operational in Europe into a British context.	Acknowledged as potential limitations of the alternative solution.
Consultation responses identified aspirations for tram or tram train services in: Aberdeen, Blackpool, Cambridge, Edinburgh, Greater Manchester, Leeds, Nottingham, Sheffield and Walsall.	Acknowledged in final RUS document.
Passenger Transport Executive Group (PTEG) noted that greater recognition of the role of local transport authorities and Local Transport Plans and potential for greater devolution was required within the RUS.	Concerns addressed by working with PTEG, prior to publication of the final RUS strategy.
Freightliner Group Ltd expressed concern that the document suggested tram as opposed to tram train vehicles could be used by requiring freight trains to operate after the last tram or before the first daytime service. It was noted that freight services may originate from rural branches but this is only part of the route. Restricting freight movements could cause greater network congestion and some terminals have planning restrictions, inhibiting overnight operations.	Text within the Draft for Consultation updated to reflect the concerns expressed.
West Yorkshire PTE (Metro) noted that joined up procurement for rolling stock should be considered to reduce cost and bespoke solutions required for adoption of tram train.	Acknowledged as an issue for inclusion in Scoping Document and final RUS strategy.
Angel Trains Ltd believed that implementing tram train may represent an inconsistency with the conclusion of the Network RUS: Rolling Stock RUS which highlighted the increased cost of bespoke rolling stock procurement to the industry.	Acknowledged, but text modified to realise that any alternative solution would need to be of a size to provide economies of scale.
Angel Trains Ltd questioned whether or not street running was required for tram train operation and could it not be separated from the need for a tramway.	The Scoping Document concluded that the conversion of heavy rail infrastructure to a tram or tram train system was most likely to be a viable option when linked to an existing on-street tramway.
Strathclyde Partnership for Transport considered that tram train should be considered as part of a package of local integrated transport improvements in response to local needs.	Acknowledged and reinforced in Draft for Consultation and final RUS strategy.
Several consultation responses commented that electrification costs of light rail are too high and they followed heavy rail trends since they are generally designed by heavy rail engineers. Therefore the full cost saving might not always be realised.	Acknowledged in the Draft for Consultation and final RUS strategy.
Capita Symonds suggested that cost savings may be available by integrating trams and tram trains into the design of new settlements, rather than retrofitting an existing tram system. This should be considered in planning new settlements.	Noted in developing the final RUS strategy.
South Yorkshire PTE and Chartered Institute of Logistics and Transport expressed concern about the lack of information regarding plans to replace older Diesel Multiple Units (DMUs) operated by TOCs. Rolling stock replacement was seen as a main reason for investigating tram trains. The issue should be given greater prominence in the document.	Noted in developing the final RUS strategy.

Table 7.2 – Summary of issues raised by consultees in the Scoping Document consultation phase (Cont.)	
Issue(s) raised	**How issues were dealt with in the Draft for Consultation and/or the final RUS strategy**
2. Innovative electrification	
Broad support for conclusions on innovative electrification.	No further action required.
Consultation responses noted that a watching brief needs to be undertaken on energy storage technology.	Text updated in Draft for Consultation and final RUS strategy to commit to reviewing emerging energy storage technology.
Consultation responses suggested that innovative electrification technologies could be combined with tram and tram train concepts.	Acknowledged and text updated in final RUS strategy.
Freightliner Group Ltd highlighted that any innovative solution, such as innovative electrification must not disadvantage freight operators.	Acknowledged in Draft for Consultation and final RUS strategy.
Consultation responses suggested that consideration be given within the RUS, to further low cost types of electrification, such as trolley wire.	Examined in Draft for Consultation and final RUS strategy.
3. Community rail	
Broad support for conclusions regarding community rail.	No further action required.
A few consultation responses felt that a community rail route was seen as peripheral due to its status.	Highlighted the importance and value of community rail initiatives to the community and industry in the final RUS strategy.
The Chester to Shrewsbury Rail Partnership believed that although there is no Community Rail designation in Wales, it is seen as no disadvantage to their work.	No further action required.
Several consultation responses identified reasons for and against seeking community rail line designation.	Included rationale behind seeking designation and not seeking designation, in final RUS strategy.
Several Community Rail Partnerships identified common examples of where they have been instrumental in one or more of: reducing anti-social behaviour, increasing ticket sales, maintaining stations and securing third party funding.	Reinforced community rail section in the final RUS strategy with examples of community rail in action in different scenarios and guidance as to how to initiate community rail initiatives.

Appendix I - Summary of further alternative solutions raised by consultees

Table 7.4 – Further alternative solutions raised by consultees			
Alternative Solution proposed	Proposal details (including any benefits/issues and examples of usage)	Raised in Scoping Document	Raised in Draft for Consultation
1. Vehicle (V)			
Bi-mode diesel electric passenger rolling stock	Bi-mode diesel electric rolling stock can be powered by electricity from an externally generated supply via a pantograph or 3rd rail collector shoe, or from an onboard diesel generator. The train is able to draw power from electrification infrastructure where available and operate beyond electrified sections or during isolations. Bi-mode trains, while operating on the electrified portion of a service, potentially permit savings to be made on energy consumption and emissions in comparison with a diesel powered train. The technology is applied in Great Britain with the Class 73 electro-diesel locomotive. In France, bi-mode EMUs operate services. A bi-mode variant in Great Britain is planned as part of the order for Intercity Express Programme (IEP) vehicles.	✓	✓
In cab signalling and driverless trains	In cab signalling and driverless trains were proposed as an alternative solution to current train control systems on branch lines. The European Rail Traffic Management System (ERTMS) involves the progressive replacement of lineside infrastructure with the European Train Control System (ETCS) Level 2. Automatic Train Operation is planned for the Thameslink and Crossrail core sections. Currently, no automatic train operation exists on the heavy rail network. Theoretically, this could be developed to provide driverless trains, similar to those on the Docklands Light Railway (DLR). In its current application in metros, it has largely focused on maximising capacity on very high frequency metro services and not on lines within the scope of this strategy. The railway industry in Great Britain has an ERTMS implementation strategy, starting with the resignalling of the Great Western Main Line. Implementation on the East Coast Main Line and the Midland Main Line are planned for Control Period 5 (2014-2019). Introduction of ETCS will be co-ordinated with the replacement of rolling stock to enable new trains to be bought with in cab signalling. The infrastructure is created for this, to be used as soon as possible. The ETCS strategy aims to be cost effective by targeting renewals rather than automatically replacing assets before life expiry.	✓	✗

Table 7.4 – Further alternative solutions raised by consultees			
Alternative Solution proposed	**Proposal details (including any benefits/issues and examples of usage)**	**Raised in Scoping Document**	**Raised in Draft for Consultation**
1. Vehicle (V)			
Hybrid diesel battery trains	Hybrid diesel trains would provide potential carbon reductions, but this has been considered elsewhere by the rail industry. This has been mentioned in Chapter 4 but not considered further by the RUS. The Network Rail National Measurement Train was trialled as a hybrid battery train. The project was undertaken by Hitachi, Porterbrook and Network Rail in 2007. It concluded that energy savings of over 10 per cent could be attained. Artemis Intelligent Power, Ricardo and Bombardier Transportation are currently collaborating on a research project aimed at providing a regenerative braking system for a diesel multiple unit. The project aims to combine a digital displacement hydraulic pump motor with flywheel energy storage system. The project is a partnership between the three companies, with co-funding from the UK government via the Technology Strategy Board's Accelerating Innovation in Rail programme. The project was expected to start in the second half of 2012.	✓	✗
Hybrid light road-railer	A hybrid light road-railer is effectively a bus which can be driven on the railway with retractable rail wheels. The technology seeks to provide greater connectivity and flexibility to service locations remote from the railway network by blending the modal advantages of bus and rail systems. These vehicles were trialled in Japan in 2007 but are not in commercial production. Such vehicles have been historically been developed in Great Britain. Road-railers are in widespread use as on track-plant to permit maintenance vehicles such as diggers to be driven on the highway and the railway. While operating on the railway they are segregated from other trains.	✓	✓
Use of technology from tram and tram train on conventional rail vehicles	A variation on the tram train concept could encompass a 'heavy tram' or 'train tram' where passenger rolling stock vehicles would comply with conventional heavy rail standards. They could be built with features found on tram trains. For example, magnetic track brakes would simplify the track control system. This strategy would avoid the loss of economies of scale seen when lines are separated from the heavy rail network using tram technology. These bespoke vehicles would still need to be balanced against the recommendations of the Network RUS: Passenger Rolling Stock document which proposed moving towards fewer rolling stock types serving the market sectors and more interoperable infrastructure.	✓	✓

Table 7.4 – Further alternative solutions raised by consultees

Alternative Solution proposed	Proposal details (including any benefits/issues and examples of usage)	Raised in Scoping Document	Raised in Draft for Consultation
2. Electrification (E)			
Flywheels for line side energy storage	Flywheels for line side energy storage have been considered by the railway industry to store energy from regenerative braking from rolling stock on the 3rd rail 750V DC network. Currently, the direct current system can only utilise regenerative braking if another train is in the section at the same time, since electricity cannot be returned to the National Grid. Flywheels would allow the energy from regenerative braking to be stored for longer and therefore dispersed to trains further behind. However, the gap between trains needs to be quite close due to the length of time that the flywheel can store the energy. Evaluation by the railway industry revealed that most of the energy from regenerative braking was already being used by trains on the network. Therefore additional benefits of longer storage were quite small. Safety and reliability of flywheels is unproven, since the current technology requires them to be replaced frequently.	✓	✗
Ground level power supply	Numerous suppliers have developed ground level power systems for on-street tramways. The technology avoids wirescapes in historic city centres. The capital cost is higher than conventional tramway overhead electrification. The system has been trialled in Germany based upon inductive power transfer with wires under the track. Other systems use a conductor rail at ground level which is energised while the tram is above the section.	✓	✓
Bio fuels and hydrogen fuel cells	The RSSB has assessed the viability of hydrogen fuels cells. It concluded that while technically possible, it was currently economically unviable (Feasibility study into the use of hydrogen fuel, (2005)). The RSSB is monitoring developments in this field and will revisit their conclusions should this situation change in the future. Biofuels have been trialled by several train operators including South West Trains, First Great Western and Virgin Trains. The RSSB produced a report in August 2010 concluding the findings which noted that trains could operate using 100 per cent biofuel without any serious problems. However, in order to do so, they would require their engines retuned at considerable cost. The highest percentage of biofuel that could be added to a fuel mixture without requiring retuning the engine would be 20 per cent. Importantly, this had a detrimental effect on performance, requiring trains to use more fuel to achieve the same performance. However, there was no impact on engine wear. A broader issue exists concerning biofuel sourcing and whether it will be sustainable in the long run given that land for biofuel crops could also be transferred to food production.	✓	✓
Simplified electrification (ways to reduce the cost of conventional overhead line electrification, possible 3rd rail extensions and trolley wire)	Simplified electrification has been cited as an alternative solution during the consultation phases. Network Rail, in developing electrification schemes, will consider the possible options for lower cost electrification where, for example, linespeed allows a lighter solution. The DfT's independently commissioned research 'Low Cost Electrification for Branch Lines' (2010) examined the potential for electrification on the Liskard-Looe and Newquay-Par routes. The report explored the case for DC tram-style electrification for self-contained branch lines.	✓	✓
Combining discrete electrification and Tram Train	Certain alternative solutions such as discrete electrification and tram train could be used in combination. This would enable benefits of both alternative solutions to be accrued. It is agreed that combining energy storage and tram train technology could be viable and is emphasised as a combined option in the final RUS. Further work will be required to explore the exact nature of the potential scenarios for application.	✓	✓

Table 7.4 – Further alternative solutions raised by consultees

Alternative Solution proposed	Proposal details (including any benefits/issues and examples of usage)	Raised in Scoping Document	Raised in Draft for Consultation
3. Other (O)			
Integration with other transport modes	A broad range of transport options could be integrated as part of a tram train scheme offering greater transport integration between the modes. Several German cities have tram train networks integrated into the local transport network, e.g. Karlsruhe.	✓	✓
Secondary infrastructure item product costs	The cost of secondary infrastructure items such as waiting shelters/station equipment is consistently higher for the railway industry than for comparable products in the public transport industry. In order to reduce costs of such items, alternative procurement policies could be considered, e.g. purchase of shelters from bus shelter manufacturers. Network Rail recognises the relatively high costs of secondary infrastructure items across the network, including community rail lines. It is currently investigating the feasibility of using non-bespoke railway manufacturers products to see whether significant cost savings could be accrued. This would have to be traded-off against asset life and specification against specific secondary railway infrastructure item manufacturers products.	✓	✓
Devolved vertically integrated management of community rail lines	Under this arrangement train operation and infrastructure management responsibilities of the community rail line would come under the auspices of a single manager. This would potentially, reduce the number of operational/infrastructure interfaces and hence reduce costs through efficiency gains.	✓	✓
Simplified and lower cost process regime for projects on infrastructure used wholly or mainly by community rail services	Development of a simplified and lower cost process regime for projects on infrastructure used totally or partly by community rail services is likely to result in significant reduction in costs of these parts of the railway. This would be further to cost reduction aspirations derived from more general simplified standards as outlined in the McNulty (2011) report. A simplified process regime would need to still demonstrate compliance with Railway Group Standards (RGS) with any derogations clearly agreed and demonstrated not to negatively impact upon overall service quality or safety of the line.	✓	✓
Franchise re-negotiation	When franchises are up for renewal there will be opportunities to specify within the broader franchise specification bidders are to bid against to develop proposals to deliver lower cost regional railway lines. As such franchises will typically be relatively large scale concerns, a clear commitment will need to be instigated to demonstrate how cost savings are to be delivered whilst maintaining (at least) or improving service quality/efficiency, safety and viability of lines over the course of the franchise within the proposed subsidy/premium payment profile.	✓	✓
Smartcard ticketing	Smartcard ticketing could represent an alternative solution to meet passenger demand affording ease of ticket purchase and multi-modal journey creation. It has seen Europe wide application in major cities with large urban transport networks. It is deemed by the RUS as a demand management issue and therefore not pertinent to this strategy.	✓	✓

Appendix J – Glossary

Glossary	
Term	**Meaning**
ACoRP	Association of Community Rail Partnerships
ATO	Automatic Train Operation
ATOC	Association of Train Operating Companies
BERR	Department for Business Enterprise and Regulatory Reform
BRT	Bus Rapid Transit
Centro	The West Midlands integrated transport authority
CIF	Community Infrastructure Fund
Control Period	Network Rail five year funding period e.g. Control Period 4 is from 2009-14
CRP	Community Rail Partnership
DCRDF	Designated Community Rail Development Fund
DfT	Department for Transport
DMU	Diesel Multiple Unit
EMC	Electro Magnetic Compatibility
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FOC	Freight Operating Company
FWHL	Friends of the West Highland Line
Gauge	A term which refers to both the structure and the vehicle gauge. The structure gauge is an outline drawing or specification, complete with application rules, defining a line inside which structures are not permitted to intrude. The vehicle gauge is a specification which prescribes maximum permissible vehicle and loading dimensions, certain suspension displacements, and certain curve overthrow limitations within the dimensions and requirements of the structure gauge.
GSM-R	Global System for Mobile Communications-Railway
HITRANS	Highlands and Islands Transport Partnership
HLOS	High Level Output Specification
kWh	kilowatt hour

Glossary	
Term	**Meaning**
Multiple Unit	A train formed of two or more vehicles with traction power distributed throughout the train. Some multiple units can be coupled together with other multiple units to form a longer train at times of peak demand
NPV	Net Present Value
OHL	Overhead Line Electrification
ORR	Office of Rail Regulation
PTE	Passenger Transport Executive
PTEG	Passenger Transport Executive Group
RIA	Railway Industry Association
ROSCOs	Rolling Stock Companies
RSSB	Rail Safety and Standards Board
RUS	Route Utilisation Strategy
SMG	Stakeholder Management Group
SRA	Strategic Rail Authority
STPR	Scottish Transport Projects Review
TEN-T	Trans European Transport Networks
TOC	Train Operating Company
TSI	Technical Specification of Interoperability
TSLG	Technology Strategy Leadership Group
VTAC	Variable Track Access Charges

Network Rail
Kings Place
90 York Way
London N1 9AG

www.networkrail.co.uk