BIRMINGHAM CONNECTED

MOVING OUR CITY FORWARD

BIRMINGHAM MOBILITY ACTION PLAN

TECHNICAL WORK PACKAGE 2
PUBLIC TRANSPORT
NOVEMBER 2014

Birmingham City Council

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks		V2	FINAL	
Date	01/09/2014	19/09/2014	07/11/2014	
Prepared by (Company)	WSP	WSP	WSP	
Signature				
Checked by (Company)	Kenneth Cobb, WSP	Kenneth Cobb, WSP	Kenneth Cobb, WSP	
Signature				
Authorised by (Company)	George Burnett, WSP	George Burnett, WSP	George Burnett, WSP	
Signature				

BIRMINGHAM CONNECTED – TECHNICAL STUDY GROUP FINAL REPORT

Work Package 2 – Public Transport

07/11/2014

Client

Birmingham City Council
1 Lancaster Circus
Queensway
Birmingham
B4 7DQ

Lead Consultant Author

Kenneth Cobb
WSP UK Ltd
WSP House
Chancery Lane
London
Tel: 020 7314 5145
Email:kenneth.cobb@wspgroup.com

Table of Contents

Executive Summary

There was overwhelming support during the Green Paper consultation to the notion that Birmingham needs mass transit systems, which would sit at the top of a public transport hierarchy supported by improved trunk and local bus services. The network concept put forward in the Green Paper was broadly endorsed, in its coverage and concept for interchanges to facilitate cross-city movement. It was also agreed that a completed network was more important than any individual corridor or a specific mode. Having a completed network would enable people to make cross-city journeys by public transport; currently something regarded as extremely difficult.

This report provides the technical background and justification for the White Paper and sets out the requirements for the future network in terms of specification for each mode. The new network is presented and explained in context, based on a revised assessment of the main corridors. Delivery considerations form a significant part of the work done for this stage and include:

- the type of interventions required on the highway to deliver the future network;
- the role of Park and Ride;
- options for vehicle propulsion systems; and
- the new network's role in a sustainable integrated public transport system.

While rail-based Metro is considered to be the long-term aspiration for certain key corridors, the emerging mass transit network is still envisaged to be delivered predominantly by Sprint (Birmingham's Bus Rapid Transit) as a mass transit mode capable of more widespread and quicker implementation.

Bus Rapid Transit (BRT) offers many of the advantages of a light rail system, such as Metro, including new, purpose built vehicles and faster, limited stop operation. As in the case of Metro, Birmingham's Sprint services will require positive priority measures to ensure that they can consistently achieve the required standards of reliability and reduced journey times. The 'before' and 'after' illustrations below show how the general concept of Sprint can be implemented to produce a step-change in public transport quality, which can be introduced in a relatively quick timescale compared with Metro. In some cases, Metro remains very much the preferred ultimate choice for certain corridors, and we believe that a successful Sprint service would provide a sound business case for 'conversion' to Metro at a later date, with the advantage that Sprint vehicles can easily be subsequently transferred to other Sprint services.

Perry Barr 'before' Sprint compared with the same scene 'after' Sprint

Hagley Road 'before' Sprint compared with the same scene 'after' Sprint

The Metro at Centenary Square

The upgrading of Birmingham's Public Transport services will rely on a hierarchy of service types, each designed to best reflect the needs of users.

- Metro light rail services, where the number of users and potential users are at their highest to justify high cost investment;
- Sprint bus rapid transit services, covering the major corridors into the City Centre where demand is high and where the importance of an integrated high quality and comprehensive rapid transit system is paramount;
- CityLink bus services, for key trunk routes which require an upgrade in quality but where investment in Sprint services is not financially justifiable; and
- Local bus services, usually shorter routes and ones that feed into the Metro and Sprint networks.

The following key principles are advocated to ensure that Sprint achieves the necessary standards of speed, reliability and quality:

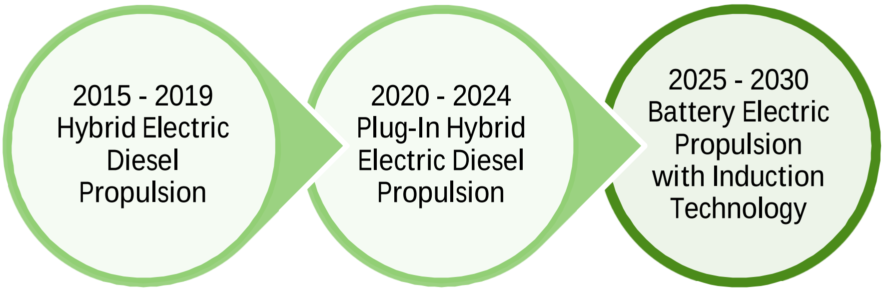
- each Sprint corridor must have a minimum of 3km of dedicated Sprint lane;
- camera-enforced coloured lanes, with or without segregation, should apply to at least 40% of the route;
- vehicles must be to a minimum Euro 6 standard, working towards zero emissions in the City Centre by 2025;
- average speed of Sprint routes must be at least 20 kilometres per hour; and
- the operation of cross-city centre routes will be reintroduced, based on connectivity, the matching of suitable frequencies on both sides of the city and anticipation that reliability can be assured.

Based on a network which meets these standards, the operational viability for Sprint is assessed as follows for routes across the city (and into the sub-region):

Sprint route	Alignment	Overall viability assessment
1	Walsall – Birmingham	Very positive
2A/2B	Pheasey/Sutton Coldfield – City Centre – Maypole – Shirley/Druids Heath	Marginal
3A/3B	Frankley – Longbridge – City Centre – Hamstead	Positive
4	Solihull – City Centre – Castle Bromwich	Very positive
5	Quinton – City Centre – Birmingham International	Positive
6A/6B	Kitwell – Bartley Green – Woodgate/QE Hospital – Harborne – City Centre	Very positive
7	Halesowen – City Centre	Very positive
11	Outer Circle	Positive

These routes will be operated by high specification vehicles, which will convey a powerful and integrated image of quality, reliability and comfort, and will typically be articulated vehicles:

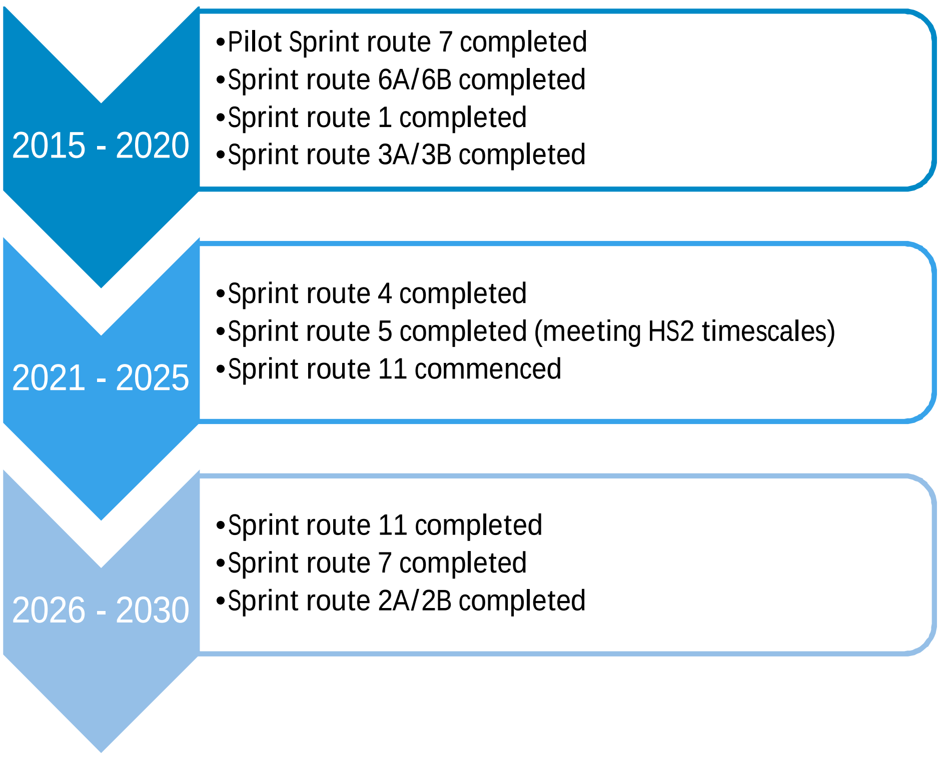
These vehicles will ideally utilise the optimum technology available at the time of introduction:



And in support of these ‘best-in-class’ emission vehicles, CityLink and conventional bus routes will also be subject to a progressive tightening of emissions standards, particularly in the City Centre which will continue to be supported by the Statutory Quality Partnership Scheme. It is likely that the delivery mechanism for the new mass transit network will need to be based on a statutory model, in order to provide the appropriate safeguarding of investment and service standards.

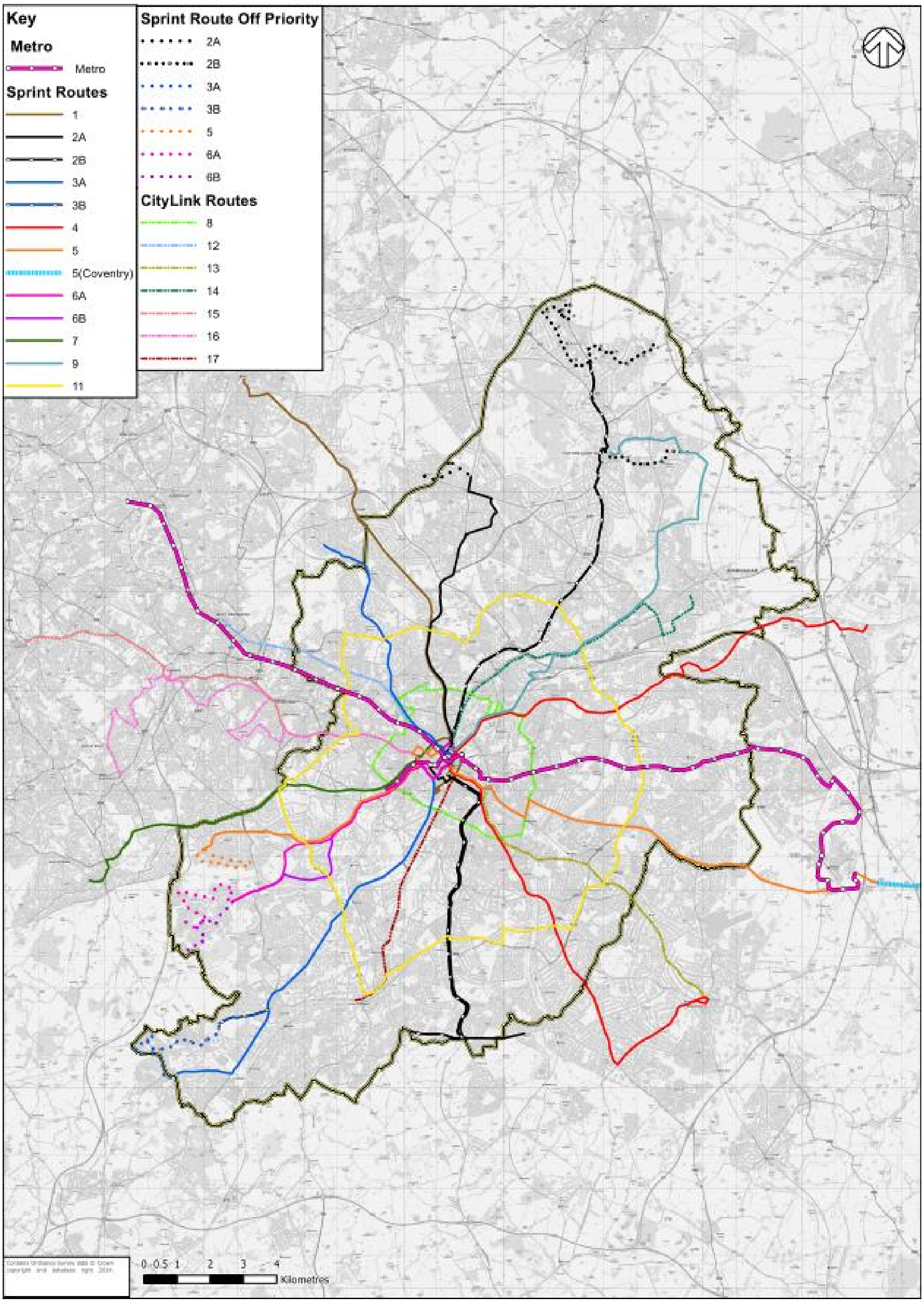
All of the public transport modes are envisaged to work together as part of an integrated network which uses technology to optimise information for the user (about journeys, both before and during) and the road network. Where physical measures are required to delivery priority, such as bus-only sections of road/lanes and traffic management measures, these need to take account of the constraints and opportunities of the route as a whole, and add value by including ‘streetscape’ improvements in order to support a holistic change in the usage of Birmingham’s transport network.

Taking into account the number of passengers to benefit from the investment, the scale of works needed and the up-front and on-going costs of each route, these routes should be introduced as follows:



Successful Sprint routes, in terms of passenger benefits and operational standards, are also candidates for further upgrade to Metro standard and routes 1, 5 and 3A/3B appear to have the strongest prospect.

The revised mass transit route network is thus projected to be as follows by the end of the Birmingham Connected period:



The main elements of each of the chapters of the report are summarised as follows:

Key points - Chapter 1

- The Birmingham Mobility Action Plan Green Paper proposed a multi-modal mass transit network
- Although the concept was welcomed during the public consultation, key questions remain to be answered
- This report addresses those questions, in light of other proposals and reports

Key points - Chapter 2

- Birmingham is served by an extensive network of public transport
- Although slightly improved, buses in the West Midlands are less punctual than any other UK region, and have seen declining usage over the past 5 years
- Rail, Metro and Sprint schemes are already planned to expand the network

Key recommendations - Chapter 3

- A hierarchy of modes is endorsed for BMAP
- As the highest-ranked mode not currently in operation, and to be successful, Sprint must seek to achieve high standards of Bus Rapid Transit operation. 28 principles are proposed to achieve this
- CityLink and conventional bus services must be improved simultaneously to ensure the integrated network approach

Key points - Chapter 4

- The BMAP Sprint network has been thoroughly re-evaluted
- Route-specific factors, such as population and Green Travel Districts, have been used to project future demand, in order to develop the network robustly
- Network-wide considerations have also been taken into account including the Birmingham Development Plan, HS2 and regional connections

Key recommendations - Chapter 5

- The criteria for Park & Ride should include increasing parking provison without using valuable city centre land, tackling congestion and reducing pollution
- 2 locations for strategic P&R are identified (Scott Arms and Maypole)
- 6 Micro P&R sites are also identified for more locally-based travel

Key recommendations - Chapter 6

- A transformative mass transit network will need to be provided with substantial priority on its routes if it is to achieve BMAP's policy ambitions
- Priority will need to be given at existing delay points and also in a range of urban highway settings which do not currently have much public transport priority
- A range of measures should be used, appropriate to the location, reflecting the characteristics of the area and the impact which Sprint will have on travel habits

Key recommendations - Chapter 7

- In order to tackle current emissions, and address future standards, clean technologies are required and these should be capable of meeting progressively tougher standards throughout the BMAP period
- In addition to emissions, the design of the Sprint vehicles must reflect the high-quality and efficient nature of the service network
- Emissions targets should be particularly stringent in the city centre where all routes converge

Key recommendations - Chapter 8

- In order to function as a seemless network, BMAP services must cover physical, network (i.e. service planning) and information integration topics
- To facilitate integration between mass transit services, defined Mass Transit Interchanges should be created to support passengers when changing routes
- Integration must also extend to other sustainable modes in order to provide a comprehensive and attractive option for all transport needs

Key recommendations - Chapter 9

- Priority for the mass transit network must provided the requisite journey times for services, while providing acceptable impacts on other traffic, including freight
- The priority must also take account of the general nature and character of the area served - the 'place' and its 'links' to the rest of the city
- Technology ('intelligent transport systems') have a key role to make best use of the physical highway

Key recommendations - Chapter 10

- The regulatory regime must secure and guarantee the benefits of the investment in the BMAP network, while remaining open to benefits of operator innovations
- The Sprint network should be prioritised to reflect the passenger benefits, deliverability, viability and cost.
- 'Upgrading' to Metro from Sprint should remain open in principle for all routes, and be expedited for those with the strongest case

Key recommendations - Chapter 11

- In order to deliver a mass transit network on the ground to the most immediate benefit of Birmingham, Sprint will form the majority of the network, without precluding Metro on certain routes
- Supporting initiatives must be taken to ensure the network is comprehensive and sound, including but not limited to Park & Ride, emissions standards and regulatory robustness.
- Implementation of the network must prioritise the key factors of passenger numbers, amount of highway work required, cost-effectiveness and investment.

1 Introduction and Background

Key points

- The Birmingham Mobility Action Plan Green Paper proposed a multi-modal mass transit network
- Although the concept was welcomed during the public consultation, key questions remain to be answered
- This report addresses those questions, in light of other proposals and reports

1.1 Original BMAP Green Paper Proposals

1.1.1 The Birmingham Connected White Paper seeks to build upon the BMAP Green Paper, which was published in November 2013. The Green Paper described a range of schemes, incorporating previously proposed schemes alongside those unique to it, in order to present a united front on transport in Birmingham.

1.1.2 Public transport schemes set out in the Green Paper included:

- Heavy rail;
- Light rail (called Metro);
- Bus Rapid Transit (called Sprint);
- Higher quality conventional bus routes (called CityLink);
- Other bus services;
- Demand responsive services (e.g. dial-a-ride and taxis); and
- Package measures (such as payment and information systems).

1.1.3 The routes and schemes requiring infrastructure on the highway (i.e. rail-based and indicative high specification ‘rubber-tyre’ modes) were shown in an overall network diagram (figure 1.1). Each of the schemes is described in further detail below.

Figure 1.1 BMAP Green Paper Public Transport Network Overview

Heavy Rail

1.1.4 The BMAP Green Paper supported the long-standing proposal to re-introduce local passenger services on the former Midland Railway Camp Hill, Sutton Park and Tamworth rail lines. This could be facilitated by the installation of the Camp Hill chords, connecting the line to Moor Street station where more capacity is available than the existing connection to New Street. The chords could also be used by Cross-Country services from the North (e.g. Nottingham) and East (e.g. Leicester), releasing capacity at New Street.

1.1.5 Capacity could also be released for services around New Street through HS2. In regard to that scheme, BMAP Green Paper also supported the 'One Station' initiative forging better links between New Street and Curzon Street/Moor Street, based upon improved pedestrian realm.

1.1.6 Further capacity enhancements were set out for services out of Snow Hill, with the re-introduction of platform 4 when the Metro services move to their own separate alignment.

1.1.7 Finally, at the time of this paper's release, work is well in hand for the completion of electrification to Walsall and Rugeley, enhancing journey times and frequencies on that corridor.

Metro

1.1.8 The BMAP Green Paper supported the extension of the Metro to Centenary Square and in the long term considered the extension of the Metro as far west as Halesowen, should the Sprint rapid transit corridor (see below) prove successful. Another long term scheme mentioned was the introduction of Metro Line 2 towards HS2 and Eastside.

Sprint

1.1.9 The BMAP Green Paper further developed pre-existing proposals from Centro and other sources regarding the implementation of Bus Rapid Transit (named Sprint) in Birmingham, specifically on the Walsall Road and Hagley Road corridors, and with another conceptual route towards the airport.

1.1.10 To these three proposed corridor concepts, the BMAP Green Paper added a further six lines on key radial routes, as well as proposing to upgrade the existing Orbital routes (Services 8 and 11) to BRT standard to facilitate greater connectivity outside of the city centre.

1.1.11 The underlying concept was to form a uniformly high quality, highly reliable systems with minimal environmental impact greatly enhancing mobility across the system and attracting people away from cars. Also included was a reintroduction of cross-city routes, a feature lost in Birmingham in recent years, which sought to connect the West of the City and facilities/venues on Broad Street with the Airport to the East, together with north – south connectivity. It also sought to improve transport on corridors where rail is currently not present or operates a less frequent service. The line to Longbridge sought to connect to a BRT route proposed as part of that area's Action Plan.

1.1.12 The Green Paper also proposed a study into the provision of Sprint-based Park and Ride sites, which is expected to be a concept carried forward to the white paper.

Figure 1.2 Potential Sprint Vehicle (BMAP Green Paper)

CityLink

1.1.13 CityLink was proposed in the BMAP Green Paper as the next tier of bus enhancement to Sprint. This would still provide corridors with enhanced journey times and better facilities but not to the more radical standards that Sprint would require. This solution was aimed at corridors which have alternative modes available, such as heavy rail, or are less populated.

Bus

1.1.14 Bus services not covered by the previous proposals would still see enhancements as part of the package measures set out below and would particularly benefit from greater simplicity and streamlining of the fares system as well as better information and shelter standards. There was also mention of studies into services around local centres outside of the City Centre.

Demand responsive services

1.1.15 For areas away from major transport hubs and making a better offer to the less mobile, a demand responsive service using electric vehicles was proposed, particularly in the area of the City within the Ring Road.

Package measures

1.1.16 The elements above are intended to be seen as one overarching package. To facilitate this, further ranges of measure were proposed. This included a master-branding exercise for the cities transport offering, encouraging greater interchange. This would be supported by a universal smart-card ticketing system, possibly building upon the existing Centro-backed Swift card and removing the current complexity of multiple operators and ticket offerings between modes. The cards would also aim to include any cycle hire or car-share schemes operating in the city helping to solve the 'last mile' problem.

1.1.17 There would also be an aspiration to uniformly high-quality stops with live information on-site, as well as a stronger, more modern online offering.

1.1.18 Finally, the Green Paper suggested that at a minimum the Sprint network should seek to be zero-emission, with proposals for electrically powered buses charged at-stop in order to reduce carbon production and pollutant emissions.

1.2 Current Brief

1.2.1 There was overwhelming support during the Green Paper consultation to the notion that Birmingham needs a mass transit system, which would sit at the top of a public transport hierarchy supported by local bus services. The network concept put forward in the Green Paper was broadly endorsed, in its coverage and concept for interchanges to facilitate cross-city movement. It was also agreed that a completed network was more important than any individual corridor or a specific mode. Having a completed network would enable people to make cross-city journeys by public transport; currently something regarded as extremely difficult.

1.2.2 The concept behind the Green Paper network was that the actual mode (be that Metro, Sprint, priority bus or any other technology) should be interchangeable and each corridor should be progressed on its own merits. The Green Paper put forward a view that the best means of delivering a whole network in as short a time as possible could be to focus on Sprint Bus Rapid Transit (BRT). However, that would not preclude any route going forward as Metro either straight away or with upgrading at a later date.

1.2.3 The wide interest in the Green Paper public transport proposals was indicated by the number of questions which were generated and which need to be considered in order to make definitive recommendations in the White Paper. The objective of this report will be to address and answer these questions:

- Confirmation of the feasibility for the corridors and orbital routes on the Green Paper network;
- How will interchanges between routes work and how can passenger penalties be reduced?;
- What is the suitability of some routes to specific modes, Bus, Sprint and Metro?;
- How can Sprint and CityLink provide the required levels of service to be attractive, in particular in relation to general traffic journey times?;
- What are the potential route alignments and connectivity to locations, specifically in relation to the BDP growth areas (builds on existing workstreams)?;
- How will the network and routes connect into surrounding authorities?;
- What are the more detailed opportunities for park and ride, both in Birmingham and surrounding authorities? Are there opportunities for localised bus-based park and ride or cycle and ride on the network?;
- Will the impacts on general traffic be acceptable in certain corridors? How can these be mitigated? – links to Road Space Allocation consideratons;
- What are the relative costs and benefits for specific routes?;

- How can the role of taxis and car clubs be supported as part of the wider public transport network?;
- The Green Paper set an aspiration for the main mass-transit network to become 'emissions free at the point of use' within the 20 year Birmingham Connected horizon. What are the opportunities and constraints of achieving this and what technology platform should Birmingham pursue?

1.3 Reports and developments affecting Birmingham Connected

1.3.1 The Green Paper was published in November 2013. In the ten months since then, various announcements, reports and proposals have been made public which affect all or some of the public transport network envisaged by the BMAP Green Paper. The key developments which this work package has sought to take account of are:

- Centro's Integrated Transport Prospectus: "Towards a World Class Integrated Transport Network" – this document sets out the long term vision and strategy framework which will help transform the transport system serving the West Midlands, and looks at the public transport system, supported by a wider narrative on the critical roles of highways, freight, cycling, walking and land use planning to help us promote a truly integrated transport system;
- HS2 Unlocking the benefits – West Midland Connectivity Package 2014 – this Connectivity Package is intended to improve regional and local links to High Speed Rail Two (HS2) and encourage sustainable growth using the released rail capacity from the West Coast Main Line. Economic benefits will therefore be maximised across the West Midlands region with capacity constraints on the already congested local transport networks being relieved;
- Midlands Connect (Draft Report) 2014 – a Midlands-wide report looking at how strategic transport investment can support the growth of the region looking towards HS2;
- Centro's PRISM Modelling Report 2012 – this modelling report outlines a future modelling scenario testing public transport interventions some of which include BRT and P&R proposals. The report concludes with projected trip numbers based on the change between 2006 and 2026 using the PTx2 Portfolio (23 potential PT schemes and policy assumptions);
- HS2 Connectivity Package PRISM Report – this report indicates that modelling work has been undertaken to update the 2012 report to account for HS2 and some change to the PT schemes, although no specific outputs or forecasts are provided;
- Solihull Connectivity Study (Steer Davies Gleave) 2014 – this report outlines high level appraisal of both LRT connection from Birmingham City Centre (Sprint Line 7 East) and BRT connectivity from Solihull Town Centre to UK Central (Airport HS2 Station). The proposal for a north – south corridor from North Solihull through the Birmingham Business Park area, the NEC, and on to Solihull Town Centre, and possibly Blythe Valley Business Park could be closely integrated with Metro Line 2 and/or the proposed Sprint Route 4, which is described later in this report;
- Airport Rapid Transit Study (Steer Davies Gleave) 2012 – an earlier report to the above which includes a benefits assessment report of Midland Metro and BRT routes from Birmingham City Centre to NEC / Airport / HS2 area and an Eastern route from Coventry;
- Centro's A34 Sprint Options Report 2011 – this report outlines bus stop proposals for each of the stops (10 stop locations) from Walsall town centre to Sheepcote Street, Birmingham. Junction improvements at the Hatherton Road / Lichfield Street, Walsall are also identified along with (limited) bus priority measures along the route;
- A34 Sprint Vehicle and Operations Technical Note (Halcrow) 2012 – this note outlines vehicle options and operational aspects;
- Birmingham – Solihull Rapid Transit Study (PB) 2013 – this report looks in further detail at the Bordesley Green LRT route;

- Birmingham to Quinton Sprint Feasibility Study (Mott Macdonald) 2014 – this report, including preliminary highway design drawings, sets out in detail the route, stopping points and highway interventions (including priority measures and works to enable turning circle alignments) proposed to introduce the first Sprint route;
- Strategic Economic Plan/Local Growth Fund – Strategic Case Template (Greater Birmingham & Solihull Local Enterprise Partnership) – 8 public transport scheme-specific business case templates provide the description, rationale and funding requirements for schemes to enable economic growth and include Metro extensions (Edgbaston/Eastside/Solihull) and Sprint corridors (A34/A45).

1.3.2 These studies provide a comprehensive and, in some cases, complex backdrop to Birmingham Connected as they are based on a range of assumptions and methodologies, the outputs and priorities of some of which may not be agreed by all stakeholders.

1.3.3 During the latter stages of the preparation of this report, revisions to the Birmingham Development Plan were developed. While the principal impact – the clearer policy case for a Sprint service on the A34 Birchfield Road – has been reflected in the final version of this report, it has not been possible to include the same level of analysis about the case for this route as for the rest of the Birmingham Connected public transport network. A separate report – the Birmingham Eastern Fringe Bus Study (conducted by CH2MHill with Phil Jones Associates) – has however considered the service options for Sprint and CityLink, alongside conventional bus services, to service the Langley Sustainable Urban Extension and has also included a detailed financial appraisal.

1.4 Scope of report

1.4.1 Following this introduction, this report will review current public transport in Birmingham in brief (in chapter 2) and then set out the requirements for the future network in terms of specification for each mode (chapter 3). The likely type of interventions required on the highway to deliver the future network are then presented (chapter 4), before the new network is presented and explained in context, based on a revised assessment of the main corridors (chapter 5). The role of Park and Ride will then be considered (chapter 6) before the options for vehicle propulsion systems are reviewed (in chapter 7). The new network's role in a sustainable integrated public transport system is defined (in chapter 8) and the impacts on other highway users are considered (in chapter 9). The approach to network delivery is presented (in chapter 10) prior to a summary of the proposals concluding the report.

1.4.2 Proposals for rail network investment (such as construction of Camp Hill Chords, connections to Birmingham Moor Street station, re-use of capacity freed-up by HS2 and a range of other schemes to enhance connectivity) are already fairly well-defined and developed and therefore the focus of this work package is to develop the network which can be designed and delivered in a shorter timescale.

1.4.3 Consideration has also been given to the development of other modes, including monorail, and Appendix 3 covers the passenger boarding and alighting implications and suitability of routes to this technology. The Appendix also compares the timescales for planning and delivery of street-based modes of LRT, BRT and monorail.

1.4.4 The ambitious Sprint and CityLink network proposed by this Birmingham Connected work package is envisaged to amount to some 240km in route length and therefore the level of detail provided at this stage is greater than in the Green Paper but it is still 'work in progress'. Before any further steps are taken in respect of the network, detailed feasibility and business case work will be required before progression to outline and, ultimately, detailed design stages.

1.4.5 Similarly, the impacts on the residual bus network will require careful planning based on detailed passenger origin and destination journey data, from the existing bus operator(s), and partnership working in order to optimise the benefits to those living or travelling through the Birmingham area.

2 Birmingham's current public transport

Key points

- Birmingham is served by an extensive network of public transport
- Although slightly improved, buses in the West Midlands are less punctual than any other UK region, and have seen declining usage over the past 5 years
- Rail, Metro and Sprint schemes are already planned to expand the network

2.1 Background

2.1.1 Birmingham is served by the following scheduled public transport services:

- A frequent and heavily used rail network, but one which is constrained in its current physical capacity to grow further;
- A single Metro (tram) line, which is in the process of being extended through the city centre;
- A comprehensive bus network; and
- A fleet of over 5,000 taxis[1].

2.1.2 These services provide a complex network of modes and are largely designed to cater for existing demand, with consequent limitations on alignment with more strategic aims. Birmingham Connected therefore needs to put forward a new network which ensures that the future public transport network both caters for and enables economic development across the city.

2.1.3 Birmingham is often a congested city, and future economic development will be dependent on improved communications and movement both within the City and also within the region. Increasing the number of car trips will further exacerbate congestion, so the need to develop high quality mass transit systems is clear, as the current network is either operating at near capacity (heavy rail), or can be relatively slow, and sometimes unreliable (existing bus services).

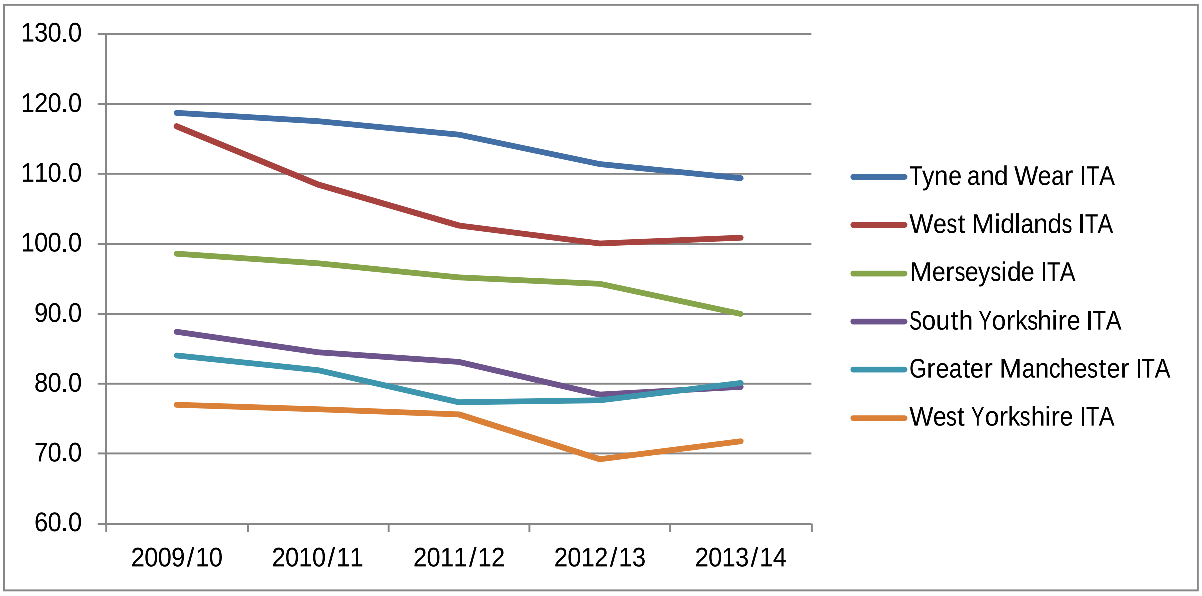
2.1.4 Comparison with successful cities in the UK and worldwide demonstrates that mass transit is an integral part of expanding economies.

2.2 Current performance of public transport in Birmingham

2.2.1 Birmingham has an extensive existing bus network, provided in the main by National Express West Midlands, who carry over 1 million passengers per day across its operations in the West Midlands (including Coventry). Centro, the West Midlands Integrated Transport Authority, is one of only 2 ITAs which currently generates more than 100 local bus journeys per year per head of population. This figure is however in decline and the decrease in the West Midlands has been greater than in any other ITA area since 2009/10 (as shown in figure 2.1).

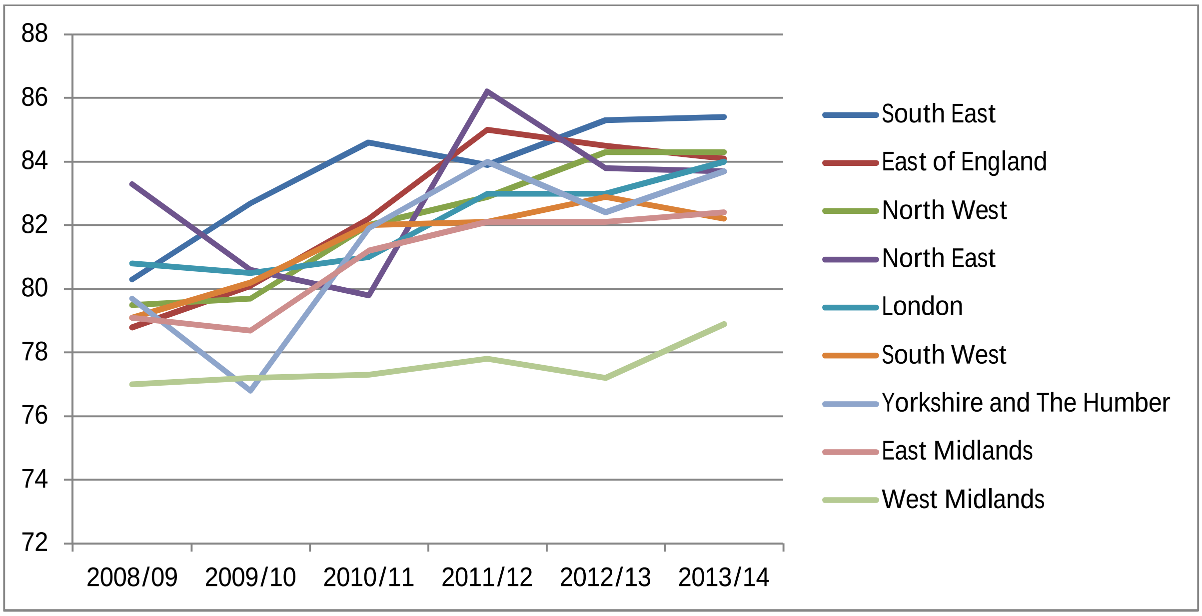
[1] Taxi is a generic term covering the precise definitions of 'hackney carriage' (hail and ride) and 'private hire' (pre-booked). The measures identified in this report would apply equally to both unless otherwise stated.

Figure 2.1 Passenger journeys on local bus services (per head of population by highway authority)



2.2.2 By the same token, bus service punctuality is significantly worse than in other regions and is an issue which will make a fundamental impact on passenger travel mode choices unless addressed through bold and significant schemes in future. The network must therefore be based upon mass transit modes which have reliable and predictable journey times, on comparable or better terms than the private motor car.

Figure 2.2 Punctuality of local bus services (% of timetabled buses on time, by year, by region)[2]



2.2.3 Birmingham Connected's ambition is to provide Birmingham with world-class urban public transport. It is therefore crucial that each of the modes of transport which forms the total network is comparable with the highest standards of their type in other countries. In order to establish the credentials for

[2] Source: DfT

Birmingham Connected's ambition, it is important to set transparent standards which identify the expectations and benchmarks against which Birmingham will be judged by its residents and peers.

2.2.4 By implementing a mass transit network, with appropriate standards of journey speed, safety, comfort and quality Birmingham will be able to address the current issues with a consistent and attractive public transport offer, which will change the current perceptions of what public transport is and what it can achieve. Examples of this sea-change in public opinion, and travel habits, can be found in South America where many large cities now have a much higher international profile because of their mass transit system.

2.2.5 Such standards are the ones to which Birmingham should aspire, and will need to achieve if it is to support economic and population growth sustainably over the Birmingham Connected period. Transport network investment is necessarily long-term and a number of schemes are already in place (or in the implementation phase) to improve current services, and these are reviewed in sections 2.3 and and 2.4 below.

2.3 Rail – current and committed schemes

2.3.1 Birmingham is unusual in rail terms in having two effectively separate railway networks which have minimal operational overlap within the city's boundaries, following divisions between companies in the 19th Century.

2.3.2 The dominant network is that radiating out from Birmingham New Street Station, the busiest railway station in the UK outside of London. 32 million people use it to get to and from Birmingham each year with a further 5 million changing between trains, which is more than double what it was designed to handle when last redeveloped back in the 1960's and the station is, therefore, undergoing a massive regeneration project to handle the current passenger numbers and to improve the passenger environment. This work is due to be completed in 2015. Birmingham New Street is also scheduled to be the centre of a signalling program aimed at improving reliability in the region, starting next year.

2.3.3 Services into Birmingham New Street are also the subject of ongoing enhancement. Bromsgrove Station is to benefit from a pair of packages totalling £78 million that will see the station moved and extended. Enhanced facilities, a larger car-park for Park and Ride and electrification which will see it connected to the Cross City Line, with consequent gains to service frequency and speed. The interchange work will be completed in 2015, whilst the electrification will be connected in 2016. Also on the Cross City Line, Redditch is seeing the installation of additional loops and works south of Barnt Green to facilitate an increase in the services run through there. The overall impact will be that, rather than some of the Cross-City lines trains terminating at Longbridge, all will extend through to Bromsgrove or Redditch, enhancing accessibility to/from both. Finally, the West Coast Mainline, which connects Birmingham New Street to destinations such as London, Manchester and Glasgow, is scheduled for power supply improvements between 2015 and 2019, improving service reliability.

2.3.4 Besides the New Street centred system, the other rail network in Birmingham is that serving Birmingham Snow Hill and Birmingham Moor Street, which, following a brush with closure in the 1970's when it was deemed as a "duplicate" and "secondary" route, has since been undergoing a steady regeneration with the arrival of new stock and infrastructure improvements, resulting in it being one of the UK's fastest growing routes. This renaissance is set to continue with a range of schemes. First of these is the £10 million investment in Snow Hill Station Phase 1 package which seeks to improve the transport interchange centred around the station, allowing better access to, from and across the station alongside urban realm improvements. Commuters into Birmingham from the south are also to benefit from extended platforms on the line, allowing longer trains to run between Birmingham Moor Street and London Marylebone. There are also plans for additional trains on the route.

2.3.5 Finally, work is also in hand to improve connectivity between the City Centre stations. The Midland Metro work described elsewhere will connect Snow Hill directly to New Street in connection with the completion of the latter's renewal in 2015. Another scheme, the £7 million "One Station", is a pedestrian realm project aimed at improving the connection between New Street and Moor Street from its completion in 2015/16. This scheme is also targeted at benefitting connectivity through to the High Speed 2 Curzon Street station when it opens in 2026.

2.3.6 While these schemes will expand and make better use of existing rail capacity, the lead times for some of these, and potential future schemes, mean that the outline design and funding has already been determined. Therefore the remainder of this section, and the rest of this report, is focused on providing a much greater level of detail on the 'street-running' public transport network.

2.4 Metro / Sprint – current and planned schemes

Metro

2.4.1 The first Midland Metro line opened to the public on 30th May 1999 and follows a route from Birmingham through the Jewellery Quarter, Handsworth, The Hawthorns, West Bromwich, Wednesbury and Bilston on the way to Wolverhampton. It operates seven days a week with a frequency of every eight minutes during the day and every 15 minutes during the evenings and Sundays. The current route has 23 stops, of which four have Park and Ride facilities, and carries around 5.2 million passengers per year.

2.4.2 Shortly prior to the launch of Birmingham Connected, the Metro received a £40m fleet of 21 new trams. These are a third bigger than the Metro's existing trams, carrying around 210 passengers compared to 156 on the previous vehicles. This, together with an increase in frequency to ten trams an hour, will increase overall capacity by 40 per cent and ease peak time overcrowding.

Figure 2.1 New Metro tram rolling stock

2.4.3 An extension of the current route is currently being constructed through Birmingham which, when completed in 2015, will see trams return to the city centre's streets for the first time in more than 60 years. The £128 million extension project is also expected to increase the number of passengers using the Metro each year to 8 million. Work is currently ongoing to lay the on-street tracks for the extension from Snow Hill through Bull Street, Corporation Street and Stephenson Street, terminating outside New Street rail station.

2.4.4 Beyond the 2015 opening of the Metro line to New Street, further extension is planned to take the line west in two phases. The first phase, priced at £42.4 million[3] will be catalysed by the redevelopment of the Paradise Circus complex and the ring-road beneath it. This will facilitate the extension of the Metro through to Centenary Square which hosts the New Library for Birmingham, the REP theatre and the International Conference Centre. The Paradise Circus redevelopment is also intended to be a major trip generator in its own right, with 12,000 jobs planned for the site alongside recreational facilities and public spaces. This work is aimed for completion by 2017-8.

2.4.5 Phase 2 of the westbound extension has received provisional funding in the Local Growth Fund. Priced at £67.5 million[4] overall, it would see the Metro extended from Centenary Square out to Edgbaston at a point west of Francis Road. This would serve the Five Ways and Broadway Plaza complexes en route as well as serving other amenities and residential land in Edgbaston itself. This is aimed for completion by 2021.

2.4.6 These developments would act as extensions of the existing 'Line 1'. Plans are also in hand for the creation of Line 2, again in phased approach. The first phase branches off Line 1 at Bull Street. Depending on the redevelopment of the Martineau galleries shopping complex, Line 2 will then access Moor Street Queensway before continuing on a new alignment to a stop on New Canal Street, under HS2's Birmingham Curzon Street. It then continues into Digbeth and Deritend to Adderley Street, where a Park and Ride facility for both the Metro and HS2 is proposed.

2.4.7 The long-term aspiration for Line 2 is continuation on to Birmingham Airport/The National Exhibition Centre and on to the HS2 Interchange Station, as well as the proposed UK Central development. En-route, the line would connect the Birmingham City Football Club's stadium, Bordesley Green, Stetchford, Lea Hall (and the Ace Trading Estate there), Sheldon, Chelmsley Wood and Birmingham Business Park.

Sprint

2.4.8 During Autumn of 2014, Centro carried out consultation on its plans for the first Sprint route, from Birmingham to Quinton (via Hagley Road). The package of measures to implement the route (including the purchase of articulated vehicles) amounts to around £15 million and if approved in 2014, construction could start next year and be completed within 18 months.

2.4.9 The route to Quinton has been chosen for the following reasons:

- Deliverability;
- Potential for economic development;
- Ability to integrate with other public transport;
- Most likely to appeal to passengers;
- Demand and viability;
- Less impact on the environment; and
- Cost and financial implications.

2.4.10 Six bus priority schemes, covering bus lanes and other physical highway priority (such as making Snowhill Queensway bus-only), have been proposed, along with Selective Vehicle Detection (SVD) at all 30 sets of traffic or controlled pedestrian traffic signals on the line of route. With the exception of an outbound bus lane from Highfield Road to Vicarage Road, an inbound bus lane on approach to Monument Road and an outbound bus lane from Fiveways to Highfield Road, the priority schemes are generally fairly low-cost and therefore of localised benefit to reducing delays, rather than addressing the end to end journey time.

---

[3] http://www.birmingham.gov.uk/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobkey=id&blobtable=MungoBlobs&blobwhere=1223537900707&ssbinary=true&blobheadervalue1=attachment%3B+filename%3D295477Prioritised_scheme_template_Greater_Birmingham_and_Solihull_LTB.pdf

[4] http://centreofenterprise.com/2014/07/06/midland-metro-extension-to-edgbaston-birmingham/

2.4.11 Although not as advanced as the Hagley Road proposals described above, Centro has commissioned work to develop options for Sprint on the A34 (Walsall to Birmingham). The purpose of this work was to develop proposals to maintain journey time reliability and to consider how to provide Sprint-standard bus stops which would be capable of accommodating articulated vehicles as well as upgraded, high-specification, passenger facilities stops, including off-bus ticket machines. For each of the 10 stops identified, proposals were drawn up which detailed the reasons for the improvements, any constraints and issues in the locality, reflected a design 'philosophy', described the shelter/bus stop layout, and identified delivery risks, along with the need for traffic regulation orders and enforcement requirements.

2.4.12 The designs produced need to be deliverable within a current estimated scheme budget of approximately £15 million, which will also make provision for other scheme items such as new vehicles and associated infrastructure investment and marketing and branding.

2.4.13 It is however understood that the next corridor on which Sprint would be implemented by Centro is intended to be between the City Centre and the airport (via A45 Coventry Road), serving the proposed HS2 Interchange and Birmingham International station.

3 Criteria for an effective mass transit system

Key recommendations

- A hierarchy of modes is endorsed for Birmingham Connected
- As the highest-ranked mode not currently in operation, and to be successful, Sprint must seek to achieve high standards of Bus Rapid Transit operation. 28 principles are proposed to achieve this
- CityLink and conventional bus services must be improved simultaneously to ensure the integrated network approach

3.1 Alternative mass transit modes

3.1.1 Birmingham Connected sets out a vision of a hierarchy of mass transit modes, with each mode becoming a progressively higher standard of operation, quality and reliability, with consequent increases in investment required to deliver each mode. The modes can be illustrated as follows:

Figure 3.1 Mass Transit Modes

Rail
- Suburban and inter-urban trains, feeding into the national network

Metro/Monorail
- Rail-based tram, so route alignment has to be fixed for long-term
- Ultimate standard for local public transport in Birmingham

Sprint
- BRT vehicle, with supporting infrastructure required over medium-term
- Capable of 'upgrade' to Metro where demand is proven

City Link
- Premium quality bus services, providing higher standards as a pre-cursor or alternative to Sprint

Bus
- Conventional bus services, able to respond flexibly to changing patterns of demand

3.1.2 The brief for this work package required a more detailed explanation of the specification for each of the road-based mass transit systems for the specific routes developed for the network (as reviewed in chapter 1).

3.1.3 The specific criteria which apply to each of these road-based modes are provided in this chapter and these have informed the capital and operational costs which underpin the assessments carried out for the allocation of each mode to each route (as described in chapter 5).

Rail

3.1.4 Local rail services play a crucial part in the overall transport system in Birmingham and have been a success story in recent years. Scope to expand capacity further is becoming more limited, together with the typically-longer lead-times means that the primary expansion of the public transport network will rely on the introduction of services that do not rely on the existing rail network corridors.

Metro/Monorail

3.1.5 As the mode at the top of the street-running mass transit hierarchy, Metro's quality is the standard to which all other modes should aspire, but will consequently be the mode which has the fewest number of routes in the early years of Birmingham Connected as the planning, funding and delivery timescales of rail-based options will be the longest of any mode. Monorail has also been considered as an alternative rail based option to either Metro, or to Sprint, but the physical characteristics of the majority of approaches to the city centre would restrict the potential for Monorail in Birmingham to a small number of corridors, with the A45 Coventry Road having the most potential – further study work would be required to determine the relative advantages and disadvantages of these systems. More detail on the subject of monorail is available as Appendix 3.

3.1.6 Metro already exists on the corridor between Birmingham, West Bromwich and Wolverhampton and is currently in the process of being extended from Snow Hill to New Street Station, via the city centre. This Line will be further extended to Fiveways, and a proposal for a Line 2 is at an early stage of feasibility to operate from the City Centre to the proposed HS2 station, and then on to Birmingham International Airport via Bordesley Green and Chelmsley Wood.

Sprint

3.1.7 Sprint is envisaged to be the primary, initial 'transformative' mode for Birmingham over the next 20 years as it will be rolled-out across multiple key corridors in the city and will be capable of achieving such expansion in the shortest timescales, as it strikes the optimum balance between quality improvements, deliverability and cost.

3.1.8 Key to the achievement of this vision will be the speed of overall journey time – in simple terms, the 'rapid' element of Bus Rapid Transit (BRT).

CityLink

3.1.9 Where sufficient priority and/or patronage is not likely to support Sprint operation, but significant bus-based public transport improvements are required to support, regeneration, accessibility and economic growth, existing bus services should be upgraded to a standard that is demonstrably better than conventional bus services. City Link will fulfil this role by a combination of bus priority, service standards and integration with other routes and modes.

Bus

3.1.10 While conventional local bus services, as the foundation tier of the mass transit hierarchy, may be perceived to be the 'poor relation' of other modes, Birmingham Connected does not expect, and Birmingham cannot afford for, bus services to remain in their current form. Ways in which existing bus services will need to change include responding to the development of the public transport network as a whole, providing a 'feeder' role into the other public transport modes and responding flexibly to development away from the city centre, where critical mass cannot (initially) be achieved to justify a satisfactory business case for greater investment.

3.1.11 Improvements to the bus network which are required include vehicle investment (prioritising the deployment of lower emission vehicles), expanding the boundary of the existing Statutory Quality Partnership Scheme (SQPS) from the City Centre to either the whole of Birmingham, or to the major corridors from the City Centre, and broadening and raising performance standards.

3.2 Birmingham's strategy for mass transit

3.2.1 In the development of the BMAP Green Paper there was overwhelming support given to the vision that Birmingham needs a step change in the provision of public transport. A mass transit system was the aspiration and, ultimately, the development of a wider tram (Metro) system, which would sit at the top of a public transport hierarchy supported by local bus services. The Green Paper outlined that the best means of delivering a whole network in as short a time as possible would be to focus on Bus Rapid Transit (BRT), known as 'Sprint'. However, that would not preclude any route being designed as Metro either initially or with a view to upgrading at a later date. The concept being that the actual mode (be that Metro, Sprint, conventional buses or any other technology) should be as interchangeable as possible and each corridor should be progressed on its own merits.

3.3 Minimum criteria for successful Sprint operation

3.3.1 In order to provide a measure of uniformity in the definition and scoring of existing and proposed BRT systems, the New York-based Institute of Transportation & Development Policy (ITDP), defines BRT as "a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service" (Wright and Hook, 2007).

3.3.2 To reinforce this definition, the ITDP has established, in conjunction with a panel of respected International experts, an evaluation tool called 'the BRT Standard. This sets out the requirements for a system to qualify as a basic BRT, and then awards recognition for the very best system corridors by nominating Gold, Silver and Bronze categories. The ITDP notes that the BRT Standard was developed to create a common definition of bus rapid transit and recognize high-quality BRT systems around the world. It also functions as a technical tool to guide and encourage municipalities to consider the key features of the best BRT systems as they move through the design process.

3.3.3 It has to be said that the standards adopted by the ITDP are extremely high, and in some senses aspirational, particularly when set in the context of an existing, old and very densely developed city environment. It is inspired by segregated systems using central reservation operation, where land space is far more plentiful than in UK cities, but, nevertheless, it is a useful tool to set basic criteria for state of the art best practice BRT systems, and, suitably interpreted, can be used to test whether the proposed Sprint Network in Birmingham qualifies as a proper basic BRT system, as a so-called 'BRT Lite' system, or whether it can only achieve the status of an improved conventional bus service.

3.3.4 The criteria, as applicable to the Birmingham environment, can be expressed by the following:

1. Each BRT Corridor must have a reasonable proportion of dedicated lanes - an accepted international standard is for a minimum of at least 3km (although not necessarily contiguous);
2. Coloured asphalt busway lanes with or without segregation with camera enforcement should be provided – an accepted international standard is for this to apply to at least 40% of the busway corridor length;
3. Whilst central reservation operation should be provided for Metro wherever possible, it is recognised that BRT segregated lanes will need to operate on a nearside kerb basis;
4. Sprint should be based on a cashless smartcard fare collection system with full facilities;
5. Some turns should be prohibited across the busway, and physical priority should be provided on the approach to junctions wherever possible;
6. All vehicles should have a facility to be completely level with the platform/kerb level with no other measures necessary for reducing the gap in place (this will require the pavement height at some bus stops to be raised);
7. Two or more Sprint routes should be permitted to operate on each BRT corridor (this would apply to most but not all Sprint corridors);
8. CityLink and Local services should be allowed to operate on the BRT corridors, in addition to the limited stop Sprint routes;

9. There should be a Control Centre covering all Sprint Services;
10. Each Sprint Corridor should be selected as being one of the top ten demand corridors into the City Centre;
11. Each Sprint route should include the highest demand segment for that particular corridor;
12. Both late-night and weekend services must be operated, and 24/7 services if justified by demand;
13. All subsequent BRT corridors should be planned and designed to integrate with existing ones;
14. There should be a capability for Sprint vehicles to overtake slower services on Sprint corridors;
15. Vehicles must be to a minimum Euro 6 standard (a suggested additional aspiration for Birmingham is that by 2025 all Sprint services must be zero emission in the City Centre);
16. As a general principle, 75% of stops on the BRT corridor itself should be set back 26 m (85 ft.) from junctions unless the distance between junctions does not permit this;
17. 50% of stops on a given Sprint service must be located on the priority corridor;
18. Sprint Service stops should be spaced, on average, between 0.3 km (0.2 mi.) and 0.8 km (0.5 mi.) apart;
19. Most stops on each corridor should be wide and attractive. Wherever possible, given available pavement width, stop shelters should have an internal width of at least 3 meters (10 ft.). They should be weather-protected, including from wind, rain and snow and be appropriately designed to match the multiple doors of the vehicles used, facilitate the cashless fares system and be appropriate to the conditions in a specific location. Safe stops that are well-lit, transparent, and have security (CCTV) are essential;
20. All Sprint vehicles should have at least 3 doors for boarding/alighting (unless demand can comfortably be accommodated by 12 metre length single deck vehicles with 2 doors);
21. Stops should be designed to accommodate at least 2 Sprint buses simultaneously;
22. All buses, routes, and stops in each corridor should feature a single unifying brand, but this may be different from the rest of the PT system;
23. Functioning real-time and up-to-date static passenger information should be provided corridor-wide;
24. There should be full accessibility at all stations and on all vehicles;
25. There should be integration of both physical design and fare payment with other bus services;
26. Good, safe pedestrian access should be provided at every stop;
27. Commercial speed of Sprint buses must be a minimum of 20kph; and
28. The passengers per hour per direction (PPHPD) should be in excess of 500 on each corridor.

3.3.5 These criteria have been developed in discussion with BCC officers and Centro and are considered to strike the appropriate balance between ambition, practicality and deliverability.

3.4 Defining the role for CityLink

3.4.1 Although Sprint is planned to be the backbone of the public transport network, and conventional bus services will provide the majority of local transport across the city, another level of service is required on main corridors where the demand and scope for highway priority is such that it does not meet the required Sprint standard fully. Indeed, for some corridors the transition from bus to Sprint could be too radical in a single step and therefore an intermediate step, which improves services and integration, is crucial in serving important, but less well-used corridors.

3.4.2 CityLink would therefore be deployed on a small number of routes, perhaps in some cases only on a temporary basis, while Sprint is established. The key aspects which would differentiate CityLink from Sprint are:

- Lower level of on-road priority;
- Lower frequency and shorter distances between stops;
- Different vehicle type;
- Formal interchanges at key crossing-points with other routes.

3.4.3 None of these terms would be 'permanent' such that upgrade to Sprint status would be possible if the business case justifies that step.

3.5 Upgrading the bus network

3.5.1 The network developed under this work package does not envisage that Sprint and CityLink services will be developed in isolation from the bus network; indeed, it is a crucial aspect of the vision of Birmingham Connected that the public transport network is treated as a 'whole' in order to deliver the optimum benefits. It is therefore not recommended that Sprint or CityLink is introduced in addition to existing bus services, (with the exception of the 'pilot' scheme between Quinton and the City Centre being developed by Centro), but rather that bus services are rationalised and optimised to take account of the greater appeal (in terms of speed, reliability and vehicle environment) of Sprint and CityLink and that conventional bus services are themselves upgraded in order to provide a seamless and attractive network, recognising that even with an extensive mass transit network, many passengers will either rely on buses entirely for their local travel or may need to use a bus service at the start or end of their journey.

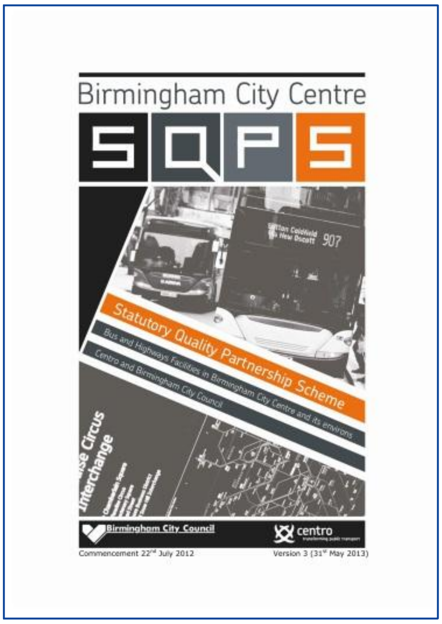
3.5.2 Although the residual conventional bus network is considered to be lower down in the hierarchy of modes of the future mass transit network, it will be of crucial importance to the success of the network overall and therefore must not be 'left behind' in terms of investment or standards of service. Therefore, whichever approach is adopted, key steps must be taken in order to achieve a co-ordinated and attractive public transport network. These are:

- Complete geographic coverage of the city, to the same extent for all operators;
- Low-emission vehicles (technology options and standards for this are given in chapter 7);
- Frequency, timetable and service standards;
- Arrangements to deliver punctual services; and
- Transparency of performance and monitoring data.

3.5.3 Such improvements to the bus network should be coordinated across the city and between operators and therefore it will be necessary to formalise the development and implementation of bus network reviews and upgrades. A number of regulatory options exist to create the right mechanism for delivering the future bus network (and are reviewed in more detail in section 10.1 and Appendix 2) with some of these already employed in and around Birmingham.

3.5.4 Birmingham city centre is covered by an existing Statutory Quality Partnership Scheme (SQPS), which was signed in 2012 and is due to be in place until 2022 (mid-way through the Birmingham Connected period). The SQPS is one of very few statutory schemes in England and was successfully negotiated with the bus operators, including new arrangements for terminating bus services at a number of 'interchange' points on the edges of the central area. One of the objectives of the proposed Sprint network is to improve connectivity of services in the City Centre, including the reintroduction of cross-city routes, without any adverse impacts on emissions within the SQPS area. Indeed, the introduction of new technology (as described in chapter 7) is intended to reduce greatly current emission levels.

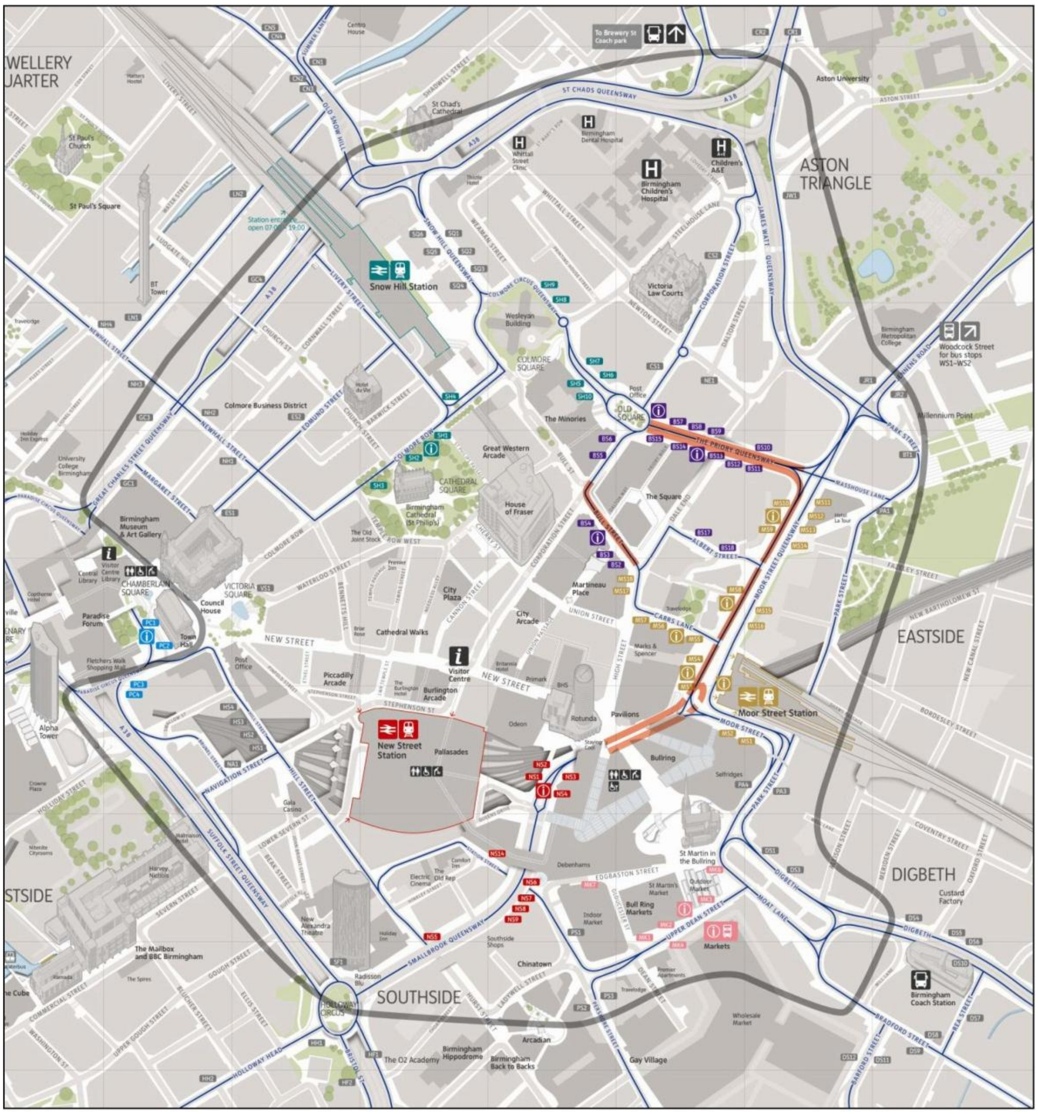
Figure 3.2 Birmingham City Centre Statutory Quality Partnership Scheme document



3.5.5 Given its status as the first SQPS for Birmingham, it is understood that the authorities (BCC and Centro) compromised on emissions and other vehicle standards, based on planned and realistic fleet replacement strategies of the bus operators, in order to ensure that the slot-booking system could be implemented within the requisite timescale. This is an understandable approach in the circumstances and negotiating, or if necessary imposing, higher standards in future will be made easier by its existence. It should however be recognised that while the SQPS sets standards which apply to all core bus services which operate in the area, the standards are the minimum applicable at the time of implementation, rather than containing any stretching targets for the improvement of services and the fleet used (e.g. in terms of accessibility and emissions).

3.5.6 Where the SQPS does require bus companies to provide service levels in excess of statutory minima, or to act in a controlled manner, the requirements are fairly limited (such as no additional fare costs for onward travel within the SQPS area) and infrastructure-based (i.e. adherence to a slot-booking system for bus stop allocations). While the latter was the primary objective of the authorities and is necessary for the prudent management of scarce road space within the city centre, it does not provide any additional benefits to the network such as by informing route alignments.

Figure 3.3 Birmingham City Centre SQPS Area



3.5.7 By its nature, the SPQS formalises responsibilities of both the operators and public authorities and therefore a considerable portion of the SQPS is concerned with the specification and maintenance of highway and passenger infrastructure (e.g. information displays and shelters).

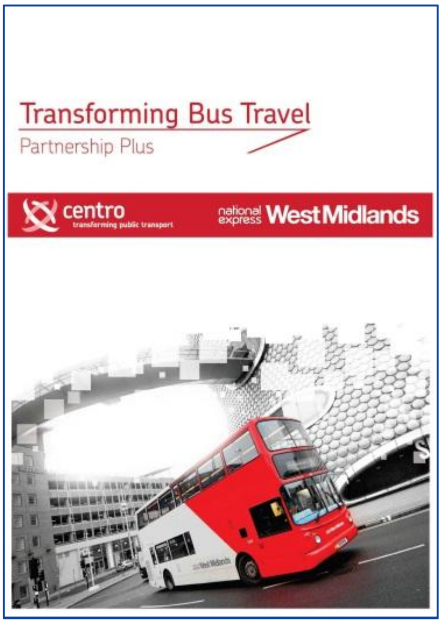
3.5.8 Multi-operator standards are also currently encouraged by means of Voluntary Multilateral Bus Partnership Agreements, which cover (or have covered) North Birmingham and Sutton Coldfield, East Birmingham and North Solihul, Coventry and Wolverhampton and West Walsall. The types of actions covered by these agreements are typically:

- ticketing and fares;
- vehicle specification and driver training;
- branding and marketing;
- data sharing of punctuality and monitoring;
- commitment to principles of ‘Transforming Bus Travel’ (Centro’s vision); and
- infrastructure, journey times and highway enforcement.

3.5.9 The quantified target outcomes typically concern increased passenger satisfaction and patronage (of between 2 and 6%, depending upon the area). Although the publication of results of progress is promised, none are currently publicly available.

3.5.10 Birmingham also benefits from the regional voluntary partnership agreement – Transforming Bus Travel Partnership Plus – between National Express West Midlands and Centro, which does include commitments to improving the delivery of services across categories such as partnership, information, safety, highways, ticketing, customer engagement, staff, marketing, vehicles, infrastructure and cost control.

Figure 3.4 Transforming Bus Travel Partnership Plus document



3.5.11 The agreement covers 83 specific deliverables during the period of 2013 – 2015. The main points are identified by Centro and NXWM, as being:

- Introduction of SPRINT bus rapid transit;
- Ten new 'gold' corridors with significantly improved vehicles, information and bus priority[5];
- 300 new buses, of which at least 15 will be hybrid;
- 350 new bus shelters, plus a new bus station in Merry Hill;
- 150 new RTI displays;
- South Birmingham network review and refreshed VMAs;
- Swift smartcard for all modes of travel, with full range of ticket types;
- As far as commercially viable, NXWM average fares rises limited to RPI + 1%;
- Further action on Safer Travel, taking this industry-leading scheme to a new level;
- More CCTV on buses, with real time monitoring from police command centre;
- Expanded on-bus cleaning programme;
- Golden rules of customer service rolled out to all drivers and staff – and rewards for excellent service; and
- Working with districts to enhance bus priority and reduce journey times.

[5] These are now referred to by NXM as 'Platinum' services

3.5.12 NXWM's 'Platinum' and Arriva's 'Sapphire' brands are indicative of the kind of enhancements which should be made to existing bus services as they feature, among other things, targeted route scheduling, better seating, on-board Wi-Fi and better driver training, all packaged with a more striking livery.

3.5.13 In summary, the above partnership documents demonstrate the structural issues within the bus industry – bus operators are more willing to commit to improvements where it is in their commercial interest to do so, and where such changes are voluntary, but will typically only agree to mandatory enhancements where the onus on the public authorities is equal (or greater).

3.5.14 While the existing City Centre SQPS provides a solid basis for the current operation of services, its limitations in terms of geographic scope and marginal overall increase in standards of service mean that significant development will be required in order to achieve the overall aims of Birmingham Connected. The regulatory regime options to be followed in order to secure the delivery and overall benefits of Sprint and CityLink are considered further in section 10.1 (and Appendix 2), but the potential of the SQPS option means that it should be possible to deliver significant improvements to the residual conventional bus network without pursuing the option which would give most control, Quality Contracts.

3.5.15 It is however acknowledged that mechanisms with significant voluntary or negotiated elements can risk weakening confidence of stakeholders that all public transport will actually improve in line with expectations of the Birmingham Connected vision. Therefore the option of Quality Contracts, potentially tailored by mode, has to be retained, although the challenges of introducing Quality Contracts mean that this is by no means certain to be delivered by the Authorities.

4 Meeting Birmingham's future needs

Key points

- The Birmingham Connected Sprint network has been thoroughly re-evaluted
- Route-specific factors, such as population and Green Travel Districts, have been used to project future demand, in order to develop the network robustly
- Network-wide considerations have also been taken into account including the Birmingham Development Plan, HS2 and regional connections

4.1 Public Transport network (Green Paper)

4.1.1 The public transport network proposed in the BMAP Green Paper was derived from the vision for Birmingham to develop mass transit in order to function as a major city on the international stage. The brief for this work package required a more detailed assessment of the viability and suitability of mass transit modes to given routes and corridors and also to review potential route alignments and connectivity to key locations, specifically in relation to the Birmingham Development Plan (BDP) growth areas. The realisation of the growth aspirations of the BDP will be fundamental to the level of economic activity within Birmingham over the period of Birmingham Connected and the assumptions around jobs and residential development are based on the projection of population growth of 150,000 by 2031.

4.1.2 The BMAP Green Paper highlighted that one of the objectives of investing in the public transport system through the Sprint proposals is to accommodate a forecast increased demand for public transport trips. Four specific sources of likely increased public transport usage in Birmingham have been identified:

- Forecast increases in population and employment;
- Increased public transport usage from delivering a step change in provision through the introduction of a mass transit network (predominantly based on Sprint);
- The introduction of cross-city Sprint bus services; and
- Modal shift from the introduction of Green Travel Districts.

4.1.3 Each of these sources of demand have been considered as they relate to each individual mass transit corridor and have been factored into the viability assessment which underpins the revised network presented in section 4.4.

4.2 Re-examining the network

4.2.1 The future mass transit network presented in the Green Paper was derived from existing knowledge of the current public transport network. In order to validate the Green Paper network, the first task was to approach the network afresh, in order to gain a thorough understanding of public transport demand in terms of current and future catchment areas. This review has been based on 2011 Census data at the Lower Layer Super Output Area (LSOA) level, mapped against the routes as the have been developed during the work package, and the input existing bus patronage data used in PRISM (described more fully below). This section therefore considers the existing demand for bus-based travel on the key corridors and orbital routes and, combined with the future growth assessment that is outlined later in section 4.3, enables this work package to make definitive recommendations for public transport based on the forecast viability of individual services.

4.2.2 The detailed route alignment and the Census data has been analysed in a geographic information system (GIS), using a reasonable walking distance of 400m, as the likely limit within which people are likely to walk to a high-quality, high-frequency mass transit service. Given the city's plans for jobs growth, and the need to tackle peak-hour commuting, a particular focus has been given to demand arising in connection with employment. The results by Sprint and CityLink route are provided in Table 4.1.

Table 4.1 Current bus demand within 400m of mass transit network

Sprint/City Link route	Residents	Residents in employment	Bus patronage (per day)	Proportion of those in employment using bus
1	184,600	96,131	18,472	19.22%
2A/2B	492,924	275,783	51,307	18.60%
3A/3B	414,286	220,191	37,041	16.82%
4	364,787	188,644	29,552	15.67%
5	340,561	205,367	31,392	15.29%
6A/6B	311,865	182,963	29,891	16.34%
7	170,815	108,466	17,118	15.78%
11	558,307	315,016	63,908	20.29%
8	293,251	130,873	28,274	21.60%
12	125,202	63,187	14,039	22.22%
13	166,216	85,684	14,007	16.35%
14	100,551	51,979	10,279	19.78%
16A/16B	432,712	238,109	43,211	18.15%
17	115,275	130,873	10,913	16.74%

4.2.3 It can be seen from table 4.1 that most corridors are within the band of 15 – 20% of residents in employment using current bus services, with only 3 routes exceeding 20%. Given the aim of making the mass transit network carry the majority of travellers along the given corridors, the scale of the challenge for Birmingham Connected is clearly considerable, and will have to be met by substantial interventions if it is to be achieved.

PRISM

4.2.4 Another measure of public transport usage, as part of overall travel patterns, is the Policy Responsive Integrated Strategy Model (PRISM), which is the transport model of the West Midlands, formed of a highway assignment model and a public transport (PT) assignment model using the VISUM software package, linked with a demand model built in ALOGIT.

4.2.5 PRISM's function includes the ability to take account of defined scheme and policy interventions to model the likely change in patronage and mode share of all transport modes from a base year to a future year. By varying the input parameters, it is possible to generate significant variations in expected outcomes, with each variation being tested either in isolation or in aggregate with other interventions when the model is run.

4.2.6 Further runs of the model are expected as a result of the Birmingham Connected work packages however these are not expected to be available for review prior to the completion of the work package reporting. The public transport package has provided inputs and agreed assumptions about the development of the public transport network with the PRISM team however these are, in some cases, broad-brush as a list of detailed schemes is not an expected output of this work package.

4.2.7 Previous public transport-specific outputs have relied on an older version of the model which relied on historic data, with the most recent version based on a household travel survey from, and validated to, 2011. This later version models a reduction in bus usage, with a transfer to rail and Metro. While such a trend reflects current bus usage, it is not reflective of the investment and improvements in non-rail based mass transit envisaged by Birmingham Connected. It is therefore not feasible to rely on existing PRISM outputs to provide a detailed assessment of the viability of individual Sprint routes at this stage. Consequently, the assessment within this report has been developed from first principles and raw data used by PRISM in the 2011 base year, rather than from modelled future public transport usage.

4.2.8 By reviewing both sets of data, and developing the viability assessment in light of them, it has been possible to update and develop the indicative network presented in the Green Paper to reflect the more detailed information available about the nature of current and future demand on each corridor, and the network detailed in section 4.4 also reflects the balance of making cross-city connections where there are sound network-planning benefits from the more efficient use of resources.

4.3 Future Viability Assessment

4.3.1 Having considered the potential and current demand, the projection of future patronage will be a key deciding factor in the progress to CityLink, Sprint or indeed, in time, to Metro and is therefore a key element of the overall viability assessment.

4.3.2 It is essential that the mass transit network both provides for and facilitates the growth plans of the city, and therefore the single most important factor in the projection of future patronage is the impact of population and employment growth, which has been set out in the Birmingham Development Plan. This factor has been varied by corridor, based on the degree to which an individual route is understood to vary from the typical growth rate, which itself is an ambitious target for the period until 2031. Clearly, if economic growth does not occur in the timescales or the extent envisaged, the case for progressing given corridors to Sprint operation will need to be re-evaluated.

4.3.3 The other factors used in the calculation have been applied to the current level of patronage, based on their applicability (or not), to each leg of each Sprint route:

- ‘Sprint’ factor – by making a radical improvement to journey time, comfort, convenience and standards of service, an increase in usage over current bus services has been applied at a uniform rate of 10%. Where Park and Ride sites (described in Chapter 5) are recommended, these have been applied at an additional factor of 5%;
- Green Travel District factor – the investment in sustainable travel recommended by another Birmingham Connected work package will enhance the awareness and convenience of the Sprint network; even where Sprint serves a GTD, not all residents and workers will be within walking distance of a Sprint route and the impact of this on Sprint routes has been varied accordingly; and
- Cross-city factor – by improving connectivity, and making overall journey times quicker as well as achieving better permeability of the city centre, an increase in usage has been applied at 5%.

4.3.4 The impact of each of these factors, on each of the Sprint routes, is shown in Table 4.2.

Table 4.2 Sprint network viability assessment factors

Sprint/ CityLink route	Alignment	Population and employment factor	Sprint factor (with Park & Ride)	Green Travel District factor	Cross-city factor
1	Walsall – Birmingham	33%	15%	2%	0%
2A (north)	Pheasey – Kingstanding – City Centre	33%	10%	2%	5%
2B (north)	Hillhook/Falcon Lodge/Roughley – Sutton Coldfield – City Centre	23%	10%	4.5%	5%
2A/2B (south)	City Centre – Maypole – Shirley/Druids Heath	23%	15%	1%	5%
3A (south)	Frankley – Longbridge - City Centre	43%	10%	5%	5%
3B (south)	Frankley – City Centre	43%	10%	3%	0%
3A (north)	City Centre – Hamstead	23%	10%	1.5%	5%
4	Solihull – City Centre	23%	10%	0%	5%
4	City Centre – Castle Bromwich	33%	10%	0%	5%
5	Quinton – City Centre	23%	10%	0%	5%
5	City Centre – Birmingham International	33%	10%	3.5%	5%
6A	Bartley Green - Woodgate - Harborne – City Centre	23%	10%	0%	0%
6B	Kitwell - Bartley Green - QE Hospital - Harborne – City Centre	23%	10%	2%	0%
7	Halesowen – City Centre	23%	10%	0%	0%
11	Outer Circle	3%	5%	2.75%	0%

4.3.5 Clearly, in the event that the scale and nature any of the factors identified in this assessment changes, a consequential impact would apply to the overall viability assessment and the prioritisation of the order of Sprint route implementation.

4.3.6 Having determined a level of future patronage, the assessment of viability by route is dependent upon the calculation of revenue and cost. Based on the 2031 AM peak hour patronage forecasts for the Sprint network, annual revenue has been calculated for each route and where a Sprint route operates cross-city, estimates have been calculated for each leg of the route. The assumption used in the revenue calculation is that an average fare for travel on Sprint services will be £2 (at current prices), which is consistent with values used in previous PRISM outputs.

4.3.7 The Birmingham Connected network planning element of this work package is described in section 4.4, and one of the key outputs shared with the other Birmingham Connected work packages is the measured length of the route network. Using the target average speed for sprint or the current speed where it is higher, it has been possible to calculate the number of vehicles required to provide the frequencies of service envisaged. This number of vehicles, which obviously varies by route, has been incorporated into the viability assessment and a unit cost per vehicle has been determined to reflect both the direct annual operating costs (drivers' wages, fuel, maintenance etc.) and overhead and vehicle capital costs, based on the higher specification of Sprint vehicles. Given the bespoke nature of the intended design of Sprint vehicles, compared at least to other BRT schemes in the UK, this value is somewhat higher than would be anticipated for CityLink and conventional bus services, but is considered reasonable at this stage.

4.3.8 Based on the revenue and cost calculations described above, the following services are all estimated to be viable for operation as Sprint, but with understandably varying levels of viability, which is summarised in Table 4.3. The individual operational viability values are presented in Table 4.4.

Table 4.3 Sprint service viability assessment

Sprint route	Alignment	Overall viability assessment
1	Walsall – Birmingham	Very positive
2A/2B	Pheasey/Sutton Coldfield – City Centre – Maypole – Shirley/Druids Heath	Marginal
3A/3B	Frankley – Longbridge – City Centre – Hamstead	Very positive
4	Solihull – City Centre – Castle Bromwich	Very positive
5	Quinton – City Centre – Birmingham International	Positive
6A/6B	Kitwell – Bartley Green – Woodgate/QE Hospital – Harborne – City Centre	Very positive
7	Halesowen – City Centre	Very positive
11	Outer Circle	Positive

4.3.9 This viability assessment is based on the combination of a number of factors and assumptions, where naturally any significant change in any one of the inputs could have an important impact on the resultant outcome. The overall evaluation of suitability of routes to go forward in a Sprint programme will therefore be based on a number of other considerations, and which is presented in section 10.2.

4.4 Developing the Birmingham Connected Vision

4.4.1 In the BMAP proposals produced in 2013, a high level vision was developed with an indicative set of Sprint mass transit routes to complement the more limited number of Metro routes. This was based on an overview assessment of current usage and demand derived from the current road-based service levels of public transport. The opportunity to utilise disused rail lines and other brownfield corridors in Birmingham is strictly limited, and consequently the assessment was based on the premise that a mass transit system would largely need to be based on the existing highway corridors. It was also a key element of the strategy that Bus Rapid Transit services can be implemented in a significantly quicker timescale than rail based tram or Light Rapid Transit (LRT), as well as being a lower-cost solution. Whilst the planned extensions of the Metro system, including a new line to Birmingham Airport, form a key element of the proposed mass transit network, the priority of the Birmingham Connected Vision is that Birmingham needs and deserves a comprehensive mass transit system in the shortest possible timescale, and that the proposed strategy is the most effective way of delivering this.

4.4.2 However, this strategy is not intended to be an 'either, or' determination, but should allow for the potential to 'convert' Bus Rapid Transit to a rail-based system, provided that the potential usage and the business case justifies the investment, and that a satisfactory rail-based system can be accommodated physically, given the constraints discussed elsewhere in this report.

4.4.3 In simplified terms, there is no reason why a significant start cannot be made in introducing Sprint services to Birmingham in the five year period up to 2020, whereas it is extremely unlikely that even one new LRT line could proceed through the detailed feasibility, planning and financing stages for an introduction before 2025. There is a concern that 'converting' a Sprint service to a Metro-type service would be made more difficult by the 'scheme benefits' of upgrading the service level from conventional bus services to Metro being partially or wholly taken up by the interim Sprint service. Whilst this is accepted as a potential risk, the ultimate decision should, in reality, be made on the basis of how pressing it is felt the need is for Birmingham to develop an extensive and complete mass transit system.

4.4.4 The importance of Sprint has been clearly recognised, and Centro has already obtained access to funding for the development of a pilot Sprint service between Quinton and the City Centre, which it is hoped will be operational by 2017. A second Sprint route is planned between the City Centre and the International Airport/HS2 Interchange via Coventry Road, with a view to completion by 2021.

4.4.5 Whilst both these proposals are completely in tune with the BMAP Green Paper Vision, we believe that the development of Sprint needs to be accelerated, such that a complete network covering the key corridors into the centre of Birmingham, other than any earmarked for Metro services, should be in position by 2030. Consequently, this report considers the initial outline Sprint proposals in the BMAP Green Paper and attempts to assess whether they remain fully valid, or whether detailed adjustments are needed in order to take account of operational, financial or practical considerations.

4.4.6 In order to assess the potential viability for the outline Sprint network proposed in the BMAP Green Paper, the following methodology has been undertaken:-

- Assessment of current major corridors in terms of current service frequencies, routeings and usage;
- Identification of catchment areas, development proposals (from the Birmingham Development Plan, as described in section 4.5, and including GTDs) and consequential potential future usage based on improved services and time savings;

- In order not to destabilize the new or the existing network, a working assumption that any new Sprint services will replace identified key bus routes, and integrate with the remaining network;
- Use of the BRT principle that once vehicles reach the end of the priority corridor, they can, if required, continue by 'fanning out' to serve high density areas or other specific locations – this is in contrast to an LRT system, where it would be necessary to design a series of localised feeder bus services to allow all passengers not within walking distance to be transported to access the LRT; and
- Application of the criteria set out in paragraph 3.3.4 above.

4.4.7 The net result of the reassessment is that the proposed corridors in the Green Paper are generally robust in terms of their potential use for Sprint services, but with the following alterations and adjustments:-

- Several corridor routes have been joined together to create further cross-city services, which are more feasible as a consequence of priority measures for Sprint and also have the benefits of increased connectivity and reduced stand time for vehicles in the City Centre;
- Cross-city services have been reconfigured to match more closely their proposed frequencies, thus minimising or eliminating any need for 'short workings' that would need to terminate in the City Centre;
- Particular attention has been given to cross-boundary connectivity, as described in further detail in section 4.9 below;
- The CityLink service previously proposed in the Green Paper between Sutton Coldfield and the City Centre has been upgraded to Sprint status, in view of current usage and the potential for growth as a result of forecast new development adjacent to that corridor;
- The Inner Circle route 8 has been changed from Sprint service to CityLink, in view of the potential difficulties in achieving the required average speed for a Sprint service (20 kph);
- Various extensions have been added at the ends of the Sprint routes, which are not part of the priority corridors, but which replicate existing service coverage;
- In view of the priority given by Centro to the proposed Metro service between the City Centre and Birmingham Airport via Bordesley Green and Chelmsley Green, it is envisaged that this route will be developed initially as Metro without an interim Sprint service being required.

4.4.8 Figure 4.1 shows the network of proposed Sprint and City Link services, followed by table 4.4 which sets out the operational details of the Sprint routes. As noted in paragraph 1.3.3, a Sprint route to serve the A34 corridor has been included in the network map, but was not included in the underlying analysis carried out for this report.

Figure 4.1 Revised Birmingham Connected public transport network

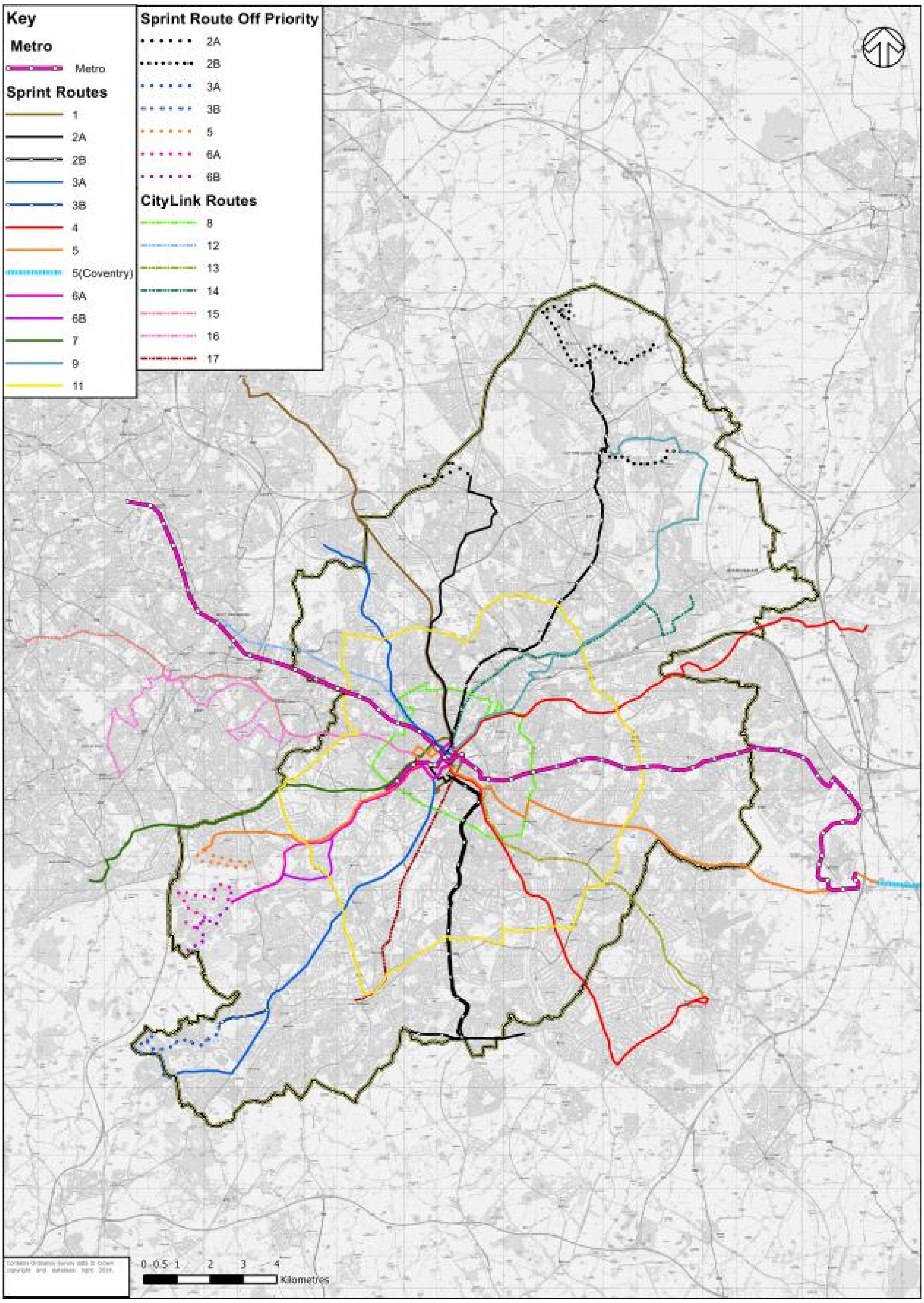


Table 4.4: Proposed Sprint services operational details

Sprint route	Main locations served	Proposed peak frequency	Proposed off-peak frequency	Number of peak buses required	Passengers per day	Operational viability (per annum)	Current bus routes replaced in full	Comments
1	Walsall - Great Barr - Perry Barr - Snow Hill - HS2 Curzon Street - Markets Area	6 minutes	7.5 minutes	13	15,800	£2.3million	X51	Requires rebalancing of frequencies between X51 and 51
2A	Pheasey - Kingstanding - Perry Barr - Birmingham New Street - Markets Area - Kings Heath - Maypole – Shirley	10 minutes	10 minutes	17	16,689	£2.4 million	33/50	Includes routes 902/904/905 into Sutton Coldfield. The combination of 2a and 2b would provide a frequency of 14 Sprint vehicles per hour between the City Centre and Maypole
2B	Hillhook/Falcon Lodge/Roughley - Sutton Coldfield - Yenton - Erdington - Birmingham New Street - Markets Area - Kings Heath - Maypole – Druids Heath	7.5 minutes	7.5 minutes	28	14,563	-£2.5 million	902/904 / 905/50	
3A	Frankley - Longbridge - Selly Oak - Birmingham New Street - Moor Street - Handsworth Wood - Hamstead	7.5 minutes	10 minutes	25	15,685	£2.3 million	16/61/63	The main service is split at Northfield to cover both major bus routes to Frankley. Service 3A operates cross-city.
3B	Frankley - Selly Oak - Birmingham New Street - Moor Street	10 minutes	10 minutes	19	14,182			
4	Coleshill Parkway - Water Orton - Washwood Heath - Birmingham	7.5 minutes	7.5 minutes	28	23,996	£2.2 million	70/6	

	Moor Street - Digbeth - Sparkbrook - Hall Green - Solihull							
5	Woodgate Valley North - Harborne - Birmingham Snow Hill - Small Heath - Sheldon - BHX - HS2 Interchange	10 minutes	10 minutes	19	14,720	£0.7 million	24/900	The section between the City Centre and BHX forms Centro's next priority for Sprint after service 7 (see below). Possible eventual extension of service to Coventry
6A	Bartley Green - Woodgate - Harborne - Birmingham New Street - Law Courts	12 minutes	12 minutes	14	16,160	£2.1 million	22/23	Combined frequency on main corridor will provide bus every 6 minutes
6B	Kitwell - Bartley Green - QE Hospital - Harborne – City Centre	12 minutes	12 minutes					
7	Halesowen – City Centre NOTE: Centro plan to introduce a pilot Sprint service between Quinton and the City Centre – this proposed service would build upon the pilot and extend the service to Halesowen	7.5 minutes	7.5 minutes	12	12,153	£1.9 million	9	The Stourbridge - Halesowen - Birmingham route would need to be replaced by a new variation of route 9 operating on a limited stop basis between Halesowen and Birmingham
11	Outer Circle (Clockwise and Anti-Clockwise)	7.5 minutes	7.5 minutes	36	29,459	£2.1 million	11	

4.4.9 The values presented in table 4.4 are those projected for the end of the Birmingham Connected period and therefore a phased approach to the introduction of the frequencies is likely to be appropriate both in operational and financial terms.

4.4.10 While the development of the mass transit network has identified and proposed high frequencies and capacity on key corridors, the needs of peripheral areas have not been ignored. As set out in paragraph 4.4.6, the development of the network has resulted in the majority of Sprint routes (2A, 2B, 3A, 3B, 5, 6A and 6B) extending beyond the priority section to the outer edges of the Birmingham Connected area and onwards into the West Midlands region (as described in section 4.9). The proposals for Mass Transit Interchanges (as set out in section 8.2) also set out how modes can support the mass transit network, thereby providing enhanced journey opportunties for those who are peripheral to the urban area and the more discreet areas which are closer to the urban centre, but not immediately adjacent to the route alignments of the mass transit network.

4.4.11 Although the mass transit network has been developed to be deliverable based on sound network planning and projected demand, it is also imperative that the network feeds into other plans and initiatives and the most important and relevant of those are:

- Birmingham Development Plan;
- HS2;
- Green Travel Districts;
- West Midlands regional connections; and
- Accessibility.

4.4.12 Each of these is reviewed in turn in order to demonstrate the context in which this work package has been developed.

4.5 Birmingham Development Plan

4.5.1 The Birmingham Development Plan (BDP) provides the strategy to drive forward the city's ambition to be "renowned as an enterprising, innovative and green city that has undergone transformational change growing its economy and strengthening its position on the international stage"[6]. The pre-submission version, published in December 2013 for consultation, set out the framework to guide future development across the city and contained a number of policy statements of particular relevance to public transport.

4.5.2 One of the primary objectives is to "provide high quality connections throughout the City and with other places including encouraging the increased use of public transport, walking and cycling".[7]

4.5.3 The BDP intends to strengthen the role of the City Centre and beyond it, significant opportunities for growth are identified as follows:

- Greater Icknield: 3,000 new homes to the west of the City Centre;
- Aston, Newtown and Lozells: 700 new homes, up to 10,000 m^2 of office space and up to 20,000 m^2 of comparison retail, including the growth of Perry Barr district centre.
- Sutton Coldfield Town Centre: up to 30,000 m^2 of comparison retail floor space and up to 20,000 m^2 of office floor space to improve the current limited retail (and leisure) offer.
- Langley Sustainable Urban Extension: 6,000 new homes on land removed from the Green Belt;
- Peddimore: 80 hectares of new employment land;
- Bordesley Park: 750 new homes and 3,000 new jobs;

[6] http://bigcityplan.birmingham.gov.uk/

[7] Page 18, paragraph 3.5

- Eastern Triangle: 1,000 new homes of which 350 are at Shard End;
- Selly Oak and South Edgbaston: up to 25,000 m^2 of comparison retail floor space and up to 10,000 m^2 of office floor space at Selly Oak district Centre, with 700 new homes at the former Selly Oak Hospital Site; and
- Longbridge: 1,450 new homes, 13,5000 m^2 of retail floor space and 10,000 m^2 of office space.

4.5.4 Supporting these specific sites, the BDP adopts policies specifically in relation to connectivity, which Birmingham Connected is explicitly stated to develop further. The policy in respect of public transport (TP40) is shown in figure 4.2.

Figure 4.2 BDP public transport policy

Policy TP40 Public transport

Bus and Coach

The bus remains by far the most important mode of public transport in Birmingham. There continues to be a challenge in making bus travel attractive as a sustainable alternative to the private car.

The City Council will continue to work with Centro and bus operators to improve the bus network by:

- Supporting partnership measures to develop and improve the bus network including the City Centre Statutory Quality Bus Partnerships and Bus Network Reviews.
- Ensuring that road space is managed efficiently to support public transport through initiatives such as SMART routes and other bus priority measures and infrastructure.
- Ensuring that adequate coach access is provided for as part of new developments where it is required.

Rail

Proposals to enhance the City's rail network will be supported, including:

- Reopening the Camp Hill and Sutton Park railway lines to passenger services.
- The delivery of the Camp Hill Chord scheme and the facilitation of services from the Camp Hill line and from Tamworth/Nuneaton to run into the new platforms at Moor Street station.
- The provision of new stations at Kings Heath, Hazelwell and Moseley on the Camp Hill route, Walmley and Sutton Park on the Sutton Park route, at the Fort and Castle Vale and at Soho Road on the Wolverhampton and Walsall route.
- Redevelopment of Snow Hill station and reinstatement of Platform 4.
- The expansion of park and ride sites including Kings Norton, Four Oaks and Lea Hall.

Rapid Transit - Midland Metro and Bus Rapid Transit

The development and extension of metro/bus rapid transit to facilitate improvement/enhancement in the public transport offer on key corridors and to facilitate access to development and employment will be supported.

In particular support for:

- An extension of the Midland Metro Tram network from New St to Centenary Square.
- Bus Rapid Transit routes from the City Centre along the Walsall Road and Hagley Road.
- A rapid transit link between the City Centre and Birmingham Airport and the proposed HS2 interchange in Solihull.

Implementation

	Local/ National Funding	Partnerships	CPO	CIL/ Section 106	Planning Management	Other Local Plan/ SPD/Regeneration Framework
Policy TP40	✓	✓	✓	✓	✓	✓

4.5.5 As the BDP addressed connectivity as a whole, the other policies contained elements which contribute to an integrated approach and those which have greatest relevance to public transport are listed in Table 4.5.

Table 4.5 Other BDP connectivity policies relevant to public transport

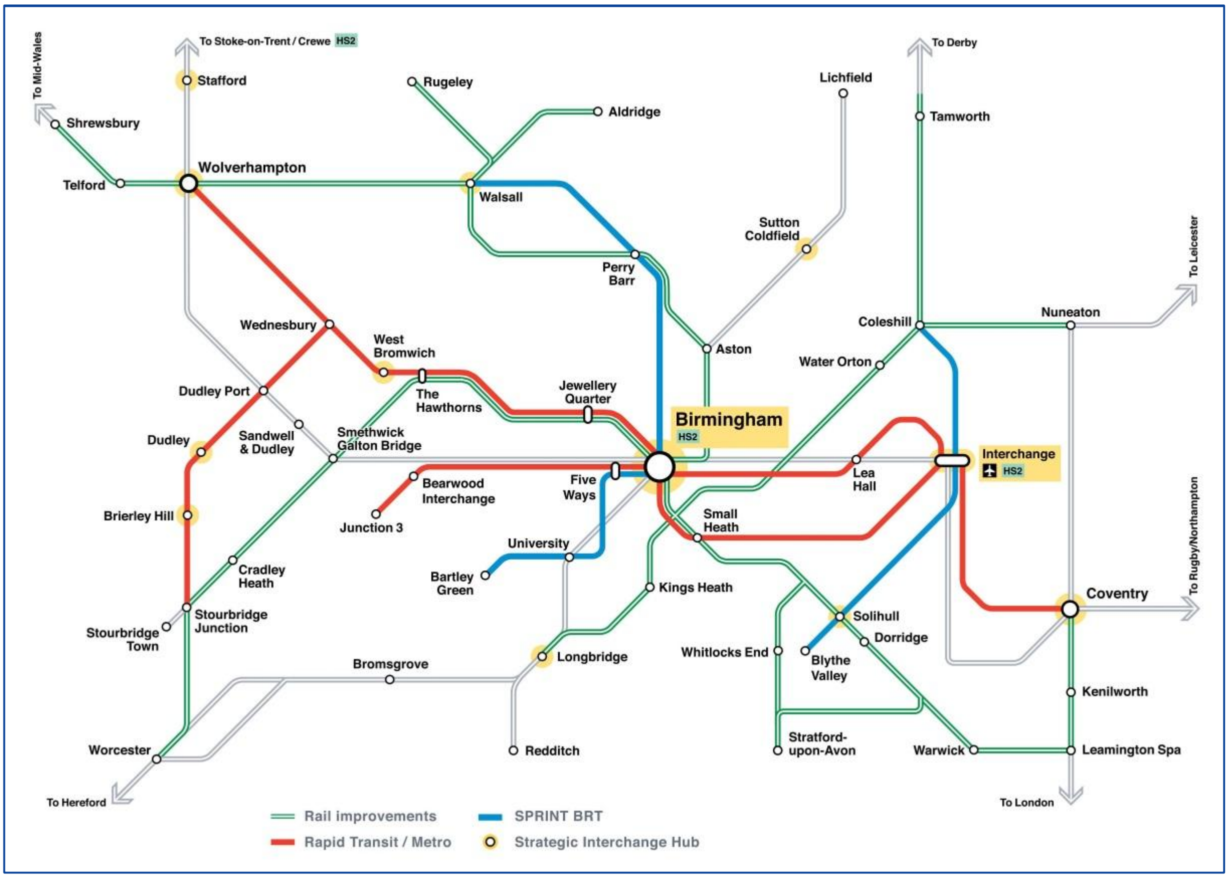
Policy reference	Policy Title	Policy relevance to public transport
TP37	A sustainable transport network	Improved choice by developing and improving public transport, cycling and walking
TP38	Walking	Ensuring new development incorporates high quality pedestrian routes which promote walking as an attractive, convenient, safe and pleasant option for travel including to and from bus stops, train stations and Metro stops
TP39	Cycling	Development of different route types e.g. improvements to major radial roads and other main roads including improved crossing facilities and creating new, quieter, parallel routes, using roads with lowers speed limits and traffic flows, linking residential areas, green spaces, local centres and transport interchanges in order to encourage short trips and offer an alternative to busy A and B roads.
TP41	Freight	Where road haulage is involved in the transport of large volumes of freight or the carrying of bulk materials, planning conditions and obligations will be used to define and agree suitable traffic routes and the need for other necessary environmental and traffic management controls.
TP42	Low emission vehicles	Working with partners to explore how the use of other alternative low emission vehicle technologies can be supported e.g. hydrogen fuel cells across a range of modes e.g. private cars, buses and/or small passenger and fleet vehicles
TP43	Traffic and congestion management	Ensuring that the planning and location of new development supports the delivery of a sustainable transport network and development agenda
TP44	Accessibility standards for new development	An appropriate level of public transport provision (in terms of frequency, journey time and ease) to main public transport interchanges at the most relevant times of day
TP45	Digital communications	The City Council will continue to develop its Intelligent Transport System (ITS) for Birmingham that enhances real-time and interactive information for users to navigate and explore the City by all modes of transport through…working with Centro and operators to provide quality public transport information and easy ticketing

4.5.6 Taken together, the BDP policies are very closely aligned with those in the BMAP Green Paper and developed further in this work package.

4.6 HS2

4.6.1 The ‘West Midlands Connectivity Package’ published by Centro has identified a network and a number of schemes to ‘capture and maximise the distribution of HS2’s potential benefits’. This network is shown in figure 4.3.

Figure 4.3 West Midlands Connectivity Package Network



4.6.2 Schemes for which funding has already been allocated amount to £320m, with unfunded schemes costed at £2.1bn.

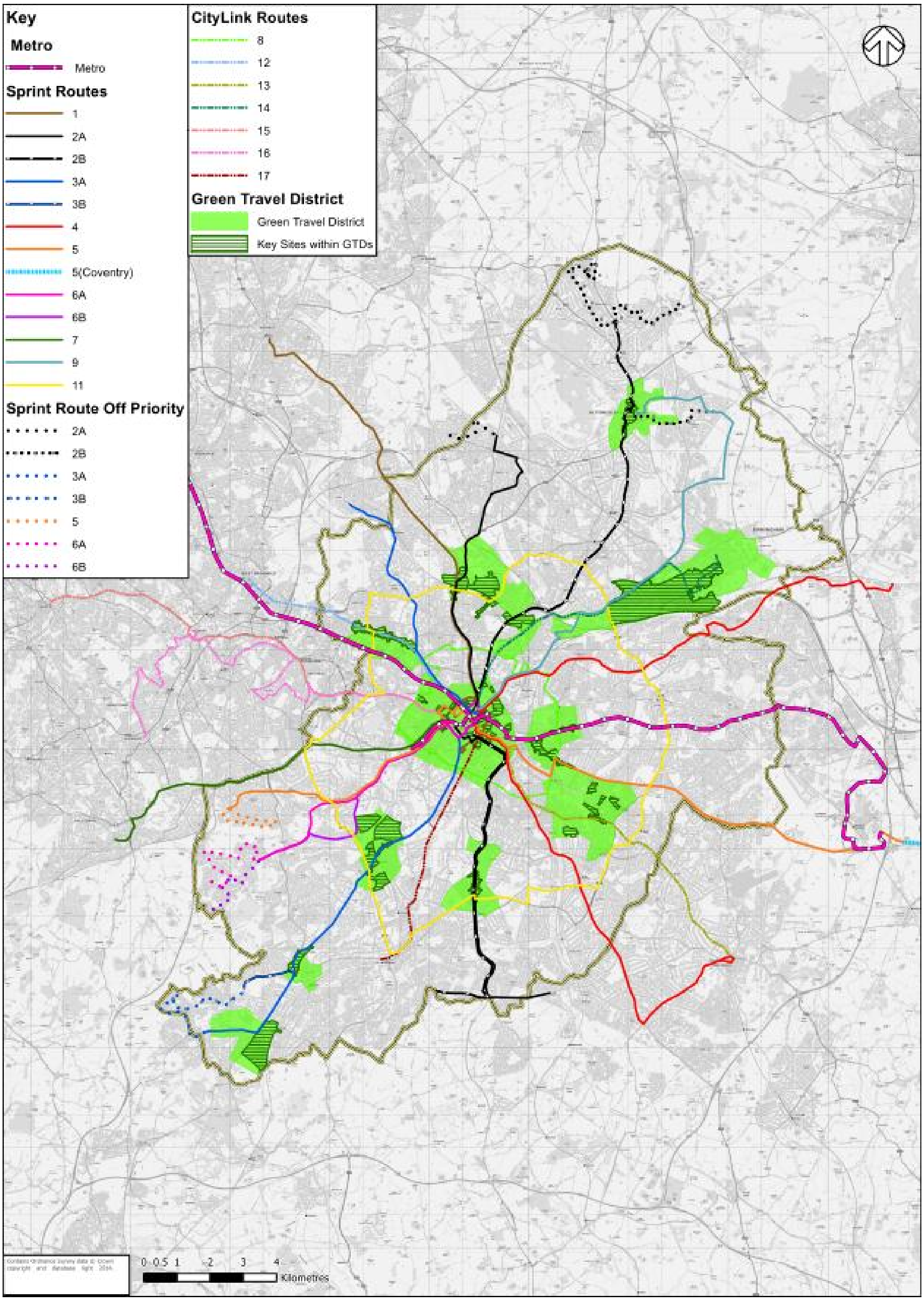
4.6.3 In terms of Rapid Transit/Metro, it will be noted that in the above figure, the planned Metro extension to Five Ways is extended to Bearwood, Quinton and to Junction 3 of the M5, which is assumed to be a Park and Ride facility. This largely parallels Centro’s planned pilot Sprint route, but does not extend to Halesowen as in the proposal for Sprint Route 7 in this report. The proposed Metro Line 2 to Birmingham International Airport is also shown, together with a further Metro service to the Airport via a route paralleling Coventry Road. It is assumed that the latter would be an upgrading of the eastern section of proposed Sprint Line 5, in this report, which is also planned initially to be a Sprint route by Centro. Should this section be converted from Sprint to Metro, the Sprint service from Woodgate Valley and Harborne to the City Centre would no longer operate as a cross-city service.

4.6.4 The only other Sprint services affecting the Birmingham area identified are the Bartley Green to City Centre via University route (equivalent to Sprint Route 6b in this report), and Birmingham to Walsall (equivalent to Sprint Route 1 in this report). In this regard, it is important to note that the series of Sprint routes proposed in this report are considerably more ambitious in terms of providing a comprehensive mass transit system for Birmingham than the Connectivity Package illustrated above, and would also provide a greater degree of connectivity with the HS2 proposals.

4.7 Green Travel Districts – Modal Shift

4.7.1 Although by no means identical to the growth areas identified in the BDP, Green Travel Districts (GTDs) have been developed as part of Birmingham Connected work package 4. The areas covered by the GTDs, relative to the public transport network, are shown in Figure 4.4.

Figure 4.4 Public transport network and Green Travel Districts



4.7.2 Designated Green Travel Districts will be subject to specific interventions covering a broad range of sustainable travel topics. 40 specific interventions, covering infrastructure, technology and other 'soft' measures, have been developed for public transport (including park and ride), with 22 of them considered to have a major or direct impact on the overall objectives of the GTDs. The cumulative impact of all of these measures has been reflected in the assessment of viability carried out for each Sprint route leg, as detailed in section 4.3, as well as being reflected in other elements of this work package (such as park and ride).

4.7.3 Two of the key interventions proposed in the GTDs have network-wide significance for the public transport network:

- The One Card – a multi-modal smartcard; and
- Urban Transport Interchanges (UTI Hubs) – sustainable transport interchanges located on-street to facilitate intermodality.

4.7.4 The BMAP Green Paper envisaged that the "network will be underpinned by a payment system which uses smart technologies, is simple and transparent, incentives sustainable transport and ties into a number of other Council and commercial services". The proposal from the GTD work package is that The One Card is a smartcard with a difference which pulls together a number of functions on one card. The card will pay for public transport but will also be valid to pay for cycle hire, car club, car parking and fuel, and can work as a corporate fuel card to make it easy for individuals and organisations to flexibly choose among a range of transport options for business and other transport needs. The card could also be extended to include leisure membership and library membership similar to the existing Nottingham CityCard.

4.7.5 A network of kiosks should be developed alongside an online portal to make it faster, easier and more cost effective to buy, collect and top up One Cards for journeys in and around the city. A monthly debit program will where the card will track actual use of services and trigger a debit from the customer's bank account at the end of the month to cover the fares should be included.

4.7.6 Further details of how smart ticketing (albeit not necessarily delivered by a smartcard) will support Birmingham Connected are given in chapter 8 and the aspirations set out for The One Card are fully in line with the principles of ensuring that Birmingham Connected is the catalyst for sustainable mobility – and that for any particular journey, the payment system facilitates choice in mobility between different shared modes rather than providing a barrier to multi-modal journeys. It should however be noted that the current Swift smartcard scheme in the West Midlands has not yet reached full roll-out and the challenges of delivering Swift illustrate the gap between the reasonable aspirations of Birmingham Connected and the capacity of current structures to deliver multi-modal public transport. Options for delivery are considered in section 10.1.

4.7.7 The UTI Hubs proposed through the GTDs are intended to promote intermodality, and its enhancement is of vital importance particularly in highly congested urban areas. The weak links in the overall intermodal passenger transport chain are considered to be the intermodal terminals (hubs), as often inadequate planning leads to the reduction of the level of service, thus resulting in a shift to other transport modes, mostly to private vehicles. Instead, an integrated design with emphasis on intermodal super hubs which act as the interface between the different modes not only increases the proportion of commuters who use urban public transport but also consolidates the overall public transport system of an urban area.

4.7.8 Regarding the location of super hubs, it is essential that they are located in central locations, retail centres or employment centres within GTDs where most of the public transport routes pass through. They should also be easily accessible by foot and bicycle. For the latter there should be secure, covered cycle parking spaces available as well as lockers.

4.7.9 It is envisaged that the hubs will provide a community facility and become destinations in their own right with the following characteristics:

- Pedestrian and cycle friendly infrastructure and design;
- Cycle parking and lockers;
- Cycle hire;

- Real time information;
- Comfortable and weather proof waiting areas;
- Parcel collection lockers (for home shopping deliveries);
- A Sustainable Urban Initiatives for Travel shop (SUIT) for personalised travel planning advice;
- One Card (smartcard) top-up and purchase booth;
- A pleasant environment to meet, wait and buy and enjoy refreshments; and
- A communication mechanism for the Green Travel District Associations.

4.7.10 The specification for UTI Hubs is a further development of the concept of Mass Transit Interchanges (set out in chapter 8) and is therefore fully-aligned with the assumptions about how users will connect between public transport routes and services and with other sustainable modes (such as car clubs).

4.8 West Midlands regional connections

Existing cross-boundary connections

4.8.1 The brief for this work package required a more detailed description of how the network and routes will connect into surrounding authorities. Although formal consultation with neighbouring authorities is not within the scope of the brief for this study, in reassessing the proposed Sprint network, priority has been given to ensuring that the amended network fully addresses regional and local traffic objectives wherever feasible.

4.8.2 Current bus services provide a comprehensive and frequent service network, connecting many of the major centres in the West Midlands. However, there are only a limited number of semi-express bus services therefore longer distance public transport links are usually provided for by the local railway network.

Addressing cross-boundary connectivity

4.8.3 The proposals for Sprint services would make substantial changes to operations in the City Centre area. The re-introduction of cross-city services would not only improve local connectivity within Birmingham, but would also be designed to provide better connectivity with the major stations in the centre, including the proposed HS2 station. Thus combined rail/Sprint trips will provide a major improvement for those travelling into Birmingham from the West Midlands and further afield. Almost 25% of the route lengths of the proposed Sprint and CityLink services would be outside the Birmingham City Council administrative area.

4.8.4 Successful bus based rapid transit solutions require the implementation of extensive priority measures, will are described in detail in Chapter 6 below, consequently when considering the benefits of improving connectivity in a regional context, pro-active cooperation will be necessary in order to ensure the integrity of the system as a whole. Given a positive partnership approach, there are significant benefits to be obtained from the Sprint proposals for the individual West Midlands Metropolitan Boroughs and the region as a whole. The following section summarises how the Sprint Network proposed for Birmingham can be used to create wider benefits.

4.8.5 **Walsall**. Sprint Route 1 would provide a rapid link between Walsall and Birmingham, building on the existing X51 bus route. The extension of Sprint Route 2A from Kingstanding to Collingwood Drive, Pheasey would retain and improve significantly the level and quality of service to Birmingham City Centre.

4.8.6 **Sandwell**. Sprint Route 3A to Hamstead would retain and improve significantly the level and quality of service to Birmingham City Centre from that area of Sandwell. CityLink Route 12 would generally improve the quality of the current main bus service between Birmingham and West Bromwich, whilst complementing the established Metro service. Enhancing the current main services between

Smethwick and Birmingham City Centre with proposed CityLink Routes 16A and 16B would provide higher quality and faster journey times, whilst retaining the connections to Dudley/Blackheath and Oldbury from Smethwick.

4.8.7 **Dudley.** As mentioned above, CityLink Route 16A would provide an improved service between Dudley and Birmingham, via Oldbury and Smethwick. Sprint Route 7 is designed to expand on the proposed Centro service by extending it through Quinton to terminate in Halesowen, thus providing an enhanced service between Halesowen and Birmingham City Centre.

4.8.8 **Solihull/Birmingham International Airport**. Sprint Route 2A is intended to provide a new high quality service between Shirley and Birmingham City Centre via Alcester Road South, Kings Heath and Balsall Heath, whilst Sprint Route 4 would provide an improved service between Solihull and Birmingham City Centre via Stratford Road. This Route would continue through the City Centre to Washwood Heath, then through Castle Bromwich to Water Orton and Coleshill Parkway in Warwickshire. Sprint Route 5 is a cross-City service from Woodgate Valley North and Harborne through the City Centre and on to Small Heath and Sheldon to serve Birmingham International Airport and extended to the proposed HS2 Interchange. Birmingham Connected also assumes that the proposed Metro Line 2 will be constructed between the City Centre, Bordesley Green, Chelmsley Wood and Birmingham International Airport.

4.8.9 **Coventry**. Sprint Route 4 would be intended to partially replace the current bus service 900, which operates between Coventry and Birmingham via the International Airport. It may well be feasible to consider extending Sprint Route 4 to Coventry, to create an improved, high quality, link serving a different customer base to that provided by the local, regional and national rail services between the two cities.

4.9 Accessibility

4.9.1 All public transport schemes will be developed to be compliant with the Equality Act 2010 and will be inclusive for people with disabilities. ‘The Access Strategy for People with Disabilities’ will be referenced during all scheme development, in particular the Table of Considerations and the Design Reference Guide that form part of the Access Strategy.

4.9.2 Those tables ensure all types of disability have been considered including locomotive impairments, visual impairments, hearing impairments, reaching, stretching and dexterity impairments and cognitive impairments. The tables have been developed through interaction with groups representing those with specific disabilities and with documents that are approved by those groups.

4.9.3 In the public transport context, the Table of Considerations and Design Reference Guide note that considerations for people with disabilities should encompass the waiting areas, the access / egress to the vehicles, the on-vehicle environment in terms of space and facilities and the information provision, including the positioning of timetables and other information, the simplicity of messaging and the format of the messaging to include visual and audio messaging. Also future fleet changes to include quieter propulsion systems, such as hybrid or ‘pure’ electric vehicles should include acoustic vehicle alerting systems (AVAS).

5 Meeting the need for Park & Ride

Key recommendations

- The criteria for Park & Ride should include increasing parking provison without using valuable city centre land, tackling congestion and reducing pollution
- 2 locations for strategic P&R are identified (Scott Arms and Maypole)
- 6 Micro P&R sites are also identified for more locally-based travel

5.1 Introduction

5.1.1 The brief for this work package required an assessment of more detailed opportunities for park and ride, both in Birmingham and surrounding authorities together with consideration of whether there are opportunities for localised bus-based park and ride or cycle and ride on the network.

5.1.2 As the future Birmingham Connected network is intended to be formed initially by Sprint services, offering a rapid and direct route to the city centre, the focus has been on the identification of sites Park and Ride sites which can be delivered quickly and which would require limited modifications to the Sprint network.

5.2 Current Park and Ride

5.2.1 At present, Park & Ride into Birmingham is entirely focused on rail-based modes, both National Rail and Midland Metro. The majority of Park & Ride stations listed give free parking, with the exceptions usually being places which are destinations in their own right, such as Coventry or Birmingham International. Ownership of the Park & Ride facility is also a deciding factor. At present, those owned by Centro are all free, whilst those owned by rail franchises vary depending on operator policy. The 'ride' fare is the prevailing normal public transport fare.

5.2.2 The following information was retrieved from Network West Midlands and gives the numbers of parking spaces at stations, along with their zones and whether they charge or not.

Table 5.1 Current Park and Ride Provision

Line	Station with Park & Ride Facility	Centro Zone	No of Spaces	Charge
Cross City North	Blake Street	5	155	FREE
	Four Oaks	5	275	FREE
	Sutton Coldfield	4	312	CHARGE
	Wylde Green	4	51	FREE
	Chester Road	3	150	FREE
Coventry	Coventry	5	420	CHARGE
	Canley	5	94	FREE
	Tile Hill	5	129	FREE
	Berkswell	5	132	FREE
	Hampton in Arden	5	68	FREE
	Birmingham International	5	1,390	CHARGE
	Marston Green	4	96	FREE
	Lea Hall	3	28	FREE
Dorridge	Dorridge (Centro P&R)	5	93	FREE
	Dorridge (Chiltern P&R)	5	121	CHARGE
	Widney Manor	4	273	FREE
	Solihull	4	277	CHARGE
	Olton	4	98	FREE

	Acocks Green	3	132	FREE
Shirley	Earlswood Whitlocks End Shirley Yardley Wood Hall Green	5 4 4 3 3	12 45 80 100* 105	FREE FREE FREE FREE FREE
Cross City South	Longbridge Northfield Kings Norton Selly Oak	4 4 3 2	102 205 213 76	FREE FREE FREE FREE
Stourbridge	Stourbridge Junction Stourbridge Town[1] Lye Cradley Heath Old Hill Rowley Regis Langley Green Smethwick Galton Bridge The Hawthorns (also for Metro)	5 5 5 5 4 3 3 3 2	797 353 16 227 51 340* 30 77 184	FREE CHARGE FREE FREE FREE FREE FREE FREE FREE
Wolverhampton	Wolverhampton Coseley Tipton Dudley Port Sandwell and Dudley	5 5 5 4 4	400 87 55 36 369	CHARGE FREE FREE FREE FREE
Walsall	Rugeley Town Hednesford Cannock Landywood Bloxwich North Bescot Stadium Tame Bridge Parkway	5 5 5 5 5 4 4	30 56 87 26 26 122 237	FREE FREE FREE FREE FREE FREE FREE
Metro	Black Lake Priestfield The Hawthorns (also for railway station) Wednesbury Parkway (also for bus interchange)		86 37 184 161	FREE FREE FREE FREE

* Work is presently taking place to add an additional 59 spaces to Yardley Wood
** Work is presently taking place to add an additional 360 spaces to Rowley Regis
1 Dudley MBC managed car park, located just off Birmingham Street, Stourbridge.

5.2.3 The table shows that Rail Park and Ride sites vary in size from 12 parking spaces at Earlswood through to 1,390 at Birmingham International. The total number of spaces is over 9,500 and utilisation in most car parks was above 80% (based on the last published figures in 2009). Although successful there is a need for Park and Ride at locations not served by rail and the remainder of this chapter therefore considers the potential for Park and Ride served by the Sprint network.

5.2.4 The work carried out for the BMAP Green Paper sought to locate Park and Ride provision at several of the junctions around the motorway 'box', where mass transit lines could replace car trips into the city and for new sites, identified Sprint-based Park and Ride on the following corridors:

- Walsall Corridor – Scott Arms
- Druids Heath Corridor – Maypole
- Halesowen Corridor – Quinton Meadows:

5.2.5 The Green Paper also recommended the retention of all existing P&R sites, as detailed in table 5.1, and also proposed to formalise locations where commuters have found convenient places to leave their car before switching to buses, or to avoid city centre parking charges.

5.3 Park and Ride Policy

5.3.1 BCC's Parking Policy (2010) distinguishes between Strategic Park & Ride and local Park & Ride. The former seeks to intercept larger flows to key centres, whilst the latter seeks to influence shorter distance trips.

5.3.2 The council's current policy states that it will, with regard to Park and Ride:

- Support additional provision of Park & Ride facilities at rail stations, Metro stations and bus termini where appropriate.
- Encourage the use of feeder bus services to Park & Ride stations where appropriate.
- Facilitate better access by walking and cycling to all stations and the development of station travel plans.
- Work with Centro and neighbouring authorities to identify and deliver improvements including additional capacity at Park & Ride stations where feasible. Where appropriate, funding should be sought from planning agreements.
- Work with Centro and bus operators to seek to improve feeder services to Park & Ride stations.
- Continue to identify opportunities to improve access to interchanges by walking and cycling.
- Monitor on-street parking close to well used Park & Ride stations and use appropriate measures to reduce the impact on local residents and traffic.

5.3.3 The West Midlands Local Transport Plan (LTP 3, 2011) states that the role of Park and Ride is to "encourage transport users to take public transport for a significant part of their journey". It recognises that the car is essential for a portion of the population in order to start and finish their journey, - but it need not be necessary for the whole journey, especially if they want to access central areas where congestion exists.

5.3.4 The LTP3 sets the following criteria for identifying future Park and Ride sites:

- Park and Ride development will take into account:
- Congestion Benefits
- Frequency, capacity, and quality of the public transport offer
- Environmental, design and traffic impact
- Potential for interchange with other public transport services
- Implications for the wider public transport network

5.3.5 Given Park and Ride's purpose is to displace car parking from congested locations and to encourage modal shift for a substantial portion of the journey, its success (or failure) is intrinsically linked to the availability, quality and price of alternative parking at the destination.

5.3.6 Car parking in Birmingham City Centre is provided by both the City Council and private operators (such as Bull Ring Shopping Centre). The current pricing for City Council car parks includes a special "Shoppers Tariff" which offers 5 hours of parking for £3 after 9.30am. Although attractive, this sort of offer does not necessarily encourage mode shift to non-car modes such as Park and Ride and therefore the pricing element of car parking policy will be considered as part of the City Centre Masterplan Work Package.

5.3.7 It is understood that the BCC will be reviewing its parking policy in 2015 and this will reflect approaches being adopted as a result of Birmingham Connected.

5.4 Criteria for future Park and Ride

5.4.1 The following factors outline the key benefits of Park and Ride:

- It can **effectively increase parking provision** for access to the central area without increasing central area land take. Finding additional land for car parking in city centres is expensive, and the land would often be better used for commercial or retail purposes.
- It can **reduce car journeys and levels of traffic congestion** downstream of the Park and Ride facility, usually on key corridors. Encouraging people to leave their cars on the edges of built-up urban areas obviously reduces trips in those areas which are most susceptible to congestion. When car parks are operating near capacity, drivers tend to circulate in central areas seeking parking spaces, which further adds to congestion and pollution.
- It can **reduce air and noise pollution** downstream of the Park and Ride facility. Reducing the level of and length of trips clearly has a direct impact on air and noise pollution, and this can be enhanced if an existing bus service is utilised or any additional bus service uses modern low emission vehicles.
- It can **reduce the level of long stay car parking** in the city centre. A common approach to enhancing the economic viability of city centres is to deter long stay parking and encourage short stay, in order to increase the number of parking 'visits'. Displaced long stay parking can often be accommodated at Park and Ride sites, and may be more economic and convenient for employees who normally have to pay for scarce parking.
- It **improves accessibility** to city centres. Park and Ride adds a further mode choice to those wishing to access employment and retail facilities, thus enhancing accessibility.
- It can **release central area space** for other uses. In the case of substantial Park and Ride schemes, the additional capacity generated can lead to a reduction in publicly provided parking space in the city centre, and land can subsequently be used for more productive purposes such as retail and commercial development.
- It may have the potential to **generate new business or retail opportunities** at the Park and Ride site. Where Park and Ride sites are located on the periphery of urban areas, it may be possible to incorporate additional commercial premises on the site footprint, subject to planning suitability.

5.4.2 In terms of best practice, a widely-recognised reference work on Park and Ride (Park & Ride Great Britain, TAS Partnership Ltd, 2007) analyses a range of Park and Ride sites to provide a set of guidelines demonstrating the features which a good Park and Ride site should include.

5.4.3 It concludes that car parks should, ideally:

- be located close to the strategic highway network;
- have safe and easy access and egress;
- be sited outside the congested area to maximise the potential advantage;
- have sufficient adjacent land to allow expansion to meet growth in demand; and
- be in keeping with surrounding land uses and meet planning requirements, in particular, those applying to the Green Belt.

5.4.4 Additionally, the 'ride' element should:

- be frequent (more than 4 buses per hour minimum) and reliable. To offer reassurance, it is always useful to have a vehicle at the terminal stop all the time (i.e. as one departs the next one arrives);
- provide a journey time that is competitive with the alternative car journey (and ideally no more than 15-20 minutes in length);

- ensure that costs should be set to be competitive with the alternative car journey (central area parking costs plus any time and cost perceptions regarding the need to drive into the centre and the time spent in finding a parking space, including the cost of fuel);
- charges should thus be set to be competitive with city centre car parking; and
- be designed with the target market in mind, for example if access to retail is an important market, the costs of Park and Ride should take into account the whole family unit (if all passengers in a single car each have to pay a bus fare, this can easily outweigh the parking charge applicable in a city car park).

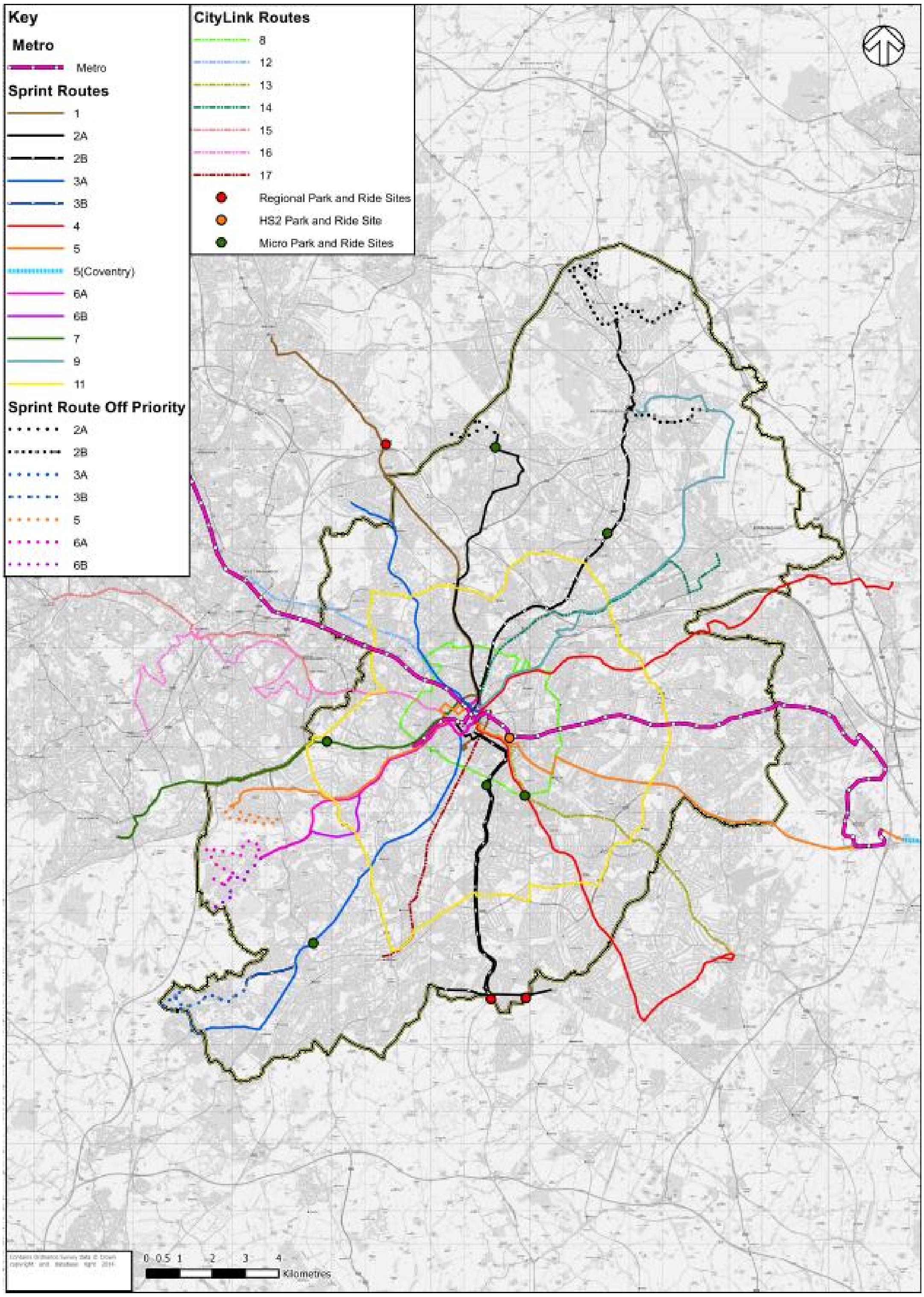
5.4.5 Further research outlined on the KonSULT (Knowledge base on Sustainable Urban Land Use and Transport) website identifies some key areas for further consideration when locating a Park and Ride site, which are as follows:

- enhanced facilities for pedestrians and cyclists should be provided at park and ride sites to encourage modal shift in the case of short access trips (‘Walk and Ride’ and ‘Cycle and Ride’);
- passenger abstraction from local bus services may be experienced in areas where Park and Ride operates in parallel with existing services, and fares on the Park and Ride service are cheaper, unless user costs are carefully structured; and
- park and ride sites further out from the town centre present the greatest savings of mileage to users, although sites too far out from the city centre on radial routes can lead to drivers having to travel longer distances around the edge of the city to reach each site.

5.5 Potential Sprint-based Park and Ride sites

5.5.1 From a list of existing BCC-owned land which may be suitable for development into park and ride facilities, a number of potential strategic and micro park and ride sites have been identified, as shown in Figure 5.1.

Figure 5.1 Potential Park and Ride Sites



Strategic Park and Ride

5.5.2 Strategic Sprint-based Park and Ride sites have been proposed which are aimed at intercepting car drivers on their approach to Central Birmingham. The BMAP Green Paper listed three potential Strategic Bus Based Park and Ride sites (Scott Arms, Maypole and Quinton Meadows). The Quinton

Meadows site has since been discounted due to the lack of a suitable location and the availability of other options on neighbouring corridors. The remaining two sites are described below.

Table 5.2 Potential Bus Based Strategic Park and Ride Sites

Site	Sprint Route	Potential Number of Spaces	Estimated Journey Time to City Centre by Sprint (based on current off peak journey time by bus)
Scott Arms (Site 1)	1	2984	23 minutes
Maypole (Site 2.1)	2A/2B	1241	25 minutes

5.5.3 The location proposed for the Scott Arms Park and Ride site is north of Junction 7 on the M6. It is noted that the GBS LEP proposals refer to a location closer to the Scott Arms crossroads (south of the M6), but the LEP proposals acknowledge that no land is currently available in that location.

5.5.4 The recommended location for the Maypole Park and Ride site is south of the A435/Maypole Lane Roundabout (Site 2.1) with an alternative location to the east on Maypole Lane (Site 2.2).

5.5.5 Other locations considered for Sprint-based Park and Ride included Adderley Park and Longbridge. Adderley Park has been identified by the GBS LEP as a potential site for a Metro Park and Ride to be used primarily for access to the proposed HS2 Station at Curzon Street. This location is on the proposed Sprint Route 5, but is considered too close to the City Centre to be a Park and Ride for the central area. Car drivers are less likely to transfer to Park and Ride if they have almost reached their destination already.

5.5.6 At Longbridge there is currently a large car park adjacent to the A38 and the proposed Sprint Route 3B. However this land has been identified for development and therefore this location has been discounted.

5.5.7 The proposed Sprint-based Park and Ride sites complement existing and proposed Strategic Rail Park and Sites to provide an extensive network of Park and Ride on main corridors into the city centre as demonstrated in Table 5.3.

Table 5.3 Proposed Park and Ride network by corridor

Approach to Birmingham City Centre	Long Distance Connections	Park and Ride Option
A34 (Walsall)	M6 – The North West	**Scott Arms Sprint Park and Ride (Proposed)**
A38(M) (Sutton Coldfield)	M42 – The North East	**Fort Parkway Rail Park and Ride (Proposed)**
A45 (Birmingham International)	M6 – The East	**Birmingham International Rail Park and Ride (Existing)**
A41 (Solihull)		**Tyseley EEA Rail Park and Ride (Proposed)**
A34 (Shirley)	M40 – London, The South East	*No specific provision, but directed to Maypole*
A435 (Kings Heath)		**Maypole Sprint Park and Ride (Proposed)**
A441 (Redditch)		*No specific provision, but directed to either Maypole or Longbridge*
A38 (Bromsgrove)	M5 - The South West	**Bromsgrove Rail Park and Ride (Pending) and Longbridge Rail Park and Ride (Expanded)**
A456 (Halesowen)		*No specific provision, but on proposed Sprint Corridor*
A41 (West Bromwich)		*No specific provision, but on existing Midland Metro Corridor*

Micro Park and Ride

5.5.8 Micro Park and Rides involve using existing car parks outside city centres, which are either served by regular bus services or which might require a dedicated bus service. A Micro Park and Ride site is intended to only serve a small local catchment area and, unlike Strategic Park and Ride sites, would not be signposted from the Strategic Road Network.

5.5.9 Factors which should be taken into account in considering Micro Park and Ride sites are:

- Existing car park facilities where their normal use does not conflict with their use as a park and ride site;
- Sites where their enhanced use as a park and ride facility does not conflict with planning requirements;
- The need to improve facilities at suitable sites, such as by providing better lighting, CCTV and ensuring that the surfacing and marking of the site is to an acceptable and safe standard;
- The implications of increased movement in and out of the site on the highway network; and
- The existence of a suitable local bus service adjacent to the site, where frequency and fares are attractive to potential Park and Ride users.

5.5.10 Micro Park and Rides may well be a viable option for existing car parks in the Birmingham area, where the current car park use fits in with the operations of the park and ride, rather than displacing existing car park users and placing increased pressures on surrounding streets.

5.5.11 Micro Park and Ride sites also have the potential to act as transport hubs, improving access and improving sustainable travel to employment, education, retail and health amenities from locations not suitable for full scale Park and Ride. This indicates a potential role for the Council to promote such sites, in accordance with the needs of the Park and Ride and Car Park Strategies.

5.5.12 An exercise was undertaken by this study to identify locations owned by Birmingham City Council upon which small Park and Ride sites could be built to capture local trips. Areas looked at were within 200m of the Sprint Route and not on long-term lease.

5.5.13 Sites currently allocated as recreational use or parks were discarded on the grounds that local places and green activities are a key part of the overall Birmingham Connected philosophy of sustainability. This approach leads to the formation of the list below, which consists of existing small council-owned car parks to which sign-posting could be added, or areas of wasteland awaiting development where there is potential for a new use.

5.5.14 The number of spaces at each site was estimated by examining existing surface car parks spaces per square metre and applying that to the number of square metres identified by mapping of the potential Micro Park and Ride car parks.

5.5.15 Potential locations for Micro Park and Ride are shown in Figure 5.1, with the detail of each site, the relevant Sprint route, number of spaces and estimated journey time given in table 5.4.

Table 5.4 Potential Micro Park and Ride Site details

Site	Sprint Route	Potential Number of Spaces	Estimated Journey Time to City Centre by Sprint (based on current off peak journey time by bus)
1	2	29	30 minutes
2	7	83	16 minutes
3	3	64	31 minutes
4	2	200+	10 minutes
5	4	66	11 minutes
6	2B	151	20 minutes

5.5.16 The estimated journey time to the City Centre is shown in table 5.4 however those parking at these Micro Park and Ride sites would also use Sprint services to access other destinations along the route such as Local District Centres and Employment Areas and not necessarily travel all the way to the City Centre.

5.5.17 The potential number of spaces for each Micro Park and Ride site varies from 29 to over 200 spaces. The fluctuation in car park size is similar to the existing provision of car parking at Rail Stations (as summarised in table 5.1). Micro Park and Ride sites are only intended to be used by the local catchment area and would not offer the facilities associated with Strategic Park and Ride sites including Waiting Rooms and Toilet Facilities. The car park at the Micro Park and Ride site may be shared with other users and a pricing structure would be introduced to ensure there is not excess demand at smaller Micro Park and Ride sites, which would otherwise compromise the use of the car park or spill over into residential streets.

5.6 Cycle and Ride

5.6.1 Park and Ride facilities are not only an opportunity for cars drivers to transfer to bus services. They offer an opportunity for local residents to arrive by foot or cycle and then transfer to bus services. All Park and Ride sites are proposed to include high quality facilities for cyclists including secure covered cycle parking.

5.6.2 The Strategic Park and Ride sites are on the edge of Birmingham and as such are not connected to the current Birmingham Cycle network. However, improvements would be made to ensure cyclists are able to access these sites to transfer to Sprint services. The six Micro Park and Ride sites are close to the network of cycle routes being enhanced by the Birmingham Cycle Revolution (BCR) project. This will improve access to these sites by bike as well as also providing the opportunity for a “Park and Cycle” facility for either the Central Area or Local District Centres.

5.6.3 Furthermore, the Park and Ride facility is by its nature a transport interchange and there may be the possibility of car drivers transferring to modes other than bus to reach their destination. A cycle hire scheme could be provided at the Park and Ride site which enables car drivers to transfer to a bike, a “Park and Cycle” facility.

5.6.4 There will be crossover between the provision of these types of facility and the promotion of Green Travel Districts (GTD) under the GTD work stream.

6 Effectiveness of Priority Interventions

Key recommendations

- A transformative mass transit network will need to be provided with substantial priority on its routes if it is to achieve Birmingham Connected's policy ambitions
- Priority will need to be given at existing delay points and also in a range of urban highway settings which do not currently have much public transport priority
- A range of measures should be used, appropriate to the location, reflecting the characteristics of the area and the impact which Sprint will have on travel habits

6.1 Introduction

6.1.1 The brief for this work package required an assessment of the suitability of routes to specific modes: Bus, CityLink, Sprint and Metro, because each mode will have its own particular requirements set against the general principle of priority for public transport such that it transports the majority of users (passengers), rather than the majority of vehicles (private cars).

6.1.2 The success of the revised public transport network, and in particular Sprint, will therefore be determined by the effectiveness of the priority which it receives. Without priority measures public transport services get caught up in general traffic congestion, particularly during peak periods, but also at other times. Congestion consequently affects journey reliability, which makes it more difficult for public transport to operate in accordance with their timetables; it also reduces journey speed. The result is reduced attractiveness of public transport to new customers and also to existing passengers who have a choice of mode by which they could travel. Hence, introducing measures to improve priority for public transport, alongside other improvements, can make services more attractive to both existing and new passengers.

6.1.3 In the context of Birmingham Connected, significant investment is recommended in order to generate a step-change in the quality of the public transport network as a whole and it is therefore crucial that new modes achieve higher levels of speed and reliability than can be achieved currently if the investment is to pay off and travel habits are to change sustainably.

6.1.4 It is important to recognise that there is a range of strategies and measures available and hence there is not an ‘off the shelf’ solution that will maximise the benefits to buses regardless of location. Appropriate packages of measures will need to be tailored to local circumstances, not only reflecting the outcomes sought for the total public transport offering (including interchange) but also taking account of the relative importance of the competing demands for road space and the potential responses of all users (including, for example, occupiers of property adjacent to the route as well as travellers).

6.1.5 The road network in Birmingham is extremely diverse, with some key routes being constrained to a single lane in each direction over long distances, whilst other main roads provide multiple lanes on all or part of the route. The effectiveness of potential interventions on public transport reliability will be dependent upon the level of priority provided along the totality of the public transport route. Provision of simple priority measures only on sections where the highway space is easily available will not be sufficient to provide the level of priority needed to make public transport efficient and attractive. To achieve such a step change requires a high level of priority to be given along routes. Physical priority measures, which separate public transport from general traffic, tend to be the most effective and should be used wherever practical, however such measures are not always going to be achievable, hence there will also be a need to consider the use of technology based solutions. Even where priority measure cannot be implemented along the whole length of a route it will still be important to maximise the amount of priority provided so as to reduce delays and improve reliability as much as possible, and where possible manage queuing to locations where greater road-width exists.

6.1.6 Where it is essential to accommodate turning movements or for fully justified capacity reasons that a dedicated lane ends before a junction, priority and enhanced journey times should be achieved by appropriate engineering measures. This will typically include:

- Removal of all on street parking and loading in the immediate vicinity of the junction, at least for peak periods;
- Provision of "public transport advance areas" where Sprint vehicles are allowed to approach the junction whilst other traffic is held back; and
- Active priority at traffic signals so that Sprint vehicles are allowed through with minimal delay.

6.1.7 Each junction or signal controlled network will require a bespoke priority strategy that maximises the priority given to Sprint vehicles and other public transport, whilst also accommodating pedestrians, cycles and general traffic. This will need to be informed by detailed understanding of the network operation and the degree of saturation of each junction, with capacity being allocated in line with policy objectives and to manage the performance of the whole network, rather than more simplistic approaches which attempt to minimise delay for all traffic.

6.1.8 Prediction and detection of public transport vehicle arrivals will be a key part of each strategy, with consideration needing to be given both to the normal situation where vehicles arrive in line with the timetable, and situations where it is necessary to recover from any disruption or delay.

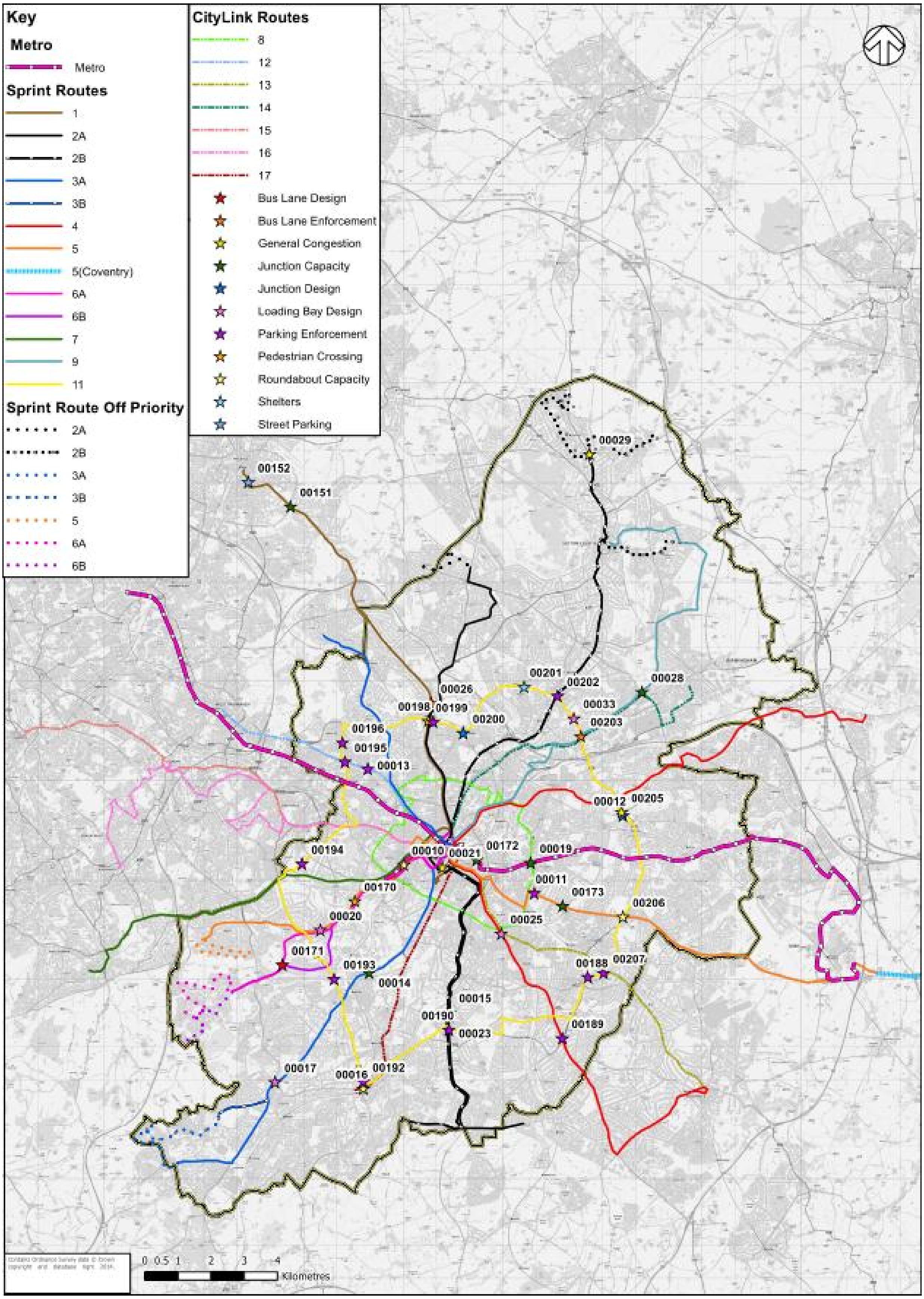
6.1.9 The overall management of vehicular traffic needs to consider how to avoid congestion ever occurring on links where public transport shares with other traffic, through measures including gating of traffic at upstream junctions and point closures or filtered permeability to prevent traffic joining a main route where it cannot be suitably managed. The focus needs to be on enabling convenient travel by public transport and sustainable modes so that demand for private car travel can be reduced enabling capacity to be reallocated without causing disruption. In many cases, this will not be instantaneous and will require iterative interventions (physical, regulatory, technology and behaviour change) that together reallocate capacity to public transport. A single intervention making all the desired change at once may be difficult to implement (both practically and politically), so it is therefore appropriate to set a suitable vision and progress towards it.

6.2 Identified existing congestion points

6.2.1 Information has been received from Centro regarding congestion points on bus routes in the Birmingham area, as collated from reports by operators. These have been very useful in understanding the differences in average speed apparent on bus services on the principal corridors and have enabled the identification of particularly difficult congestion 'hot spots' and the most appropriate types of priority measures to counteract them.

6.2.2 Congestion points have been broken down into a number of different types, and are shown in the figure below. It should be noted that the figure only shows those congestion points that are located on the proposed Sprint routes, but represent a guide for any future detailed programme of priority measures for each of the corridors concerned.

Figure 6.1: Map of Congestion Points on Planned Sprint Route Corridors



6.3 Potential measures

6.3.1 The work undertaken to date in the BMAP Green Paper, indicates that the proposed corridors represent viable options for being taken forward as part of a revised and enhanced strategy, as set out in chapter 4 above. Whilst it has not been possible to undertake a thorough assessment of the level of priority which can be provided on all of the identified routes at this stage, this is work which would be undertaken as part of individual scheme design and associated business case development going forward. It has, however, been possible to look at a sample of the Sprint routes to identify different types of locations with different challenges, and to suggest the types of measures which could be considered as examples of how priority routes could be developed.

6.3.2 Examples of the approach are set out below and measures will need to be developed in accordance with the Link & Place principles developed by Package 1. In developing each measure, consideration will need to be given to the competing needs for the road network, how can they be managed recognising 'link' and 'place' functions and how they contribute to achieving the wider objectives of Birmingham Connected and other council policies. Opportunities to prioritise particular users on different road/link categories will need to be identified as will the management and mitigation of impacts on general traffic, parking, loading etc.

Kings Heath High Street - Sprint Route 2 Crossing Sprint Route 11

6.3.3 There are currently sections of north-bound (toward City Centre) bus lane along the A435 on the approach to the High Street, but the bus lane stops short of the main retail area. There is on-street parking along significant lengths of the high-street, and some off-street car parking is available. A review of parking demand and provision would indicate whether there may be some potential to remove on-street parking and extend the bus lane as a quick win. Even where a quick win is not possible, a review of parking could identify where additional off-street parking facilities could be made available in the longer term.

6.3.4 There is also potential to improve bus reliability by technology measures in line with the Council's Intelligent Transport Systems Strategy, for example by using selective vehicle detection at the traffic signals at the A435/B4122 junction to extend green times or even call a green stage as buses approach. A strategy for limiting right turns would also be a very useful element to the overall proposals. Where the need for priorities has particular impacts on the 'place' functions of individual locations, such as Kings Heath High Street, it is proposed that the scheme costs should incorporate general streetscape and other improvements to ensure that local facilities are protected and enhanced.

Coventry Road (Sheldon) - Sprint Route 5

6.3.5 The road is a dual carriageway with currently two lanes for all traffic in each direction. The City Council has recently introduced improvements along the route to assist accessibility, improve safety and journey time reliability for all users. Opportunity was also taken to review and simplify 'on street' traffic order regulations, including the introduction of red route orders.

6.3.6 Physically there is the option of reallocating up to one lane in each direction to bus only lanes, however, there are a substantial amount of on-street parking bays, which would interact with a nearside bus corridor. Furthermore, given the recent investment to improve reliability for all road users, road space reallocation would need to be considered carefully given the potential for increasing queueing for other modes along the route, though it may still be a desirable solution for the longer term.

6.3.7 An alternative approach would be to encroach into the central reservation and verges where available to widen the road to provide a bus lane in addition to the traffic lanes. This would, inevitably be more expensive and only practical for parts of the route but would avoid increasing congestion for other users.

6.3.8 For the shorter term implementation of selective vehicle detection technology at the traffic signals would assist buses along the route. For the roundabouts, an option could be to signalise them with some local widening (either encroaching into the central reservation or verges where available) to provide a short stretch of bus lane with a signalised bus gate onto the roundabout.

Selly Oak - Sprint Route 3

6.3.9 The current bypass around Selly Oak is not presently an optimal route. This should be improved once Phase 2 of bypass work is completed. In the meantime there remains a significant amount of traffic passing through Selly Oak, travelling along a route with currently two all traffic lanes in each direction.

6.3.10 There are a number of options for improving bus priority. One option, which would prevent through traffic passing through the area, would be to introduce a bus only gate covering the centre of the high street. An alternative option which would reduce through traffic rather than remove it would be to reduce the number of all-traffic lanes to one in each direction. The remaining space could be reallocated to bus lanes for reasonable lengths, with allowance still being made for loading and unloading for shops and parking for residents where there is no off-street alternative.

6.3.11 There is substantial pavement space along the routes which could be re-allocated to cycling.

6.3.12 A quick win would be to improve signage - connections and signage to the railway station need improving and similarly signage to the university a short walk away is also exceptionally poor from the High Street and the bus shelters.

Perry Barr - Sprint Routes 1 and 2 Crossing Sprint Route 11

6.3.13 This is a complex part of the highway network comprising grade separated junctions and flyovers. Bus priority measures would be dependent upon the nature and funding for any future major alterations as the current layout does not lend itself to easy interchange with the rail station, nor for access to the retail park as this would entail buses having to negotiate a what would effectively be a U-turn at a mini roundabout (which would be impossible in articulated vehicles). Significant alterations to the highway would be needed.

6.3.14 Interchange location would have to be decided between serving the railway station and One Stop shopping centre, or the route 11/1/2 crossing which is currently a roundabout with an underpass. Grade levelling the area, with a conventional junction and simplifying the pedestrian environment could be considered in the longer term as the structures near the end of their lives.

6.3.15 Rationalisation of southbound services to serve a single stopping point could be considered as currently they loop a reasonable distance away.

Coventry Road (Small Heath) - Sprint Route 5, Crossing CityLink Route 8

6.3.16 This area is highly congested with a significant amount of on-street parking both on the high street and nearly all the side streets. Whilst it would be desirable for the Sprint route to serve this area it would be very difficult to provide sufficient priority to make the route reliable. Originally the proposal was for the Sprint route to serve this centre, as most present radial buses do, but it is now recognised that the optimal solution for this Sprint service would be to operate via Small Heath Highway. In the longer term it may be possible to plan for land use changes which include the provision of off-street car parking to enable on-street parking to be removed, and for the Sprint service to be diverted to serve Coventry Road and the centre of Small Heath.

6.3.17 To keep interchange with CityLink route 8, provision of a facility would be needed in the vicinity of the Poets Corner roundabout, which could also serve Small Heath station.

Other General Measures

6.3.18 The measures listed in table 6.1 below are examples of types of solutions which could be considered across the network. They are not intended to be a comprehensive list of all available measures, nor is it expected any particular scheme will use all measures at all locations.

Table 6.1 Examples of potential measures

PROBLEM	EXAMPLE	POTENTIAL MEASURES
Bus stop delay	BRT cannot access stop as occupied by other service	Provide dedicated stops for BRT, or if necessary limit the number and timings of conventional bus services
Buses delayed in general traffic	queuing traffic on approach to a critical junction	Provide physical segregation for all buses (where feasible) or BRT only. Provide maximum level of traffic signal priority for BRT
Buses delayed in general traffic – where segregation not feasible	Slow moving traffic along a length of corridor delays BRT	Gate general traffic so other vehicles held elsewhere and speed increased on narrow sections. Combination of point closures, one way operation, access only sections, and use of signal timings to restrict traffic entry (to match exit capacity)
Buses slow in narrow bus lanes	Bus driver caution where lanes are narrow and there is a risk of encroachment by other road users.	Maximise use of "soft guidance" – electronic guidance, e.g. based on following line marking or buried cable enabling buses to progress at higher speeds on narrower alignment. Detailed engineering of 3D swept path so e.g. pedestrian guardrail can be closer to edge of carriageway than would typically be accepted. Demarcation by vertical features (e.g. traffic cylinders) to deter other vehicle entry.
BRT delayed by parking /loading activities	Cash collection vehicle stopping on carriageway delaying all traffic (even off peak).	Dedicated loading spaces clear of "carriageway" – redefine the "carriageway" to the swept path of buses – separate the "stopping" function from the "movement function" within the available highway area – note that this changes along the length as at some points width will not allow the desired space. Vigorous enforcement with awareness campaigns to build public support for enforcement. Design to provide for essential activity away from bus route - relocate longer term parking further away or remove from highway. Maximise use of freight consolidation / smaller vehicles / cycle deliveries.
BRT delayed by cyclists	Buses slow behind cyclists – and need to be cautious in overtaking	Building and promotion of off carriageway routes (noting that it may be more efficient to have narrower carriageway with no cyclists, faster flow than wide shared carriageway)

BRT safety	Higher speed buses would have higher collision impact – particular concern for vulnerable road users	Need to segregate so that collision risk is reduced – ensure suitable crossing facilities where required. Clearly define the bus “alignment”. Consider level difference between bus and general traffic lanes (buses higher) − if buses are guided so no risk of leaving lane.
BRT Interchange	BRT stops are separate from other services limiting passenger willingness to transfer	Minimise walk / interchange distance / time. Clear link identification. On-bus interchange information (potentially including real time indication of time until next bus).
BRT stops busier − causes delay	large numbers of passengers delay boarding / alighting, especially when vehicle busy	Multiple doors. Consistent door locations, marked (tactile) on waiting area. Shelters large enough to accommodate peak flows. Shelter designs allow direct alighting (automatic doors to exit) minimising passenger conflict. Level access at all doors. Gradients of carriageway and footway adjusted. Smart and integrated payment system.
BRT delayed by conventional bus	Stopping service ahead of BRT, resulting in BRT operating at same speed as conventional bus.	Conventional bus stops to be at locations where they can be overtaken (e.g. in layby, consistent with the ‘link’ and place’ function of the location, or with bus gate enabling BRT to gain prioritised access to general traffic lane to overtake). Bus boarder for BRT with conventional stop at Kerbside where carriageway is wide and parking / loading accommodated. Double width bus lanes. Stops on side roads to accommodate "minor" services. Buses joining corridor held on side roads to join behind BRT. Services managed so that BRT departs in front where sections of route will not permit overtaking.
Drainage issues	Standing / flowing water at stops results in excessive slowing	Drainage / carriageway profile to take water away from kerb line at stops and carriageway to be suitably constructed to avoid rutting.
Pedestrians in bus lane	Pedestrians cross bus lane then wait in it to cross other lanes.	Provide high quality pedestrian facilities on desire lines and at stops, giving absolute priority to buses with high level of service to pedestrians (accepting delay to other traffic). Provide refuge islands between bus and general traffic lanes where feasible.

Vehicles slowing to access permitted parking / loading	Vehicle stopped in live lane to reverse into a parking bay.	Move parking off bus routes. Provide bays long enough to accommodate reasonably quick entry / exit. Restrict lengths of stay / permitted vehicles to reduce demand so movements are quicker due to space available.
Buses delayed by turning traffic	Vehicle emerging from side road pulls into traffic lane to wait for a gap to turn right.	Point closures for motor vehicles where minor roads intersect bus route. One way operation of side roads (preferably away from BRT route, with access onto BRT route only at signal controlled junctions).
Drivers circulating looking for parking space cause delay.	Vehicles emerge from one side road and turn into another, slowing traffic	Parking availability to be managed in a way that minimises vehicle circulation – e.g. limited waiting, charging for parking and use of permits to manage demand. Parking space finding app.
Greater stop spacing results in longer walk distances	Potential passengers, especially mobility impaired, choose to travel by other modes to avoid walking	Provide high quality cycle and ride facilities at the majority of BRT stops, and enhance local street networks for walking / cycling. Detailed analysis of stop locations to maximise catchment populations at detailed design stage. BRT stops to be located where there is or will be a local destination (for linked trips and so walk/cycle networks serve both purposes). Enable park and ride and drop off / pick up arrangements at stops serving larger catchments. Facilitate taxi interchange where appropriate. Consider local link services (potentially demand responsive) to tie into Sprint, and potential use of existing bus services as feeders.

6.3.19 Traffic management measures can often provide cost effective options without the need for land acquisition or expensive civil engineering works. As can be seen from some of the examples set out previously the types of measures which can assist buses include:

- No Stopping Restriction e.g. removal/relocation of parking/loading with parking relocated to side roads/car parks and loading bays provided off main routes
- Traffic gating e.g. such that general traffic cannot enter an area until capacity is available for it to leave
- Side road closures e.g. reducing the number of accesses onto the main road and hence reducing the number of right turn movements on the main road which block through traffic
- One way streets and turning movement restrictions e.g.:
    - no right turns from single lane sections anywhere on the route
    - no right turns from side roads unless signal controlled

6.3.20 Similarly, as set out in the City Council's Intelligent Transport Systems Strategy, technology can have a significant beneficial impact on bus performance, whilst also helping to manage and minimise impacts on other traffic. Birmingham currently has very limited implementation of bus priority at traffic signals and in order to deliver the desired outcomes for buses, there will need to be a significantly greater level of implementation, particularly for the Sprint and CityLink routes. This will need to be underpinned by careful data capture and analysis and a detailed understanding of the operational implications. Many of the fundamental tools are in already place (including the UTMC common database) which could facilitate some quick wins. Care will need to be taken going forward that any new equipment and systems will achieve the intended aim, can be integrated with existing systems and can be operated from day one. It will be important to avoid expenditure on systems which are either only used for a short period or end up not being used at all.

6.3.21 Perceptions of high quality public transport modes are not only dependent on journey time. Other aspects will need to be considered, for example:

- Where feasible, the public transport track should be engineered to provide excellent ride quality – with horizontal and vertical alignment optimised for a smooth ride, and surface irregularities including gullies and access covers removed from the wheel track of public transport vehicles. This can apply even where the road space is shared.
- Level access should be provided at all doors at all stops – and for all vehicle types using the stop. This requires clear, unobstructed access, and alignments requiring public transport to make difficult movements to enter laybys must be avoided to maintain journey times. This also has a substantial impact on ride quality, as maintaining as straight a path as possible within the constraints of the alignment minimises sideways forces experienced by passengers, and avoiding steering movements should allow sprint vehicles to decelerate and accelerate more smoothly yet still offering quicker journeys.

7 Achieving zero emissions at the point of use

Key recommendations

- In order to tackle current emissions, and address future standards, clean technologies are required and these should be capable of meeting progressively tougher standards throughout the Birmingham Connected period
- In addition to emissions, the design of the Sprint vehicles must reflect the high-quality and efficient nature of the service network
- Emissions targets should be particularly stringent in the city centre where all routes converge

7.1 Existing Bus Emissions Regulations

7.1.1 The brief for this work package identified that the Green Paper set an aspiration for the main mass-transit network to become 'emissions-free at the point of use' within the 20-year Birmingham Connected horizon. This study details the opportunities and constraints of achieving this and the technology platform which Birmingham should pursue.

7.1.2 It is understood that feasibility work is already underway to determine the scope and standards of any Low Emission Zone (LEZ), whether defined on a statutory, formal or voluntary basis in order to set ambitious targets for the reduction of CO2 and address other pollutants in the existing Air Quality Management Area (AQMA). In any event, the challenges of air quality, climate change and declining natural resources all mean that urban transport systems must find reliable and sustainable fuel sources now and in the future.

7.1.3 The contribution of bus services to air quality and pollution in the City Centre has already been given much consideration, culminating in the introduction of the Statutory Quality Partnership Scheme (SQPS) in July 2012. This scheme, amongst many other requirements, means that, by May 2017, all buses that operate 'core' services in a defined area of the Centre will have to be compliant with at least the Euro IV standard. The scheme will expire in 2022, The Vision for Birmingham Connected is that, by 2031, all bus services operating in the City Centre area will emit zero emissions at the point of operation, and that the Sprint and CityLink services will have lead the way in this objective by being exemplars in employing cutting-edge technology to be the first services to achieve zero emissions.

7.1.4 As far as European Emission Standards are concerned, the following table shows those for heavy duty diesel powered engines, in terms of engine energy output (grams per kilowatt) from Euro II onwards:-

Table 7.1 Emissions standards by European classification

Tier	Date	Carbon Monoxide (CO)	Hydrocarbons (HC)	Nitrous Oxides (NOx)	Particulate Matter (PM)	Smoke
Euro II	Oct 1998	4.0	1.1	7.0	0.15	-
Euro III	Oct 2000	2.1	0.66	5.0	0.10	0.8
Euro IV	Oct 2005	1.5	0.46	3.5	0.02	0.5
Euro V	Oct 2008	1.5	0.46	2.0	0.02	0.5
Euro VI	Dec 2013	1.5	0.13	0.4	0.01	-

7.1.5 From this table it will be seen that buses now starting to be delivered to Euro VI standards are very substantially improved in terms of Hydrocarbons and Nitrous Oxides compared with the Euro IV standards applicable to the SPQS. Consequently, it is important that the SPQS is kept under review and that the standards to be adopted for any subsequent agreement are carefully considered.

7.1.6 It would also be practicable to design a roadmap for the types of vehicle which will be needed to provide mass transit services in Birmingham, so that this will act as guidance for the vehicle specification requirements, regardless of whether these are supplied by commercial operators or through some form of contractual process.

7.2 Sprint Vehicle Options

7.2.1 As far as Metro services are concerned, it is clear that these will be powered by electricity, probably through conventional overhead power supply, although there may be alternative or additional systems to consider, such as partial flywheel technology or contactless inductive power transfer installed beneath the track. However, that technology is more concentrated on removing the street clutter caused by overhead wiring than it is to do with reducing emissions.

7.2.2 For Sprint vehicles, using rubber tyre technology, the alternatives available were considered in the original BMAP Green Paper. In order to recap, the technical possibilities for the vehicles which might be used for Sprint services, are as follows:-

- CNG powered buses
- Flywheel technology
- Diesel Electric Hybrid buses
- Diesel Electric Plug In Hybrid buses
- Trolleybuses
- Battery powered buses
- Battery powered buses using induction technology
- Fuel Cell Hydrogen/Electric buses

7.2.3 A detailed description of these technologies is provided in Appendix 1 to this report.

7.3 Summary of Sprint Propulsion Options

7.3.1 In determining a road map for ensuring that the Sprint network achieves zero emissions as quickly as is possible, it is necessary to assess current and future known technology by balancing innovation with practicality, bearing in mind that Sprint services will require a high degree of reliability. Table 7.2 summarises the advantages and disadvantages of the technologies described above.

Table 7.2 Technology comparison table

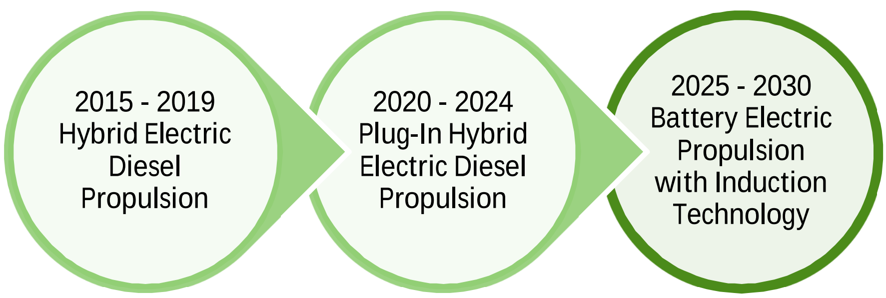
Technology	Advantages	Disadvantages	Conclusion
1. Euro VI Diesel engines	■ Standard technology for all new buses ■ Reduced emissions	■ Other fuel systems still 'cleaner' ■ Not zero emissions	■ Suitable for use on Sprint services in the short term but not innovative.
2. Euro VI CNG powered engines	■ Well established technology ■ Fuel cost savings ■ Less emissions than Euro VI diesel	■ Higher cost than diesel option ■ Fuel infrastructure costs ■ Difficult to install fuel tanks on double deck buses ■ Not zero emissions	■ As in the case of Euro VI diesel vehicles, but the additional costs involved do not appear to be justified by the small emission benefits.
3. Flywheel technology	■ Lower emissions than standard diesel ■ Lower cost than hybrids ■ Can be retro-fitted to older buses	■ No quantification of emissions savings yet ■ Largely untried technology for buses ■ Higher cost than diesel option ■ Not zero emissions	■ In emission terms, not proven that this is as good a solution as hybrid technology, although produces lower purchase and operating costs to bus companies.
4. Diesel Electric Hybrid	■ Fuel savings around 25% ■ Reduced emissions ■ Largely tried and tested technology	■ Substantially more expensive than standard diesel ■ Not zero emissions	■ Probably the best short term solution in terms of vehicles to enter service in the next 1-3 years.
5. Diesel Electric Plug In Hybrid	■ Further fuel savings ■ Further reduction in emissions ■ Potential to operate up to 70% of time without emissions	■ Substantially more expensive than standard diesel ■ Still under trial ■ Not zero emissions (but could operate in City Centre as zero emissions)	■ Still under trial, but likely to be the next best step on the way to full electric operation.
6. Trolleybuses	■ Well established technology ■ Zero emissions at point of operation	■ Vehicles are more expensive than diesel equivalents ■ Overhead infrastructure expensive to erect and maintain and can be visually intrusive	■ Not likely to be suitable due to cost and implications of overhead wiring and inflexibility of system.
7. Battery power	■ Zero emissions	■ Vehicles are more expensive than diesel equivalents ■ Weight and size of	■ Yet to be proven in terms of range, adequate vehicle size and passenger

		batteries restricts passenger carrying capacity ■ Range restricted by current technology ■ Cost of replacement batteries expensive	capacity – may require further advances in battery technology before able to replace full size vehicles.
8. Battery powered buses with induction technology	■ Zero emissions ■ Operational range extended to be comparable with diesel buses	■ Still under trial ■ Vehicles are more expensive than diesel equivalents ■ Passenger carrying capacity still adversely impacted ■ Cost of replacement batteries expensive	■ Likely to be the long term favoured option once performance issues are resolved to the point where the space required for batteries and their weight is acceptable.
9. Fuel Cell Hydrogen/ Electric	■ Zero obnoxious emissions	■ Highly experimental ■ High fuel handling and installation costs ■ Vehicle costs very high	■ Possible future long term option, but technology still requires substantial development.

7.3.2 From the above analysis, it is proposed that the path required to transition Sprint services to zero emission would be as shown in the figure below. On the basis of a ten year life for vehicles, by 2030, all sprint services would be capable of zero emission operation through the City Centre, and many would be capable of full emission free operation. If a policy of 'cascading' vehicles from Sprint services to CityLink services were to be pursued, zero emissions for Sprint services could be achieved earlier than this proposed schedule.

7.3.3 It is appreciated that forecasting technological development is not always easy, however current developments do point strongly in the direction summarised in figure 7.1 as a **guide for the propulsion system for the purchase of new Sprint vehicles**.

Figure 7.1 Propulsion systems for Sprint vehicles



7.4 Suitable Vehicle Types for Sprint Services

7.4.1 There are a number of factors which determine the most appropriate type of vehicle for operating Sprint services, once the most appropriate propulsion system has been determined. These are:-

- Compatibility with the preferred engine propulsion system;
- Provision of suitable capacity for the projected usage/required frequencies;
- Seating/standing balance in accordance with the average distance travelled by passengers and the main characteristics of the individual service;
- Capability of fast boarding and alighting to minimise dwell time at stops;
- Physical characteristics (primary factors such as length of vehicle, wheelbase/turning circle) to enable the selected vehicles to operate safely on the required roads; and
- Vehicles which are attractive in appearance and promote a modern, innovative image.

7.4.2 With regard to the pilot Sprint service planned for operation by Centro between Quinton and the City Centre via the Hagley Road, it is understood from discussions with Centro that the preferred option is for 24 metre long double articulated buses, such as the Van Hool ExquiCity shown below (figure 7.11).

Figure 7.11 Van Hool ExquiCity

7.4.3 Clearly this vehicle is of a very striking appearance however it will require specific permission from the Department for Transport to operate in the UK, as it is technically illegal under current legislation. The Birmingham Connected Sprint approach is for services to replace certain key existing routes, taking advantage of bus-based rapid transit's ability to operate away from the main corridors to ensure penetration into residential and other key catchment areas. Consequently it is unlikely that this type of vehicle would be practicable for many of the future proposed routes. However, there are a number of alternative options which incorporate the need for a unique appearance, particularly when combined with a well-designed vehicle livery and general image.

7.4.4 Having regard to the points listed as essential in paragraph 7.4.1 above, there are three types of vehicle we would recommend for Sprint operation in Birmingham, dependent on the circumstances of the route concerned. A final decision would result from the required detailed feasibility study for each Sprint service. The types recommended are shown in table 7.3 below, including their passenger carrying capacity and suitability features.

Table 7.3 Vehicle comparison table

Vehicle Type	Typical Capacity	Comments
1. Articulated single deck bus of 18 metre length. 	150 passengers, including 40 seated – three or four wide doors for quick boarding and alighting	Envisaged as the 'standard' Sprint vehicle except for longer distance trips, where a higher seated capacity would be advisable. Available as Electric Hybrid to Euro VI specification.
2. New Routemaster double deck type bus of 11.2 metre length. 	87 passengers, 40 seats on upper deck, 22 seats on lower deck plus 25 standing – three doors and two staircases to ensure faster boarding and alighting than can be achieved with conventional double deck vehicles.	Offers the highest combination of seated passengers against standing capacity. Currently available as Electric Hybrid to Euro V specification, but future deliveries will be to Euro VI specification.
3. Single deck bus of 12 metre length. 	100 passengers, up to 30 seated – two or three wide doors for quick boarding and alighting.	Envisaged as the best option where the capacity required does not justify articulated buses. Available as an Electric Hybrid to Euro VI specification.

7.4.5 All the above options fulfil the criteria set out in paragraph 7.4.1, with hybrid technology to Euro VI standard available now or very shortly. With the possible exception of the New Routemaster, both of the other types of vehicle will also be available with plug-in hybrid technology, and eventually with full electric operation without the need for auxiliary diesel engines.

7.5 Sprint Image

7.5.1 Sprint services must be designed as an integrated network. Consequently it is important to ensure that the image is retained across the different routes, particularly where different vehicle types may be in operation. This report considers elsewhere how control may be retained over the sprint operation specifications and image, and this particular requirement is important in ensuring that Sprint services reach the position of being emissions free within the 15 year period up to 2030.

7.5.2 Having discussed the Sprint concept with officers from Centro, it is clear that they are very committed to this element of the project. This also includes the need for control over the appropriate specification for Sprint vehicles, and as the emissions element is of particular importance to the City Council, it is highly advisable that a close liaison continues between the key stakeholders on both this and other specification issues.

7.6 CityLink

7.6.1 CityLink services are intended to benefit from bus priority measures, but will not be designed to be a mass transit system like Sprint. Consequently, the specifications for the vehicle types to be operated will be less circumscribed, however it is important these services also contribute towards achieving a reduction in emissions, particularly in the City Centre. Consequently, CityLink vehicles, of whatever specification, should be at least to Diesel Electric Hybrid Euro VI standard.

7.7 City Centre Statutory Quality Partnership Scheme

7.7.1 As reviewed in section 3.5, the current Statutory Quality Partnership Scheme (SQPS) covering the City Centre area is due to expire in 2022, when it will be reviewed by the participating stakeholders to consider the implementation of a new scheme. Achieving this Partnership agreement has been a significant achievement, however the critical importance of emissions makes it essential for this process to advance in line with the road map envisaged above for the technical specification of Sprint vehicles.

7.7.2 As air quality is a statutory responsibility of the City Council, it would seem appropriate that advance notice could be given about the future aspirations for controlling emissions. Buses, taxis, and to a lesser degree delivery freight vehicles, are the major cause of transport related emissions in the City Centre, and thus measures to control and reduce their impacts are not just reasonable, but essential. Whilst such higher standards obviously have impacts on the cost of service provision in terms of the need to invest in new vehicles, the need to improve air quality should be an overriding priority, and advance notice of intentions should be helpful to stakeholders in planning their future investment decisions. A staged and planned programme should be more favourable to vehicle operators than the alternative of a Low Emissions Zone (LEZ), which might become essential if adequate progress is not achieved.

7.7.3 As an initial proposal, it is recommended that:-

- By 2016, the City Centre SQPS area should be readjusted to cover all major bus stop locations;
- By 2018, the base standard for buses should be raised from Euro IV to Euro V;
- By 2022, the replacement SQPS should have a base standard of Euro VI.

7.7.4 When combined with the proposed road map for Sprint new vehicle purchases shown in 7.7.3 above, and the proposed vehicle schedules which are intended to reduce significantly the number of buses terminating in the Centre, this would provide a clear plan to show how air quality will be improved in the City Centre over the next 15 years.

8 How will system integration be achieved?

Key recommendations

- In order to function as a seemless network, Birmingham Connected services must cover physical, network (i.e. service planning) and information integration topics
- To facilitate integration between mass transit services, defined Mass Transit Interchanges should be created to support passengers when changing routes
- Integration must also extend to other sustainable modes in order to provide a comprehensive and attractive option for all transport needs

8.1 Integration types

8.1.1 Integration can be described as the connection between two (or more) forms of transport. Such integration can however take different forms, broadly grouped into the following headings:

- Physical integration – e.g. proximity of stops on different routes and infrastructure;
- Network integration – e.g. service frequency/timetabling and ticketing; and
- Information integration – e.g. signage and real-time journey updates

8.1.2 The brief for this work package required an assessment of how interchanges between routes will work and how any passenger dis-benefits can be reduced. This requirement is equally valid for interchange between two mass transit services as it is between mass transit and other public transport modes. As part of a sustainable future for Birmingham, public transport modes will also link to other shared transport modes such as taxis and car clubs. The 'penalties' associated with the need for interchange for passengers (in the guise of additional journey time, fares and uncertainty) are also typically reflected in the modelling and development of business cases for public transport schemes[8], and therefore addressing these successfully will not only benefit passengers but will be more likely to result in the investment in the first place.

8.1.3 The scale of physical integration required between different modes (e.g. rail to bus) and services (e.g. Sprint route to Sprint route) will be determined by passenger travel patterns and network design. For example, the consideration of which Sprint routes should operate cross-city (and which ones will not) has been informed by both the viability assessments and the optimisation of the routing within the city centre. More informal integration is always possible where any two services operate in reasonable proximity however in order to maximise the efficiency of the network, specific locations (called Mass Transit Interchanges) are identified where additional facilities would be provided in order to complement the in-vehicle journey experience.

8.1.4 In terms of network integration, Metro and Sprint services are specified to be sufficiently frequent so as to be 'turn up and go' and therefore no particular scheduling (or operational connection) is intended to be required for integration between mass transit routes, most of which will take place in the city centre, although this has itself been mitigated by the network including 4 cross-city services, which represent two-thirds of the Sprint corridors. Equally, because Sprint will provide for mass transit journeys into the city centre in the main, it is unlikely that transfer between Sprint routes outside of the city centre will be in the same direction at the same stop, with the possible exception of transfer from Sprint services 6A, 6B and 7 onto the western leg of service 5 before it reaches the city centre on its way to the Airport

8.1.5 The Birmingham Connected network is intended to operate as a comprehensive, integrated sustainable transport offer and therefore information and ticketing are two key areas for consistency

[8] This is typically referred to a 'generalised costs' and include time (waiting and going to and from stops), fares and quality of service (e.g. overcrowding)

in specification and branding across all modes. Information is considered in paragraphs 8.1.9 – 8.1.13 below and for a range of reasons, including attractiveness, convenience, operational efficiency and security, the Birmingham Connected network must be based on cashless transactions at the point of travel. That is not to say that prospective users cannot pay cash at certain points, but that at the time of boarding, the passenger transaction is intended to be one of validating an existing ticket or recording a journey to be used in the calculation of the appropriate fare by a system which covers all modes.

8.1.6 Steps have already been taken to embark on the transition to smart ticketing (with the confines of existing technology and delivery structures) by means of initiatives such as the English National Concessionary Travel Scheme (for the elderly and disabled) and Centro's Swift Card. The complete roll-out of 'Swift' to all modes for all fare types (including Pay As You Go) should be an early target for Birmingham Connected although it should be recognised that over the horizon of Birmingham Connected, new payment technologies are likely to become widely-available. Current pilot projects in the UK indicate that new developments are more likely to be delivered through mobile technologies (such as Smartphones) than through a separate smartcard. Proposals for smartcard ticketing in Green Travel Districts have been described in section 5.8, which build upon the vision set out in the BMAP Green Paper ("A New Way to Pay"). It is however important to understand that 'smart ticketing' does not necessarily have to depend upon 'smartcards', as the objective should be a public transport payment system which is simple and user-friendly, and enables payment for public transport to be no more difficult that it is in other small-value retail scenarios (such as 'wave and pay' for purchasing a coffee or newspaper, at or around the same price as a single local transport trip). Birmingham Connected should therefore be 'technology-agnostic', but should be prepared to be available through multiple mainstream channels (e.g. Android iOS, Windows, Blackberry and Amazon stores).

8.1.7 Future payment systems capable of delivery through a multitude of devices will inevitably entail security and other levels of integration with other financial services companies and systems. Ticket products (such as day, weekly and multi-journey tickets) will become less 'fixed' and account-based ticketing, which calculates the optimum fare based on travel over a period of time, will increase the incentive for users to use the network as flexibly as they currently use their private car.

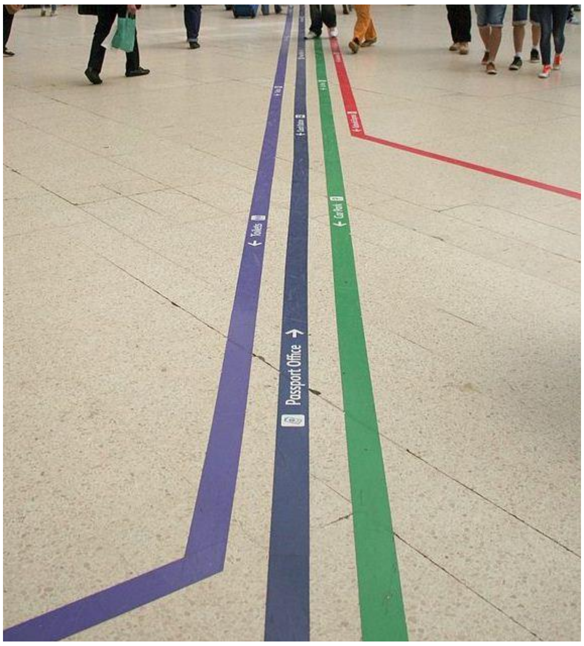
8.1.8 In terms of fare structures, the BMAP Green Paper proposed a zonal structure which should apply across all modes. This does not need to mean that end to end journeys have to be made for the same cost whether it involves one single trip or multiple legs on different modes, as the operational costs attached to each mode are not equitable.

8.1.9 Similarly, the development of 'cloud' technologies and their delivery format is such that Birmingham Connected cannot prescribe the actual method of information provision however it can describe how such information could be expected to be provided given existing online and mobile systems. By considering a typical passenger journey requiring interchange, the vision of Birmingham Connected can become clearer. Whether the journey is made by a regular passenger, or one who has planned their journey for the first time, the requirement upon the information systems to provide clear, timely and reliable messages remains the same.

8.1.10 While travelling on the first leg of the journey, the passenger is provided with audio and visual map-based updates within the vehicle, providing clarity and reassurance about where the vehicle is and how well it is performing against the schedule. The same central control system can provide these updates to the user's own device if they have requested travel updates so that while they are reading their e-book, they don't lose their 'place' on the journey. This will be particularly beneficial if the passenger has planned their journey ahead as details of the subsequent journey will also be provided (for reassurance that the intended vehicle is only minutes away).

8.1.11 When the public transport vehicle is approaching the intended interchange point, an audio and visual alert will be provided and the user will be guided to the next stop by a combination of mobile real-time mapping, fixed signage and stop identification and, for Metro and Sprint routes, colour-coded pavement 'tracks', which could be in the style already adopted at other public transport interchanges, as illustrated in figure 8.1.

Figure 8.1 Pedestrian interchange floor markings (at Victoria Rail Station, London)



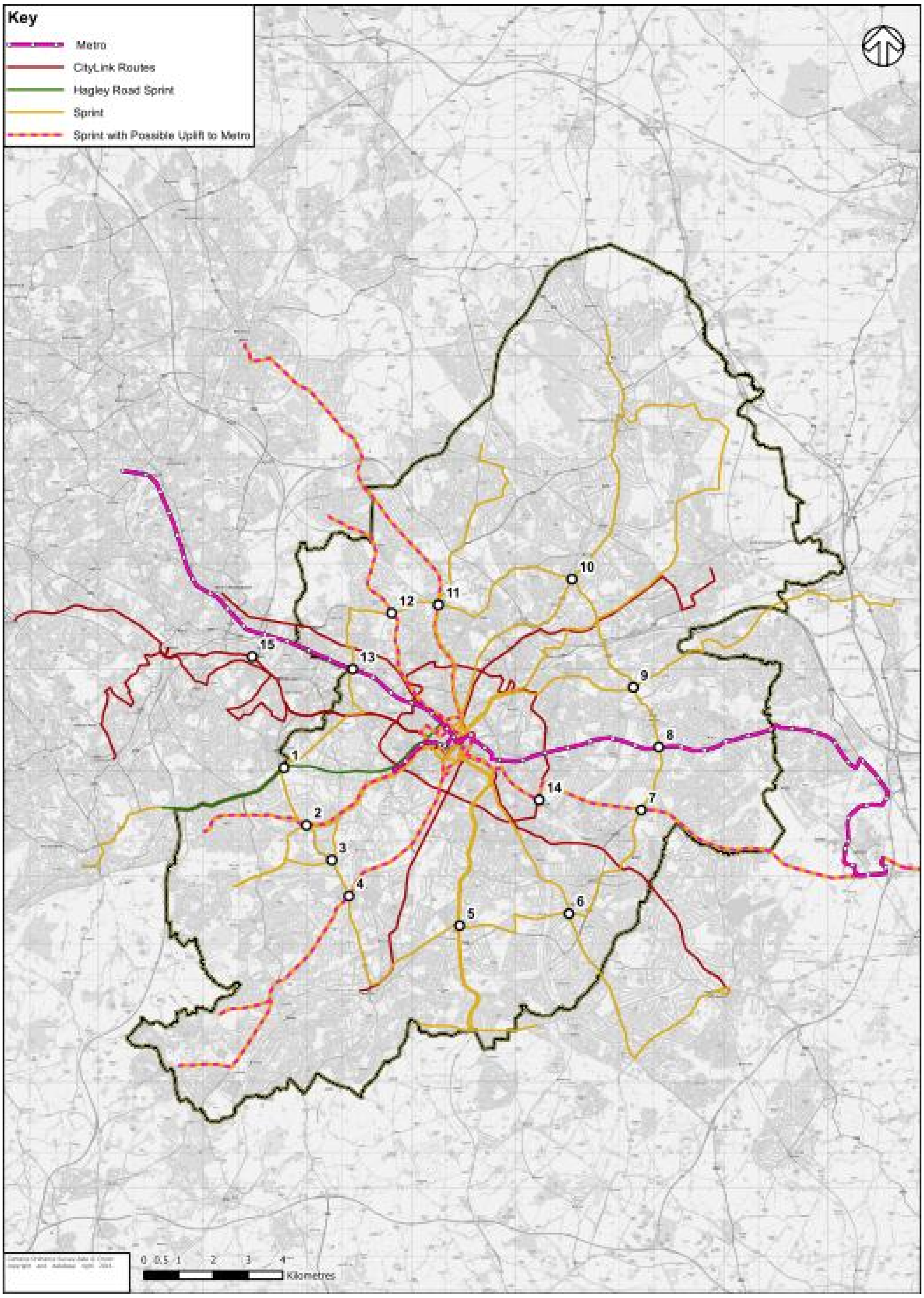
8.1.12 Although all shelters at Sprint stops will be markedly larger and more clearly branded than at conventional bus stops, way-finding and information services will be available at all mass transit interchanges for reassurance and to cater for any passenger interruptions to journeys (e.g. going to buy a sandwich to eat on the way). As no road will have more than 4 mass transit routes operating on it, it will be feasible to mark the route to the next Metro or Sprint service in the pavement by coloured and, if appropriate, textured paving (taking due account of disability access).

8.1.13 Centro has already introduced a real-time passenger information system across its area with the information available at stops, online and through apps and SMS. Such a system, developed according to further refinements and upgrades of the technology is intended to be an essential element of the information architecture of the Birmingham Connected network.

8.2 Mass Transit Interchanges (MTIs)

8.2.1 The revised Metro, Sprint and CityLink network has been reviewed for key connections between these services and between the mass transit network and local and national rail services. Taking into account the transport services and key public amenities and facilities within the immediate area, a schedule of 15 interchanges has been identified, as shown in figure 8.2.

Figure 8.2 Mass Transit Interchanges



8.2.2 Mass Transit Interchanges are intended to be focal points on the network where a high degree of convenience and comfort can be provided. The principles to be adopted include ensuring that where Metro/Sprint stops are located at crossroads, these mass transit stops are closest to the junction, with the conventional bus stop further away from the junction. Where feasible, pedestrian crossing 'green' phases should enable crossing of the whole carriageway without the need to wait at a central reservation island.

8.2.3 MTIs would not be as extensive in terms of personal support as the Urban Transport Interchange (UTI Hubs) developed for Green Travel Districts, as they would be a more common element of the city-wide network. The key features of each mass transit interchange would be:

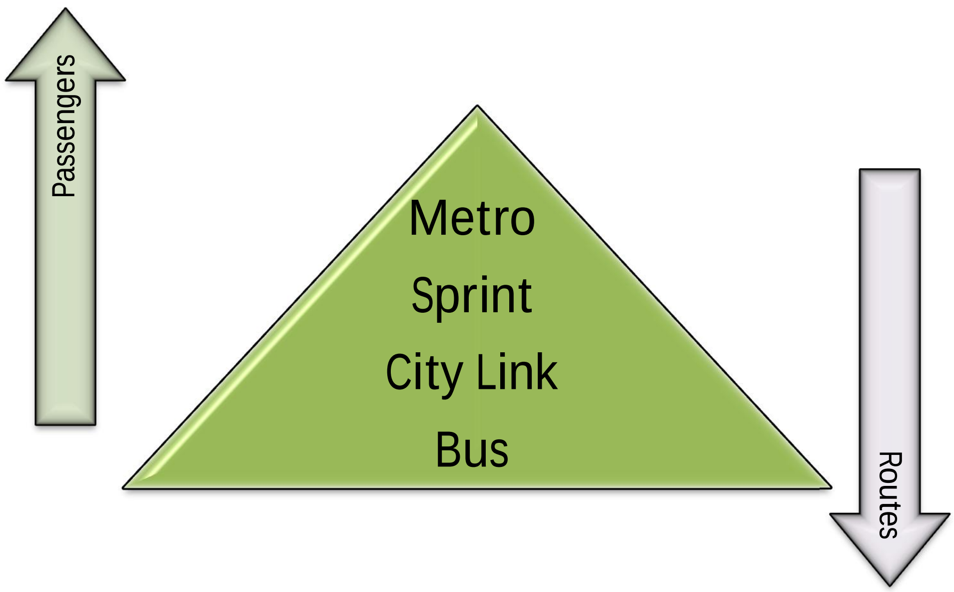
- High-quality pedestrian environment to walk between stops;
- Enlarged shelters;
- Full Birmingham Connected schedule and real-time information display and terminal;
- Smart ticketing registration/top-up/payment facility;
- Cycle storage;
- Taxi rank and car club parking space within 100m; and
- Public convenience (with baby changing facility);

8.2.4 These measures will reduce the perceived and real ‘penalties’ of changing route by ensuring that the time between services is low and that the environment between stops is designed to provide priority and comfort to the mass transit user. Furthermore, the information systems will provide advance alerts and reassurance and the ticketing system will not result in a disproportionate fare for the subsequent journey.

8.3 Other public transport integration

8.3.1 As indicated by the name, Mass Transit Interchanges will be where the modes which carry the largest numbers of passengers meet. Although Metro, Sprint and City Link will, in descending order, carry the greatest numbers of passengers by route, geographic coverage and penetration into peripheral areas will be achieved through the conventional bus network, which will therefore also need to connect efficiently and seamlessly to MTIs. The relationship between the number of passengers and the number of routes is shown diagrammatically in figure 8.3.

Figure 8.3 Relationship of modes between passenger numbers and number of routes



8.3.2 Thus the role of the conventional bus network at MTIs is to transfer in aggregate substantial numbers of passengers to and from the mass transit modes, which will also therefore require investment in terms of the space and facilities available. Careful consideration of how to allocate local bus services to the bus stops adjacent to the Metro/Sprint/City Link stops will be needed to minimise the overall journey time and walk distances.

8.3.3 While Metro, Sprint and City Link services will have a high frequency and operate to common standards and therefore require no specific timetabling interventions, conventional bus services should be scheduled to take into account first and last Metro, Sprint and City Link times, so that the full benefits of the mass transit network can be connected to the wider conurbation.

8.3.4 As with the current 'network west midlands' concept, all bus services should be covered by the same ticket products and information initiatives to allow for fully integrated travel.

8.4 Other shared mode integration

8.4.1 Although taxis and car clubs will not provide for mass public transport movements, they will provide a flexible and essential supporting role to the 'fixed' network and are likely to be more influential in the overall sustainable transport offer than other alternatives such as car-sharing, due to their greater flexibility in terms of travel time and focus on 'personalisation'.

8.4.2 Taxis in Birmingham are understood currently to have a relatively poor perception due to vehicle age, emissions and presentation (whether Hackney Carriage or Private Hire). The BMAP Green Paper put forward potential measures to address these issues, including a review of licensing and a Taxi Quality Partnership. The effect of these would be to increase standards, and could even go as far as to introduce a standard livery, in keeping with the promotion of the Birmingham Connected network as a whole. The fragmented and diverse nature of multiple suppliers is fairly typical of the UK taxi industry and therefore, over time and even if only temporarily, it is likely that there would be a reduction in the supply of taxis in order to deliver an increase in quality.

8.4.3 Alternatively, some element of investment which is not currently made in the taxi market may be required in order to achieve the overall objectives of Birmingham Connected. This is particularly relevant in relation to vehicle emissions, although Nissan is understood to be introducing vehicle recharging infrastructure in the city centre, which may assist in reducing emissions from the taxi fleet, if operators can generate the requisite fuel savings. While financial support is not currently provided to the taxi industry, Birmingham Connected is an ambitious vision to place Birmingham as a city of international standing and therefore such investment would be merited to achieve the overall aims.

8.4.4 To assist with the integration of taxis into the Birmingham Connected network, ranks would be provided at all MTIs and provision would be sought at other main stops. Mobile booking and payment technologies are already fairly common for taxis and during the Birmingham Connected period, these will become the norm – indeed ride sharing apps like Uber present a challenge to both taxi operators and legislators. The advent of personalised accounts for transport will mean that through-fares and other discounts can be developed in order to provide a mutually beneficial connection between taxis and the public transport network, making end-to-end journeys seamless and a credible alternative to the private car.

8.4.5 Car clubs have not yet made a substantial impact on Birmingham's travel patterns as schemes delivered to date have either been small-scale (such as City Car Club) or social enterprises with limited geographic reach (such as Green Revolutions' Co-Wheels), while a larger-scale scheme backed by a car manufacturer, Car2Go, was introduced (and subsequently withdrawn). Together these experiences demonstrate that the customer proposition and business model of car clubs is still in a development phase in the UK context, with familiarity with current alternatives (i.e. taxis) and a generally lower level of local public transport usage compared to mainland Europe cited as barriers to take-up.

8.4.6 Birmingham has a long way to go to catch-up with London, which has 86% of the UK's 164,000 car club members[9]. The availability of high-quality and frequent public transport services and road space constraints on car ownership and usage undoubtedly help London residents to consider going 'carlite' however it is a credible example of what can be achieved, even where integration of payment and journey planning is not complete between the public transport network and car clubs.

---

[9] https://www.tfl.gov.uk/info-for/media/press-releases/2014/july/london-holds-inaugural-car-club-event

8.4.7 Although more than one car club exists currently in Birmingham, there are different business models; the now-defunct Car2Go scheme offered a single point to point service, which in theory provides for lower cost (as there is no requirement to return the vehicle to the point of origin) and could be described as a 'self-drive taxi'. Other car clubs are more akin to car hire or rental, where the car has to be returned to the designated parking area, and BCC has previously introduced dedicated on-street bays for such vehicles. Where the council provides support for car clubs, it has the scope to lead the low carbon agenda by promoting the most fuel efficient vehicles or those with zero-tailpipe emissions (such as electric plug-ins).

8.4.8 In any event, the integration with public transport should cover physical integration at key interchanges (e.g. identified and/or lower cost parking for car club members), network integration on all routes (e.g. where account-based smart ticketing allows for a discounted rate on either the car club or public transport leg of the journey) and information integration (where an optimised journey planner will identify the quickest/cheapest/least polluting option based on a combination of modes).

8.4.9 The GTD work package intends a further development of integration, based on a station based approach, with car club stations in each GTD. These may be more appropriate than the free floating scheme such as Car2Go. Bremen in Germany has been internationally recognized for its private car share organization (CSO), Cambio. Shared cars and shared parking addressed the city's space constraints by reducing the need for a separate space for each driver. Cambio features a shared access card for public transit vehicles, and coordinates car station locations with the city's bus and bike share system, offering its users complete, seamless integration.

9 Impact of Mass Transit corridors on general traffic

Key recommendations

- Priority for the mass transit network must provided the requisite journey times for services, while providing acceptable impacts on other traffic, including freight
- The priority must also take account of the general nature and character of the area served - the 'place' and its 'links' to the rest of the city
- Technology ('intelligent transport systems') have a key role to make best use of the physical highway

9.1 Introduction

9.1.1 Although the mass transit network is intended to provide fast, reliable and efficient travel for the majority of travel demand on any given corridor, even the best systems do not provide for all journey opportunities and therefore general traffic will still exist in some volume. The brief for this work package required an assessment of whether the impacts on general traffic of implementing Sprint would be acceptable in certain corridors and how these can be mitigated.

9.1.2 Delivery of an effective mass transit system will require that each route be engineered to give priority and facilitate easy access to public transport, as appropriate to local conditions. This requirement cuts across all elements of the Birmingham Connected strategy, which will need to take account of delivering effective public transport as central to a vision for urban development.

9.1.3 Work package 1 has been specifically tasked with answering the following questions:

- What are the competing needs for the road network and how can they be managed recognising ‘link’ and ‘place’ functions?;
- What are the opportunities to prioritise particular users on different road/link categories?;
- How can the Birmingham Connected objectives be considered on different roads?; and
- Will the impacts on general traffic, parking, loading and so forth be acceptable in certain corridors? How can these be managed and mitigated?

9.1.4 The working practices adopted in the formation of these public transport proposals and the principles of road space allocation has ensured that the requirements for Sprint and other bus-based modes have been fully considered and accommodated

9.1.5 The aim of priority is to ensure minimal delay to Public Transport. For Sprint Vehicles, a target minimum of 20km/h commercial speed has been defined. The aim should be to enable this to be achieved on the vast majority of journeys (with only the most exceptional incidents causing disruption to public transport movement).

9.1.6 In the event of incidents or works closing lanes the strategy for dealing with the issue should be to continue to provide suitable public transport priority wherever practical. In some cases, particularly for single carriageway routes, it may be appropriate to re-route general traffic to enable public transport reliability to be maintained (for example if shuttle working past a lane closure is necessary).

9.1.7 It should be appreciated that there are a wide range of responses possible for drivers who might be inconvenienced by a reduction in road capacity. These include:

- Change mode;
- Reduce frequency of journey;
- Change departure time;
- Change route;

- Avoid trip; and
- Change destination.

9.1.8 Longer term responses, including change of home or business location, will influence demand over longer periods of time. For this reason, it is important that infrastructure changes are clearly visible and evidently permanent (as would be the case for rail based modes).

9.1.9 The following is an extract from a paper produced by Dr Adrian Davis[10] who reviewed research into the impact of reducing highway traffic capacity.[11]

"The 1994 SACTRA[12] report re-examined the issue for the case of new or widened roads and concluded that increases in road capacity in congested conditions were likely to induce extra motorised traffic to the extent that it did materially affect appraisal. Therefore, by symmetry, it could be expected that a reduction in capacity could lead to some overall *reduction* in traffic volume, so that traffic impacts of capacity reductions would be less severe than expected. For this reason a major study was conducted in 1997-98 by Cairns et al.[13] Evidence from over 100 places from across the world was studied.

Capacity reduction cases varied and included bridge closures due to structural weakness, new bus lanes, essential maintenance work on major roads, pedestrianisation, and vehicle restrictions around urban centres… While the effects of a particular capacity reduction is substantially influenced by the circumstances of the case, the size of the changes in traffic flows and individual response choices can vary considerably. Three situations were defined:

- No reduction in capacity, because any reductions on the treated road were offset by capacity increases elsewhere, or by changes in traffic management, or by spontaneous changes in driving styles - packing more vehicles into the same space
- A real reduction in capacity but no negative effect because there is still spare capacity on alternative routes, or other times of the day, or there are no measures to discourage people using this. Congestion spreads out over time and space, but the overall number or pattern of trips, and vehicle mileage, are less affected
- Significant reduction in capacity where there are no alternative routes or at acceptable other times, and in these situations (as well as rerouting and retiming) a proportion of traffic does 'disappear', due to a very extensive set of behavioural responses. These include but are not confined to mode choice changes, destination and trip frequency.

In sum, traffic does 'disappear' in response to reductions in road capacity, but only to the extent that it needs to do so. A proportion of drivers take action to avoid what they consider to be unacceptable conditions. The impact of capacity reduction is rarely more intense than the already endemically bad levels of congestion that many towns experience. In addition, wider policies which tilt the balance in lifestyle decisions that many people will be making anyway will be important and so the authors stress the need for an integrated transport policy which takes account of interactions between transport and other activities."

9.1.10 The combination of responses available plus the evidence from research makes it reasonable to expect that congestion will not significantly increase on the routes where priority has been reallocated to the Birmingham Connected public transport network.

---

[10] Dr Adrian Davis is a consultant who has advised the Department for Health, Department for Transport, the World Health Organisation, and other public bodies.

[11] Essential Evidence on a page - No.5, Impact of highway traffic capacity reductions, Adrian Davis 02/01/09

[12] Standing Advisory Committee on Trunk Road Assessment, 1994 Trunk roads and the generation of traffic. London: TSO

[13] Cairns, S., Hass-Klau, C., Goodwin, P. 1998 *Traffic impact of highway capacity reductions: assessment of the evidence*. London: Landor Publishing.

9.2 Transition to mass transit

9.2.1 By definition, where public transport is being upgraded on the route, trips along the corridor offer greater scope for mode change, including attracting trips from alternative routes than present e.g. to new Park and Ride sites. The gradual development of the network, within a clear longer term plan, facilitates a degree of responsiveness on the part of users.

9.2.2 Monitoring of flows after projects that reduce road capacity has shown on many occasions that traffic levels reduce overall (similarly and conversely, it is widely acknowledged that road building leads to traffic generation). The phenomenon is known as Traffic Evaporation.

9.2.3 The aim should be that as public transport mode share increases, traffic capacity is further reallocated to public transport, so that overall reductions in person travel time are achieved whilst vehicle travel times remain similar (to current congested conditions) but with reduced volumes of motor traffic on many routes.

9.2.4 With road space being a scarce commodity, a central element of the work done to develop Birmingham Connected's proposals has been to consider how it can be used to achieve the wider objectives of Birmingham Connected and other council policies. Work package 1 has considered the competing needs for the road network and how can they be managed recognising 'link' and 'place' functions. The working practices adopted in the formation of these public transport proposals and the principles of road space allocation has ensured that the requirements for Sprint and other bus-based modes have been fully considered and accommodated. For example, the recognition of 'link' and 'place' functions has been catered for by a matrix of five classifications of each:

Table 9.1 Link and place classifications – work package 1

Place: / Link:	National / city	Sub-regional	District	Neighbour-hood	Local
Highways Agency core network	I-A	I-B	I-C	I-D	I-E
Primary distributor roads	II-A	II-B	II-C	II-D	II-E
District distributor roads	III-A	III-B	III-C	III-D	III-E
Local distributor roads	IV-A	IV-B	IV-C	IV-D	IV-E
Local access roads	V-A	V-B	V-C	V-D	V-E

9.2.5 In addition to all Sprint corridors being identified as link level two (as highlighted in table 9.1), the needs of public transport users and operators have also been reflected in their activities when using links and spaces e.g. for passengers when waiting for their public transport service and for operators when pulling at stops for boarding and alighting.

9.2.6 The classifications of place have also been reflected in the assumed costs of each Sprint route, with an increasing cost anticipated for each place category to reflect the likely greater challenges of delivering priority for Sprint in very busy local suburban centres and high street locations. This ensures that full recognition is given to the fact that Sprint provides an opportunity to transform the public realm, in addition to making a step-change in the quality of public transport.

9.2.7 It is worth noting that some elements of the traffic management required will speed up traffic movement for all vehicles on parts of the public transport corridors. However, it is not generally desirable to attract additional traffic and these need to be considered as being offset against increased general traffic journey times in other areas.

9.2.8 Removal of rat runs and limiting certain routes and turning movements to particular classes of traffic (whether public transport or pedestrians/cyclists) may be perceived to remove capacity. With good design, there should be overall benefits to the ability of the network to meet demand. For example, where side road vehicle traffic (making turning movements from a single lane) is reduced and the demand focussed on the main corridor enabling more efficient use to be made of junction capacity. An integrated approach to design is appropriate to make sustainable modes attractive whilst also speeding up public transport and reducing the impact of vehicular traffic in critical locations.

9.2.9 It should be appreciated that the demands on the network are based on individuals and organisations making individual decisions in response to the anticipated conditions and benefits to them. Provision of good quality information can assist in encouraging choices that also reduce impact on the network. Similarly, managing the network to provide consistency for all modes is relevant.

9.2.10 It is accepted that vehicles heading for central Birmingham use a variety of routes, often using the motorway box to approach by the radial route they consider most appropriate. This flexibility should be understood and used to inform decisions – capacity for “through” traffic can be met on alternative routes, including some potential for park and ride, whilst more local trips should offer transfer potential to non−car modes, so long as the networks meet the needs.

9.2.11 Whilst there will be some resistance to change, it is worth noting that travel patterns are already changing away from the car in UK cities – for example in Bristol, the majority (57%) of people in employment age under 40 years get to work other than by driving. Similarly around 72% of commuters travel to central Manchester by non-car modes. Birmingham is currently experiencing a similar trend. For example, the 2011 morning peak trips by public transport into Birmingham represented a 59.9% share of all trips (bus 28%, rail 30.1% and Metro 1.8%), with car representing the remaining 40.1% share[14].

9.2.12 There is more likely to be impact on localised routing, and on the availability of parking spaces on and near to main public transport corridors. This will need to be managed carefully – for example, loading spaces typically need to be closest to retail premises, followed by parking for disabled people, with short stay parking and then residential / unrestricted parking further away. The perception that parking should be available on street close to destinations will need to be changed; the walk from a parking space should not always be shorter than the walk from a public transport stop. A high quality urban environment with convenient step free access would contribute to ease of movement for all – and is relevant for those who walk further from a parking space as well as those accessing public transport.

9.2.13 Acceptability is much wider than the simple numerical changes in network performance, and will be dependent on clear communication of benefits and promotion of the importance of these benefits. Similarly, potential dis-benefits will need to be seen in context. For example, a restriction on delivery times is much more acceptable in the context of a business that sees increased footfall and improved trading conditions as a result of an overall improvement package. A longer walk to a bus stop is more acceptable where the overall journey becomes quicker and more reliable. An increase in travel time at one location is more acceptable where it is clear that there is a corresponding reduction elsewhere and a reduction in traffic on residential streets. Where Sprint routes are introduced in such circumstances, it has been assumed that costings for priority measures will include the necessary improvement packages.

9.2.14 It is relevant to understand the individuals and groups of users that will benefit and be impacted by particular schemes. Building support from those who will benefit and those who support the principles and wider benefits of the scheme is relevant, especially as resistance to change tends to be the position that gains vocal support when schemes are considered.

9.2.15 It will also be necessary to change the perception of the importance of local transport – currently it appears to be perceived that more radical changes could be made for Metro, but not for bus-based modes. Increasing the “normality” of bus use, particularly amongst higher income groups would help to build support for future change. Hence, Sprint should be promoted as equivalent to Metro in all feasible respects – as part of an integrated transport network.

---

[14] Source 2013 West Midlands Travel Trends, Centro

9.3 Intelligent transport systems

9.3.1 The use of technology to manage the performance of the network will be crucial both in providing the effective priority required for public transport and mitigating impacts on other users.

9.3.2 Current traffic signal control techniques including UTC, UTMC, SCOOT and MOVA[15] have a role to play in managing traffic, alongside specific bus priority measures. Whatever technique is used to control traffic, which may vary by time of day as well as by location, the parameters controlling the system need to be set appropriately to the conditions and policy aspirations.

9.3.3 There is scope to enhance network performance for traffic movement in general based on wider implementation of established techniques, including SCOOT and MOVA, and the optimisation of existing arrangements. Making such changes as part of a coordinated strategy alongside investment in public transport priority (both physical and ITS measures) would not only benefit public transport but also help to mitigate impacts on general traffic.

9.3.4 On-street assets (including traffic signals and detection) would continue to be maintained under the highways PFI arrangements, giving confidence that once investment has been made, equipment will be available over the life of that contract.

9.3.5 There is a need for ongoing investment in many areas, including

- Data analysis and review, including the identification of trends and opportunities for improvement
- Validation and optimisation of systems
- Upgrade of systems to gain value from new technologies.
- Adjustment of system settings to reflect changing use of the network and policy requirements.

9.3.6 The technology and systems used to control traffic incorporate significant aspects and techniques based on systems developed in the 1970s. Technology has developed rapidly and will continue to develop, and it is to be expected that new systems will be developed to take advantage of these changes.

9.3.7 Most current responsive traffic management systems use inductive loops buried in the road surface. These can provide only limited information about the vehicles passing over them. They are also prone to damage. It is already possible to gain more sophisticated information, for example automatic number plate recognition (ANPR) data and data from tracking Bluetooth devices, that can indicate journey times and patterns of movement. Over the life of Birmingham Connected, it is anticipated that significantly more data from vehicles, not only public transport but also freight and private traffic, will become available. These datasets would enable a better, more accurate, understanding of movements which in turn would enable better traffic management.

9.3.8 Privacy concerns can be seen as limiting the use of some data sources – but it should be acknowledged that most people are willing to share data where the benefits to them are clear, and that most data can be anonymised without loss of value.

9.3.9 To gain the maximum value from ITS technology, it should be implemented within a clear policy framework that sets the direction and seeks to maximise the desired benefits. The Birmingham ITS Strategy is a good starting point. The next stage is to develop more detailed strategies for each corridor. These could contain more complex requirements that vary over time – for example, pedestrians may be prioritised in shopping areas at main shopping times, whilst public transport traffic is given priority through the area at main commuting times and deliveries and servicing accommodated overnight.

9.3.10 It is likely that a short term work programme (say over 4−5 years) for ITS measures including PT priorities will need to be developed and delivered, but also a continuing forward look and re-prioritisation that reflects changing use of and aspirations for the network.as well as emerging technologies. Continued investment in appropriate updates and development of systems is vital –

[15] UTS = Urban Traffic Control; UTMC = Urban Traffic Management and Control; SCOOT = Split Cycle Offset Optimisation Technique; MOVA = Microprocessor Optimised Vehicle Actuation

there has been a tendency to focus on investing in new systems and equipment rather than on optimising the performance of the network using available tools.

9.3.11 ITS equipment and systems have a relatively short life compared with other highway assets – suitable strategies will need to be developed to cover future renewal and expansion as well as ongoing revenue costs.

9.4 Maintaining Freight Access

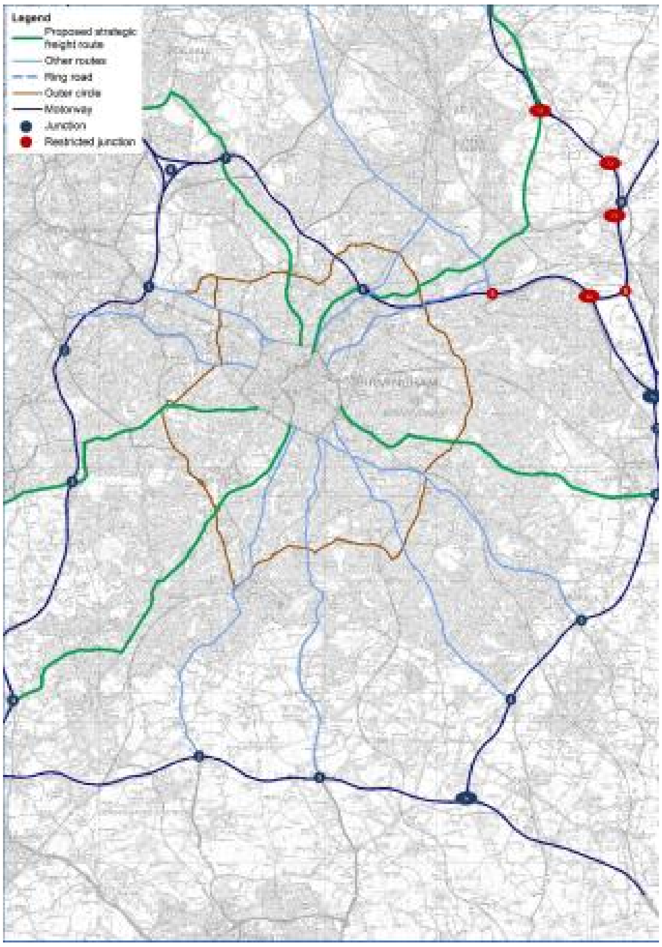
9.4.1 Work package 3 is developing a specific freight strategy which considers the needs of the city as a whole but also the specific needs from identified current and future freight generators. It is considering a range of 'freight' movements which cover the movements of both heavy and light goods vehicles. This strategy will seek to answer the following and other key questions relating to freight:

- What are the key freight movements across the city and how may these change in the future?
- How can these movements best be facilitated given the various aspirations of different stakeholders - what are the requirements from the freight industry?
- What innovative initiatives could be brought forward to improve the conditions for freight and deliveries?
- What are the biggest negative impacts from freight felt across the city e.g. How can freight movements be decarbonised, what is necessary to improve road safety related to freight movements, what opportunities are there for ITS to improve more efficient freight movements?
- What initiatives could help alleviate the identified negative impacts whilst not overly impinging on economic activities?
- Links to the planning process – e.g. freight delivery plans, freight parking provision etc.

9.4.2 The emerging strategy proposes a strategic freight network for Birmingham, based on evidence obtained in the data review process. Routes have been identified on the basis of the nature of existing freight traffic demand and the appropriateness of routes for carrying freight traffic (such as whether routes are built to single or dual carriageway standard). The strategic freight network corridors suggested are:

- A38(M) Aston Expressway;
- A45 Coventry Road;
- A38 Bristol Road;
- A456 Hagley Road;
- A34 Walsall Road; and
- To the north of the Birmingham Motorway Box, the strategic freight route towards Sutton via the A38 corridor rather than the less suitable A5127.

Figure 9.1 Proposed Strategic Freight Network



9.4.3 It is proposed that measures would be drawn from a menu of measures that are applicable according to the nature of the road itself. These seek to achieve similar outcomes to Transport for London's '4Rs':

- Reduce;
- Retime;
- Reroute; and
- Revise mode.

9.4.4 The strategy advocates a mixture of physical, operational and behavioural measures, as it is unlikely that a solution would be confined to any one of type of measure in isolation. Operational and behavioural measures are scalable, so can be promoted where there are particularly constrained lengths of highway (regardless of link / place hierarchy). Through the implemented measures, it is intended that freight will be encouraged to use appropriate routes due to improved journey time reliability and other improvements. The list of measures being considered includes:

- Linking up of BCC's UTMC with that of the HA, to provide advice on the motorway network about which radial routes to use to access Birmingham;
- Use of advanced vehicle detection at key signalised junctions to provide some priority to large goods vehicles;
- Use of consolidation centres on the City's ring road (potentially 2-3 locations);
- Use of VMS to provide reliable journey information from the motorway box to the ring road;
- Introduction of hold-back areas on routes do not have suitable diversionary routes available;

- For district and local distributor roads:
    - Making better use of existing parking bays;
    - Use of local consolidation;
    - Extensive use of 'freight friends', with sharing of servicing areas between different companies;
    - Limited use of VMS, to direct freight either back towards the strategic freight network; and
    - Extensive use of some of the behavioural initiatives, such as collaborating on procurement strategies.

9.4.5 The freight network will interact with a number of proposed Mass Transit Corridors however this does not necessarily mean that the public transport and freight networks are automatically incompatible. Measures aimed at improving journey time reliability can be equally effective for public transport as well as freight e.g. removal of on street parking, red routes, and junction improvements. However, it will be necessary to review proposals in more detail for each corridor. Future corridor strategies will need to consider what access is needed, and by what time of day. The strategies should also consider whether to assign different priorities at different times, for example prioritising buses during commuting periods. Wherever possible and practical, freight should be encouraged to use the network at quieter times.

10 Delivery approach

Key recommendations

- The regulatory regime must secure and guarantee the benefits of the investment in the Birmingham Connected network, while remaining open to benefits of operator innovations
- The Sprint network should be prioritised to reflect the passenger benefits, deliverability, viability and cost.
- 'Upgrading' to Metro from Sprint should remain open in principle for all routes, and be expedited for those with the strongest case

10.1 Regulatory delivery mechanisms

10.1.1 Current schemes to work with operators in order to improve bus services are reviewed in section 3.5. During the development of the revised network proposals, discussions with BCC and Centro covered the need to consider the regulatory regime for the most effective delivery of the route enhancements, as the investment being proposed will only realise its full potential if it is deliverable and provides the appropriate safeguards and incentives for all parties.

10.1.2 A briefing note on the alternative mechanisms, and their principal advantages and disadvantages is provided in Appendix 2. This has been developed for the Birmingham context from previous work carried out into the development of fixed alignment schemes.

10.1.3 Further discussion is recommended between BCC and Centro to develop the preferred option, following publication of the BMAP White Paper.

10.2 Prioritisation of Sprint network implementation

10.2.1 Having developed the network of Sprint routes, it is necessary to consider how they should be prioritised into a delivery programme. At this stage, and given the data available, we have identified a number of factors which we believe should be used in the assessment process. These are:-

- Potential passenger numbers (calculations for which are described in sections 4.2 and 4.3 above);
- Deliverability (ease of deliverability is described by the percentage improvement over current bus journey times required in order for a Sprint service to achieve the minimum 20 kilometres per hour average speed identified in the criteria set out in paragraph 3.3.4 above);
- Business Case (assessed by the potential excess income from a service after allowing for vehicle and operating costs); and
- Capital Cost (the calculated costs involved in new infrastructure, bus priorities and area treatment/improvements for each Sprint route).

10.2.2 The scoring system adopted is based on ranking each route from 1st to 8th, depending on their performance in each factor. Consequently, the lower the total score, the higher the performance. The ranking in the four categories are then added together to create a final score, and to calculate final positions. These positions are taken to represent the optimum combination of factors for successful early delivery, and thus influence the choice and time order of routes to be taken forward into a working programme for scheme delivery. These factors have been collated and are set out in the table 10.1 below.

10.2.3 It should be noted that Sprint route 7 to Halesowen is envisaged to be a substantial upgrade on the current Centro proposals for Sprint to Quinton (via Hagley Road) and therefore, while there will be some elements of savings, the 10+ year gap between the investments as proposed in figure 10.1 means that the cost values are still relevant for the purposes of this assessment.

Table 10.1 Sprint route delivery prioritisation

Sprint route	Main locations served	Passengers per day	Rank	Deliver-ability	Rank	Business case	Rank	Capital cost	Rank	Total score	Position
1	Walsall - Great Barr - Perry Barr - Snow Hill - HS2 Curzon Street - Markets Area	15,800	6	0%	1=	£2.30 million	2	£47.97 million	3	12	1=
2A	Pheasey - Kingstanding - Perry Barr - Birmingham New Street - Markets Area - Kings Heath - Maypole – Shirley	31,251	1	29%	6	-£0.12 million	8	£108.03 million	8	23	8
2B	Hillhook/Falcon Lodge/Roughley - Sutton Coldfield - Yenton - Erdington - Birmingham New Street - Markets Area - Kings Heath - Maypole – Druids Heath										
3A	Frankley - Longbridge - Selly Oak - Birmingham New Street - Moor Street - Handsworth Wood - Hamstead	29,867	2	34%	7=	£2.33 million	1	£71.66 million	4	14	3
3B	Frankley - Selly Oak - Birmingham New Street - Moor Street										

Sprint route	Main locations served	Passengers per day	Rank	Deliver-ability	Rank	Business case	Rank	Capital cost	Rank	Total score	Position
4	Coleshill Parkway - Water Orton - Washwood Heath - Birmingham Moor Street - Digbeth - Sparkbrook - Hall Green - Solihull	23,996	4	14%	4	£2.20m	3	£80.92 million	6	17	4
5	Woodgate Valley North - Harborne - Birmingham Snow Hill - Small Heath - Sheldon - BHX - HS2 Interchange	14,720	7	0%	1=	£0.71 million	7	£73.35 million	5	20	5=
6A	Bartley Green - Woodgate - Harborne - Birmingham New Street - Law Courts	16,160	5	0%	1=	£2.13 million	4	£46.14 million	2	12	1=
6B	Kitwell - Bartley Green - QE Hospital - Harborne – City Centre										
7	Halesowen – City Centre	12,153	8	34%	7=	£1.88 million	6	£35.24 million	1	22	7
11	Outer Circle (Clockwise and Anti-Clockwise)	29,459	3	26%	5	£2.13 million	5	£104.16 million	7	20	5=

10.2.4 It will be seen from this table that forecast passenger usage varies from 12,153 to 31,251, but it should be remembered that some routes only cover one corridor, whilst others are cross-city routes, which might be expected to draw significantly higher numbers.

10.2.5 In terms of deliverability, it is noted that three of the proposed Sprint routes already achieve a peak hour average speed of at least 20 kph. The implementation of priority measures will further enhance these services, without the degree of difficulty inherent in raising the lower average speed of those routes which currently perform poorly.

10.2.6 The business case figures are based on a detailed assessment of potential income set against the vehicle and operational costs for the routes concerned, as described in section 4.3. Consequently these figures are critical in terms of considering the potential of major projects having the capability of attracting external investment.

10.2.7 Capital costs reflect the cost of infrastructure, priority measures, and streetscape improvements required for each individual Sprint route to achieve the standards required. It should be noted that these costs do not include the capital cost of the Sprint vehicles, which are included in the overall business case figures, but they do reflect anticipated levels of investment required to maximise the impact of the ‘link and place’ functions evaluated in a parallel work stream.

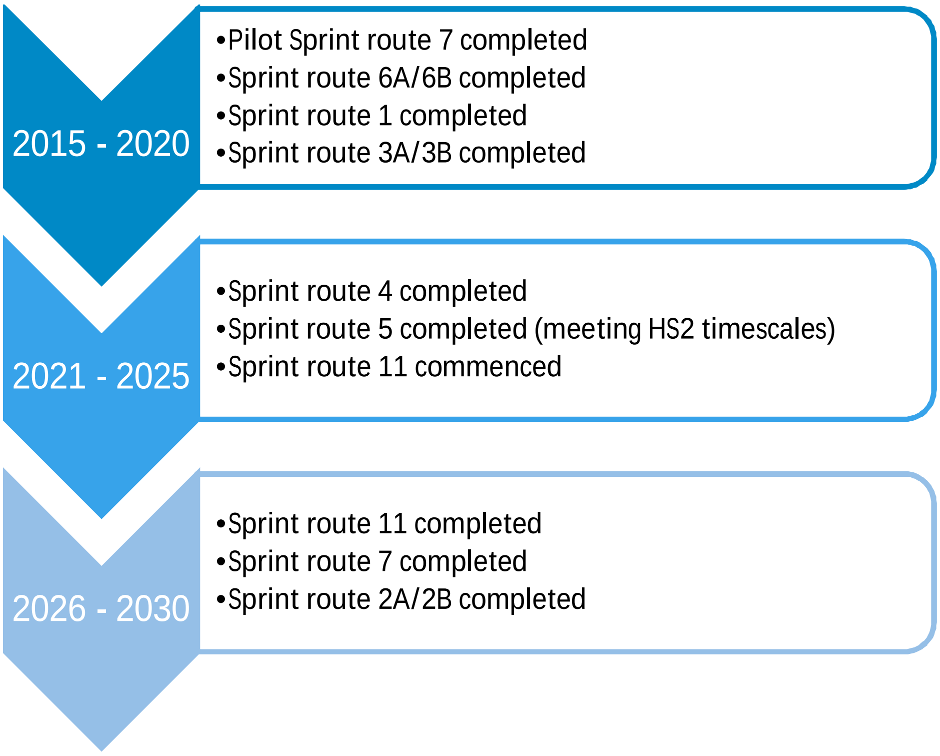
10.2.8 The cumulative capital cost of the Sprint network is £567.5m at current prices, however there is a reduction of £17.5m by implementing the whole network due to shared sections of route between:

- routes 1 and 2A on Walsall Road;
- routes 5 and 6A/6B on Harborne High Street and Harborne Road; and
- routes 5, 6A/6B and 7 on Broad Street.

The costs given for 6A/6B already reflect the long section of shared route and while no reduction has been made for common sections in the City Centre, these are relatively short and could well be off-set by the additional cost of introducing Sprint routes along those sections of carriageway.

10.2.9 Given the ranking of Sprint route prioritisation in Table 10.1, and the overall funding requirements for the Birmingham Connected public transport network, the implementation of Sprint routes is projected to be as shown in Figure 10.1. The prioritisation of Sprint route 5 over Sprint route 11, despite their equal weighting, is due to the lower capital cost and to ensure that Sprint route 5 is completed in line with the expected completion timescale for HS2.

Figure 10.1 Sprint route implementation schedule



10.2.10 In addition to the ambitious nature of the Birmingham Connected mass transit network, the above programme is a challenging, but deliverable, schedule which will require considerable joint working and pooled resources to realise. The options for funding this £0.5 billion network, plus the supporting public transport investments in Park & Ride sites, Smart and integrated ticketing and Intelligent Transport Systems, are covered in the Birmingham Connected Funding work package.

10.3 Progress towards a Metro network

10.3.1 While Sprint is designed to be a high-quality, dependable mass transit network, many stakeholders view Metro as an even more tangible and long-term transport option. Recognising the desire to extend and expand Metro, there would appear to be potential for certain Sprint corridors to be upgraded to Metro, although the change in passenger experience, and thus business case benefits, are not as transformative when upgrading from Sprint to Metro as they are when upgrading from bus to Sprint. The disruptive impact of substantial highway works on Sprint operation while Metro is under construction would also reduce the net benefit in the short term, although should not be treated as a reason not to invest in the network, if the business case would otherwise support Metro operation.

10.3.2 In terms of balancing passenger benefits and deliverability, the order of progression to Metro would be Sprint routes 1, 5 and 3A/3B, although in the case of route 5, this would only apply to the east of the City Centre in order to support strategic development of the network in respect of HS2 connectivity. The passenger volumes of other Sprint routes together with the cost and likely practicality of delivering tram lines through constrained local centres mean that they are unlikely to represent a feasible option within the Birmingham Connected period.

11 Conclusion

Key recommendations

- In order to deliver a mass transit network on the ground to the most immediate benefit of Birmingham, Sprint will form the majority of the network, without precluding Metro on certain routes
- Supporting initiatives must be taken to ensure the network is comprehensive and sound, including but not limited to Park & Ride, emissions standards and regulatory robustness.
- Implementation of the network must prioritise the key factors of passenger numbers, amount of highway work required, cost-effectiveness and investment.

11.1 Public transport work package

11.1.1 The BMAP Green Paper proposed a comprehensive public transport network using modes which were adjudged to be appropriate to the corridor (based on current service levels) and meeting the network-wide imperative of delivering a system which supports the city's growth plans.

11.1.2 In responding to the legitimate queries raised through the Green Paper consultation, full cognisance has been taken of a number of relevant contemporary studies and plans which have already sought to advance Birmingham's current bus network into a mass transit system of global stature.

11.1.3 While Sprint will form the majority of the future network, it will not be the only street-based mode to augment the role of rail and Metro; CityLink and conventional bus services will have a key role to play in the concept of an integrated system and services operated by these modes will also have to be improved to appropriate standards.

11.1.4 The further work carried out by this study has validated and developed the proposed Sprint-based routes by carrying out a more detailed analysis of the likely demand and costs (both capital and operational), and has largely endorsed the previous network, with the following important adjustments and developments:

- Several corridor routes have been joined together to create further cross-city services, which are more feasible as a consequence of priority measures for Sprint and also have the benefits of increased connectivity and reduced stand time for vehicles in the City Centre;
- Cross-city services have been reconfigured to match more closely their proposed frequencies, thus minimising or eliminating any need for 'short workings' that would need to terminate in the City Centre;
- Particular attention has been given to cross-boundary connectivity;
- The CityLink service proposed between Sutton Coldfield and the City Centre has been upgraded to Sprint status, in view of current usage and the potential for growth as a result of new development adjacent to that corridor;
- The Inner Circle route 8 has been changed from Sprint service to CityLink, in view of the potential difficulties in achieving the required average speed for a Sprint service (20 kph); and
- Various extensions have been added at the ends of the Sprint routes, which are not part of the priority corridors, but which replicate existing service coverage.

In view of the priority given by Centro to the proposed Metro service between the City Centre and Birmingham Airport via Bordesley Green and Chelmsley Green, it is envisaged that this route will be developed initially as Metro without an interim Sprint service being required

11.1.5 The Sprint network also has the potential to support carefully selected conventional Park and Ride sites, as well as enabling more localised ‘Micro Park and Ride’ sites to take advantage of the quality and frequency of Sprint services.

11.1.6 A key challenge for the delivery partners will be the provision of sufficient priority for the future mass transit network which will enable it to achieve the 28 standards identified for the Birmingham Sprint ‘brand’. The extent of the network means that the amount of priority required will involve interventions at different types of locations, each with their own opportunities and challenges.

11.1.7 The supply market for low and zero emission vehicles is developing rapidly and the introduction of new Sprint vehicles will facilitate the introduction of the most up-to-date environmental standards, which should also act as a catalyst to tighten progressively the standards for the remainder of the Birmingham Connected fleet. At a minimum, this should be:

- By 2016, the City Centre SQPS area should be readjusted to cover all major bus stop locations;
- By 2018, the base standard for buses should be raised from Euro IV to Euro V; and
- By 2022, the replacement SQPS should have a base standard of Euro VI.

11.1.8 This cleaner fleet is expected to form a key pillar of a transport network which is sustainable in all its elements. Integration between modes will therefore be a pre-requisite, covering information (both before and during the journey), ticketing and non-public transport modes and the network will be aided in its promotion by the creation of Green Travel Districts.

11.1.9 The implementation of a mass transit network to cater for the majority of people movements on a corridor will change the current use of road space and key tools in this approach will be the widespread and co-ordinated use of Intelligent Transport Systems, together with road space re-allocation where appropriate.

11.1.10 A delivery mechanism will need to be established which safeguards the investment and service standards of the new network. It is recommended that this forms part of an early discussion between BCC and Centro, in order to determine the preferred option, although it is almost certain that the relationship with the operator will have to be based on a statutory basis.

11.1.11 The scale of the Birmingham Connected network means that it is impossible to introduce every route simultaneously. The order of implementation has been arrived at following consideration of the major factors which affect the deliverability of any street-based mass transit, namely:

- the number of users to benefit;
- the scale of priority needed to achieve the Sprint standard;
- the operational viability given the vehicle resources needed; and
- the capital cost of implementing each route.

11.1.12 By focusing on the strongest cases at the outset, the concept of Sprint will prove itself and positively affect the business case for the remainder of the network. Indeed, for the strongest performing Sprint routes, (1, 5 and 3A/3B) it will also be possible to consider an upgrade to Metro operation.

Appendices

Appendix 1 – Birmingham Connected Sprint Vehicle Technology Options

Introduction

This appendix considers the various technology options available for consideration when selecting vehicles to use for Sprint services. In terms of sustainability, technical progress is currently moving very fast and developing along a number of different directions. It is very important to select the most appropriate technology for the operating conditions which will apply to Sprint vehicles in terms of the following factors:-

- Optimising sustainability in terms of fuel consumption and emissions;
- Selecting a technology which will not be made obsolete through future developmental changes;
- Adopting cutting edge technology, but only if it has a reasonable track record of reliability; and
- Taking into consideration operational factors, such as vehicle size and fuelling facilities.

The following sections describe the various technology options that might be considered for Sprint services.

Technology options

CNG Powered buses. Compressed Natural Gas (CNG) is not a new technology, and was tried before in the UK for buses some 20 years ago. However, it now appears to be more attractive and is receiving serious attention, with operators such as Stagecoach and Reading Transport having conducted trials in 2011/12 with a MAN EcoCity single deck bus. Subsequent deliveries have been made to bus operators for CNG powered vehicles, including 20 Scania/ADL buses for Reading Transport and 21 MAN buses for Arriva.

Figure A1.1 Arriva MAN EcoCity CNG bus

Circumstances which have changed have been the rise in the cost of diesel, such that a CNG bus offers about a 30% reduction in fuel costs, whilst having an additional purchase cost of only about 50% of a diesel electric hybrid. New CNG buses also meet Euro VI standards, and modern designs feature purpose designed CNG engines.

Whilst CO_2 output is reduced, CNG powered buses also have virtually no PM emissions. Previous problems with fuel supply can be overcome with modular fuelling stations taking gas from the nearest mains supply. The use of CNG buses is common in Europe, North America and Asia. There are other gas based alternatives, such as Liquefied Petroleum Gas (LPG), but CNG is more popular for buses and commercial vehicles. However, gas powered buses do not deliver zero emissions, and there is an increasing view that whilst they have lower fuel costs, their emissions advantage over standard Euro VI specification diesel buses has reduced significantly. In addition, there are significant infrastructure costs involved in the installation of fuel storage and filling equipment.

Flywheel Technology. The Go-Ahead Group has placed an order for GKN Hybrid Power to supply 500 of its Gyrodrive systems to the transport operator.

GKN Hybrid Power's Gyrodrive electric flywheel technology is a Kinetic Energy Recovery System (KERS). When a vehicle brakes, it harvests the energy normally lost as heat. The flywheel stores the energy and returns it to the wheels on demand, boosting power, saving fuel and reducing emissions. When the driver brakes, a traction motor on one of the axles slows the vehicle, generating electricity at the same time. This electricity is used to charge the flywheel, spinning it at up to 36,000rpm. When the driver accelerates, the system works in reverse. The energy is drawn from the flywheel and converted back into electricity to power the traction motor. This reduces the work done by the internal combustion engine, which it is anticipated will improve fuel economy by up to 25%, depending on the application. It will consequently also reduce both CO2 emissions and pollutants, although direct comparisons with Diesel-Electric hybrid technology are not yet available.

The system is designed to last for the life of the bus eliminating the need for any battery changes, and was originally developed by Williams Hybrid Power, part of Williams Grand Prix Engineering Limited, and subsequently acquired by GKN. GKN in turn has formed GKN Hybrid Power, which is focused on delivering complete hybrid solutions across multiple vehicle, power and industrial markets. The system can be retro-fitted to existing conventional diesel buses as well as to purpose-built new buses.

Diesel-Electric Hybrid buses. Hybrid electric buses are powered by both a diesel engine (usually smaller than those in normal buses) and an electric motor. They also usually have regenerative braking, which means they generate electrical energy when braking, which is stored in a battery pack and used to drive the electric motor.

There are two main types of hybrid electric bus – (1) series hybrids, which have no mechanical link between engine and drive axle, with the engine powering a generator that charges the battery pack, which in turn drives an electric motor powering the wheels, and (2) parallel hybrids, where the engine powers the drive axle and a generator that charges the battery pack or directly drives the rear axle at low speed. Hybrid electric buses are currently by far the most popular alternative to conventional diesel buses in the UK, and their introduction has been encouraged by the DfT's Green Bus Fund.

Transport for London claims the benefits of hybrid electric buses to be:

- A minimum 30% reduction in both fuel use and carbon dioxide emissions
- A 3 dB(A) reduction in perceived sound levels
- Reduced oxides of nitrogen and carbon monoxide

The main disadvantage of diesel electric hybrid buses is the purchase cost. A typical double deck bus costing £200,000 would cost 50% extra as a diesel electric hybrid version, and in the four years in which these buses have been in production, there has been little reduction in their initial cost. This type of hybrid bus has been introduced in Birmingham recently, but the numbers involved are not particularly high in comparison with other areas of the UK. The vehicles for the West Midlands consist of 39 double deck ADL and Volvo buses and 8 single deck Optare buses. Currently, 18 double deck buses are operating on the Harborne Road Corridor into Birmingham City Centre (the proposed corridor for Sprint routes 5, 6a and 6b), whilst a further 21 buses are scheduled for operation in Wolverhampton. A typical double deck hybrid diesel-electric bus is shown in figure A1.2.

Figure A1.2 National Express West Midlands hybrid double deck[16]

Although the latest version of these buses feature ‘stop-start’ technology (the engine stops automatically whilst the bus is stationary), and some versions use the electric motor by itself to reach a pre-determined speed when the diesel engine cuts in, they are still subject to emissions from their engines, albeit at a reduced rate compared to a conventional bus. Whilst the majority of hybrid buses in the UK have been double deck vehicles to date, hybrid technology is also available for single deck and articulated buses.

Transport for London is in the process of purchasing 600 of the specially designed New Routemaster between 2013 and 2016. This design features three doors and two sets of staircases, which has the benefit of allowing faster loading, whilst offering a higher seating capacity than articulated vehicles. The rear platform arrangement (with an ‘attendant’) is a ‘London’ feature promised as a commitment by the Mayor of London, but there is no reason why the rear platform cannot be treated as a conventional door. The vehicles also use electric hybrid technology, and have an approximate cost in the region of £340,000 each. A New Routemaster is shown in figure A1.3.

Figure A1.3 New Routemaster hybrid double deck

[16] Photo from Birmingham Mail

Diesel-Electric hybrid buses are in continuous development, and models to Euro 6 specification are already on the market, such as the Volvo single deck 7900 model, with further claims of better fuel consumption and reduced emissions compared to Euro 5 hybrid vehicles.

Diesel Electric Plug-In Hybrid buses. Of particular note is the introduction of new plug-in hybrid buses on an experimental basis by Volvo in Gothenburg. It is claimed that fuel consumption is reduced by over 80% and the total energy consumption by over 60%. The field test in Gothenburg began in June 2013 and includes three plug-in hybrid buses, whose batteries are recharged at the terminals. This makes it possible for the buses to run on electric power for most of the route. Volvo claims that, “Although there are many long, steep gradients on the routes, the plug-in hybrid buses can run on electric power for about 85% percent of the time. The diesel engine only kicks in when the bus needs some extra power”. The field test of the plug-in hybrid buses in Gothenburg involves 10,000 operating hours and will continue for most of 2014. A demonstration project that will bring eight more plug-in hybrid buses into service will commence in Stockholm in 2014.

A number of European cities are showing an interest in plug-in hybrids. Hamburg and Luxembourg have already signed contracts for supplies of buses in 2014 and 2015. Volvo Buses plans to commence commercial manufacture of plug-in hybrids towards the end of 2015. Features of these new Volvo plug-in hybrid bus, one of which is illustrated in figure A1.4, are that they are:

- Fitted with an electric motor which is powered by a lithium battery. It also has a small diesel engine.
- Recharged from the mains power supply via an energy storage unit mounted on the roof. It takes 5 or 6 minutes to recharge.
- Can run exclusively on electric power for approximately 7 kilometres without noise or emissions.

Figure A1.4 Volvo plug-in hybrid single deck

Plug-In hybrid technology is also to be introduced shortly in the UK, with both ADL and Optare proposing to produce suitable vehicles. ADL has now indicated that their first plug-in hybrid (which they are calling ‘virtual electric’) will consist of a modified version of the Enviro 350H, with fully low floor layout. It will have the standard BAE Systems hybrid driveline, a bigger battery capacity and an inductive charging function that will enable it to run in a sensitive area in zero emission mode for as long as required, provided that it is opportunity charged periodically. This technology will also become available on the Enviro 400 double deck vehicle. The 350H is illustrated in figure A1.5 and A1.6.

Figures A1.5 and A1.6 Enviro 350H, front and rear

Trolleybuses. When compared to battery-electric and induction charging vehicles, trolleybuses are a very much older technology. Whilst trolleybuses were introduced on an experimental basis before the 1st World War, they remained on a limited scale until the 1930's when they began to replace 1st generation electric tramways. Their advantages were seen to be a lower capital cost than trams, no need for expensive steel tracks and the associated high maintenance costs and a degree more flexibility in being able to navigate around highway obstructions and road repairs. In many cases, local municipalities were anxious to retain electric traction, as their own generating companies supplied the power needed. However, the balance of fuel costs, and the requirement to maintain overhead electrical infrastructure, together with the price premium compared to a diesel engine bus, led to systems being abandoned from the 1950s onwards. Birmingham Corporation Tramways operated a trolleybus system comprising 5 routes and 78 vehicles up to 1951 when it was closed, with the Coventry Road service being the last one operated.

Many existing systems have now been re-equipped with new state of the art trolleybuses, and there is a renewed interest in the introduction of new systems. The French energy company, EDF, has estimated that there are about 40,000 trolleybuses in service in the world, with over 300 operators, of which some 5,000 vehicles have been delivered recently. There are some 60 systems operating in Europe. The main advantages of the trolleybus are its zero emissions characteristic at the point of operation, although it must always be the case that emissions at the point where electricity is produced should be fully taken into account as well. In addition, the life of a trolleybus is generally longer than a diesel bus, partially defraying the additional unit cost, which can be twice that of a comparable diesel powered vehicle. This is due to the complex electrical equipment and the fact that manufacturers are unable to benefit from the economies of scale for large scale production. In addition, the capital cost of overhead wiring is substantial, and unless trolleybuses are operated on reserved road space, they can be adversely impacted by poorly parked vehicles and are restricted by their overhead wiring when required to be diverted due to road closures etc.

Nevertheless in the UK, a new trolleybus system is planned for introduction in Leeds, marketed as New Generation Transport, with the first route proposed to operate between Holt Park to the north of the city and Middleton Road in the south via the city centre. Construction is planned to start in 2017 with the service being operational in 2020.

The majority of modern trolleybuses are now specified to have dual-mode capability. This may take the form of a supercapacitor, a battery pack or a small diesel engine, which permits them to operate reasonably long distances away from their overhead wires. Dual-mode capability can either take the form of auxiliary or emergency use only, or full dual-mode capability, which permits the vehicle to be used on a part of its route without the need for overhead wires, or as a means of returning to its depot. In addition, it can be used to reduce or remove completely the need for complex wiring within the depot itself. However the cost of a new trolleybus can be in excess of 50% higher than a comparable size diesel engine vehicle.

Figure A1.7 Van Hool Exqui.City Trolleybus in Barcelona

Battery powered buses. This technology has a long history and is mature, with the exception that, despite advances in battery technology, there are still practical problems with range, the speed at which batteries can be recharged and the weight penalty associated with the batteries themselves. Typical distance range achieved by the latest battery technology buses is in the order of 190 kms. However, whilst this may be potentially acceptable, it is still the subject of pilot experiments to discover whether this is, indeed, a reliable and practical proposition for the continuous and intensive use which is typical of bus operation. We are not of the view that this technology is sufficiently proven yet to provide the very high level of reliability required for intensive bus operation in an area like Birmingham.

Single deck buses manufactured by BYD, a Chinese manufacturer, have been used on long term demonstrations in a number of European cities, including London. One of the vehicles involved is shown in figure A1.8, while in use on TfL route 507 during 2013/14.

Figure A1.8 BYD electric bus

However, technical advances are being made, such as fast charging systems which reduce the time taken to recharge battery electric buses from the usual 6-7 hours to 30 minutes. In the UK, this technology is being pioneered by the manufacturer, Optare, with their Solo SR EV midibus and Versa EV full size bus.

This type of bus has been introduced in experimental numbers in the UK cities of Nottingham, Durham, and Coventry, as well in Poundbury, Dorset and at Heathrow Airport. An order for 20 further electric buses has recently been placed by Nottingham City Council, which it is claimed will result in the city taking a lead in the introduction of this advanced technology into its public transport network with what is thought will be the largest free-running Electric Vehicle (EV) bus fleet in Europe. Nottingham City Council already has 8 Solo EV midibus models in daily use on its high frequency CentreLink and MediLink city centre services. They have proved highly popular with users and are contributing to the City's ambitious target of achieving a reduction of 26% in carbon emissions by 2020 when compared with the levels in 2005.

The largest Solo SR model can carry up to 33 seated passengers plus standees and the largest version of Versa can carry up to 40 passengers plus standees. Each of the new buses will be equipped with a rapid charge system allowing them to use charging stations being installed at the Queen's Drive Park and Ride site on the outskirts of the city. This technology will allow 'opportunity charging' during lunchtime layovers in the schedule to enable their daily range to be effectively doubled.

In Coventry, the three Optare Versa EV vehicles operated (as shown in figure A1.9) are owned by Travel De Courcey, and are operated on the park and ride route in the city. These were the first rapid recharge system to operate in the UK, and the operator has claimed that the 30 minutes recharge time is what has made their operation financially viable. Nevertheless, this is very much regarded as an experiment over a long period of time, and the financial viability of the project depends upon the 200 batteries being used lasting at least for the projected five years before they need replacing at substantial cost.

Figure A1.9 Optare Versa EV

Optare has recently delivered 4 of their MetroCity single deck buses for Transport for London service. These electric bus trials will be used to establish whether the technology can stand up to the rigours of operating in an intense urban environment such as London. The manufacturer's tests demonstrated that while the initial capital cost of these vehicles was more than that of standard diesel, the significantly lower running and maintenance costs would offset this within the typical lifetime of the vehicle. The buses take around five hours to fully charge overnight, or two hours using fast charge technology and have a range of up to 100 miles depending on operating conditions. These vehicles are 11 metres in length and can seat up to 44 passengers, dependent on the specification.

Battery powered buses using induction technology. This is an innovative and potentially exciting way of tackling the main failing of battery powered buses, that of lack of range. Pure battery electric vehicles are still a very small portion of the market in most countries, although many cities have been looking to integrate electric or hybrid vehicles into their public transport networks. Whilst electric-hybrid buses have successfully been put into effective mass production, attention is now being given to new techniques designed to tackle battery life, which remains a severe constraint on electric public transport vehicles, as they normally need to interrupt their routes to recharge. This is based on the principle that more regular recharging leads to shorter charge times.

Various experimental systems are under assessment in a number of locations in Europe, North America and Asia. In the UK, Arup and bus manufacturer Wrightbus, together with other partners, have signed a five-year agreement to run a trial route in Milton Keynes, in the South Midlands. This is partially motivated by a view that the current government bus fuel subsidy programme will eventually be phased out, and that will make full electric vehicles more commercially attractive.

The scheme, led by a partnership between Arup and Japanese conglomerate Mitsui, is designed to show that using wireless charging technology to recharge the electric buses throughout the day would allow them to fully replace diesel ones. The trial involves the installation of wireless charging technology from German company Conductix-Wampfler at three points along a bus route in Milton Keynes, which commenced in 2013, and which allows new electric buses to recharge quickly during the timetabled 10-minute driver changeover time. It is believed that these 10-minute charges should replenish around two-thirds of the energy required by buses used on the route, and that this will enable the buses to be able to complete an entire timetable, which could be up to 20 hours' long in busy urban areas, without the need for a prohibitively expensive and heavy battery.

It is anticipated that replacing the existing diesel buses should remove around 500 tonnes of tailpipe CO2 emissions a year, as well as 45 tonnes of other noxious tailpipe emissions. The route currently transports more than 775,000 passengers a year over a total of 450,000 miles. Wireless technology is key to charging the battery in such short periods of time because it removes the need for a large, heavy cable that would slow the process down considerably, and although electric buses are generally twice as expensive to buy as equivalent diesel ones, the running and fuel costs should be much lower.

The trial will run until 2017 in order to collect enough to data to demonstrate the economic viability of low-carbon public transport, which the partners hope could kick-start electric bus projects in other towns and cities worldwide.

Fuel Cell Hydrogen/Electric. This technology is still very experimental and costly, but a fleet of 5 VDL SB200 Wright Pulsar vehicles is currently operating in London (figure A1.10). A fuel cell works like a battery. As hydrogen gas flows into a fuel cell, the hydrogen combines with oxygen and is converted into water. In the process it produces electricity and this powers the electric motor which drives the vehicle.

Figure A1.10 Wrights Pulsar fuel cell hydrogen/electric

Appendix 2 – Birmingham Connected Sprint Schemes; Regulatory Context

Introduction

This section is intended to provide further detail on the options available to secure and safeguard bus operations related to the SPRINT schemes being introduced to form part of the Birmingham Connected Network, and is based on statutory guidance issued by the Department for Transport (DfT) linked to the Local Transport Act 2008. It is not intended to provide formal legal advice or to make firm recommendations on which of the options is considered to be most suitable for implementation at this stage.

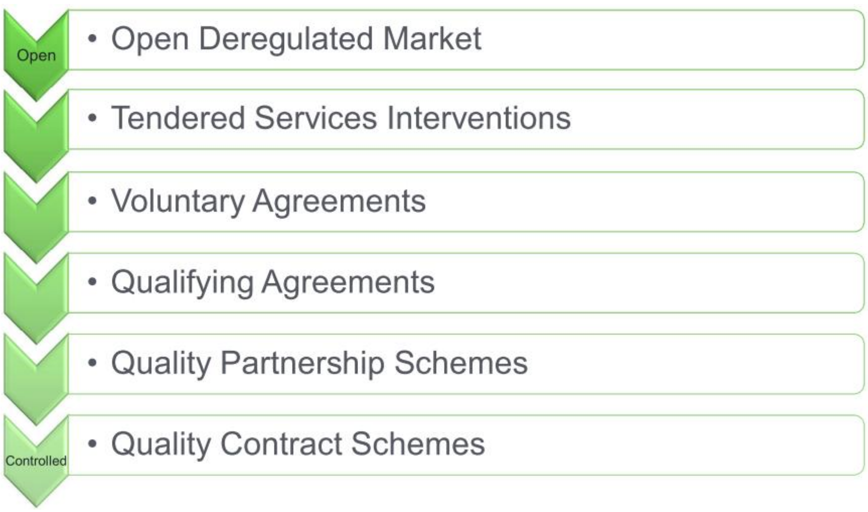
Context

The enabling legislation for Quality Partnership Schemes (QPSs) was originally introduced in the Transport Act 2000, and later amended by the Transport Act 2008. The 2008 Act widened the components of the scheme that could be specified by the authority making the scheme, but also provided safeguards to prevent unrealistic conditions being set which could be deemed to affect the commerciality of bus service provision. This is an important consideration where high standards are being aspired to. The 2008 Act was also intended to address feedback from operators and Local Transport Authorities in order to make schemes easier to implement.

In parallel with the guidance specifically related to the Transport Act 2008, changes to competition law were also introduced in order to make some of the agreements between bus operators more practical to achieve. There is a lot of weight given to the use of statutory arrangements being used as a way of underpinning voluntary agreements with shared objectives and outcomes (being complementary), rather than being a way of forcing operators to either take part in a scheme, or to achieve certain standards (a substitute). Voluntary agreements have successfully been implemented in four areas of the West Midlands to date (Coventry, East Birmingham/North Solihull, North Birmingham/Sutton Coldfield and Wolverhampton).

In broad terms the levels of control over standards of provision, network planning and fares increase through the range of options available as shown in Figure 1 below

Figure 1 – Operating Options



It should be noted however that each of these options may not exist in isolation and are often complementary. For example tendered services will operate alongside commercial services in a deregulated market, and Qualifying Agreements could be used within a QPS. A Quality Contract gives the highest level of control, but also carries significant risk and would have protracted timescales. It is for these reasons that this option is not being recommended in the delivery strategy at this stage.

The making of a QPS, along with the supporting framework of Qualifying or Voluntary Agreements and Tendered Services is often seen as the most effective way of delivering the required level of certainty, control and quality specification, whilst still allowing operators to maintain a sufficient level of commercial freedom.

Service Components

There are a number of elements to the overall delivery of services that contribute to the passenger 'experience'. Some of these such as the timetable and route network are very easily defined, with others such as vehicle quality often being more subjective. Linking to the range of interventions available, Figure 2 below gives an assessment of what may be specified by the Local Transport Authority (LTA) in each case.

Figure 2 – Level of Control for LTA

Service Procurement Option	Timetable	Routes & Network	Control of Facilities	Vehicle Quality	Fares	Driver Training	Revenue Risk	Legally Enforceable
Open Competition	✗	✗	✗	✗	✗	✗	Operator	✗
Tendered Services	✓	Partial	✗	✓	✓	✓	LA	✓
Voluntary Partnership	✗	✗	✗	✗	✗	✗	Operator	✗
Qualifying Agreements	✗	✗	✗	✗	✗	✗	Operator	✓
Quality Partnership Scheme*	✓*	Partial	✓	✓	Partial*	✓	Operator	✓
Quality Contract Scheme	✓	✓	✓	✓	✓	✓	LA	✓

*Subject to 'Admissible Objections'

In addition to the aspects identified above, the 2008 Act also allows the use of bus service 'Registration Restrictions' allows a further degree of protection for the operators and LTA following investment to achieve the higher levels of provision and quality.

Quality Partnership Schemes

A Quality Partnership Scheme (QPS) is a statutory scheme and as such must follow a clearly defined process and include prescribed form and content. The scheme is 'made' by the respective LTA and whilst partnership working and consultation is encouraged as part of the formation process, it is not an 'agreement' between the parties. Once the QPS is made, the respective operators wishing to make use of the facilities included in the scheme must give a written undertaking to the Traffic Commissioner that they will meet the required standards and provide services to the required levels, as set out in the scheme. The QPS must specify what is included by the scheme within two broad areas: **Facilities** and **Standards of Service.**

Facilities are generally those provided by the authorities and are defined as those that are 'expected to bring benefits to passengers by improving the quality of service, reducing or limiting congestion, and noise or air pollution'. They must not however include any facilities that are considered to be a statutory duty of the authority to provide (such as bus service information provided under section 139 or 140 of the Transport Act 2000). Improved levels of information provision (such as Real Time Information for example) could be included however.

Facilities do not have to be newly constructed or provided to be included in the scheme but if they are more than 5 years old, operators must agree to their inclusion. Facilities more than 10 years old cannot be included. The facility may not entirely be provided by the LTA or Local Highway Authority, but where other parties are included (such as the Police or Highways Agency) they must be included in consultation during the making of the scheme to demonstrate the scheme is practical and deliverable in its entirety.

It is possible, for example, for a LTA to make a Traffic Regulation Order that includes a trunk road, providing the Secretary of State gives consent. This process should be directed via the Highways Agency Regional Office.

Standards of Service are the aspects generally provided by the operator and include all specifications of the service itself (times, frequencies, fares, etc. – subject to admissible objections.) but also other qualitative aspects such as driver training, breakdown arrangements, liveries or branding and service stability (including the frequency of change and notification periods). It can also include the specifications for data sharing (e.g. patronage and performance data).

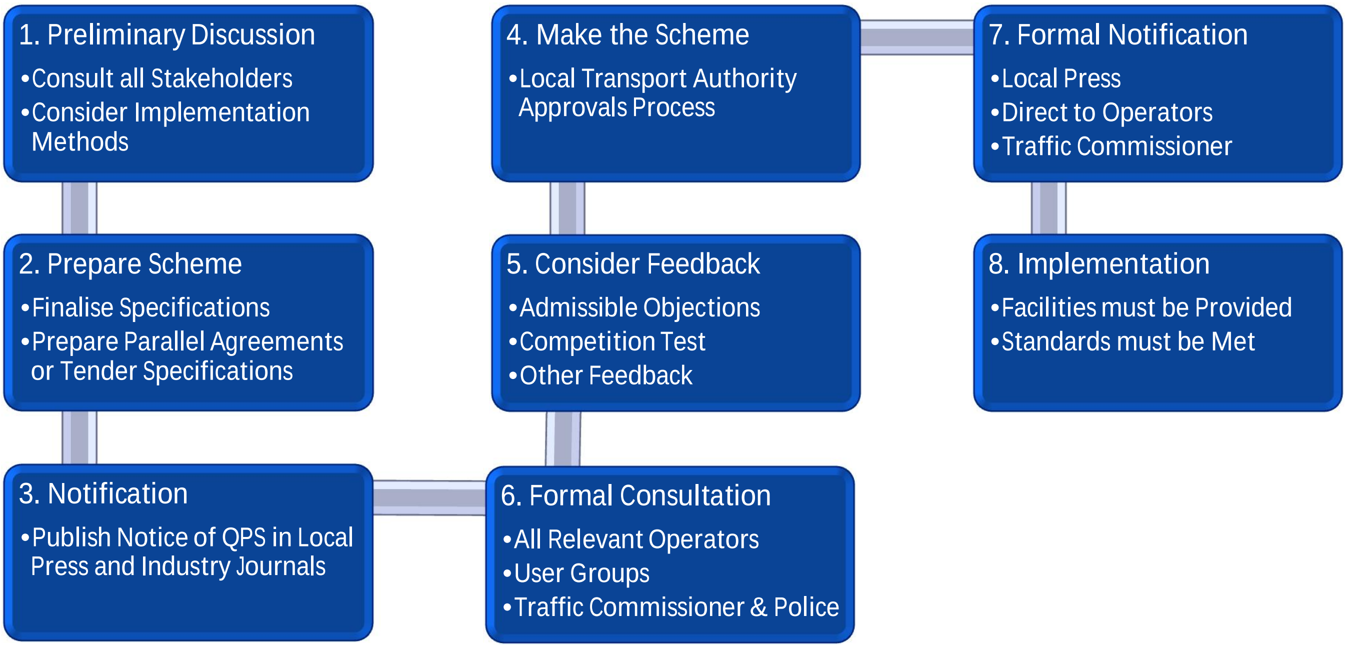
Being clear on the scheme objectives will help to determine what aspects must be included in the scheme in order for it to be effective. Demonstrating these clear links and providing an evidence base will help to justify the scheme components and defend against objections should these be forthcoming. There are certain ‘admissible objections’ that can be made by operators, which again, are identified in the guidance. Admissible Objections include those aspects where it would not be practicable, or commercially viable, for the operator to provide services to the standard specified (such as the purchase of new vehicles in a period of time which is considered too short or impractical, or the additional cost of meeting the standards which makes services commercially unviable).

A QPS does not have to be applied consistently across the entire coverage of the scheme and there may be valid reasons to vary specifications, timings, frequencies or fares across different corridors, different services or different times of the day, or even to exempt certain services from the scheme if they are deemed not to be crucial to the success of the scheme, or to include them would be disproportionate. The implementation dates for component parts of the scheme can also vary, enabling phased improvements to be introduced. The scheme area must be defined, and this should be proportionate to the facilities being provided.

QPS Process

The process for preparing and implementing a QPS is clearly defined, and must follow a number of dependant stages. The principle of ‘frontloading’ is encourage, including as much informal discussion with stakeholders in advance of scheme preparation in order to ensure that the subsequent formal process proceeds as smoothly as possible. Figure 3 below illustrates these stages and component parts.

Figure 3 – QPS Process and Stages



The SPRINT scheme would currently be considered to be at Stage 1, where preliminary discussions with operators and other parties such as manufacturers have been undertaken and broad principles, objectives and specifications discussed. The implementation methods are now being clarified and this would enable the draft scheme to be prepared, with a greater level of detail and a better understanding of the likely operator reactions. Further operator discussions would then help to identify and likely potential for objections. There is an expectation from DfT that operators use this informal consultation stage to highlight potential conflicts so these can be resolved, wherever possible, before the formal making of the scheme.

The expected period for the making of a scheme from official notification to implementation would be expected to take around 18 weeks (4 ½ months) if there were no admissible objections, and up to 27 weeks (almost 7 months) if objections have to be resolved. This would clearly be dependent on internal authority approval processes and dependent timescales within this period.

Supporting Processes

Traffic Regulation Orders – whilst Traffic Regulation Orders (TROs) would not be considered 'facilities' in their own right, and would therefore not be included in a QPS, they will often be necessary for the scheme to be effective. This is because any facility such as a Bus Lane, Bus Gate or other measure that restricts traffic in any way requires the presence of a TRO in order for it to be legally enforceable and for action to be taken against those who infringe the restriction. The TRO process would work in parallel with the QPS implementation, and consultation for the TRO should be completed to give certainty over its implementation. Existing TRO's can be used if they are 'fit for purpose'.

Registration Restrictions – Sometimes it may be deemed necessary to provide a degree of commercial protection for operators and LTAs when implementing and investing in a QPS and its enabling infrastructure. As bus services in the UK (outside London) operate in a deregulated environment, the making of a QPS would normally allow any operators to subsequently use the facilities as long as they are able to demonstrate they meet the minimum Standards of Service. If the network of services has the potential to be undermined across all or part of the routes in question, it is now possible under the 2008 Act for the LTA to include Registration Restrictions which then gives the Traffic Commissioner the power to refuse applications to introduce, change or withdraw services that form part of the QPS if it is expected to have a significant negative impact.

When considering the use of Registration Restrictions, the LTA must consider the wording of restrictions in order not to prevent changes that could be beneficial to the scheme (i.e. an increase in service frequency to support passenger growth or deal with overcrowding). The Authority must detail its intention to include Registration Restrictions as part of the scheme during the consultation period with stakeholders, and take due notice of any representations made.

Once the Registration Restrictions and QPS are in place, any new registrations received by the Traffic Commissioner will trigger a statutory consultation process with the affected LTA and Bus Operators in order to allow them to make relevant representations, setting out why they feel that acceptance of the registration would be detrimental to existing services covered by the scheme. The Traffic Commissioner will then decide whether or not to accept the registration. Changes required to comply with a legal requirement (such as a TRO) or simple changes such as an operator's details are not covered by the restrictions.

In making a scheme that includes Registration Restrictions, it is important that the authority considers the impact of restrictions on competition and that the competition test in the 2000 Act is applied. This must demonstrate that the restrictions do not have 'a significant adverse effect on competition' or that the impact on competition is proportional to the benefits to passengers gained through the improvements. If there is very little existing competition it could, for example, be demonstrated that protecting the existing market was the main objective of the restrictions with a view to allowing operators to gain the benefits from their investment in order to meet the Standards of Service.

It is important to note that in relation to the QPS and Registration Restriction context, definitions within the legislation identify what are considered to be 'relevant operators' and these are only those who currently operate services within, or affected by, the QPS or who have registered services to start in the area. This effectively prevents 'rogue' objections or representations from outside operators that simply have the intention of interfering with the scheme.

Voluntary Agreements – In order to deliver the objectives of the QPS it may, in some circumstances, be appropriate for operators (either individually or collectively) and other relevant parties (such as the Highways Agency, Police or Local Health Authority) to enter into a voluntary but legally binding agreement to cover aspects not directly covered by the QPS itself. This could include wider measures to encourage modal shift such as enforcement, promotion, co-ordinated travel planning or integrated information provision. This should be seen as a supporting and complementary process.

Qualifying Agreements – In order for operators to meet the Standards of Service prescribed in the QPS, it may be necessary (or beneficial) for operators to jointly provide services. This has a number of benefits as it can allow the more efficient delivery of higher levels of service, reduce costs across the network and provide a more sustainable solution in the longer term. On a single corridor the required service headways, frequencies and capacity could in some cases be delivered by a number of services provided in a co-ordinated way and this is where Qualifying Agreements become relevant.

Centro would specify the required Standard of Service through the initial QPS consultation process and the operators would decide whether they were able to meet these standards individually. If not, it may then be appropriate for them to enter into a Qualifying Agreement, setting out what each would deliver, and this undertaking would then be certified by Centro and submitted by the operators to the Traffic Commissioner.

Again, Qualifying Agreements and Registration Restrictions are able to pass the Competition Test where there is no demonstrable impact on competition, or where the impact is proportional to the benefits being accrued.

Competition Tests – The 2000 Act includes provisions to ensure that barriers to market entry or competition are not created by the QPS and this process is overseen by the Office of Fair Trading (OFT). These provisions, known as the Competition Tests are satisfied if the scheme either does not have a significant adverse effect on competition, or if the effect is proportionate to the achievement of quality improvements or benefits to users.

In order to allow constructive consultation, upon publishing the draft scheme, the LTA should also set out how they understand the Competition Test is satisfied. The process of referring anti-competitive matters to the OFT is separate to that of Admissible Objections, which itself relates to particular components of the scheme effecting bus operators.

Figure 4 below demonstrates how the processes identified above enable the two main components of the scheme to be delivered.

Figure 4 – QPS Components and Enabling Processes

Practical Examples of QPS Implementation

In addition to the example in central Birmingham, there have been a number of examples where QPS legislation has been used to implement schemes in England, following the first scheme in Sheffield, introduced in 2007. The scope and content of these schemes varies, covering a range of corridor and area based SQP's.

Sheffield was the first QPS in England and was introduced across an area of North Sheffield. The scheme followed a number of Voluntary Agreements on corridors in the city, linked to the countywide Quality Corridor programme. The 'Better Buses' scheme in North Sheffield incorporated a range of infrastructure improvements including area wide shelter and bus boarding improvements and a number of bus priority schemes to deal with pinch points along the main arterial corridors.

As this scheme was introduced under the 2000 Act provisions it did not include any standards relating to frequencies or fares, but there was a supporting voluntary agreement which supported the introduction of a revised bus network. The services were divided into 'core' and 'supporting' services depending on their relative frequencies and coverage and this allowed a slightly different standard to be applied to each. Unfortunately as the agreement was not binding, a number of service changes and some withdrawals were implemented by First, the main bus operator, within a relatively short timescale. Overall, however, the network demonstrated growth of around 3% against a background of declining patronage in other areas of the city.

SYPTE who made the original scheme followed with a further area based QPS in **Barnsley** Town Centre, which effectively captures the majority of services operating across the district, as they pass through the town centre. Again, the standards were linked to a number of infrastructure improvements including a rebuilt Interchange, and bus priority measures.

Sheffield now has a wider Sheffield Bus Partnership Agreement implemented in October 2012, which supports the introduction of a revised network and will run for five years, including a degree of consolidation to maintain its commercial sustainability. The agreement follows a number of years of negotiation and public consultation (The Bus Vision) originally working towards a Quality Contract arrangement. Whilst the Bus Partnership Agreement is a voluntary arrangement, it will also incorporate at least two corridor based Qualifying Agreements to remove wasteful competition on some routes, and quality standards which will see new vehicles introduced. There is no QPS at present but the ITA has declared this could be included on corridors where specific improvements are introduced. At present there will be no legal control over underperformance.

The new agreement has also attracted additional funding as part of the City Deal, and recognising the partnership, the Government has agreed with the City Region to devolve 100% of BSOG for the Sheffield

Partnership area and agreed a potential 33% top-up fund to invest in measures to secure patronage growth through the partnership in Sheffield. This amount could be worth up to an additional £8.5m over 5 years and complements the £2bn funding already secured through the Highways PFI Scheme in Sheffield to improve highway and street lighting quality and maintenance. These synergies provide what is probably a unique set of circumstances. It is seen by the ITA that the proposed Sheffield VPA provides a significantly earlier delivery to customers and with a more equitable spread of risk across the partners.

Nottingham has had a QPS in place since May 2010 which covers an area of Nottingham City Centre incorporating 96 bus stops but not including the main Broadmarsh and Victoria Bus Stations. Similar to the original Sheffield scheme, the QPS includes a defined list of specified services defined by Core and Complementary with relevant Standards of Service for each. The scheme includes a range of city centre TRO related measures (parking restrictions, bus lanes, etc.) to help maintain reliability, and also infrastructure in the city centre, including the free city bus service and standards of maintenance. In order to further control congestion in the City Centre, the QPS includes a 'slot booking' system for the allocation of space at bus stops and agreements on prior discussions when service registrations are being submitted.

The form and content of the Nottingham scheme is fairly straightforward, in that it simply identifies a geographic area and sets clearly defined standards for those buses and services entering the zone and using the facilities. The required standards are not considered too onerous (vehicles for example had to meet Euro III by 2013) and it is not clear how many of the facilities were newly introduced as part of the scheme. Facilities up to 10 years old are included.

Oxford – The situation in Oxford is slightly different to other examples, as the primary reason for the implementation of bus operational restrictions is the need to improve Air Quality. As a result of this, the City Council have been pursuing a Low Emission Zone (LEZ) requiring all Public Service Vehicles (PSVs – including coaches and tour buses not simply local service buses) operating in Oxford city centre to meet the Euro V emission standard by the end of 2013. Rather than using the QPS legislation it was felt more appropriate to implement a Traffic Regulation Condition (TRC) through powers held by the Traffic Commissioner. A TRC is placed on the Operator's Licence of each operator in the area and this limits the way buses can be operated in the area defined by the condition. This could be the route or stopping places of services, or the number and frequency of vehicles through certain streets.

Subsequently, and in order to meet some of the restrictions being placed on the number of buses in the City Centre, the main operators (Stagecoach and Oxford Bus Company - endorsed by the Local Authority) entered into a Qualifying Agreement (QA) during the autumn of 2010, which included four of the city's main bus corridors. The QA includes shared frequencies using new double deck vehicles to deliver improved capacity with fewer vehicles, and supporting measures such as information and smartcard ticketing to promote modal shift. Whilst the QA does not form part of the LEZ or TRC legal process, it is seen as a way for the operators to meet the requirements of each without the need for them to be impeded, which appears to have offered clear benefits for the operators, with their ability to remove 19 vehicles from the fleet, but with an increased passenger capacity per hour.

Manchester – A joint scheme has been recently introduced by Transport for Greater Manchester (TfGM) with Manchester City Council and Stockport MBC. This is a corridor based QPS on the A6 from Manchester to Hazel Grove through Stockport and is one of the busiest bus corridors in the UK. The scheme started in April 2012 and will run for five years. It includes specified levels of service depending on the percentage of operation on the corridor and these levels then determine what Standards of Service must be achieved. The QPS included minimum vehicle standards, Euro IV increasing to Euro V by January 2014 and maximum vehicle age, making it one of the most stringent set of standards. The predominant operator Stagecoach has also entered into a Voluntary Partnership Agreement addressing further supporting activities outside the QPS. Along the corridor the Infrastructure Scheme clearly identifies the bus stops and other facilities that are included in the scheme.

The existing SQPS and VMAs described in section 3.5 have been approached on an area basis and this is supported for a future base-level SQPS for Birmingham Connected as a whole (as described in paragraph 3.5.2). It is however possible to consider the application of a QPS at the corridor level, particularly where there could be a danger of otherwise unconstrained bus service provision which would undermine the investment in the mass transit network. It is understood that Centro is advocating an SQPS for the first introduction of Sprint on the Birmingham to Quinton route and this is an appropriate approach for the mode. There is also the potential to develop the corridor approach where an operator is already committed to upgrades (e.g. NXWM's

‘Platinum’ and Arriva’s ‘Sapphire’ initiatives) in order to ‘lock-in’ these enhancements and use it as an initial step towards eventual Sprint or Metro operation.

Appendix 3 – Monorail Potential in Birmingham

UNITED
BY OUR
DIFFERENCE

MONORAIL POTENTIAL IN BIRMINGHAM

23/09/2014

Confidentiality: Confidential

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft Final			
Date	24/9/14			
Prepared by	George Burnett/ Matthew Tozer			
Signature				
Checked by	George Burnett			
Signature				
Authorised by	Simon Statham			
Signature				
Project number	50401069			
Report number				
File reference				

MONORAIL POTENTIAL IN BIRMINGHAM

23/09/2014

Client

Birmingham City Council

Consultant

George Burnett
Mountbatten House
Basingstoke
RG21 4HJ
UK

Tel: +44 12 5631 8763
Fax: +44 1256 318 700

www.wspgroup.co.uk

Registered Address

WSP UK Limited
01383511
WSP House, 70 Chancery Lane, London, WC2A 1AF

WSP Contacts

Click here to enter WSP Contacts

Table of Contents

1 Introduction

The Birmingham Mobility Action Plan (BMAP) envisages a series of mass transit services operating along the main corridors into the City Centre. The proposals within BMAP consist of extensions and a new line for the existing Metro light rail system, with the remainder of the network consisting of Sprint services, which would be a Bus Rapid Transit network. The choice of the latter technology is based on its effectiveness in presenting a more modern image to users, its capability of carrying large numbers of passengers and its ability to be implemented relatively quickly at relatively low cost.

However, it is very much recognised that Sprint lines may need to be upgraded in the future if usage and economics justify this. Whilst the obvious upgrade would be to convert Sprint services to Metro, there are other alternatives available for consideration. Whilst an underground metro system has been ruled out on cost and funding grounds, one alternative to LRT (either street tram or a segregated Metro type service) would be a monorail system.

Monorail systems used for mass transit purposes in urban areas can be found in various areas of the world, although such systems are not particularly common in Europe. The most relevant system in the wider European area is that in Moscow, an image of which is shown on the front cover of this report.

The Monorail Society defines a monorail system *as 'a single rail serving as a track for passenger or freight vehicles. In most cases rail is elevated, but monorails can also run at grade, below grade or in subway tunnels. Vehicles are either suspended from or straddle a narrow guideway. Monorail vehicles are wider than the guideway that supports them.'* Thus monorails are not confined to elevated systems, although, like all railed vehicles, they do need their own trackway, and this would be physically difficult, if not impossible, to share with other traffic.

Light Rapid Transit systems can also be elevated (an example would be the Dubai Metro network), but the requirements for this type of system are considerably more heavy weight and extensive in terms of the infrastructure and space required, when compared to a monorail system. This report considers the main types of monorail systems currently available in the market, concentrating on those which have a significant installation track record in urban areas comparable to Birmingham (Bombardier, Hitachi, Intamin and Scomi), together with the Metrail system, which has been proposed as the basis for a possible study into system and route feasibility by Birmingham Business Focus.

2 Overview of Current Monorail Technology

This section seeks to review the current performance of monorail technology. The five companies described are capable of offering a whole-system package and have at least one full system currently in operation, with the exception of Metrail, which is included on the basis of being featured in Birmingham Business Focus's proposal for a 24/7 High Speed Monorail Service. For robust comparison, example systems are drawn from those aimed at Mass Transit, rather than the many examples which can found in amusement parks, such as Disneyland, or purely site internal systems such as Phoenix SkyHarbour.

2.1 Bombardier

Bombardier is a worldwide transport manufacturing firm with a wide portfolio of rail and metro experiences. This allows them to draw on existing components and knowledge for their monorails. Bombardier's current Monorail offering is the Innovia 300. System features are claimed to be:

- Up to 80km/h running
- Automated operation allowing short head-ways between trains
- Maximum capacity 48,000 passengers per hour, per direction
- Compliant with safety standards
- Short head-ways
- Flexible train length configuration
- Extremely low energy use
- Good ride quality on spring suspension
- Low land take due to slender guide beams and the ability to handle tight corners
- Spacious vehicle interiors with flat floors from end-end
- Half the construction time of a conventional LRT/Metro

The first line to use this system opened its first phase in August 2014. This is Line 15 in Sao Paolo, Brazil, and is the most ambitious of the three currently on Bombardier's books and will be 24km long when completed, serving 18 stations and will have cost $1.4bn to build.

Line 15 is known as Expresso Tiradentes, and will run between the Vila Prudente and Cidade Tiradentes urbanizations and connect with the São Paulo Metro Line 2. The journey currently takes almost two hours by car: the Monorail 300 system will reduce that journey time to approximately 50 minutes and benefit 500,000 users daily. When fully equipped the monorail system will have the capacity to transport 48,000 passengers per hour per direction (pphpd).

The system will feature 54 seven-car trains (378 cars) with *CITYFLO* 650 automatic train control technology for driverless operation. Bombardier is also providing project management, systems integration and engineering, testing and commissioning for the new trains and signaling.

Prior to Sao Paolo's Line 15, Las Vegas has operated the Innovia 300's immediate predecessor since 2004, linking seven major attractions with a fully automated system covering 6.4km and 7 stations at a cost of $65m. After initial technical issues, the system has become one of the busiest transit systems of its kind in the US whilst maintaining a 99% in-service rate. The maximum speed the trains attain in service is 50kph, giving an end-end time of 14minutes.

The smallest of the three Bombardier lines under construction is in Riyadh, reaching just 3.6km but covering 6 stations with connections to hotels and other public transport facilities.

Bombardier will supply, install, operate and maintain this Monorail 300 system for the prestigious new finance and business district in the capital of Saudi Arabia, which will utilise six two-car Monorail 300 trains. They will be equipped with *CITYFLO* 650 communications-based train control for fully automated operation, and the signaling system will allow for shorter headways between trains and provide reliable and comfortable service for passengers.

2.2 Hitachi

Hitachi has been offering Monorail systems since 1964, when the Tokyo Monorail opened. The Company currently offers infrastructure and signalling packages along with three different types of train (small, medium and large), with different performances, all based on the "Alweg" guideway straddle design.

System features include:

- 3minute minimum headway for 20 trains per hour.
- Capacity of up to a maximum of 24,680 passengers per direction per hour assuming a large train at ‘full’ capacity.
- 60 metre minimum radius for medium to large vehicles as likely to be seen in Birmingham.#
- Capable of handling 6% grade
- Narrow guideway and surface land-take
- Two different styles- two tracks with nothing connecting for light to pass through, or two lines with a safety gangway between them
- Through-carriage connection between connected trains
- Airy design and air conditioning, flat floor throughout
- Quiet ride quality
- Variety of track switch designs for branch lines if required

Being the oldest current monorail manufacturer, Hitachi has a large portfolio of working systems, of which a small sample are covered below.

As mentioned above, the first line to use Hitachi’s technology was the Tokyo Monorail, serving 11 stations on a network reaching 17.6km at a maximum speed of 80km/h. This line is the only one identified during this review operating express services which do not stop at all stations, only serving the main railway station and the airport which form the two end points of the line, and is classified as a medium system.

Another recent suburban monorail project in operation includes the Tama Toshi monorail line in Tokyo, opened in full in 2000. Despite cost overruns causing the initial corporation to become insolvent, the line is a key part of West Tokyo’s transport network. Trains can run at up to 65kph on the 16km network which connects 19 stations in three suburban cities.

The most recent Hitachi system to open is Line 2 of the Chongqing system in Southwest China, covering 19.2km and 18 stations at present, with an extension under construction. This is classified by Hitachi as a large system.

Hitachi is also presently working on a Monorail line in Daegu, South Korea. This 24km system with 30 stations has cost $333m to build and is currently undergoing testing. One unique feature of this line is the provision of train windows that are capable of ‘clouding up’ whilst passing through residential districts to prevent the overlooking of properties. Unlike the previous Hitachi lines, Daegu will have automated operations.

Hitachi has also built the only operating Monorail system in Dubai, UAE, the Palm Jumeirah Monorail which is 5.4kms long and operates along the central ‘trunk’ of this man-made development built into the sea. Entering service in 2009, this system features three car units with a maximum speed of 70kph.

Hitachi quotes a maximum system capacity carrying capability of just under 25,000 passengers per hour per direction, which represents 8 car units operating every 3 minutes. Hitachi claims three advantages for its system, which are:-

- Medium and large type vehicles can maneuver around a curve radius as tight as 100 meters, and can negotiate a minimum curve radius to 70 meters if the numbers of tight curves are limited or for non-revenue service portion like a depot or storage area. By employing rubber tyres, Hitachi monorails can cope with a 6% grade within continuously 400 meters long. The guideway (track beam) requires less space, which simplifies the installation of Hitachi’s System, especially in developed urban areas where space is limited.
- Systems are more environmentally-friendly due to its simple, narrow guideway compared with the wide bridge structure required by other transit systems. The narrow guideway allows sunlight through to the surface street and surrounding residential/commercial area. Airflow is not blocked to/from the surface street, and avoids causing air pollution under the structure by exhaust gas from cars. The narrow guideway feels less constrained for the public along the corridor. The illustration on the left shows the Hitachi System, whilst that on the right purports to show typical alternative Monorail systems.

- The guideway beam is produced using traditional pre-stressed concrete casting techniques. The track beams are manufactured at an offsite-casting yard. The completed beams are transported to the site just before the installation. The site impact is limited to the column construction. This greatly reduces the traffic flow impacts during construction. The quality of the track beams can be more precisely controlled at the casting yard than at the construction site. This is also effective for cost control. In addition, the guideway structure is much lighter than the wide bridge structure required by other transit systems. Consequently, the columns can be narrower, which is more economical and less obtrusive. The majority of the guideway is concrete, which requires less routine maintenance.

2.3 Intamin

Intamin Transportation has many years’ experience in Monorail technology, commencing with tourist attraction type operations but recently moving to suburban operations with its People Mover P30 and 35 systems. System claims for Intamin include

- Smooth riding
- Efficient operation
- 1-5,000 people per hour per direction
- Light-weight track system
- 15-20% compound curves
- Automatic operation
- Lower cost/km compared to conventional metro (rail based) systems
- Quieter operation

Intamin currently has one of its larger systems in operation in Moscow. This line is 5km long with 6 stations. It cost approximately $240m to build when it opened in 2008 after complications and delays due to contractor inexperience with Monorail systems. It connects the City Centre to the Airport.

The company also opened a system recently in Port Harcourt, Nigeria. This is only a 2.1km long shuttle service at present, with an option for a second track in the future.

The largest Intamin system is the People Mover P35, which is claimed to be the ideal solution for heavy mass transit for medium sized or large metropolitan environments. Large trains with spacious cabins, combined with a powerful propulsion system will allow a fast and efficient transport in urban environments, such as cities and airports. The trains are running silently on the track beam and are equipped with all state of the art features to provide transport at a superior comfort level. Based on carefully selected and robust materials as well as durable and proven components, the rolling stock is designed to achieve high reliability and low lifetime costs.

Train capacity is from 70 to 350 passengers per train, depending on the selected train length. This seems to suggest a system capacity of 7,000 passengers per hour per direction given a 3 minute operating frequency, which is significantly less than the other systems described.

2.4 Scomi

Scomi is another company with a strong record in successful full system delivery of monorails. Their system features are claimed to be:

- Speeds up to 80km/h
- Able to handle sharp turns and climbs better than conventional rails
- Advantage over conventional ground based transport through travelling it over it
- State of the art air conditioned stops
- Projected operational capacity (Mumbai) of 8,300 passengers per hour per direction
- 96passenger per car capacity at 4-5 people per m^2

Current operational examples include the Kuala Lumpur (KL) monorail and the more recent Mumbai Monorail. The former opened in 2003 and covers 8.6km with 11 stations, connecting a transport hub with a major shopping and entertainment venue. It cost US$2.5 billion to build and has had only two incidents during its operation caused by power supply failures.

The Mumbai system is more substantial, running four coach trains compared to the two seen on the KL network. The 1st phase of line 1 opened February 2014. This section runs for 8.93km and cost US$176million to build. Initially popular, ridership has fallen away of late with locals citing the line's poor connectivity with other modes outside of the centre. The second phase is scheduled to open in 2015, costing US$304million and bringing the system to at total length of 20.21km. The long term ambition is for a comprehensive network covering 135km.

Another line using Scomi's whole-system package and currently undergoing testing is Sao Paolo's lines 17 and 18, set to open in 2015 and 18 respectively. The former will be 21.5km long with 14stations, whilst the latter is proposed to be 15km long with 18stations, costing US$1.7billion.

2.5 Metrail

Metrail is the system which has been suggested by Birmingham Business Focus for supplying the Birmingham System. Their design claims include:

- Hybrid electric power with the power supply on train, rather than collected through the rail

- Cheaper installation as there are no electrical supply installation costs
- Power supply uses hybrid technology, in this case the use of a small diesel engine
- As with other monorail packages, Metrail offer a variety of train sizes depending on situation. The largest appears to be the Metrail Ultra, capable of 55,000pphpd.
- 20-30m turn radius
- 80-90kmh running speeds
- Less than 2 minute headway between trains can be achieved
- Optional upgrading to automated technology
- Optional supplementary solar power

At present, Metrail only has a test track in operation in Malaysia, which demonstrates the efficiency of their system. Unfortunately, their major contract for a full system in Saudi Arabi, a US$122 million system at Dubailand, has been stalled since the 2008 financial crisis. Costs were projected to be $20 million per km.

2.6 Summary

Monorail technology is now regarded as mainstream in terms of its use for urban high density systems. However, the majority of such systems have been introduced in Asia and South America, and the technology is not common in Europe or North America, other than for theme parks and airports.

Monorail systems should quite legitimately be considered as a mass transit option for new proposals, and their suitability needs to be assessed against construction costs, operating costs, income generation, capacity, engineering integration, service integration, environmental benefits and environmental impacts, in exactly the same way as any other potential mass transit system. Like any other rail based system intended to largely follow highway corridors, the ability to engineer the structural requirements into the existing topography and environment is a particularly critical consideration.

3 Boarding and Alighting Implications

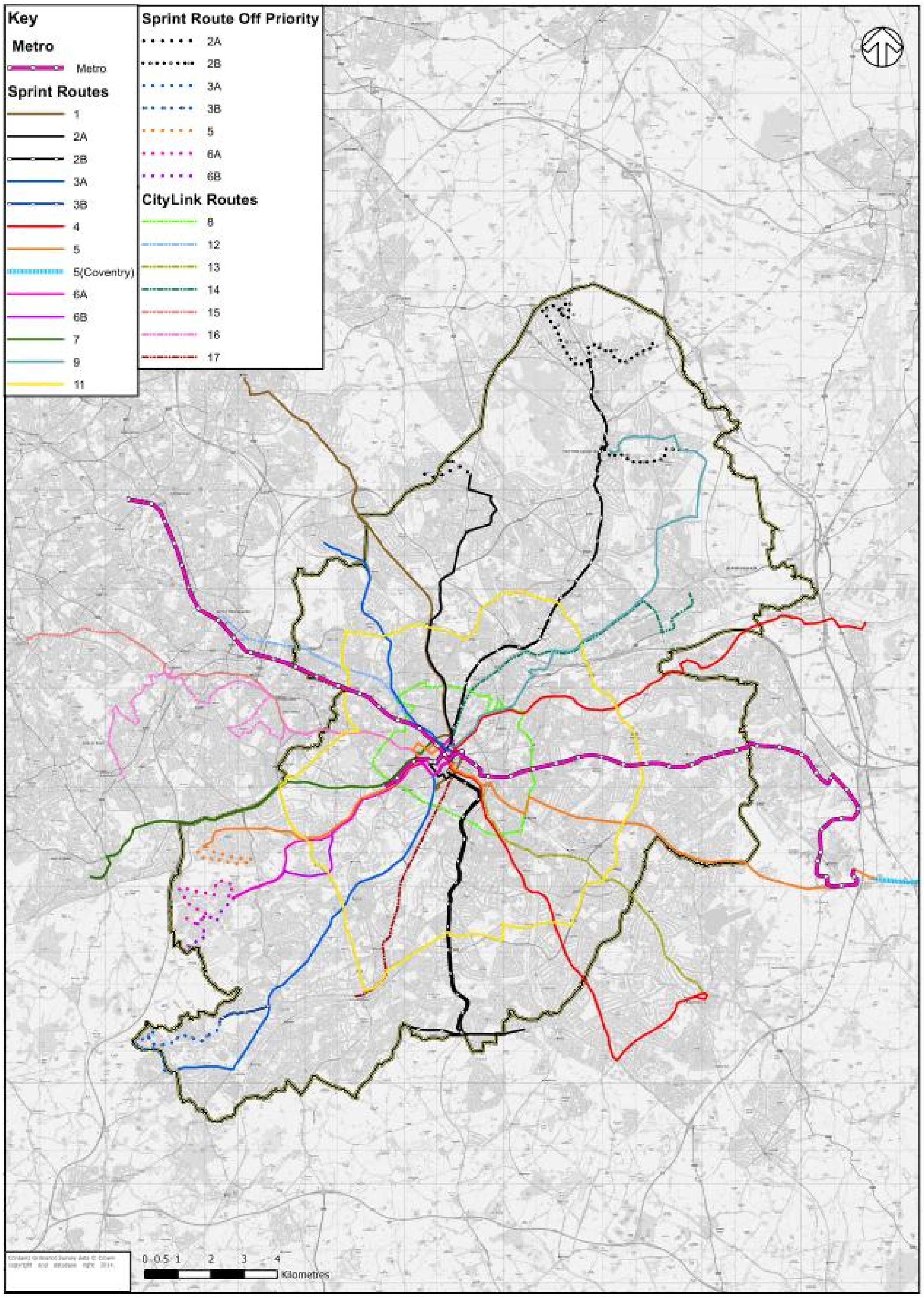
More than bus based, or even light rail systems, Monorail has to use boarding and alighting facilities that are much more akin to railway stations than a bus or tram stop. Almost inevitably, Monorail systems will be engineered to operate on elevated track and infrastructure, and this has a direct impact on the design and cost of stations. Features of such stations will need to include:

- Sufficient length to accommodate the rolling stock used, which could vary from 3 to 8 cars in length;
- Provision of elevated platforms in both directions, with sufficient floor space to safely accommodate the projected number of passengers boarding and alighting;
- Waiting facilities on the elevated structure to provide protection from inclement weather;
- Ticket issuing machines if there is no on-board fares collection system;
- Full accessibility to the elevated structures, which would require lifts, and possibly also escalators, for accessibility to both platforms, in accordance with the Disability Discrimination Act;
- Although it may be possible to provide the necessary access from the central reservation of a dual carriageway, if the latter is sufficiently wide, it is more likely to be required from the pavement sides of the highway, in order to obviate the need for large numbers of passengers to cross the highway. Where roads are particularly wide, this will entail significant lengths of covered walkways at elevation to access the stations;
- In view of the equipment and facilities provided at these stations, a robust security and safety system will need to be in place to prevent crime and vandalism;
- Associated with boarding and alighting requirements, emergency facilities will need to be installed along the entire length of any elevated structures to allow emergency evacuation of the Monorail units – this is likely to take the form of a walkway between the two monorail tracks, together with emergency staircases where the distance between stations is significant. The Metrail system assumes this provision, but notably some other manufacturers do not, and the positive features promoted by some of a ‘light’ footprint allowing less obstruction by the elevated structures are thus unlikely to be achievable.

The features listed above are inevitably going to result in substantial structures for stations, and the full costs of these will need to be factored into any comparative cost per km, when looking at alternative systems.

4 Assessment of Suitability of Proposed Birmingham Mass Transit Corridors for Monorail

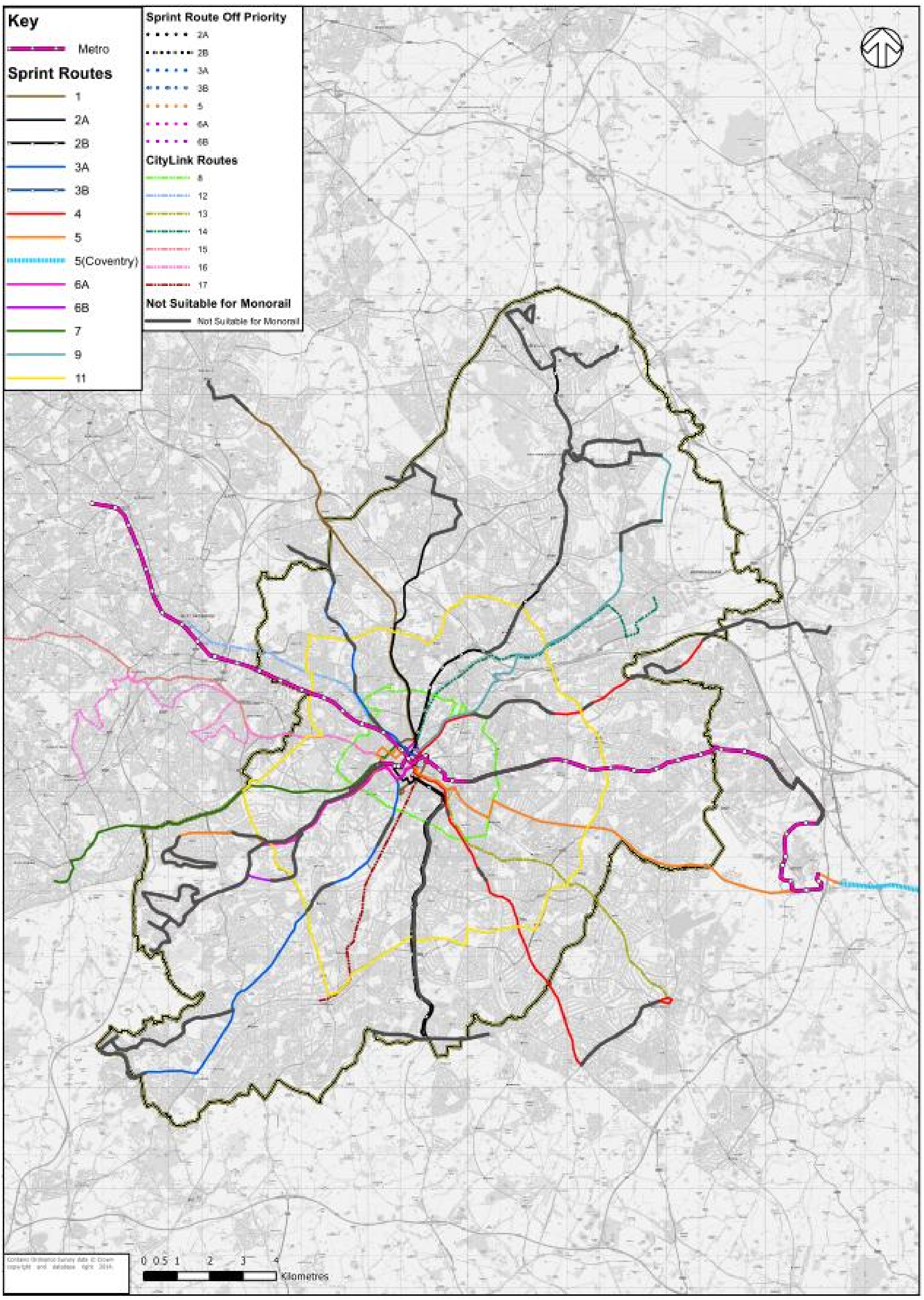
In the Birmingham Mobility Action Plan Green Paper, the dominant mass transit modes proposed were Bus Rapid Transit with an option to upgrade to Metro on corridors with sufficiently high demand. These would have allowed the network illustrated below:



From this proposed network, the Sprint Lines and the eastern extension of the Metro have been considered as potentially feasible for Monorail operation. The CityLink routes were not considered on the grounds that their lower demand and income potential would make the financial case less viable.

In considering these corridors, we would regard the key feature for monorail viability as being the ability to accommodate support columns within the available road space. This space could take the form of wide medians or possibly even extensive ‘ghost island’ areas, but where the road reduces in width to a standard two way, two lane layout, this would create a substantial impediment to monorail feasibility, unless accompanied by very wide pavements, which could be reduced in width to create a central reservation. In other situations, whilst the option of removing a traffic lane may be considered, this would obviate most of the advantages that monorail could offer over conventional modes.

Based on these constraints, the following map was constructed:



As can be observed, the suitability of Sprint routes for conversion to Monorail ranges widely. A synopsis of the routes is below:

- **Sprint Line 1:** Whilst the A34 Corridor would largely be viable for Monorail implementation the narrower streets and built up areas within Walsall's ring present a considerable barrier.
- **Sprint Line 2A:** This route shares line 1's A34 section part way then transfers onto the A435. Whilst initially there is space for monorail infrastructure, there is no road space available once the route moves off of the A435 at Kingstanding. This is a disadvantage as it reduces the accessibility of the line within the housing estate. The only alternative would be to terminate the monorail service at Kingstanding and operate shuttle bus feeder services.
- The southern end of route 2A, currently allegedly the most frequent bus route in Europe, would regrettably be largely impractical as a monorail route, due to being predominantly two lanes, featuring narrow roads with no central space for columns.
- **Sprint Line 2B:** This line leaves the City Centre initially on the A38M. Whilst this corridor has space available, cost might prove prohibitive. Once off of the A38M, however, the Gravelly Hill road towards Sutton Coldfield does not have the space available for Monorail. There might also be oversight issues given the predominantly residential nature of this line.
- The southern section of this route is shared with 2A and therefore encounters the same difficulties.
- **Sprint Line 3/3A:** The northern route of this line follows the A41/B4124 Corridor out of the City. The road is of a quite mixed nature; with many comparatively narrow sections. It is not thought that it would be suitable for monorail infrastructure. It also includes sections of extensive gradient.
- The Southern section of this line follows the A38 corridor. As far as Edgbaston, the road is of four lanes width, but is of a very narrow nature and with quite narrow pavements, possibly precluding the installation of support columns. Beyond Edgbaston the route has large central reservations suitable for monorail with a notable exception at Selly Oak; where neither the new bypass nor the direct line through the High Street (which is the alignment for the currently proposed Sprint route) has room available in their present. Similar to Line 2A's northern alignment, the line (particularly the 3A which diverges from the A38 earlier) would encounter greater difficulty when off priority as the residential estates served off of the A-road sections would be largely implausible for monorail infrastructure, again reducing the catchment of the system and requiring a dependence on feeder bus services.
- **Sprint Line 4:** The north eastern section of this line is proposed to follow the B4114 corridor to the east. This route does enjoy extensive sections of wider road, however there are also some constraints around high-street locations with the road narrowing to allow wider pavement.
- The southern section to Solihull is considerably more feasible along the A34 corridor which is dominantly a four lane road with a central reservation, with one narrower section on Spark Hill High Street. The main issue with the southern section would be Marshall Lake Road from the A34 towards Solihull town centre which is another predominantly residential two lane road.
- **Sprint Line 5:** The Western section of this route is one of the most challenging for Sprint operation, due to a lack of road space. We believe that the same issue would constrain any potential for monorail on much of this alignment, except for a comparatively short section on the A4123.
- The Eastern section of this line is broadly identical to the monorail route proposed in the Greater Birmingham Monorail document. As observed in that report, the alignment is broadly four lanes with a wide central median. This would make it an ideal alignment for a centre-line located monorail, making the main issue the loss of cross-city connectivity compared to the proposed Sprint line.
- **Sprint Line 6A/B:** Operating within the tight confines of Harborne Road from the city centre and with the 6A proposed to cover Harborne's exceedingly constrained High Street; this route would probably be the least practicable for conversion to monorail due to a lack of space in which to locate the requisite infrastructure except in two minor locations.
- **Sprint Line 7:** Proposed to cover the Hagley Road corridor, this is the other route which would be broadly suitable for monorail construction, possessing extensive median strips and/or ghost islands for much of its lengths as far as Halesowen.

- **Sprint Line 9:** This route enjoys long sections with the potential for supporting monorail infrastructure, the roads possessing either four lanes or wide central margins. North of Walmley, however, the roads are predominantly narrower residential roads between the main road and the access to the Sustainable Urban Extension (SUE) and on the return from the SUE to Sutton Coldfield. Also, the natures of the roads within the SUE are an unknown quantity at the present time.
- **Sprint Line 11:** Due to the operational issues inherent to large orbital routes, Sprint Line 11 was not considered in detail for the monorail study. Information gathered in the development of the Sprint Lines does, however, suggest that it would have large sections incapable of supporting monorail, particularly where it crosses high streets. Also, interchange with other lines at crossings would be challenging, particularly for higher-frequency lines.
- **Metro Line 2:** This line broadly follows the B4114 corridor on its way to Birmingham City Airport. Whilst there is some scope for monorail infrastructure, narrow streets in the Washwood Heath and Kingshurst areas would present considerable issues and are, again, predominantly residential in nature.

In conclusion, the requirement for specialist infrastructure to support monorail would severely constrain the number of routes which could be covered by that mode, particularly in areas off the main corridors where Sprint's ability to operate off-priority allows it to cover a much greater catchment area. However, the route proposed by the Greater Birmingham Monorail promoters, which equates to the eastern section of Sprint Route 5, does seem to be suitable for the operation of such a system. However, the route would lose the cross-city benefits which will be obtained through Sprint as the western section of the proposed line is particularly unsuitable to support the required infrastructure for monorail.

In addition, as shown in the previous chapter, the line of route needs to take into account the issue of stations' footprints and locations. It is the case that the areas identified as most constrained are also those most likely to require stops/stations, on the basis that they are often the high streets and local centres, which are significant trip generators in their own right. Consequently, an elevated monorail station with its requisite lifts, stairs, platforms and shelters would be almost irreconcilable with the often historic fabric of the high streets it would be essential to serve.

5 Timescales for Implementation

One of the major intentions of the BMAP was to produce mass transit schemes which could be implemented in the quickest timescale possible, and then subsequently upgraded if the usage and business case justified such investment.

In approximate terms, a non-guided Bus Rapid Transit scheme should be implementable within a short period (up to five years). The processes involved would include outline and detailed feasibility studies, detailed design, negotiation with transport operators, ordering of vehicles and associated equipment, construction and service commencement.

For Light Rapid Transit or a Monorail, the process would result in implementation being medium term (5 to 10 years minimum), dependent on a range of circumstances. Most UK schemes have been at the upper end of this scale, and although there are arguments that the construction of a Monorail system is inherently quicker than a Light Rail scheme, through the use of precast equipment and the consequential reduction in the time and disruption resulting from on-site construction work, both types of scheme would need to be progressed through a more complex planning process, which would require a Transport & Works Act (TWA) Order. The length of planning process procedures varies considerably according to the complexity of the scheme and how controversial its impacts are considered by potential objectors. It is reasonable to assume that any rail based scheme passing through densely populated urban areas is inevitably going to attract considerable opposition from those who feel that their interests are adversely affected, either by the construction process, or by the nature of the scheme itself.

Typical required matters that can be authorised through the TWA process include:-

- powers to construct, alter, maintain and operate a transport system or inland waterway;
- powers to carry out and use works that interfere with navigation rights;
- compulsory powers to buy land;
- the right to use land (for example, for access or for a work site);
- amendments to, or exclusion of, other legislation;
- the closure or alteration of roads and footpaths;
- provision of temporary alternative routes;
- safeguards for public service providers and others; and
- powers for making bylaws.

A TWA order does not in itself grant planning permission. But the organisation applying for the order can ask the Secretary of State to grant planning permission for any development described in the order. The Secretary of State would only grant planning permission if he or she decided to make the TWA order. He or she would do so at the same time as the order was made, and may attach conditions to it. On the other hand, the organisation applying for a TWA order may apply for planning permission, separately, to the local planning authority (Birmingham City Council and the adjoining Metropolitan authorities).

A TWA application might be processed through a more informal Hearing procedure, but if deemed controversial by the Secretary of State, he or she is likely to arrange for a public inquiry to be held by an inspector. A public inquiry is also likely to be held where a statutory objector exercises their right to be heard because they oppose compulsory purchase. The whole TWA process is likely to add some 12-18 months minimum to the timescales for the delivery of the scheme.

6 SWOT Analysis of Mass Transit Systems

As a guide to the relative advantages and disadvantages of the three main types of mass transit systems, the following Strengths, Weaknesses, Threats and Opportunities (SWOT) table sets out major points for consideration.

1. Strengths	Bus Rapid Transit	Light Rail Transit	Monorail
■ Cost	Lowest cost of three systems at around £3 to £4 million per km including vehicles Can be financially justified with lower usage forecasts than other two systems		Lower overall cost than LRT at around £22 to £25 million per km including rolling stock, but any difference in cost would be eroded as LRT would be extension of existing system
■ Capacity Capability	In UK conditions could carry up to 6,000 passengers phpd	Up to 18,000 passengers phpd (could be up to 24,000 for totally segregated system)	Similar capacity to LRT in UK conditions
■ Accessibility	Costs include pavement works to enhance direct access to flat floor vehicles	Would be constructed to ensure full accessibility	Would be constructed to ensure full accessibility
■ Expansion Capability	Physical expansion of system to serve other areas relatively straightforward	Line capacity expansion capable of dealing with any likely demand	Line capacity expansion capable of dealing with any likely demand
■ System Integration	Easy to integrate with other PT modes	Easy to integrate with other modes but would require feeder service approach	
■ Deliverability	Can be delivered in short term (less than 5 years)		
■ Environmental Impacts	Future vehicle development would focus on electric powered vehicles with no emissions at point of operation	Current technology means no emissions at point of operation	Current technology means no emissions at point of operation Third rail electric supply results in no need for overhead wiring Note that Metrail uses diesel hybrid technology similar to latest bus technology
■ Public Perception		Well regarded by users and potential users	Likely to be well regarded by users and potential users
2. Weaknesses	**Bus Rapid Transit**	**Light Rail Transit**	**Monorail**
■ Cost		High cost of system requires robust usage forecasts for justification	High cost of system requires robust usage forecasts for justification
■ Capacity Capability	Difficult to expand beyond around 6,000 passengers phpd in UK conditions unless totally segregated		
■ Accessibility	'Docking' of vehicles less precise than other two modes		Requires accessible access to elevated structures Evacuation systems much more complex than for ground based transit systems
■ Expansion Capability		Physical expansion beyond existing line would be expensive	Physical expansion beyond existing line would be expensive 'Branching'/'Points Operation' is feasible but slower and technically more challenging than LRT, which is relatively simple System is proprietary and

			expansion may be locked in to original supplier (not the case with LRT)
■ System Integration		Whilst good, cost of required infrastructure likely to be high	Would need to be carefully planned in terms of elevation or ground level operation and cost of infrastructure likely to be high
■ Deliverability		System deliverability from concept to operation likely to be up to 10 years	System deliverability from concept to operation would be slightly faster than LRT but only by 1-2 years maximum
■ Environmental Impacts	Current vehicle design likely to be diesel electric hybrid, but technical advances would result in introduction of plug in or inductive battery power and eventually dispense with the auxiliary diesel engine	Overhead wires regarded as visually intrusive – alternative ground based current pick up regarded as still being experimental rather than mainstream	Elevated structure visually intrusive and has privacy concerns in residential areas
■ Public Perception	Non-rail based system not regarded as favourably by passengers unless considerable efforts are made regarding the vehicle appearance and the quality of the street infrastructure		
3. Opportunities	**Bus Rapid Transit**	**Light Rail Transit**	**Monorail**
■ Cost	Relatively straightforward to expand the system incrementally and to create through connection links	Mode shift from car likely to be easier to achieve	Mode shift from car likely to be easier to achieve
■ Capacity Capability	If BRT very successful, opportunities to upgrade to rail based mass transit	Once constructed, unlikely to be capacity problems on corridors concerned	Once constructed, unlikely to be capacity problems on corridors concerned
■ Accessibility			
■ Expansion Capability	Ramp up of entire network system of BRT lines will be easier, quicker and at much less cost than the other two alternatives	Potential to be used to upgrade BRT	Potential to be used to upgrade BRT, but may have more limited applicability due to technical constraints of topography
■ System Integration	Opportunities to integrate with other PT modes at well-designed interchange points	Creation of a more integrated LRT system with through running and interchange potential	
■ Deliverability	Quicker delivery of Birmingham-wide system than with the other forms of mass transit		
■ Environmental Impacts	Future BRT vehicles will be zero emission at point of operation	Potential for significant mode shift will reduce overall emissions	Potential for significant mode shift will reduce overall emissions, but will not be as great as LRT due to the smaller scale of the network
■ Public Perception	Successful operation will enhance public perception	Successful operation will enhance public perception	Successful operation will enhance public perception
4. Threats	**Bus Rapid Transit**	**Light Rail Transit**	**Monorail**
■ Cost		UK LRT projects have a track record of going substantially over budget Projected patronage fails to meet levels required to justify	Use of proprietary system may result in cost inflation for system expansion due to possible lack of competition for expansion tendering Projected patronage fails to

		investment	meet levels required to justify investment
■ Capacity Capability	Capacity limitations on main corridors may constrain ability to increase capacity		
■ Accessibility			
■ Expansion Capability		Number of suitable corridors for LRT may limit expansion	Number of suitable corridors for Monorail may limit expansion
■ System Integration			
■ Deliverability	Ability to successfully negotiate with commercial transport operators or implement quality partnerships or contracts could threaten ability to expand	Lack of available funding	Lack of available funding
■ Environmental Impacts	Capacity of highway system to accommodate increases in the number of vehicles, particularly in the City Centre		
■ Public Perception	If services do not provide required step change in speed and quality, the image of the system will be degraded		

7 Conclusions/Way Forward

Following consideration of the features and potential of the three modes of mass transit, the conclusions that have been reached with regard to the potential for a Monorail system are:-

- Investment in any of the systems needs to be justified in terms of potential future usage, and, unsurprisingly, LRT and Monorail require a significantly higher potential number of passengers than BRT to make an effective business case;
- Monorail technology is now proven in urban service and should be considered as an alternative to other rail based systems in future;
- However, an overview of the principal corridors proposed for mass transit by Sprint services in Birmingham suggests that only a very limited number of them are physically capable of having a Monorail system constructed through their entire length;
- The most suitable corridor for possible Monorail operation has been confirmed as the A45 Coventry Road corridor from the City Centre to Birmingham International Airport;
- There are a number of suppliers of Monorail systems with a proven delivery record, as well as some highly innovative systems, but which have not yet had the benefit of full commercial service in an urban area;
- The advantages and disadvantages of LRT and Monorail are fairly balanced, but with the main considerations being:
  - LRT is likely to be slightly more expensive
  - The level of construction upheaval is likely to be shorter and less disruptive for Monorail than for LRT (assuming that either system can be accommodated within the available streetscape, which is less likely in the case of Monorail)
  - An elevated structure has advantages in terms of footprint space on the highway, but has disadvantages in terms of accessibility provision, station infrastructure requirements and visual intrusion (noting that both LRT and Monorail can be elevated, but Monorail requires less space)
  - Monorail relies on proprietary systems, and although it may be possible to adapt one system to fit another, it is not straightforward and is likely to be expensive
  - Monorail is less suitable, although not impossible, for multi-line integration
- Sprint services are substantially less expensive than either LRT or Monorail, and can be delivered much more quickly.

Consequently, recommendations for the way forward are:-

- Determine and agree that the potential for Monorail in Birmingham is limited to a small number of corridors, with the A45 Coventry Road being the most favourable;
- In considering the way forward for this particular corridor (which BMAP recommends for a Sprint route to be implemented in the period 2020 to 2025), there should be a study into the potential patronage for this corridor, regardless of which mass transit mode is determined to be most suitable. Such a study should take into account:
  - Current and potentially new demand flows associated with new developments in East Birmingham;
  - The impact on passenger usage on this corridor of the proposed Metro Line between the City Centre and the International Airport via Bordesley Green;
  - The impact of existing and future rail services linking the end points of the proposed service; and
  - Trip generation in comparison with the proposed Sprint Line 5, which would extend westwards from the City Centre to the Quinton area, and which would generate more through traffic and benefit from potentially higher revenue on the western end of the service.

In our professional opinion, it seems unlikely that the revenue generation from this proposed route would justify the business case necessary to obtain the funding to construct either an LRT or a Monorail system. The cost of this type of study would be only a percentage of the £250,000 study proposed by Birmingham Business Focus, and would identify whether there is any justification to pursue a full feasibility study. If, however, the business case appeared to be positive, any subsequent feasibility study should examine the advantages and disadvantages of all mass transit systems (including Monorail), and should not be limited to examining the viability of one, specific, Monorail system.

WSP UK Limited
Mountbatten House
Basingstoke
RG21 4HJ
UK
Tel: +44 12 5631 8763
Fax: +44 1256 318 700
www.wspgroup.co.uk

UNITED
BY OUR
DIFFERENCE

This Report Has Been Prepared by the Birmingham Connected Technical Study Group

WSP Mott MacDonald ATKINS pba peterbrett PARSONS BRINCKERHOFF PHIL JONES ASSOCIATES Birmingham City Council

BIRMINGHAM CONNECTED

www.birmingham.gov.uk/connected

Birmingham City Council