GREATER BRISTOL BUS RAPID TRANSIT

Technology Assessment

August 2007

- DRAFT FOR COMMENT ONLY -

Contents

SUMMARY

Background

1. There is an increasing need to radically improve the quality and reliability of public transport in the West of England sub-region. Both the Grater Bristol Strategic Transport Study (GBSTS) and the Joint Local Transport plan (JLTP) identified Bus Rapid Transit (BRT) as ideally suited to contribute to the delivery of this needed improvement, and identified four cross-city corridors to be developed as a BRT network for the sub-region.

2. Line 1, included in the Bath Package, will run from Newbridge P&R through the centre of Bath to Lambridge P&R. An alignment for Line 2 will be identified at the end of 2007. The alignment for Line 2 will be the result of a full assessment of the four cross-city corridors. A bid for major scheme funding for Line 2 will be submitted in September 2008. Further technical work is now underway to support this bid.

Technology Review

3. As part of the major scheme bid it will be necessary to demonstrate that the scheme has considered all BRT technology options and selected the option that best meets the scheme's objectives, represents value for money and is deliverable.

4. The selection of BRT versus other modes such as bus or LRT was set out in the Greater Bristol Strategic Transport Study. Further detailed work may be required at a later stage to further support this decision. This report is therefore a comparison of the different technologies currently available for *bus* rapid transit systems.

Overview of Bus Rapid Transit Technology

5. Bus Rapid Transit (BRT) systems provide a flexible, high performance rapid transit mode that combine a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity.

1.1 BRT combines specialised technology in rubber-tyred street bus equipment, passenger station design, exclusive busways and service scheduling to create a high-capacity people moving capability of light rail at potentially lower cost. It is a flexible concept which is adaptable to each city's unique requirements. The primary features of a BRT systems *typically* include the following:

- Optimal segregation from other traffic resulting in frequent and reliable services.
- Buses with low floors to match station platform elevation allowing passengers to board and exit quickly. Buses have wide, multiple doorways and capability to quickly accommodate wheelchair movement.
- High quality streetside bus station design including elevated boarding platforms to match bus floor height, sufficient room to handle crowds quickly, and some form of rapid payment procedure to access the secure station area or vehicles.
- Some street design modifications are generally needed. Typical this involves some form of bus lane dedication and priority signalling at road junctions to allow BRT services to get a "jump start" on traffic.

TABLE 1 TYPES OF RAPID TRANSIT SYSTEMS

Bus / Busway Buses are the most common form of high-density public transport worldwide, often providing the entire public transport network in small and medium sized urban areas. They can serve a wide range of needs from low frequency or demand-responsive routes in low-density areas to high frequency trunk services on major corridors.	
Kerb-Guided A kerb-guided system requires the construction of a segregated guide-way with vertical guiderails (kerbs) on either side, which allows conventional buses fitted with guidewheels to be guided along the route.	
Central Rail Guidance Central Rail guided systems are rubber-tyred systems, which are held in place by a single central guiderail fitted into the roadway. Power can be distributed by overhead wires or by battery (diesel is also a possibility. Two central guiderail systems have been developed by two known suppliers: Bombardier and Lohr Industries.	
Optical Guidance (CiViS) The CiViS system includes a camera mounted in front of the steering wheel, which can read coded markings painted on the road indicating the path to be followed, and an image processor that detects and corrects to ensure vehicles maintain their alignment. The optical guidance system can in theory be built into any type of vehicle.	
Wire Guidance Wire guidance systems have two wires 300mm apart, laid 50-150 mm below the road surface which carry audio frequency, low-intensity currents derived from wayside frequency generators. The currents produce a magnetic field that is sensed via an antenna. If the bus deviates from the centreline of the path, horizontal components of the magnetic field are also sensed. The steering is then operated to bring the bus back onto the required path.	
Phileas The Phileas system is based on magnetic plugs in the road surface that provide and correct the vehicle route information via a GPS device. Phileas vehicles are currently double-articulated with rear wheel steering which reduces the swept-path of the vehicle compared with regular articulated vehicles.	
STREAM The STREAM system combines guidance and electrical power pickup from a buried power strip set into the road surface. The power strip comprises an assembly with a series of electrical contact points which are energised only when the vehicle is directly above. They are earthed at other times and pose no hazard to pedestrians and other road users. A shoe on the vehicle connects to the live contacts with a feed back to the steering mechanism.	

- Services are scheduled at very close intervals, particularly during peak periods. Spacing of one to five minutes during the peak has been achieved. BRT buses can usually accelerate quickly to top speed between stops. Buses can have computerised monitoring systems on board to control spacing between buses or this can be achieved from a centralised control room.

6. There is a range of BRT technologies available, which can run on guided or unguided systems. Unguided systems consist of dedicated segregated busway or series of segregated bus lanes. Guided systems come in three main types:

- Mechanical or physical guidance – kerb guided or slot guided.
- Optical guidance – CIVIS optical system.
- Electronic guidance – buried wire, magnets and GPS capabilities.

7. Table 1 provides a summary of the types of BRT systems considered in this assessment/. A fuller description is provided in Appendix B.

Scheme Objectives

8. The Greater Bristol Strategic Transport Study (GBSTS) states the aim of Second Generation Public Transport Improvements in Greater Bristol as "to provide high quality alternatives to the private car".

9. To deliver this, the objectives set out in GBSTS are to:

- extend choice of transport modes for all, in particular for private car drivers to encourage a shift to public transport;
- promote sustainable development by providing high quality public transport links;
- improve access to public transport areas that currently have poor provision;
- improve integration of the public transport network;
- promote social inclusion by improving access to employment, retail, community, leisure and educational facilities;
- improve safety along the corridor by providing a high quality public transport alternative to the private car.

10. More specific objectives to measure the success of BRT have been derived from these over-arching objectives. These are:

- Mode Shift – a step-change in the quality of public transport, resulting in high passenger numbers using the system.
- Help reduce traffic congestion.
- Contribute towards economic growth.

Local Context

11. The local context for the delivery of a BRT system is an important consideration in assessing technology options. Local context criteria consider the environment in which the system needs to perform, how the different technology options may be

affected by other schemes/measures and the fit with the wider local transport plan initiatives and urban fabric of the sub-region.

12. Key local considerations of relevance this technology assessment are:

- Ability to allow for other bus services to use busway infrastructure.
- Sufficient road network capacity needs to be retained in key areas, particularly on the inner ring road in Bristol City Centre.
- BRT needs to complement and integrate with the network of Showcase bus corridors and GBBN proposals.
- Line 2 should complement the proposed scheme in Bath (Line 1), with both lines forming part of an identifiable network.
- Existing cyclist and pedestrian provision should be maintained and where possible enhanced.
- Amenity value of the existing corridor needs to be considered and where possible maintained.

Physical Opportunities and Constraints

13. Opportunities and constraints in the built and natural environment are inextricably linked to the way in which mass transit systems can operate, and are likely to be a controlling factor in the design of a given solution. These factors have the potential to immediately rule out or restrict a particular type of technology.

14. The physical opportunities and constraints which have been considered are:

- Ability to restrict access to authorised vehicles – ease of which other vehicles can be restricted form entering the busway.
- Ability to leave and join at intermediate points – to provide services from further afield to leave and join the busway but also system resilience in terms of vehicle breakdown..
- Alignment width (land take) – horizontal alignment.
- Tracking/docking accuracy – ability to deliver level boarding.
- Severance – ability to negotiate or cross the busway.
- Junctions with the road network – impact on road network at junctions.
- Maintenance requirements – system and vehicle maintenance and impact on depot facilities.

Deliverability

15. There a large number of factors which affect the deliverability of a BRT scheme. For the purposes of this assessment the following key factors have been considered

- Cost – capital cost of infrastructure and vehicles.
- Risk – an overall assessment of the ‘riskiness’ of the different technologies.
- Accepted technology / UK Safety case – whether the technology is in operation, particularly in the UK.

16. A commentary provided on the implications for procurement options for both infrastructure and services.

Summary

17. Table 2 summarises the assessment of the technology options. Furthr detail is provided in Appendix A and Appendix B.

TABLE 2 ASSESSMENT AGAINST SCHEME TECHNOLOGY OPTIONS

Criteria	Technology Option							
	Bus / Busway (limited segregation)	Bus / Busway (maximum segregation)	Kerb-Guided	Central Rail Guidance	Optical Guidance (CiViS)	Wire Guidance	Phileas	STREAM
Scheme Objectives								
Mode Shift	X reduced ability to guarantee journey times and reliability	✓segregation delivers journey times and reliability	✓segregation delivers journey times and reliability ✓ fixed nature may have better passenger perception[1]	✓provided system is segregated ✓ fixed system should improve mode choice	✓provided system is segregated	✓provided system is segregated	✓provided system is segregated	✓provided system is segregated
Reduced congestion	X reduced impact on mode shift	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre	✓ impact on mode shift ✓Can use conventional bus lanes in city centre
Economic growth	X reduced impact on mode shift	✓ impact on mode shift	✓ impact on mode shift	✓ impact on mode shift	✓ impact on mode shift	✓ impact on mode shift	✓ impact on mode shift	✓ impact on mode shift

[1] Mode choice is modelled on the basis of the door-to-door travel cost of using a scheme compared with existing alternatives. The costs used are 'perceived' costs and these reflect passengers' predisposition to one mode over another. These factors include image, reliability and 'permanence of the system'. It is often argued that 'physically fixed' systems provide a sense of permanence for passengers.

Criteria	Technology Option							
	Bus / Busway (limited segregation)	Bus / Busway (maximum segregation)	Kerb-Guided	Central Rail Guidance	Optical Guidance (CiViS)	Wire Guidance	Phileas	STREAM
Local Context								
Other bus services using busway infrastructure	✓no restriction	✓no restriction	– no restriction provided buses are fitted with guide-wheels	X only specific vehicles can use the system. Vehicles find it difficult to leave and join.	– possible for other vehicles to be fitted with equipment (although currently proprietary) but adds cost	– possible for other vehicles to be fitted with equipment (although currently proprietary) but adds cost	– possible for other vehicles to be fitted with equipment (although currently proprietary) but adds cost	– possible for other vehicles to be fitted with equipment (although currently proprietary) but adds cost
Good penetration of Bristol City Centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre	✓Can use conventional bus lanes in city centre
Complement Showcase bus corridors[2]	X difficult for users to distinguish difference	– will need to show clear distinction between BRT and Bus	✓ transport network 'hierarchy' would be physically obvious	✓ transport network 'hierarchy' would be physically obvious	– will need to show clear distinction between BRT and Bus	– will need to show clear distinction between BRT and Bus	– will need to show clear distinction between BRT and Bus	– will need to show clear distinction between BRT and Bus
Allows sufficient road network capacity	✓minimal impact on road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic	N/A all systems can run with road traffic
Complements Bath (Line 1)	✓ similar technology	✓ same technology	? similar branding/ facilities to 'unify' the BRT network instead of technology	? similar branding/ facilities to 'unify' the BRT network instead of technology	✓ could look like same technology	✓ could look like same technology	✓ could look like same technology	✓ could look like same technology

[2] The complementary nature of BRT to Showcase and GBBN is largely an issues of alignment and services therefore the criteria considered here is how understandable the difference between the two are for users.

Criteria	Technology Option							
	Bus / Busway (limited segregation)	Bus / Busway (maximum segregation)	Kerb-Guided	Central Rail Guidance	Optical Guidance (CiViS)	Wire Guidance	Phileas	STREAM
Maintains existing cyclist and pedestrian	N/A cyclist/ pedestrian facilities are located along segregated corridors	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment
Amenity value of the existing corridor[3]	X significant amount of hard surface	X significant amount of hard surface	✓guideway allows for 'greening' between running surfaces	X significant amount of hard surface	X significant amount of hard surface	X significant amount of hard surface	X significant amount of hard surface	X significant amount of hard surface
Physical Opportunities and Constraints								
Restrict access to authorised vehicles	✓ bollard or gate system required	✓ bollard or gate system required	✓ self-enforcing	✓ self-enforcing	✓ bollard or gate system required	✓ bollard or gate system required	✓ bollard or gate system required	✓ bollard or gate system required
Leave and join the alignment	✓ as per conventional bus service	✓ as per conventional bus service	? break points need to be designed in	? break points need to be designed in Vehicles find it difficult to leave and join.	✓ as per conventional bus service	✓ as per conventional bus service	✓ as per conventional bus service	✓ as per conventional bus service
Width (land take)	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment	✓ minimal difference in horizontal alignment
Tracking/docking accuracy	? dependant on driver	? dependant on driver	✓ physically guided	✓ physically guided	✓ electronically guided	✓ electronically guided	✓ electronically guided	✓ electronically guided

[3] As there is minimal difference in the horizontal alignments and therefore impact on vegetation etc. is similar consideration has been given to the hard-surface versus 'green-surface' of the finished corridor.

Criteria	Technology Option							
	Bus / Busway (limited segregation)	Bus / Busway (maximum segregation)	Kerb-Guided	Central Rail Guidance	Optical Guidance (CiViS)	Wire Guidance	Phileas	STREAM
Severance	✓ no physical barrier to crossing	✓ no physical barrier to crossing	X kerbs present barrier to flat crossings	✓ no physical barrier to crossing	✓ no physical barrier to crossing	✓ no physical barrier to crossing	✓ no physical barrier to crossing	✓ no physical barrier to crossing
Road junctions	✓ standard at-grade crossing	✓ standard at-grade crossing	✓ requires entry/exit tapers	X risk with re-engagement in guidance	✓ standard at-grade crossing	✓ standard at-grade crossing	✓ standard at-grade crossing	✓ standard at-grade crossing
Maintenance and depoting	✓ standard vehicles and road maintenance	✓ standard vehicles and road maintenance	✓ standard vehicles	X specialised vehicle and maintenance requirements	X specialised vehicle and maintenance requirements	X specialised vehicle and maintenance requirements	X specialised vehicle and maintenance requirements	X specialised vehicle and maintenance requirements
Deliverability								
Capital Cost (per km of 'busway' only)	£0.5m - £1.0m	£0.5m	£1.5m - £2.0m	~ £4m [4]	£1.2 including additional strengthening to counter rutting	£1.2 including additional strengthening to counter rutting	£0.8m[5]	£1.2 including additional strengthening to counter rutting
Vehicles and Vehicle Cost	✓Standard vehicles	✓Standard vehicles	✓Standard vehicles	X ~ £1.2m per vehicle specialised, proprietary vehicles	X ~ £0.7m per vehicle Currently specialised, proprietary vehicles.	Standard buses should be able to have equipment but currently a proprietary system	Standard buses should be able to have equipment but currently a proprietary system	Standard buses should be able to have equipment but currently a proprietary system
Risk	✓ standard well used system	✓ standard well used system	✓ not widely implemented but systems exist in the UK	X no current or existing systems in operation	X untested in the UK.	X no current or existing systems in operation	X untested in the UK, proprietary system	X no current or existing systems in operation

[4] Translohr.

[5] Based on single available example in Eindhoven.

Criteria	Technology Option							
	Bus / Busway (limited segregation)	Bus / Busway (maximum segregation)	Kerb-Guided	Central Rail Guidance	Optical Guidance (CiViS)	Wire Guidance	Phileas	STREAM
Accepted technology	✓ standard well used system	✓ standard well used system	✓ systems exist in the UK	X no current or existing systems in operation	X no UK safety case	X no current or existing systems in operation	X no UK safety case	X no current or existing systems in operation
Procurement process	TRO/CPO	TRO/CPO	TWA or TRO/CPO	TWA or TRO/CPO	TRO/CPO	TRO/CPO	TRO/CPO	TRO/CPO

APPENDIX A

TECHNOLOGY REPORT - FIRST

APPENDIX B

TECHNOLOGY REPORT - HALCROW