Appendix D

Different Modes Available and their Characteristics

Overview of Public Transport systems available to Milton Keynes

Introduction

In building up to the consideration of public transport options for Milton Keynes it is critical to establish an understanding of the main systems available, their key characteristics, their main strengths and rather importantly, their costs in broad terms. It is hoped that this would provide sufficient insight to allow an appreciation of the likely step change in resources and demand which may be required to move from one system to the next, and therefore in selecting one system in preference to another.

This Chapter therefore sets out to provide an appreciation of the main public transport systems which would be considered for Milton Keynes. The systems considered in this section stop short of 'concept systems' which are a long way away from practical operation with little or no credible information with respect to their characteristics with respect to operations, infrastructure or operating costs.

In broad terms, the systems included in this Chapter can be divided into conventional bus based systems, guided bus, intermediate mode and light rail systems.

Conventional bus based systems

Bus types

In the UK buses vary in shape and size from double decked vehicles that can carry 80 passengers down to single deck vehicles and minibuses with lower capacities.

Table D1 Typical Costs for new low floor vehicles

Bus Type	Capacity	Approx. Costs	Size (width and length)
Mini Bus Alero	16 S	£50,000	7.2m X 2.5m
Single Deck	40 S	£100,000	10m X 2.55m
Double Deck	74S 17ST	£150,000	12m X 2.55m
Articulated	60S 80ST	£250,000	18m X 2.55m

Notes: S = Seated passengers ST = Standee passengers

bus capacities can vary depending on seating style, internal configuration, permitted number of standees and the number of passenger doors.

These costs would be for a reasonable specification of vehicle with good quality interior and trim. All new buses must be of low floor designs, and wheelchair accessible and have emission friendly engines (Euro III).

Recent developments have seen trials of alternative and cleaner fuels being used (LPG and CNG) and an EU funded project examining the viability of Fuel Cell technology. Another trend has been for bus manufacturers to offer complete fleet maintenance packages.

It should also be remembered that width, weight and height restrictions may preclude the use of certain types of vehicles in certain locations.

Infrastructure

Bus technology is seen as key to achieve the Governments transport strategy because in its simplest and most basic form no new infrastructure is required to operate a bus service, as existing roads and pavements can be used. Therefore it is easy to serve new areas and or change routes. Stops and shelters can be easily erected, and again be low cost as all that is required as a minimum is just a pole and flag. Therefore for a basic system the infrastructure costs are negligible.

Quality Bus Partnership

This is a marked improvement from a conventional deregulated bus service, as both the bus operator and local authority make commitments to improve conditions in the running of a bus service to mutually agreed standards.

Typically the operator will agree to maintain standards relating to the services operation that can include the type and quality of vehicles used, reliability of the service, vehicle cleanliness and the quality and training of the driver.

The local authority would in return improve the infrastructure, priority measures and passenger information elements of the package.

Infrastructure

A mixture of the following measures may be used, these will require planning applications, traffic orders and in some cases modelling and extensive local consultation as enabling works, however with council support and co-operation between parties these can normally be implemented in the short to medium term timescales (1-2 years), the list is not exhaustive.

Bus Cage
Area of road marked out with no stopping restrictions to enable bus to pull flush with kerb, special kerbing required and large pull in area. 37 metres are required for 12 metre long bus.

Bus Laybys
Areas designed to allow buses to pull off the main carriageway in order to pick up and set down passengers, special (Kassel) kerbing may be used to enable buses to pull up flush with the stop without damaging tyres. These are generally not in favour within the industry due to the problems of pulling into and out of the bus layby back into the normal flow of traffic, but are appropriate for Milton Keynes along sections of dual carriageway.

Bus Stop Boarders
An area of pavement that is built out to enable the bus entrance/exit doors to be level with the pavement without the need for the bus to pull of the main carriageway, so that the bus does not have to fight to rejoin the carriageway. They also provide an area of pavement dedicated for people waiting for buses and therefore avoid conflicts with pedestrian movements on the pavement.

Bus Lanes
These are areas of the highway that are designated for the use of buses only, special road marking is required (normally green or red). The advantage of using bus lanes are that they provide buses with their own road space segregated from the normal flow of traffic.

Therefore there is the potential to both reduce journey times and make them more reliable.

Signal Pre-emption (Selective Vehicle detection)
These are systems where traffic lights give priority to buses, sophisticated versions will keep lights on green if buses are approaching, simpler systems give priority for buses in bus lanes over the other flows of traffic, thereby reducing delays and improving overall journey time reliability.

Two types of system are in common usage, these being beacon based and loop based systems. They have similar initial set up costs:

Table D2 Typical costs for beacon or loop based systems

Description	Cost
Cost per junction approach	£5,000
Transponder /Tag cost per vehicle	£100

GPS based systems are currently being developed that could potentially offer more flexibility and the chance to interact with both traffic management and information systems.

Improving bus stop and pedestrian access
The provision of safe walking routes and crossing points to bus stops, with signage, designated walking routes, ramps, tactile flooring surfaces, lighting, cctv etc. Personal security is a key issue for many user groups.

Table D3 Basic quality bus partnership infrastructure costs

Type of measure	Cost £
Bus Cage Minimum per stop	0.5 k
Bus Cage Large 37M per stop	1-2 k
Bus Boarder per stop	3-4 k
Bus Lanes per km	40-50 k
Signal Pre-Emption per jnc approach	4-5 k

Note: Costs for each of these elements vary on scheme by scheme basis. These costs exclude the associated scheme modelling and survey works.

Bus shelters
These may be provided at no cost by the main suppliers or at a cost depending on location and the potential for advertising revenues. Basic shelters should be provided, giving protection from the elements, comfortable seating, be well lit, vandal resistant/low maintenance and have service information.

Fare and service levels

Fares

Joint ticketing may occur between operators on common sections of route, also co-ordinated marketing and perhaps integrated ticketing is also achievable in this environment, as the partnerships approach aims to draw together stakeholders to achieve common goals.

There is likely to be a greater use of off bus prepaid ticketing in this environment as routes are branded and services are made more identifiable. Switching to prepaid ticketing reduces boarding times and has the potential to reduce journey times.

There have been concerns about the influence of competition rules controlled by the Office of Fair Trading, but these are reportedly now being addressed.

Service levels

The use of priority measures should undoubtedly improve journey time reliability, such that there may be a benefit in that the resources potentially saved can be reinvested in the network in terms of improved frequencies or longer hours of operation.

Information

The quality and provision of information is a key component in the overall system package for Quality Bus Partnerships as it improves passenger perceptions and builds confidence in the system.

Information is shared and timetables commonly provided via Council websites, local travel maps, plans and countywide phone information lines etc. In some cases dynamic information systems have been developed providing customers with actual waiting times that can be accessed via websites or phone.

There are different types of system, and their cost will vary based on their specification, but a simple GPS based system would have the following approximate costs:

Table D4 Real Time Information - System Costs

Description	Costs
Base unit	£30 k
Bus equipment per bus	£2.3 k
Small bus stop display per stop	£5 k
Large bus stop displayper stop	£7 k

Whilst these costs may seem low it must be noted that a large number of buses and bus stops would have to be equipped to make the system usable to both passengers and operators.

One additional benefit from real time information is the provision of management information in terms of the reliability of service operation, which when combined with ticket machine data will provide a useful tool for service and network planning.

Quality bus partnership and Quality Bus Contracts

If the partnership approach is taken over a whole bus route and properly coordinated and implemented a quality bus partnerships can represent a “win – win - win” situation for the operators, local authorities and most importantly the user, as services are made into an identifiable, value for money, quality product. The approach is flexible in that the package can be extended to cater for route changes, and can be achieved at moderate cost, in the short to medium term. It depends, however, on the bus operator(s) as well as the local authority having the will and means to implement schemes and to sustain them.

Where there is reluctance on the part of operators to engage with the process, another option is for the local authority to pursue a Quality Bus Contract (QBC). This system more closely reflects the pre-deregulation system in that the local authority can specify the level and quality of services to be provided, and the operators must comply with this within a given contractual budget. At the time of writing there were no QBCs operating in Britain, but a number of authorities were actively investigating the possibilities, including Coventry.

Busways, guided buses and intermediate modes

Busways and Guided busways take the quality bus concept a stage further by building on the infrastructure and information improvements and combining these with the benefits of a segregated carriageway to improve journey time reliability, without the costs of light or heavy rail systems.

Conventional buses can be used on busways with slight modification required for buses to be used on side guidance systems. Intermediate modes are a hybrid type of system that can use segregated carriageways, higher quality vehicles and other forms of guidance.

Systems description

Busways
These are specific sections of roadway exclusively for the use of conventional buses, therefore the systems are available for use of bus operators without the need to modify there buses. The system in Brisbane, Queensland, Australia, being an excellent example of a high quality bespoke system designed to provide a viable alternative to car. The use of a segregated carriageway avoids the enforcement issues associated with bus lanes.

Guided Bus
Kerbed Guidance – “O – Bahn”

These are sections of busway, but for use by buses that are modified with side wheels to enable them to run in special concrete trough like roadways, the main example in the UK being Leeds.

The use of these busways precludes the use of any other vehicles, and means that the busway is for the exclusive use of modified buses only, therefore guaranteeing the potential for journey time reliability and again avoids the issues of enforcement that exist with bus lanes.

The land take up should also be less that of a conventional busway, although it will cost more to construct than a conventional busway

Table D5 **Comparison between busway and guided busway costs**

System type	ıst £
Busway cost per km	500-600 k
Guided Busway cost per km	500-800 k

Intermediate modes

Table D6 Intermediate modes costs

System type	Guidance type	Vehicle cost £	Capacity per vehicle	Vehicle length	Track costs £ M/KM
Civis*	Optical	300-500 k	150	18.5m	0.6-08.
Translohr**	Central rail	1-1.2 m	210	32m	5-8
Trams on Tyres**	Central rail	1-1.2 m	150	25m	6-9

* Optical.

** Central rail guidance.

As yet the technology used in these systems is unproven in the UK although there are some examples in mainland Europe. These systems attempt to provide a high quality environment akin to light rail systems, with delivery at lower cost. Due to the type of guidance, less land (carriageway width) may be required than with bus based systems.

Due to the high quality nature of the vehicles and the requirement for guidance systems, the cost of vehicles is considerably higher than a conventional low floor bus.

Note:

- Approval has only been granted for kerb guidance for intermediate modes in the UK at present, approval would be required for other forms of guidance;
- Infrastructure costs will vary according to the location; and
- Vehicle capacities and costs will vary according to the specification.

Factors common to all

Ticketing and fares

Fare structures are often simplified to flat and zonal structures, combined with off – vehicle ticketing via roadside ticketing machines or ticket agents, and multi-stream boarding to enable boarding and alighting times to be reduced, minimising the dwell times at stops, thus reducing overall journey times. Other changes that can improve the quality and convenience of public transport include flexible travelcards that allow, for example, transferability or multi-passenger travel at off-peak times, tickets that are interchangeable between bus and rail, fare concessions, and a fares-free zone in the city centre. Some or all of these changes could be funded through links to parking charges or levies on private non-residential parking spaces.

The aim should be to introduce systems that are simple to use and understand; that reward regular use; that encourage greater use amongst those with access to cars; and that benefit people who find the normal fares difficult to afford.

Frequency and service levels

Frequency and service levels will normally be high to maximise the use of the infrastructure and make the services attractive to users.

Benefits and disadvantages

The principal advantage in all of these systems is journey time reliability on sections of route segregated from the normal flows of traffic. This factor combined with a higher quality passenger environment both in terms of vehicles and infrastructure can provide a viable alternative to the car. The systems are more suited to high frequency operation with high passenger volumes and limited stops and therefore tend to be suited to corridors, with high population densities.

The main disadvantages of these systems are:

- Long construction lead times;
- Land take up; and
- Capital costs.

Given the requirement for capital funding, Central Government support and approval will be required, combined with a lengthy planning and consultation process. This will involve a full cost benefit analysis, including assessment of environmental impacts. Therefore these schemes will only begin to deliver benefits in the medium to long term and require significant commitment from all parties.

light rail transit systems

Introduction

Light rail can be described as an intermediate transport mode between bus and conventional ('heavy') rail. The term LRT covers a very broad spectrum of so-called "intermediate capacity" systems, from the simple "ultralight" Parry People mover up to semi or fully automated, segregated systems, e.g. airport shuttles, the DLR, the VAL system in Lille and elsewhere. However the main interest for this study is in manually driven conventional LRT system. The roundly 400 systems of this kind in the world present a great diversity of vehicle types, costs and town integration.

Light rail is seen as offering the best of both buses and train and has a modern image, this explain the resurgence of interests in these systems in Britain. In the UK, only Blackpool's tramways survived from the earlier era. However, new systems have been developed in London Docklands, Manchester, Sheffield, Birmingham and Wolverhampton and Croydon. Nottingham is under construction, Leeds has powers for its proposed Supertram, South Hampshire is currently undergoing a PFI bidding process and Bristol is developing a scheme.

Implementation process

Light Rail (and guided bus) projects in Britain face difficult hurdles from their inception; hurdles not faced by conventional buses. For schemes which gross costs would exceed £5m and for which promoters are seeking central government funding, the Department for Transport requires a full appraisal. Then any light rail scheme has to obtain statutory powers. It used to be said when Private Bills were required that this cost £1 million for each line. The reality was more like £2 million. Now, application has to be made for an Order under the Transport and Works Act 1992. The costs are almost certainly higher and the time-scale and complexity longer. Costs of this scale are inevitably daunting for any promoter.

Even more significant is the time involved and the uncertainty of the outcome. This has meant that, so far, it has only been public authorities which have had enough stamina to promote schemes, to win the support of local authorities, obtain the powers to construct and operate and justify the case to central government and win central government and European funding. Due to the requirements to transfer as much risk as possible to the private sector and to maximise the private sector's contribution, all the recent schemes in the UK have ended up being constructed and operated by private sector consortia. There are two major rules regarding the funding application: 25 per cent of the capital costs funding has to come from another source than the Department and, after the opening of the system, the scheme has to cover its operating costs with passenger revenues.

Also, the private sector has been shown to be willing to contribute to the achievement of the core networks of light rail, though, being risk-averse, not to take the risks and costs of acquiring powers and complying with stringent safety requirements.

Lack of funding for public transport infrastructure schemes remains a major obstacle in the UK. Analysis of transport investment shows that the UK performs badly in both per capita terms and as a percentage of GDP when compared with 10 other European countries.

Then, construction time for an LRT system takes an average between 4 and 5 years and involves:

- Removal/relocation of under-road utilities;
- Property acquisition/demolition;
- Provision of underground cabling for supply, signalling control, etc.;
- Disruption to traffic in the construction area; and
- Adverse local press.

After construction, a careful planning exercise has to take place to redesign the totality of the public transport system whereas bus routes will be changed so as to integrate with this new system.

Overall, in the UK it typically takes at least 10 years to develop an LRT scheme.

Costs

Infrastructure costs

Infrastructure cost constitutes the majority of the costs of implementing an LRT. It varies substantially depending on conditions and terrain but also depending on the number of stations and complementary measures, for instance pedestrianisation.

Assuming flat land (no tunnel or bridges), infrastructure costs could be estimated to £1m per km (costs do not include vehicles, stations and landscaping etc.). Total costs, excluding vehicle costs are between £4m and £8m per km for a system with limited civil engineering work (no substantial lengths of elevated tracks or tunnels). The following table presents capital costs for LRT systems in the UK.

Table D7 LRT Capital Costs

(incl. Infrastructure and rolling stock costs, planning and related costs for instance land purchase

(price bases vary)

System	Capital cost (£m/km)
Midland Metro (Initial system)	7.1
Manchester Metrolink (Initial system)	4.7
Sheffield Supertram (initial system)	8.3
Croydon Tramlink (initial system)	7.1
Tyne & Wear Metro (initial system)	5.2

Source: Memorandum by the Passenger Transport Executive Group to the House of Commons Select

Committee inquiry

Vehicle costs

Vehicle types

Similar to Bus Systems, LRT systems vary according to the type of vehicles. This would have an impact on quality (comfort, access, noise), capacity, costs and image.

The following table provides information on the characteristics of some of the latest tramway systems.

Table D8 Tramway systems characteristics

Name		Eurotram			Incentro	Citadis	
Different options		5 cars	7 cars	9 cars	36m	30m	40m
Properties		Modular by sections. Bi-directional				Length between 22 and 52m Bi-directional	
Low floor		100%			100%	100% or 75%	
Max speed (kph)		72			70	80	
Width		2.4			2.4	2.4	
Length		22	31	40	36	30	40
Capacity	Seated	76		92	76	40	80
	Standees	184		278	184	174	230

Vehicle costs for these systems vary between £1m and £1.5m depending on their type and length. Total costs also vary according to size of the purchase orders. Of course, costs can be reduced by purchasing second hand vehicles but this would be contrary to the need of improving the image of the public transport system.

However, although the cost is high, light rail vehicles have a life expectancy of 30 years (against 15 years for conventional buses).

Light Rail Transit system patronage

Tramways are mass transit systems, assuming a frequency of 1 vehicle every 90's, they have an average capacity of 10,000 passengers per hour per direction. Table D9 provides some examples of patronage in the UK:

Table D9 LRT system patronage in the UK

System	Network length (km)	Pax journeys in 2001/2002 (m)
Tyne & Wear Metro	77	33.4
Manchester Metrolink	39	18.2
Sheffield Supertram	29	11.4
Docklands Light Rail	27	41.3
Croydon Tramlink	28	18.2

Source: National Statistics (DfT website)

There is clear evidence that LRT can attract car users. A study for the UITP Light Rail Commission in 1998 showed that the proportion of all public transport passengers who previously used cars averaged over 34 systems was 11 per cent. In Manchester, it is estimated that the first Metrolink line removed 2 million car journeys per year and reduced traffic levels on the parallel main roads by between 2 and 8 per cent. In Sheffield, more than 20 per cent of passengers on Supertram previously travelled by car.

Operations

Off-vehicle ticketing via roadside machine or ticket agents is commonly available for light rail systems.

Frequency and services levels will normally be high to maximise the cost of the infrastructure and make the service attractive to light rail users.

Integration of bus and light rail operation

Some LRT systems have a high level of planned integration with the bus networks. In Hannover, buses wait across-platform for light rail vehicles to arrive and allow immediate and very easy interchange but integration of this quality is rather unusual.

LRT tracks installed in-street provide a reliable and fast journey for other vehicles. Buses can therefore take advantage of the light rail alignment by using some sections of the tracks. This also applies to taxis.

Integrated ticketing between light rail and bus systems is desirable.

Other systems

A number of other systems tend to make the headlines from time to time. In general all of the systems are designed to operate as shuttle systems and with the exception of elevated monorail systems, all other systems are at concept stage of their development and as such there is no reliable cost and performance data available for them.

Monorail

Also called Variable Level Rail System, a monorail is defined 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 or in subway tunnels. Vehicles are either suspended from or straddle a narrow guideway. Monorail vehicles are wider than the guideway that supports them.

So far, in Europe, Australia and North America, their use has been limited to theme park, airports links or short city centre shuttles apart from one in Wuppertal, Germany where there is a more comprehensive public transport system. Monorails have been more successful in busy Asian cities such as Tokyo or Osaka where patronage respectively amounts to 30,000 and 70,000 passengers per day. However, the Monorail's main role remains as a shuttle system. and is therefore most popular at airports and over relatively short and straightforward networks.

The costs are extremely variable according to the length of the system, the topography, the geotechnical conditions and the special features required (tunnels, bridges, etc). For the existing systems, the total costs (infrastructure and vehicles) have cost between £14m/km and £65m/km with an average of £39m/km, *although we understand there is an existing proposal for Portsmouth monorail which estimates a construction cost of only £6m/km.*

'Rapid Systems'

Three types of rapid systems are briefly described here. All three modes presented below differ vastly from all other 'conventional' public transport modes in that they use small electric vehicles and claim to provide frequent direct service and provide 'auto-like' personal mobility. We are unable to provide information on costs of these systems as none of the systems have been built and therefore no reliable figures have been made available. However, by their promoter's own admission, these systems are designed to serve low-volume travel movements within a relatively small network (or as shuttles) rather than a mass transit systems.

<u>Personal Rapid Transit (PRT) Systems</u>
The PRT concept requires small automated vehicles that travel on elevated exclusive guideways. The service is designed to approximate a taxi. There are three PRT systems currently under development. One is called Taxi2000, based in Minnesota, the second, called ULtra, is currently being developed in the UK and has been tested in Cardiff where it is proposed as a link between the two busiest areas of the city centre. An Australian company is developing a third called Sustran.

<u>Group Rapid Transit (GRT) Systems</u>

GRT systems are very much like PRT systems except that the vehicles, guideways and stations are larger. Two GRT systems are currently under development: Austrans in Australia with an eight-seater vehicle and CyberTran in Idaho with a six to twenty-seater vehicle

<u>Dualmode concepts</u>

The dualmode system goes further in its attempt to provide an 'auto-like' system. It features small electric individual vehicles and a larger 10 passenger vehicle for group travel. The vehicles can travel on the conventional roadway system and on a special monorail under full computer control to provide a door-to-door travel. Researchers in Denmark and Texas are currently developing dualmode concepts respectively called RUF (Rapid, Urban, Flexible) and MegaRail. A case study for a RUF system in Los Angeles resulted in an approximate cost estimation of £16m per km.

<u>Conclusion</u>

From table D10 it can be seen that there are marked differences between the modes in terms of both vehicle and infrastructure costs and also vehicle capacities.

Table D10 Overview of main systems

Vehicle type		Vehicle cost £	Capacity Per vehicle	System cost per km £ *	Implementation timescale	Customer perception of quality
Conventional Bus		150 k	74 S 17 ST	Nil	Short	Poor
Quality Bus		150 K	74 S 17 ST	To 0.5 M	Short – Medium	Good
Busway Bus		150 k	74 S 17 ST	To 0.6 M	Medium – long	V.Good
Kerb Guided Bus		155 k	74 S 17 ST	0.5-0.8 M	Medium – long	V.Good
Civis (Optically guided)		300-500 k	150	0.6 – 0.8 M	Medium – long	High
TVR/GLT	Translohr	1-1.2 M	210	5-8 M	Medium – long	High
	Trams on Tyres	1-1.2 M	40 S 110 ST	6-9 M	Medium – long	High
Light rail		1-1.5 M	70-100 S 150-300 ST	5-9 M	Long	V.High

**** System with limited civil engineering work (no substantial lengths of elevated tracks or tunnels).***

S = Seated passengers.

ST = Standees.

There are numerous examples of good quality bus partnerships in operation throughout the country, Centro (Showcase) and WYPTE (Leeds and Bradford) being excellent examples where significant investment and commitment has been given to improving the overall quality of the service by addressing the key issues of infrastructure, information, vehicle quality, driving standards and journey time reliability.

In some cases these include sections of guided busway that when combined with other traffic management measures provide the bus with a real journey time saving as opposed to using the car. As yet there are no examples of intermediate modes in operation in the United Kingdom, although there are some projects in operation in Mainland Europe.

It should be noted that whilst costs for vehicles and infrastructure are significantly higher than bus based system, customer reaction is more favourable given the higher quality vehicle and ride.

However light rail systems are perceived by customers as the best systems as the track and infrastructure create an atmosphere of permanence, they deliver a comfortable journey due to riding on rails and journey time reliability given their priority over other forms of traffic when running on street and use of segregated track. However they take far longer to implement and are far more costly.

Therefore, in the short to medium term quality bus partnerships offer the only realistic way in which traffic management and modal share problems can be addressed. The systems use proven technology and there are many examples in the UK where Councils and Bus Operators have achieved positive results.

It should be noted that whilst buses may not offer some of the perceived quality aspects of journeys provided by light rail or intermediate mode transit systems, they can provide a basis for developing quality corridors of public transport usage that then may be developed in the future for other modes. This will be possible if and when the demand justifies a system with higher capacity and speed. The advantage of this approach is that change can be introduced incrementally. In the Milton Keynes context especially, where one is starting from a very low base, it is first necessary to demonstrate that a substantial demand for public transport can be created, before commitments can be made to expense long-term solutions.