Trams and Light Rail in Melbourne’s Transport Future

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This paper has been prepared by Rail Futures Incorporated in the public interest. Rail Futures Inc is an independent non-partisan group formed to advocate cost effective rail and intermodal solutions for public transport and freight problems based on sound commercial, economic and social reasoning. Rail Futures members include very experienced rail professionals, engineers and economists.

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Introduction

Melbourne’s tram system is an iconic part of the city’s identity. Its trams play a vital role in the city’s transport system, particularly in the linking of the inner and middle suburbs to employment, educational, medical and other activity clusters in Melbourne’s CBD and surrounds and in providing local access, e.g. to inner suburban strip shopping centres. The tram network provides access to 34 per cent of all jobs in metropolitan Melbourne. An outstanding example of the role the tram system plays in supporting Melbourne’s economy is the Route 96 tram (East Brunswick – St Kilda Beach) which gives access to 11.3 per cent of all jobs in metropolitan Melbourne on its 14 kilometre route.

Yet the W-class trams that often symbolise Melbourne also signify an ageing tramway system whose performance continues to be eroded by low speeds on the majority of the network which is located in arterial roadways or suburban streets that are heavily congested and by delays on most of the network resulting from traffic management policies that still prioritise cars over people. This diminishes user benefits, inflates operating costs and impedes vehicle utilisation.

Trams and/or Light Rail is seen as an attractive public transport option for cities, based on its ability to move more people per hour in a single arterial road lane than any other road-based transport mode. Another perspective is that one E class tram with capacity for 210 passengers and occupying about 40 metres of road space has the same practical capacity as some 190 cars end to end that would occupy almost a kilometre of road space.

As a result, many cities are undergoing a Light Rail renaissance, with Sydney, Perth, Gold Coast, Newcastle, Canberra and dozens of others overseas actively planning or constructing new, modern Light Rail links built to high standards of amenity, speed, capacity and operational performance. Many of these cities are retrofitting high-capacity Light Rail Transit (LRT) into CBD’s and suburbs that once had street tramway systems, while others are introducing LRT into established urban environments for the first time.

This paper will examine the role LRT can play in augmenting Melbourne’s existing tram network. It will also examine the proposed modification of some existing tram routes to become hybrid light rail routes, where appropriate, as well as developing higher-capacity public transport services on new corridors in Melbourne’s middle and outer suburbs.

The paper also considers the important ongoing role played by much of Melbourne’s existing tram network in providing local amenity and access and how it could better perform these functions to increase its competitiveness and attractiveness and thereby achieve its full potential as a street tramway system.

While it is appropriate to upgrade some parts of existing street tramway routes to fast, efficient and modern LRT standards, most of Melbourne’s tram network will best support higher density mixed use urban development by retaining modest speed operation and relatively closely spaced stops. This will reinforce those aspects of our urban environment that makes so much of Melbourne and suburbs a truly liveable place.

Most importantly, appropriately planned and implemented, both tram and light rail networks have potentially significant city shaping impacts. They can enhance the value of land and surrounding activity, encourage higher density living, provide an incentive for mixed commercial, retail and residential development and reduce car dependency. In turn, these changes produce social, environmental and economic benefits.
Summary Snapshot

ABOUT MELBOURNE’S TRAM SYSTEM

Melbourne’s tram system is an iconic part of the city’s identity, plays a vital role in the city’s transport system and provides access to 34 per cent of all jobs in metropolitan Melbourne.

Tram and light rail networks have potentially significant city shaping impacts and major social, environmental and economic benefits. They can move more people per hour in a single arterial road lane than any other road-based transport mode; many Australian and overseas cities are undergoing a light rail renaissance to exploit these opportunities.

Key Statistics: 80% of Melbourne’s 250 km of tram routes operate as a ‘street transit’ system, with operating speeds averaging 6 to 16 km/h, with some small sections meeting LRT operating parameters and 30 km/h average speeds. Average spacing between stops is 250 metres. Only 18% has a segregated right-of-way (ROW).

Trams are hampered by road congestion, excessively low speeds and traffic management policies that still prioritise cars over people. These diminish user benefit, inflate operating costs and impede vehicle utilisation. Traffic congestion accounts for approximately 40% of tram running time, with other key delaying factors including turning vehicles blocking tram lines, passenger loading and unloading and car-biased traffic signal programming.

Passenger capacity on most routes is between 750 and 1300 in each direction per hour – at the lower end of international practice – constrained by short stop spacings, traffic delays, signal priority and lack of dedicated ROWs.

Melbourne’s tram network has remained relatively unaltered since the mid-1950’s, is biased towards the inner suburbs, does not serve the western and north-western suburbs, does not serve newer activity centres; and has poor connectivity with the rail network.

Relatively low cost additions to the network could embrace potential traffic generators, enhance network connectivity and support changed demographics.

TRAMS OR LRT FOR MELBOURNE?

Both are needed for appropriate roles - trams provide important local feeder and CBD services; LRT would be ideally suited to new trunk routes up to around 15km in length.

IMPROVING OPERATION AND EFFICIENCY OF THE NETWORK

There is a need to transform Melbourne’s tramway network to best practice operational standards, maximize the system’s potential, improve service quality, expand the system to match Melbourne’s growth and development; and greatly increase efficiency of the operation.

The following package of improvements is recommended:

Improving tram rights-of-way and priority to increase speed and reliability and improve tram utilisation - including measures such as re-allocation of existing road space with a focus on key locations where the impact is greatest. The current situation results in everyone being a loser: motorists are delayed and trams are delayed - perpetuating a very inefficient system of competing modes sharing limited road space.

Improving system technologies including more aggressive use of Intelligent Transport Systems (ITS) including software to enhance the sophistication of traffic signal priority and phasing,

Modifying road rules, including extending use of hook turns to all roads with tram routes.

Reconfiguring existing tram routes – opportunities exist to improve network connectivity and effectiveness by modifying traditional routes to provide additional trip options and better use existing infrastructure.

Increasing service frequency - “turn up and go” frequency is a key driver of public transport patronage and is fundamental to achieving overall network connectivity.

Increasing fleet capacity, including the urgent need to commit to a follow-on order for at least 75 additional E-class trams to replace parts of the existing fleet up to 40 years old and allow cascading of newer trams.

Accelerating provision of accessible stops and vehicles for people of all abilities to reach jobs, educational, health and leisure facilities. Low-floor trams comprise only 24% of the fleet, operate on a handful of routes and only 21% of stops have level boarding access.

Improving interchange with other modes - the best performing tram systems are tightly connected with bus and heavy rail to form an integrated network, multiplying the range of possible destinations and provide a credible alternative to the car.
EXPANDING THE NETWORK

Melbourne needs a combination of “street transit” routes providing short trip and local feeder services; and high quality, faster and longer LRT routes on selected cross-town corridors linking employment nodes, activity centres, stimulating land use density and diversity and serving new urban renewal areas. This can be achieved by:

(a) Modest extensions to some existing tram routes to properly serve activity centres, other trip generators and intermodal connections and generally allow the network to “catch up” with land use development since the 1940s.

(b) Conversion of parts of selected tram routes to create hybrid LRT operations where these already have or could have extended segregated ROWs.

(c) Developing strategically located new cross-town LRT routes for longer journeys where local access needs are relatively dispersed (most of which can make use of existing wide arterial road easements and boulevards).

While parts of existing street tramway routes should be upgraded to fast, efficient and modern LRT standards, most of Melbourne’s tram network will best support higher density mixed use urban development and shorter journeys for local access by retaining modest speed operation and relatively closely spaced stops. This will reinforce those aspects of our urban environment that makes so much of Melbourne and suburbs a truly liveable place.

Recommended new LRT corridors include:

a) Ballarat Road LRT Corridor: Serving the emerging 14,000-job employment cluster around Sunshine, linking a range of high-value jobs in universities, medical research and health, including Sunshine hospital.

b) Wellington Road/North Road LRT Corridor: Serving the rapidly growing Monash employment cluster, the North Road/Wellington Road corridor, over 58,000 high-value jobs, providing cross-town connectivity linking the Frankston, Dandenong and Sandringham rail lines.

c) Doncaster LRT Corridor: Via Alexandra Parade, Eastern Freeway and Doncaster Road to Doncaster Hill activity centre. Provides a significantly more cost-effective rail solution for the Doncaster corridor which would be competitive with car travel.

SUPPORTIVE LAND USE PLANNING

Public transport-supportive land-use planning is crucial to maximise the benefits of a modern LRT and tram network. Trams and LRT have become a superior option for delivering higher residential and job densities and land value uplift along corridors and for promoting development around stops.

Opportunities for infill and corridor development should be pursued particularly in areas where the tram network is densest. Continued reliance on outer suburban areas to absorb population growth and dispersal of retail and commercial activity to ‘out-of-centre’ sites is not supportive of increased densities nor does it stimulate economic activity or provide easier access to jobs.

Melbourne E class tram – fifty of these Bombardier Flexity Swift trams are currently being delivered
The Existing Network

Melbourne’s tram network was largely laid out in the 1920s with parts (e.g. the Bourke Street lines) constructed as late as the mid-1950’s. It has since remained relatively unaltered apart from three main extensions (Box Hill, Bundoora and Vermont South), three minor extensions into the Docklands precinct and two conversions from heavy rail (St Kilda and Port Melbourne).

Much of the tram network was developed in an era when rail and tram services were generally regarded as competing rather than complementary modes, a culture partly derived from its earlier history of operation by municipal authorities followed by creation of the Melbourne and Metropolitan Tramways Board in 1923 as an independent statutory authority. This contrasts with Sydney’s experience where much of the tramway network was initially developed and managed by the railway administration.

Today, Melbourne’s tram network extends over 250 route kilometres on 25 separate routes (including the City Circle tourist service), has 1760 designated stops and operates a fleet of around 500 vehicles. If it were possible to build such a network in today’s environment, extrapolated from that of the recently opened 13km Gold Coast G-Link line, its construction cost would be around $30 billion.

The tram network still serves Melbourne well, but is heavily biased towards the inner northern, eastern and south-eastern suburbs in ways that largely reflect Melbourne’s development between the First and Second World Wars. A number of important activity centres have since emerged in these suburbs and beyond that are not served by tram. Similarly, there has been almost no extension of the network into the middle western and north-western suburbs that are gateways to new growth areas in Melbourne’s north and west.

Moreover, there is still little effective tramway connectivity with the metropolitan rail network and, where this does occur (e.g. in the CBD), it has been more by historical accident rather than by design. The same lack of designed connectivity occurs in most cases where it interfaces with the bus network. As discussed later in the paper, relatively low cost additions to the tram network can be introduced to embrace potential traffic generators, enhance overall network connectivity and to both support and take advantage of changed demographics.

What’s the difference between Trams and Light Rail?

Melbourne’s tram system is essentially a form of public transport known as ‘street transit’. Street transit modes such as (tramways, buses and trolleybuses) run on streets in mixed traffic on arterial and local roads with stops relatively short distances apart to increase the potential passenger catchment. Reliability of trams (and buses) running in mixed traffic depends on prevailing road conditions, primarily levels of traffic congestion and the whether road space is allocated to give trams a clear path through traffic.

The average operating speed of trams is also affected by traffic congestion, along with the need for trams to brake and accelerate in and out of stops, time spent picking up and setting down passengers at stops, distance between stops and delays at traffic signals. Under these sorts of operating conditions, tram route capacity can be severely degraded. However if routes are engineered to provide reasonable levels of tram priority, at least 2000-5000 passengers per hour can be carried at average speeds of around 16-24 km/h.

LRT on the other hand is a form of public transport often described as ‘semi-rapid transit’. Semi-rapid transit such as LRT or Bus Rapid Transit (BRT) provides an intermediate step between ‘street’ and ‘rapid’ transit such as heavy rail systems. Operating in largely separated rights of way with minimal interaction between Light Rail Vehicles (LRV’s) and other road users, LRT and BRT systems typically carry between 4,000 and 15,000 passengers per hour at average speeds ranging between 25-45 km/h and typically with top speeds of around 80km/h and up to 105km/h on some LRT systems in North America.
Performance Characteristics – Trams and Light Rail

Some of Melbourne’s tram routes are a hybrid of the original street tramways of the early 20th Century (particularly in the inner suburbs) and LRT-like extensions running in central medians of arterial roads or a dedicated alignment. While these extensions operate like LRT routes, providing higher average speeds and longer distances between stops on segregated alignments, their overall performance is compromised once on-street running commences, particularly through mixed-traffic strip shopping centres, the inner suburbs and CBD.

Therefore, even those parts of Melbourne’s tram system cannot be classified as Light Rail. Only on those short segments of the St Kilda and Port Melbourne routes that were originally heavy rail do average operating speeds, stop spacing, levels of separation and priority for LRV’s in its right-of-way (ROW) and passenger capacity approach the parameters for modern LRT. This is important to note, as many decision makers confuse street tramways with LRT and vice-versa. The following section outlines the different characteristics and performance of both trams and LRT.

Average Operating Speeds

The vast majority (around 80 per cent) of Melbourne’s tram network operates ‘on street’ with rights-of-way located in arterial roads and local roads. This means average operating speeds on the network are relatively low (around 16 km/h) compared to other Australian and overseas systems that feature greater separation from other road traffic. On some built-up tram corridors through shopping strips, particularly Sydney Road and Chapel Street, average speeds can go as low as 6 km/h. This provides a very poor level of performance akin to (degraded) street transit in contrast to semi-rapid transit.

Parts of Melbourne’s tram system (particularly sections of Routes 75, 86, 96 and 109) are in segregated ROWs, operating at LRT speeds averaging over 30km/h, but only on the LRT-like sections converted from former heavy rail lines (routes 96 and 109) or on central median alignments with a degree of traffic light coordination at intersections. Once trams leave the segregated sections on these routes, they revert to street running, meaning average speeds on the three routes drop to 16-17 km/h.

New LRT routes in other cities typically have full segregation from other vehicular traffic except at intersections which are signalised to automatically provide priority passage for LRV’s. Combined with extended spacing between stops (see below) and the high acceleration and braking rates of modern LRV’s, achievable average service speeds are typically in the range of two to three times that of conventional street based tramways, with the major variable being dwell times at stops.

Stop Spacing

Stop spacing represents a trade-off between accessibility for current and potential passengers and the operational performance of the network and affects a route’s average speed. On Melbourne’s tram system, the average spacing between stops is 250 metres. Short distances between stops increases delays and reduces average speeds from continual starting and stopping, while longer distances between stops allow higher average speeds, at the cost of reduced accessibility.

Stop placement is also an important factor affecting tram speed and reliability, particularly at road intersections. Placing stops on the ‘near’ side of traffic signals can compound delays from passengers boarding and alighting if green signal cycles are missed. In comparison, ‘far’ side stops can reduce delays by allowing trams to pass through on a green signal cycle before stopping. This is a valuable measure provided the signals are equipped to provide priority for trams so they do not still have to also stop before the intersection.
Spacing of stops on purpose built LRT routes typically vary in the range of 500 to 800 metres, sometimes more, which allows modern high performance LRV’s to reach and maintain maximum permitted speeds for some distance between stops. Stops on LRT routes almost invariably involve raised platforms to vehicle floor height which speeds up alighting and boarding. Unfortunately, in the Melbourne context, the rate of provision of platform stops will still involve street level boarding of trams at the majority of stops for many years to come.

As such, the placement and frequency of stops on LRT routes bears a closer resemblance to those on metros or suburban railways, with local access ideally provided by walking, cycling, connecting buses or, where conditions permit, by the use of “park and ride” facilities.

**Delays**

Street tramway systems are often delayed while in service, meaning low average speeds and poor operational performance, particularly in reliability and lack of consistent frequency. It has been calculated that the congestion incurred by tram operation in mixed traffic accounts for approximately 40% of tram running time.\(^8\)

Sources of delay on Melbourne’s tramway network include traffic congestion on arterial roads, turning vehicles blocking tram lines, delays caused by passenger loading and unloading and traffic signal cycles that prioritise private vehicles over public transport vehicles.

Effective ROW segregation on LRT routes should, by definition, involve engineered solutions to eliminate the majority of such delays.

**Vehicle design**

Modern trams and LRV’s can be almost indistinguishable from each other, and more so for use on hybrid routes involving a mix of traditional on-street operation with closely spaced stops and higher speed running on segregated ROWs. Purpose built LRT routes tend to have fewer constraints on vehicle length and the use of two, three or more coupled vehicles operating in multiple unit configuration\(^9\) or the use of multi-section articulated vehicles 50 metres or more in length is increasingly common in many cities.

LRV’s typically feature higher performance characteristics than trams which can rarely exceed around 70km/h in normal running whereas LRV’s can attain up to 100km/h in some circumstances, dependent upon stop spacing and track alignment. Internal layouts of trams and LRV’s, including designed passenger seat to standing ratios, also may not differ greatly as average trip durations are often similar at around 20-30 minutes, notwithstanding the considerably greater distance that services on LRT routes can cover in that time.

**Passenger capacity**

On Melbourne’s tram system, the current passenger capacity offered on most routes is between 750 and 1,300 spaces in each direction per hour. These levels of capacity are at the lower end of those expected of street transit and are significantly less than a light rail system.

Some parts of the network are capable of offering much higher capacities, particularly where multiple routes combine to run down arterial roads in the CBD and inner suburbs. For example, the Swanston Street/St Kilda Road corridor (Melbourne University to Domain Interchange) is presently capable of offering around 5,000 spaces in approximately 50 trams in each direction per hour, a capacity at the lower end of LRT performance. Another higher capacity corridor on Melbourne’s tram network is the Elizabeth Street corridor (Flinders Street to Queen Victoria Market) offering around 3,400 spaces in each direction per hour.

Unfortunately, higher capacity corridors are presently constrained from achieving better operational performance (increased average speeds, higher frequencies, greater reliability) and higher passenger capacity from a combination of short average stop spacings, delays caused by mixed traffic operation, lack of traffic light priority and lack of dedicated ROWs.
In Melbourne, any new routes constructed to LRT standards should have inbuilt peak period capacity for at least 8,000 to 10,000 passengers per track per hour. For example, using a five section stretched version of the current E class vehicle, suitably modified for enhanced performance on segregated ROWs and with nominal capacity for 350 passengers, a two minute service frequency would provide route capacity for 10,500 passengers in each direction.

**Trams or LRT – which application is right for Melbourne?**

The answer to the above question does not reside in one or other solution but both. This paper addresses both the appropriate role of a traditional street based tramway in the Melbourne context and the potential for adapted and/or new LRT applications.

The majority of Melbourne tram routes form an essential part of local feeder services as distinct from a fast trunk system. Their major functions are to provide local access on the more heavily patronised routes and to provide direct links to the CBD from inner areas which cannot conveniently access stations on the rail network. The average trip length on most of these routes is around 3km hence journey time is not such a critical issue for short haul passengers.

However, effective use of the tramway infrastructure and vehicles still necessitates that overall transit times be reduced through more effective traffic management processes that prioritise trams and cars on the basis of numbers of people travelling rather than the number of vehicles.

The local feeder significance of the tram network is underlined by those routes which service important traditional strip shopping centres. This includes two cross-town services (Routes 78 and 82) which do not go anywhere near the CBD. These services include:

- Route 6 serving High Street, Prahran and Armadale
- Route 8 serving Toorak Road, South Yarra
- Route 11 serving Brunswick Street, Fitzroy
- Route 12 serving Clarendon Street, South Melbourne
- Routes 12 & 109 serving Victoria Street, North Richmond
- Route 16 serving Glenferrie Road, Hawthorn and Malvern
- Route 19 serving Sydney Road, Brunswick and Coburg
- Routes 48 & 70 serving Bridge Road, Richmond
- Route 67 serving Glenhuntly Road, Elsternwick
- Route 72 serving Burke Road, Camberwell
- Route 78 serving Chapel Street, Prahran
- Route 82 Footscray to Moonee Ponds (serving both shopping precincts)
- Route 86 serving Smith Street, Collingwood
- Route 96 serving Fitzroy and Acland Streets, St Kilda.

In contrast to the tram network, when properly executed, LRT provides a range of benefits to cities such as Melbourne, offering a medium-capacity urban public transport solution ideally suited to new trunk routes up to around 15km in length not requiring capacity offered by traditional heavy rail or metro systems. LRT delivers higher operating speeds, greater reliability and capacity than other road-based public transport at expenditure levels closer to regular tram and bus infrastructure than the very high cost of conventional heavy rail technologies.

LRT is often an effective solution for mitigating urban road congestion, improving accessibility to Central Business Districts (CBDs) and suburban employment clusters. In the Melbourne context, LRT offers the prospect of high quality links that could fill gaps in the existing radial heavy rail network or for introduction on selected high usage cross-town corridors. With appropriate land-use planning controls in place, LRT provides opportunities to change land-use patterns and enhance land values along such corridors, around stations and in activity centres, as evidenced by experience in other cities – well known examples being Dallas, St Louis and Portland in the US, Nottingham and Greater Manchester in the UK, Lyon in France and Dublin.
Trams and Buses

In the Melbourne context, it has been several decades since any serious debate occurred regarding the respective roles of trams and buses, perhaps in part because Melbourne’s trams are so much an accepted part of the city’s psyche and because electric traction is now generally viewed as cleaner and more environmentally friendly. Melbourne owes a massive debt to those who successfully argued in the 1950’s and 1960’s against the prevailing trend in other Australian cities and elsewhere to abandon tramway systems in favour of buses.

The tram network also provides a number of other advantages which Melbourne should steadily gain over other cities which heavily rely on buses, particularly for CBD oriented or inner suburban travel. As population pressures intensify, these advantages are likely to include a positive influence on land values from the perceived permanence and predictability of fixed rail transport and the quiet efficiency with which modern trams and/or LRV’s provide capacity to move several hundred people at a time, otherwise requiring multiple buses and much more road space to perform the same task.

Notwithstanding, the bus network will also become an increasingly critical element of Melbourne’s public transport, especially for providing cross-town connectivity necessary to properly integrate the overall multi-modal network and in the less densely populated growth areas where service frequency improvement and route development are increasingly urgent, albeit outside the scope of this paper.

There are also many locations where bus routes could effectively coordinate with the tram network, following the example of the Route 75 Vermont South tram terminus where buses provide a frequent scheduled connection to the Knox shopping centre.

Measures for a transformed Tramway Network

The historic investment in Melbourne’s extensive tramway infrastructure and rolling stock and ever increasing urban road congestion make a compelling case to change road usage policy and priorities to that of “moving people rather than vehicles” and to implement other measures that will maximise the productivity and utility of scarce road space as well as the tramway assets. These measures will produce a range of widespread benefits as described in this paper.

Rights of Way

Of Melbourne’s 250 route kilometres tram system, only 18 per cent of which (or around 45 route kilometres) operates in its own partly or fully segregated right-of-way (ROW). Around half the segregated ROWs are in the inner suburbs, particularly along the spacious boulevards and wider arterial roads radiating outward from the CBD. The remainder are located in central medians of arterial roads in middle and outer suburbs as part of later tram extensions built from the 1970s onward. However, the majority of the tram system operates in mixed traffic on arterial roads and local streets through a range of built environments. These include the Melbourne CBD, mixed use (commercial, retail, residential) corridors, shopping strips and residential areas.

Trying to bring tram routes running through the mixed-use corridors and suburban shopping strips up to notional LRT standard is problematic because of the effects such upgrades would have on the urban fabric of precincts, either through changes in road space allocation, tram priority works or stop relocation. Hence attempts to improve performance of the tram network in Melbourne’s inner suburbs have not brought the benefits originally envisaged. In recent years, VicRoads has instituted the ‘ThinkTram’ program providing peak-period tram-only lanes and clearways to better separate trams from other traffic on inner-suburban arterial roads. Outside
the peak directions in the AM and PM peaks, relatively little separation between trams and other traffic has occurred to improve the performance of the tram network.

It is contended a pressing need remains to progress these changes, particularly as average tram trip times have continued to increase as road congestion worsens, both during peak periods and at other times. The current situation results in everyone being a loser - motorists are delayed and trams are delayed. It simply perpetuates a very inefficient system of competing modes sharing limited road space. By way of example, a comparison in off-peak running times on selected routes is shown below.

<table>
<thead>
<tr>
<th>Route (terminus to City or vice versa)</th>
<th>1950s (min)</th>
<th>Present (off peak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route 8 (Toorak)</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>Route 6 (Glen Iris)</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>Route 19 (North Coburg)</td>
<td>32</td>
<td>39</td>
</tr>
</tbody>
</table>

These changes are essential to improve the average speed and reliability of tram services in on-street tram corridors. In turn, this would reduce operating costs and improve vehicle utilisation; particularly important given the $6+ million cost of each new E class and similar trams and suggesting a strong economic argument for change. Alternatively, more services could be operated with the same size fleet.

As such, decisions need to be made on the reallocation of road space along many tram corridors to provide trams with more efficient ROWs, notwithstanding the challenges in meeting conflicting community expectations at many locations. There are encouraging signs a majority of the community supports this transformation, with a recent poll in a Melbourne newspaper finding 62% of readers favouring increased priority for trams over cars.10

Potential treatments could involve a mixture of:

- increased restrictions to on-street parking,
- expanded clearway times,
- lowering of speed limits for all traffic in shopping strips,
- greater traffic signal priority for trams at intersections
- provision of additional platform stops to speed alighting and boarding, and
- reallocation of road space to create dedicated tram lanes.

The possible introduction of road pricing measures on selected tram routes also requires close examination, albeit in the context of a wider road pricing policy framework. The technology for this is already well established.

Such changes need to be focussed on the key locations and roads where the impact is greatest on tram speeds and service variability caused by traffic congestion. By definition, these routes are not suitable candidates for the application of LRT technology.

**System Technologies**

A range of system technologies provide a critical factor in the transformation of Melbourne’s tram system. They are also generally relevant to a modern LRT system. Changes in both the transport ‘software’ and ‘hardware’ technologies are important in this transformation, with examples given below.

**Transport system ‘software’ – Intelligent Transport Systems (ITS)**

Melbourne’s tram network already uses Intelligent Transport Systems (ITS) to provide operational information on vehicle locations and to identify potential network disruptions. Using ITS is important to minimise delays, increase average speeds and improve service reliability between stops and along tram corridors.

Currently, traffic signal priority on the tram system is largely ‘passive’, such as providing right turn arrows to allow cars blocking tramlines to clear the intersection, along with ‘tram-only’
phases in some signal cycles to allow trams through on red signals. While these systems are generally useful for allowing late-running vehicles to make up time, they do not allow increases in average speeds to lower overall journey times for passengers.

‘Active’ signal priority measures using GPS-based vehicle tracking and transponder technology favouring public transport over other road users by altering signal phases on approach of trams or buses have been successfully used overseas and in Australian cities. More aggressive use of these systems to not only bring late running trams back on time, but reduce journey times and increase average tram speeds are essential components of the transformation process for both trams and light rail.

**Transport system ‘software’ – Road management rules**

Most car drivers in Melbourne’s CBD know about ‘hook turns’. Trams can move freely through intersections in the CBD without being blocked by shifting cars turning right into the left lane. Extending the use of hook turns beyond their current use in the CBD and inner suburbs to all roads with tram routes would improve tram performance by clearing tram lanes currently blocked by vehicles turning right.

A 2005 trial of hook turns (along with stop relocations, signal priority and kerbside parking reductions) at four intersections on Clarendon Street, South Melbourne found tram performance and reliability improved during the trial, particularly in the AM and PM peaks. Alongside the use of ITS to provide active traffic signal priority, it is expected that the impact on the tram and LRT network would be positive (increased average speeds, reduced delays and greater reliability) as part of a package of complementary priority measures.

**Transport system ‘hardware’ – Terminus rearrangement**

Single track termini at the end of most tram routes limit the ability of Melbourne’s tram system to deliver the increased service frequencies required by modern tram and LRT systems. Rebuilding existing single-track termini to increase their capacity offers the ability to provide greater frequency and operational flexibility to accommodate the newer, longer trams being currently delivered or allow the ‘cascading’ of higher capacity trams from the existing fleet.

**Higher frequency services**

The ultimate goal for a tram operator from improved ROWs and system technologies is to increase the efficiency with which the service operates, either allowing the same level of service to be run with fewer vehicles or to run additional services. For example, a 10 percent increase in the efficiency of Route 19 (North Coburg – City) could notionally free up two additional trams in the AM peak that would allow service frequency to move from every 5½ minutes to every 5 minutes.

A critical factor in encouraging greater public transport use is to enhance the attractiveness of services by providing “turn up and go” frequencies of 7-10 minutes or better during inter-peak periods and at weekends, easing to around 15 minute intervals at nighttime. More frequent services not only minimise average passenger waiting time (and hence door to door trip times) but are fundamental to improving overall network connectivity wherever trip origins and destinations require interchange between tram and/or bus routes or at railway stations.

**Reconfiguration of existing tram routes**

There are opportunities to improve network effectiveness and connectivity by selective reconfiguration of some tram routes. Some of these are not new concepts but most offer the prospect of adapting the traditional route structure at modest cost to better accommodate current travel patterns, provide additional trip options and more effectively utilise existing track infrastructure.
Another important reason for some of these changes is to spread tram route coverage more evenly across Melbourne’s Central Activities District (CAD) in recognition of the fact that it is now much larger and more diverse than say, 30 or 40 years ago. Presently, most tram routes converge on just a few city streets and there few routes on other streets, the most obvious example of this disparity being the nine full-time routes on Swanston Street and only one on William Street.

These changes would variously require new curves at some tramway intersections, short infill sections, altered tram stops or upgraded interchange facilities. Examples worthy of detailed investigation include:

- Splitting of Route 72 (City-Camberwell) at Gardiner station (with an interchange at that location facilitated by the impending level crossing removal) and conversion of the present Burke Road route into a separate north-south spine, possibly extended to both the north and south (see separate section re potential network extensions).

- Removal of the present Elizabeth Street terminus at Flinders Street which presently serves Routes 19 (North Coburg), 57 (West Maribyrnong) and 59 (Airport West) and extension of these routes into Flinders Street in both directions to provide direct links between the Victoria Market and Parkville precincts and Docklands, Jolimont and/or Richmond Stations and/or Domain Interchange.

- Alteration of Route 8 (City-Toorak) or another St Kilda Road route to divert at Domain Interchange and run via Park Street, Kings Way, William and Peel Streets to a new major interchange in Royal Parade at Parkville.

- Construction of a 300 metre infill section immediately west of Kings Way in Park Street, South Melbourne to allow one or more St Kilda Road routes to divert at Domain Interchange and run via Park Street, Clarendon, Spencer and Latrobe Streets to Southern Cross Station and Docklands.

- Construction of a 500 metre deviation of Route 82 in Footscray to service the main Victoria University campus in Ballarat Road by continuing east along Ballarat Road and then turning south into Tiernan Street to rejoin the existing route in Droop Street instead of turning from Ballarat Road into Droop Street.

- Re-arrangement of some routes to improve passenger rail/tram interchange at Southern Cross Station and particularly to minimise the current extent of pedestrian traffic crossing Spencer Street at grade to access tram services in Collins and Bourke Streets.

**Passenger comfort**

A subjective comfort factor is that half of the present Melbourne tram fleet (those built prior to 1987) currently lack air-conditioning in the passenger saloons. Melbourne’s weather, whilst relatively benign compared with many overseas cities, is famously variable with spells of quite severe summer heat leading to uncomfortable travelling conditions in these older vehicles. Climate change is increasing the frequency of these very hot days.

**Increased fleet capacity**

As part of a long-term goal is to increase service efficiency, increasing vehicle capacity (either with or without higher frequencies) would improve the carrying capacity of the system to accommodate actual or anticipated demand. For example, the full introduction of new E-class trams on Route 96 with a capacity of 210 people will increase the peak hour/peak direction capacity on the route by around 50% over the existing service that until recently was operated by Combino and Bumblebee trams, supplemented by smaller trams at times.14
There is an urgent need for the new State Government to commit to a follow-on order for at least a further 75 additional E-class trams to replace large parts of the existing small tram fleet on high demand routes and allow the cascading of suitable older trams to increase capacity elsewhere on the system.

Once the requirement for high capacity extended length vehicles is fulfilled on the busier routes, a tranche of somewhat smaller vehicles should suffice and enable the withdrawal of the remaining Z class by the early to mid-2020's, some of which by then will have been in operation for over 40 years. The slightly younger A class trams could then be deployed on routes with lighter patronage.

A key message here is that the progressive introduction of higher capacity vehicles on various routes as new E class trams enter service must not be traded-off against any perceptible reduction in service frequency. This would compromise the critical role that “turn up and go” frequencies play in generating public transport patronage and in reducing car dependency. For similar reasons, the unnecessary use of high capacity vehicles on lesser patronised routes should be avoided.. Any resurgence in patronage may be quelled as a consequence.

### Accessible stops and vehicles

There is a need to make tram stops and vehicles fully accessible to people of all abilities for whom public transport provides the ability to reach jobs, educational, health and leisure opportunities. Level boarding also speeds up passenger ingress and egress and thus also contributes to journey time reductions. The need is particularly apparent in the tram fleet, with approximately 76% of vehicles still high-floor units with steps down to the roadway and thus non-compliant with Commonwealth Disability Discrimination Act (DDA) requirements, as shown below:

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Classes</th>
<th>Years built</th>
<th>No. in service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-DDA compliant trams</td>
<td>W</td>
<td>1939-1956</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Z1, Z2, Z3</td>
<td>1975-1984</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>1984-1987</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>B1</td>
<td>1984-1985</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>1987-1994</td>
<td>130</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td></td>
<td></td>
<td><strong>364</strong></td>
</tr>
<tr>
<td>DDA compliant (low floor) trams</td>
<td>C1</td>
<td>2001-2002</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>2005</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>D1, D2</td>
<td>2002-2004</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>2013 onwards</td>
<td>17 to Feb. 15</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td></td>
<td></td>
<td><strong>117</strong></td>
</tr>
</tbody>
</table>

Although all new trams delivered in the last decade have been low-floor, they currently make up around 24% of the fleet and only operate on a handful of routes. By the time that all 50 E class trams currently on order are delivered (anticipated by late 2016 or early 2017), all but around 12 W class and all of the remaining Z1 and Z2 classes are likely to have been withdrawn from service. This will reduce the non-compliant fleet to around 325 trams with the compliant fleet then comprising 150 trams or approaching one-third of the fleet.

On current indications, the last of the non-compliant fleet (130 B2 class two-section articulated trams) are unlikely to be retired for at least a further two decades. Many European cities have chosen to overcome this problem by the insertion of a third low floor centre section in similar articulated vehicles. Assuming this option made sense economically, the same solution could be adopted in Melbourne. By adding a central low floor section to all 130 B2 class trams, a significant increase in capacity would result and the proportion of DDA compliant vehicles could increase to almost 60% by the early 2020’s.

On some routes where low-floor trams operate, not all stops have level boarding access, still requiring a step down to street level. While the platform stop program has steadily been rolling out across the network with approximately 370 stops out of a total of 1770 (21%) completed to
date, at current rates of work, it will take several decades to modify all stops to achieve level access boarding.

**Interchange with other modes**

Evidence from European and North American tram and LRT systems indicate that the best performing systems are those that are tightly connected with bus and heavy rail routes to form a fully integrated public transport network. Such a network provides access to a wide range of metropolitan origins and destinations and creates the best opportunity for significantly reduced car dependency.

In the Melbourne context, this is particularly important where public transport linkages can be created to facilitate effective cross-town or non-CBD oriented journeys which are currently overwhelmingly undertaken by car. Facilitated by “turn up and go” service frequencies (as previously defined) on all principal routes, this will be a key factor in transforming Melbourne’s tram system and Melbourne’s public transport generally from largely autonomous modes into a true multi-modal network.

Interchange locations should be easy for passengers to navigate, with good information systems and signage and few physical or other barriers to quick interchange between modes. High quality interchange infrastructure, coupled with sufficiently high service frequencies and a wide span of operating hours will provide a credible mobility alternative to the car for many urban residents.

**Demand Generators and Attractors**

Current and planned land use patterns tend to be significantly influenced by the presence of existing fixed rail corridors, whether rail or tram. Bus routes do not seem to exert influence at a similar level, perhaps associated with perceptions of permanence and the strong visual elements of fixed rail systems. Land use densification is a common response along tram, LRT or heavy rail corridors, particularly in the close vicinity of some railway stations.

The other side of the coin is that existing and planned land use should be a key driver for the development of transport links where these do not already exist or exist in ways which do not adequately meet community needs. On corridors which are likely to have high usage between residential areas and employment locations or other movement attractors, these may offer potentially viable applications of either tram or LRT service, depending whether local access needs are closely spaced or relatively dispersed.

Potential demand generators in the Melbourne context include the considerable scope for additional housing on existing non-residential land in and around activity centres, brownfield sites and some railway stations. Other potential demand generators include planned extensive urban development precincts such as at E-Gate, Arden-Macaulay and Fishermans Bend.

Typical movement attractors are:

- Shopping complexes
- Hospitals
- Larger schools and tertiary Institutions
- Local neighborhood activity centres

A study of potential extensions to the existing network is warranted where these traffic generators have been established beyond the current reach of tram services or where gaps in the combined rail and tram networks can be filled by modest extensions that should link to effective interchange facilities at nearby railway stations. In most cases, such extensions involve relatively short distances ranging between a few hundred metres and two or three kilometres. These are appropriate applications for street based tramways.
Suggested Tram Network Extensions

 Shortly after the Melbourne and Metropolitan Tramways Board was constituted in 1923, it developed a Master Plan for tramway development. This included conversion of the remaining cable tram routes to electric operation and a program of tramway extensions to provide additional cross-town links and to lead development in new outer suburbs.

The extension program came to an abrupt end in the early 1930s following the onset of the Great Depression. With the exception of the Bourke Street routes which were belatedly converted from bus to tram operation during 1955-56, almost none of the proposed further extensions were ever progressed. This explains why several tram routes still terminate at locations devoid of evident traffic generators and away from major activity centres. Over 90 years later, some of the planned extensions from the 1923 Plan remain relevant today and therefore feature in the list below. Several of these were also proposed in the 1969 Melbourne Transportation Study.

A range of modest tram route extensions that link to major activity centres, local activity centres or potentially provide efficient modal interchange at nearby railway stations appear to have prima facie justification. Such extensions would be important in helping to convert an old and somewhat unconnected network into one with logical destinations that support inner and middle suburban densification, create land value uplift and considerably strengthen network connectivity – all essential elements in reducing car dependency and improving urban amenity.

Carefully selected network extensions would also complement the suggested reconfiguration of some routes as suggested earlier in this paper.

The extensions would mainly be on-street but with segregated ROWs wherever practicable. Such extensions would be quite separate from the completely new higher capacity LRT corridors described later in the paper.

There needs to be reasonable evidence of sufficient additional patronage to justify the capital outlays required, as alternative and less costly measures such as bus links could be implemented on a case by case basis, for example to test potential demand. A “rule of thumb” sometimes used is that tram operation is more economical than bus operation where peak-hour loads are likely to be above 750-1000 passengers per hour, but obviously each case is different.

In other cases, trams are unlikely to be an appropriate solution. An example is the popular Route 401 bus linking North Melbourne Station with the Parkville hospital and university precinct where it is considered that the bus is likely to remain a more effective solution, in this instance due primarily to road layout conditions. In any event, if and when Melbourne Metro eventuates, this would at least partly offset the need for a North Melbourne Station to Parkville direct bus link. A bus option would still be more suitable should suggestions for an extension of Route 401 from Parkville to either Richmond or Victoria Park stations be adopted.

Potential tram network extensions that should be individually investigated in the context of combined public transport network strengthening and wider urban planning objectives are listed in the following table.

Subject to satisfactory business case assessment showing a net benefit when the economic, social and environmental factors are properly considered for each extension, they should then be prioritised for implementation,
### Potential tram network extensions

#### Group One – short infill extensions

*(NOTE: Not ranked in any priority order)*

<table>
<thead>
<tr>
<th>Route No.</th>
<th>Present terminus</th>
<th>Proposed extension terminus</th>
<th>Probable Route Details</th>
<th>Extension length</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>East Malvern (Darling Rd)</td>
<td>Caulfield Station (Racecourse side)</td>
<td>Via Normanby Road, terminating on south side of Caulfield Station</td>
<td>300 metres</td>
<td>Provides improved rail/tram network connectivity and terminus for potential route reconfiguration short working</td>
</tr>
<tr>
<td>5</td>
<td>Malvern (Burke Rd)</td>
<td>Darling Station</td>
<td>Via Wattletree and Malvern Roads, terminating at Darling Station.</td>
<td>1.4km</td>
<td>Provides rail/tram network connectivity</td>
</tr>
<tr>
<td>6</td>
<td>Glen Iris (Malvern Rd)</td>
<td>Stage One to Glen Iris Station</td>
<td>Via High Street terminating at Glen Iris Station</td>
<td>300 metres</td>
<td>Provides rail/tram/bus network connectivity, improved access to Glen Iris Local Activity Centre</td>
</tr>
<tr>
<td>19</td>
<td>North Coburg (Bakers Road)</td>
<td>Merlynston Station</td>
<td>Via Sydney Road, Shorts Road and rail reserve terminating at Merlynston Station</td>
<td>900 metres</td>
<td>Provides rail/tram network connectivity, stimulate property densification potential along Sydney Road and relocate present unsatisfactory terminus</td>
</tr>
<tr>
<td>57</td>
<td>West Maribyrnong (Cordite Ave)</td>
<td>Avondale Heights Shopping Centre</td>
<td>Via Cordite Avenue, Canning Street and Military Road terminating at Clarendon Street.</td>
<td>1.2km</td>
<td>Provides improved access to Avondale Heights Local Activity Centre and general area with relatively poor public transport. Also potential for later extension to East Keilor</td>
</tr>
<tr>
<td>59</td>
<td>Airport West</td>
<td>Westfield Airport West Shopping Centre and bus interchange</td>
<td>Via Matthews Avenue and Dromana Avenue terminating at Airport West Shopping Centre.</td>
<td>350 metres</td>
<td>Provides tram/bus network connectivity and improved access to Airport West Major Activity Centre</td>
</tr>
<tr>
<td>67</td>
<td>Carnegie (Koornang Rd)</td>
<td>Carnegie Station and shops</td>
<td>Via Koornang Road terminating at Carnegie Station. (Assumes prior removal of Carnegie level crossing).</td>
<td>900 metres</td>
<td>Provides rail/tram network connectivity and improved access to Carnegie Local Activity Centre</td>
</tr>
<tr>
<td>82</td>
<td>Footscray (Irving St)</td>
<td>Victoria University Footscray - South Campus</td>
<td>Via Irving and Nicholson Streets terminating at Buckley Street</td>
<td>500 metres</td>
<td>Provides improved access to Victoria University South Campus and local schools. (Also see earlier proposal for deviating this route to also serve Victoria University North Campus in Ballarat Road)</td>
</tr>
</tbody>
</table>
## Potential tram network extensions

### Group Two – longer network connectivity and activity centre extensions

<table>
<thead>
<tr>
<th>Route No.</th>
<th>Present terminus</th>
<th>Proposed extension terminus</th>
<th>Probable Route Details</th>
<th>Extension length</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>East Malvern (Darling Rd)</td>
<td>East Malvern Station and Chadstone Shopping Centre</td>
<td>Via Waverley Road, Belgrave Road and Dandenong Road, terminating at Chadstone Shopping Centre.</td>
<td>2.7km</td>
<td>Provides rail/tram network connectivity, improved access to Chadstone Major Activity Centre and stimulate property densification potential.</td>
</tr>
<tr>
<td>6</td>
<td>Glen Iris (Malvern Rd)</td>
<td>Stage Two to Ashburton Station and Ashwood Shopping Centre</td>
<td>Via High Street terminating at Warrigal Road, Ashwood. (Assumes prior elimination of High Street, Glen Iris level crossing).</td>
<td>2.9km</td>
<td>Provides rail/tram/bus network connectivity, improved access to Glen Iris, Ashburton and Ashwood Local Activity Centres and stimulate property densification potential.</td>
</tr>
<tr>
<td>8</td>
<td>Toorak (Glenferrie Rd)</td>
<td>Hartwell Junction</td>
<td>Via Toorak Road terminating at Camberwell Road. (Assumes prior removal of Toorak Road level crossing of Glen Waverley line).</td>
<td>3.8km</td>
<td>Provides tram/tram network connectivity and logical extension along Toorak Road to serve Tooronga Village Major Activity Centre, cross-link between Glen Waverley and Alamein lines and encourage residential densification along Toorak Road.</td>
</tr>
<tr>
<td>11</td>
<td>West Preston (Regent St)</td>
<td>Reservoir Station &amp; bus interchange</td>
<td>Via Gilbert Road and Edwardes St. terminating at Reservoir Station. (Assumes prior removal of Reservoir level crossing).</td>
<td>2.8km</td>
<td>Provides rail/tram/bus network connectivity, improved access to Reservoir Local Activity Centre and stimulate property densification potential.</td>
</tr>
<tr>
<td>48</td>
<td>North Balwyn (Balwyn Road)</td>
<td>Westfield Doncaster Shopping Centre &amp; bus interchange</td>
<td>Via Doncaster Road terminating at Doncaster Shoppingtown.</td>
<td>3.6km</td>
<td>Provides tram/bus network connectivity, improved access to Doncaster Major Activity Centre, stimulate property densification and form part of potential CBD to Doncaster LRT.</td>
</tr>
<tr>
<td>64</td>
<td>East Brighton (Nepean Hwy)</td>
<td>Moorabbin Station, Shopping Centre &amp; bus interchange</td>
<td>Via Nepean Highway and South Road terminating at Moorabbin Station.</td>
<td>2.6km</td>
<td>Provides rail/tram network connectivity, improved access to Moorabbin Local Activity Centre and stimulate property densification along Nepean Highway.</td>
</tr>
<tr>
<td>72</td>
<td>Camberwell (Cotham Rd)</td>
<td>Caulfield Station (from Gardiner Station)</td>
<td>Via Burke Road and Sir John Monash Drive terminating at Caulfield Station.</td>
<td>3.2km</td>
<td>Present route ex CBD would terminate at Gardiner Railway Station. New Route 72 creates major north-south crosstown spine along Burke Road linking Camberwell and Caulfield, three railway stations and seven other tram routes and stimulate property densification potential.</td>
</tr>
<tr>
<td>72</td>
<td>Camberwell (Cotham Rd)</td>
<td>Doncaster Road (from Cotham Road)</td>
<td>Via Burke Road terminating at Doncaster Road.</td>
<td>1.9 km</td>
<td>Extends existing north-south crosstown route to connect with the Doncaster tram corridor. Serves Kew Secondary College, sporting facilities and institutions.</td>
</tr>
<tr>
<td>96</td>
<td>St Kilda Beach (Acland &amp; Barkly Streets)</td>
<td>Elwood Shopping Centre</td>
<td>Via Barkly and Mitford Streets, Broadway and Ormond Road terminating at Elwood shops</td>
<td>2.1km</td>
<td>Provides improved access to Elwood Local Activity Centre along the former VR tram route that closed in 1959. Would stimulate further property densification potential.</td>
</tr>
</tbody>
</table>
Realising Melbourne’s LRT potential

Given appropriate applications, LRT is widely recognised as providing a catalyst for significant investment around stops and along routes and for improving liveability and amenity by attracting investment, as the long term nature of its fixed infrastructure provides certainty for developers. LRT also offers the ability to closely integrate into the community and very efficiently bring people into the centre of high activity areas.

According to research carried out by the Centre for Economic Development and Research at the University of North Texas, about a decade after it opened, the Dallas Area Rapid Transit (DART) light rail had generated developments worth $4.26 billion18. In Portland, Oregon, LRT operator TriMet estimates there has been $10 billion invested in development within walking distance of its light rail stations since the decision to build was announced in 1980. On Queensland’s car dominated Gold Coast, 9 months after opening, the new light rail system is being hailed as a major catalyst for recovery in the commercial property sector.

In the Melbourne context, any LRT application should consist of four key elements:

- Segregated Rights of Way;
- Stops spaced at least 500 metres and up to 1km apart
- Appropriate System Technologies, and;
- Attractive Service Quality.

To be effective, LRT combines fully or largely segregated ROWs, relevant system technologies (light rail vehicles, control systems, passenger facilities) and attractive service quality (frequency, span of hours, stopping patterns) into a package of public transport technology that can be marketed with a strongly branded image and identity to present and potential users.

In order to realise Melbourne’s light rail potential, some sections of the current tramway should be upgraded to significantly increase average operating speeds and service frequencies, reduce delays and increase route capacity. However, true LRT operation will in most cases involve the development of new routes on wholly or largely segregated ROWs, principally for the reasons that the existing tram network mostly supports (and needs to support) shorter journeys for localised access and because the extent of achievable improvement to tram infrastructure and operations (as discussed earlier in this paper) will still fall well short of what is required for effective LRT operation.

To ensure that new and existing users are provided with an efficient system connected to the core public transport network, any new routes should be developed, built and operated to contemporary LRT standards.

An LRT Development Plan

As part of any plan to develop LRT corridors that will form key elements of the overall public transport network, a coordinated mix of land use and transport strategies must be developed where it is proposed to upgrade key routes on the existing network to LRT standards and/or construct new routes and corridors to LRT standards. Examples of these network strategies are provided below.

Conversion of tram routes to hybrid LRT lines

The previous Victorian Government’s metropolitan strategy Plan Melbourne outlines a plan for conversion of the most heavily utilised tram routes into LRT.19 These routes generally feature significant amounts of running in off-road ROWs. The first route targeted for conversion is Route 96 (East Brunswick-St Kilda), one of the top five routes by ridership.20 As a demonstration project for LRT in Melbourne, the proposed project aims to improve tram speeds and reliability, increase the efficiency of the road network with a focus on moving people instead
of vehicles and provide better accessibility to the tram network and improved interchange with heavy rail and bus routes.21

While the aims of the Route 96 project are laudable and are probably achievable on those parts of the route that already have or can reasonably incorporate segregated ROWs, other parts of Route 96 (e.g. the northern parts of Nicholson Street in Carlton / North Fitzroy / East Brunswick and Fitzroy Street / The Esplanade in St Kilda) are currently configured to provide localised access and should continue to do so. As such, it is somewhat misleading to depict Route 96 as a genuine LRT application. In reality, in common with other tram routes that already have, or could have, extended segregated ROWs, they effectively become hybrid examples of modernised tram routes with added elements of some LRT features. The same might apply to parts of the proposed route extensions suggested earlier in the paper.

It is noted that the previous Victorian Government also signalled its intent to convert the West Preston-St Kilda routes (Routes 11/12) to LRT after Route 96. While there are sections of St Georges Road in Northcote and Thornbury and possibly parts of Clarendon Street, South Melbourne that have, or should have, segregated ROWs, these routes strongly support localised access over most of their length and it would be counter-productive to significantly increase the present 300-400 metres distance between the existing conditional stops on these routes in pursuit of higher average speeds.

**New LRT routes and corridors**

Aside from a program of some hybrid LRT conversions and various smaller route extensions, there are opportunities to create new LRT routes, nodes and corridors, particularly in areas of Melbourne with strong ‘knowledge job’ centres such as key tertiary education and biomedical research precincts. LRT corridors will also provide important spines anchoring urban renewal, particularly in ‘brownfield’ sites in the inner and middle suburbs.

Many of these potential LRT corridors in the inner and middle suburbs of Melbourne can make use of the wide arterial road easements and boulevards, a legacy of from previous generations of sensible road planning. In the longer term, new infrastructure on high patronage corridors may need to be built to provide completely segregated ROWs for increased capacity and speeds, including on elevated structures or lowered ROWs in cut and cover trenches.

Planning for such corridors will have long lead times and involve many institutional and physical interfaces. Short term, high frequency “SmartBus” or similar services are a logical transition to LRT in helping to change travel behaviour and prove up potential demand. They will also allow time to build community support, progress corridor protection measures and, above all, undertake an integrated process of transport and land use planning at a localised level.

Some examples of potential new LRT routes and corridors follow.

**Ballarat Road LRT corridor**

An emerging employment cluster around Sunshine in Melbourne’s west provides an opportunity to link a range of high-value jobs in universities, medical research and health care. With almost 14,000 jobs in the Sunshine area, there is real potential to develop a significant health and education node for Melbourne’s west, with spin-off jobs in retail and professional services for the region, all served by high-quality public transport, with LRT along the Ballarat Road corridor an important component that would complement existing suburban and regional rail services.22

The existing Route 82 tram (Footscray – Moonee Ponds) provides an LRT entry point into the major activity centre of Footscray that serves both the railway station, town centre and (potentially) the Victoria University campus on Ballarat Road. Developing an LRT corridor along Ballarat Road, with segregated running at least in the central median to the west of Ashley Street would provide high-quality road-based public transport to residential and industrial areas of Maidstone and Braybrook and also serve the Victoria University campus at Sunshine.
Utilising parts of the electricity transmission pylon easement and rail corridor along St Albans Road would also allow a connection to the major medical and research facilities at Sunshine Hospital in Sunshine North.

**Dynon Road LRT corridor**

A complementary addition to the Ballarat Road LRT would be the development of LRT infrastructure extending from the CBD in Spencer Street to an interchange at North Melbourne Station, then via Dynon Road, Hopkins Street and Irving Street to Footscray Station. From there it would link into the current Route 82 and the Ballarat Road LRT, as above.

An alternative but more complex option would be for this corridor to commence from the present Footscray Road terminus at Docklands, cross through the proposed E Gate development precinct to North Melbourne Station and then as described above. This would have the considerable advantage of providing direct links between the CBD, Docklands, E Gate, North Melbourne station and Footscray.

Suitably engineered, either of these options would provide an important alternative link between the CBD and Footscray however implementation would most likely become justified at the time that railway land to the north of Dynon Road became available for redevelopment.

**Wellington Road/North Road LRT corridor**

The Monash employment cluster along the North Road/Wellington Road corridor in Melbourne’s south-east is a major generator of jobs and economic activity, with over 58,000 jobs located in the cluster. Many of these are high-value knowledge-based jobs, anchored around Monash University, the CSIRO, the Australian Synchotron and Monash Medical Centre sites. In a ‘business as usual’ scenario, another 45,000 additional jobs and 25,000 additional residents will locate along the corridor by 2040, making it an essential part of Melbourne’s economy.

The corridor has been served by bus-based public transport for decades, despite repeated promises of a railway line to Rowville. The previous Victorian Government’s recent study on the Rowville rail corridor did not seriously evaluate alternative public transport options to heavy rail such as LRT, improved bus services or Bus Rapid Transit. However, there are viable LRT alternatives that could provide important cross-town connectivity in the area at far lower cost and without the wider rail network capacity implications of a heavy rail line to Rowville.

Introduction of additional higher frequency bus services between Huntingdale railway station and Monash University has increased bus patronage significantly, with all-day travel demand in both directions. In the medium term, increased patronage through improved bus services will create demand for levels of frequency and capacity that can only be satisfied by LRT.

A segregated corridor in the existing central median of North and Wellington Roads extending from Rowville via Monash University to serve the job-rich corridor west of Springvale Road and then continuing along North Road to the Frankston line at Ormond and ultimately to the Sandringham line at Gardenvale would be ideal for the development of LRT. This would not preclude a later potential heavy rail (mostly tunnelled) link that would also serve Monash University as part of an expanded Dandenong line corridor.

**Doncaster LRT corridor**

The Victorian Government’s feasibility study for a heavy rail line to Doncaster concluded that it would be too expensive ($3-5 billion) with low utilisation outside the peaks, too distant from the major activity centre at Doncaster Hill and difficult to integrate into the existing rail network. It has been argued that the study was compromised by a brief that focused exclusively on heavy rail to the exclusion of alternatives such as LRT.
The attraction of a rail-based solution to Doncaster is based on the provision made for a rail corridor in the central median of the Eastern Freeway to Bulleen Road and then most likely transitioning to the northern side of the freeway for the remaining 2.7km to Doncaster Road.

An LRT corridor to Doncaster along the Eastern Freeway is far more attractive than heavy rail based on cost (estimated at around $1.5 billion) and provision of capacity to meet present and future patronage. It would also meet the long-held expectations for a rail-based public transport solution for this part of Melbourne’s eastern suburbs.

The Doncaster/Eastern Freeway corridor is already served by improved bus services that are constrained by the limitations of peak-period Transit Lanes on the freeway, road congestion and lack of bus priority on Hoddle Street. A staged development package to bring light rail to Doncaster Hill could be achieved over the next decade by:

- Further improving Eastern Freeway bus services to grow patronage and capacity through:
  - greater bus priority on Hoddle Street/Victoria Parade,
  - a bus/rail interchange at Victoria Park and
  - a dedicated busway in the Eastern Freeway median (convertible to LRT);
- Extending the existing Route 48 tram along Doncaster Road for approximately 3.5 kilometres from Balwyn Road to Westfield Shoppingtown at Doncaster Hill that would join the Doncaster LRT corridor near the Doncaster Road freeway interchange; and
- Constructing a high-capacity LRT corridor from Shoppingtown to the CBD via Doncaster Road, Eastern Freeway and Alexandra Parade.

Alexandra Parade is a wide boulevard with a central median extending to Nicholson Street that could readily accommodate LRT infrastructure. Tramway intersections at Smith Street and Brunswick Street would require suitable signalised control to ensure LRT priority and probable grade separation in the longer term. Importantly, Alexandra Parade presently lacks any form of east-west public transport and yet also presents an opportunity for transformation into a grand boulevard similar to St Kilda Road or Royal Parade in line with the original vision for Melbourne. It would also stimulate urban regeneration on a significant scale given its proximity to the CBD.

The most appropriate corridors for entry into the CBD require detailed assessment however a merger with Route 96 for about 600 metres between Princes Street and Johnston Street and thence via Barkly, Rathdowne and Latrobe Streets to Melbourne Central Station and Docklands is one of several obvious options.

To be competitive with private car travel (by way of perception and reality) and to emulate as far as possible the performance of a heavy rail solution, very few (if any) stops should be provided for on the Eastern Freeway section and the selected LRV’s for use on the corridor should be high capacity, high performance units capable of operating at freeway speed, i.e. 100km/h.

Achieving the Doncaster LRT corridor vision was at odds with the former Government’s East-West Link road project, with a danger that the central median corridor could have been used as part of the widening of the Eastern Freeway from Hoddle Street to Tram Road as well as the tunnel portals precluding easy transition of the LRT onto Alexandra Parade. Now that the current Government has determined that the road project will not proceed, the case for a Doncaster LRT solution is far stronger and should be the subject of an early planning and business case process.

**Supportive land-use planning**

Many cities view LRT as a superior option to bus-based public transport technologies for initiating higher residential and job densities along road corridors and promoting Transit-Oriented Development (TOD) around stations. However, international experience in LRT development, particularly in North American and European cities, shows that the provision of
public transport-supportive land-use planning controls (i.e. zoning for increased density) on LRT corridors and a commitment to their implementation is even more important in changing land uses than the choice of transport technologies.

The previous Victorian Government recently released its new system of land-use planning zones for the state. Opportunities for infill and tram corridor redevelopment on or near the tram network should be investigated, particularly in the inner north, south east and south where the tram network is at its densest.

Continued reliance on outer suburban growth areas to absorb future population growth and dispersal of retail and commercial activity to ‘off-network’ sites on the arterial road network is not supportive of the increased densities, nor as a stimulus to economic activity or much easier access to jobs that might otherwise be driven by the transformation of the tram network and the complementary creation of a modern LRT system.

Costs and benefits

Unless already moving to adoption, the various system improvements, tram route extensions and LRT proposals discussed in this paper will generally necessitate much more detailed assessment and ultimately require development of robust business cases before any are likely to be funded and move into implementation mode.

Set against project capital and operating costs will be a range of potential benefits, both short and longer term, that will require quantification to the extent that is reasonably practicable. Examples of such benefits, some of which could leverage value capture for funding, include:

- To direct users – improved network connectivity and journey time savings
- To other public transport users – less congestion, improved service reliability
- To road users – less congestion on the road network and journey time savings
- To land and property owners - uplift in land and property values
- To Government as landowner - uplift in government owned land values
- To local communities – improved amenity and accessibility
- To business and the economy generally - increased economic activity
- To Government from increased taxation receipts and other potential value capture
- To the environment – reduced car dependence, lower emissions.

Implementation

To move towards the light rail and tram futures set out here requires consultation to build support with affected communities; careful assessment of funding and staging options, and appropriate links with the land use planning process as pre-requisites to quality implementation. It will also require alignment of political and financial support, helped by evidence of benefits flowing from comparable changes elsewhere that have been successfully implemented.

These processes, while beyond the scope of the present paper, need to achieve higher levels of involvement and credibility than has been evident in recent transport and land use planning and community consultation in Melbourne. This requirement is accentuated by the central place the tram and light rail systems play in the character, accessibility and psyche of our city.

Suggestions regarding these issues and processes will be contained in a companion paper on transport and urban planning to be issued by Rail Futures later this year.
Current Melbourne Tram Network (courtesy Public Transport Victoria)
Notes

3. Assuming Melbourne average car occupancy of 1.1 passengers per vehicle.
4. In North America, trams are referred to as “streetcars”.
9. Multiple unit operation involves the use of multiple vehicles which are mechanically and electrically connected to enable their operation by a single driver.
12. An excellent example of an efficient terminus facility is at Melbourne University in Swanston Street, Carlton. This provides the ability for three trams to turnback within around 20 seconds of each other and to load concurrently at the adjacent platform stop.
15. In Melbourne, the first General Scheme for Tramway Development was prepared in 1921-23 by the Melbourne & Metropolitan Tramways Board (M&MTB) following its formation by State Government legislation (Act #2995/1918). The M&MTB was required to:
   - operate the services it had inherited;
   - bring them under its unified control; and
   - prepare a General Scheme for Melbourne’s future tramway development.
   The Scheme was then adopted and became part of the 1929 Metropolitan Town Planning Commission Report.
16. The late conversion of the Bourke Street routes to tram operation was a consequence of the removal of cable trams from these routes in 1940 and, because of wartime conditions, the temporary substitution of buses – a situation which lasted for over 15 years.
17. The Victorian Railways independently operated two tramway routes in Melbourne – a 5’3” gauge line from St Kilda Railway Station to Brighton Beach via Elwood which closed in stages between 1956 and 1959 and a 4’8½” (standard) gauge line from Sandringham Railway Station to Black Rock which closed in 1956.