



Melbourne:

*Modernising the world's
largest tramway*

A special review in association with

yarra trams

& TRAMWAYS &
URBAN TRANSIT

BUILT IN MELBOURNE, FOR MELBOURNE



Melbourne's tramway is an iconic symbol of the city and one of the largest networks in the world, with 500km of track and almost 500 trams serving over 1750 stops. For the network's latest generation of light rail vehicles, Bombardier Transportation is supplying 50 E Class Flexity Swift low-floor trams, with an option for a further 100.

Maintaining the use of global standardised systems, the trams have undergone extensive modifications to cope with the challenging load conditions experienced in the city and mark a return to local manufacturing.

As the first trams built in Australia in 12 years, the E Class carries its 'Built in Melbourne for Melbourne' sign with pride as they are currently being built at the Bombardier plant at Dandenong in the eastern suburbs of Melbourne. The trams are 33m long, 100% low-floor, can accommodate up to 210 passengers and are equipped with the MITRAC propulsion system and rotating bogies to handle tight turns and reduce wheel and track wear. These trams are the most comfortable, the safest and have the highest capacity of the Melbourne tram fleet.

Inspired by one of Melbourne's most beloved icons, the unique frontal design and LED lighting reflects the neon crown on the Mr Moon face at the entrance to Luna Park, and the E Class was honoured with a Good Design Award at the 2014 Australian International Design Awards.

Loulou Hammad
Communications & Marketing Lead, Australia
Asia Pacific Division
Transportation
E-mail: loulou.hammad@au.transport.bombardier.com
Tel: +61 3 9794 2111

BOMBARDIER
the evolution of mobility
www.bombardier.com

An eye on the future, while paying tribute to the past

"These are exciting times for the world's longest tramway system: Melbourne."



Every year, around 180m passengers ride the Yarra Trams network, which covers more than 250km (155 miles) of double-track lines and uses over 500 trams. Some 73% of our passengers travel more than once a week and more than half do so four or five times a week. Electric trams have formed the backbone of this vibrant city for over 125 years – more than enough time to have become a vital component of a major centre that these days is home to nearly 4.5m people.

All this places a big responsibility on the operator of the system, but we at Keolis Downer are not simply happy with maintaining the status quo. Working with Public Transport Victoria we are delivering a raft of investment and improvements to a system we have operated since November 2009.

Since then, this collaboration between the world's biggest light rail operator – Keolis – and Australia's oldest railway company Downer EDI Rail has focused on our key mission: to transform Melbourne's tram network into a modern light rail system that delivers a world-class service to all our passengers, all day, every day. In summer 2014 we showed our success when the tramway hit its best performance in over ten years.

Public Transport Victoria has made, and continues to make, significant investment. Since 2010, over AUD300m (EUR205m) has been invested in Melbourne's infrastructure – and more is to come. Then there is the more than AUD800m (EUR550m) Tram Procurement Program, which since 2013 has

ABOVE: The past meets the future as Bombardier E-Class 6005 sits alongside refurbished SW6 class bogie car 925, built in the Preston Workshops and entering service in December 1946.

seen Bombardier Flexity Swift E-Class low-floor trams rolled out, as well as improvements related to operational efficiency, passenger comfort and service reliability. Reconstruction of the historic Preston Workshops into a state-of-the-art support facility for the new vehicles is underway, for completion in mid-2016.

Keolis Downer firmly believes communities should not just be connected and liveable, but inclusive to all; a key area supported by delivery of the new trams is the Premium Line strategy, which will transform the way Melbourne's tram network operates.

The 14km (nine-mile) East Brunswick – St Kilda Beach corridor was selected as the first to receive the new low-floor vehicles as it is one of Melbourne's busiest routes. Route 96 carries 16m passengers per year, and this flagship scheme provides faster and more reliable services and new accessible tram stops. The project is being delivered in partnership with Public Transport Victoria and VicRoads.

However, we are not forgetting the city's fantastic history, and a number of the iconic W-Class trams are being refurbished and modernised so they can continue service on the City Circle route.

The future for the world's longest tramway system is as bright as it has ever been; and we are proud to play a key role in its success.



Clément Michel
CEO, Yarra Trams

SUPPLEMENT EDITOR:

Tony Streeter
COMMERCIAL: Geoff Butler
DESIGN: Debbie Nolan
PRODUCTION: Lanna Blyth
TAUEDITOR: Simon Johnston

With thanks to Clément Michel, Simon Murphy and Melanie Lim from Yarra Trams/Keolis Downer for assistance. Fleet details from www.vicsig.net – an excellent resource on Australia's railways.

COVER IMAGE: Bombardier E-Class 6002 passes the iconic Flinders Street Station in 2014.
INSET: Melbourne's trams 50 years apart; 14.17m SW6 bogie car 983 dating from 1953 working a

City Circle service and the three-section 23m Alstom Citadis C-Class 3025, delivered in 2002 and working a Route 96 service, both at Parliament Station in 2015.
• *Tramways & Urban Transit* © 2015

The system: 130 years in development

Melbourne's tram network is the longest in the world with over 250km (155 miles) of double track and around 1750 tram stops. Keolis Downer operates approximately 34 500 scheduled services each week under the Yarra Trams brand.

The standard-gauge network has 24 tram routes and a free City Circle tram that is popular with tourists and residents alike; there are eight depots, with each operating between three and five routes. This system has lines spreading across the city, with no fewer than nine of them combining to run over a central north-south trunk that covers the major interchanges at Domain Interchange, Flinders Street Station and Melbourne Central, plus Melbourne University.

The city centre streets are laid out on a grid-iron pattern broadly on a north-east/south-west axis and most of the principal thoroughfares in this area are equipped with tram tracks. Swanston Street

carries the most intensive service, with nine routes all serving the city's southern and south-eastern suburbs terminating at Melbourne University (itself a projection northwards from the original Swanston Street terminus at Victoria Street). At peak times, long lines of trams can be seen in both directions along Swanston Street.

With street-running the rule across 80% of the tramway, almost all stopping places are equipped with some measure of passenger protection. In the city centre, where space constraints are most acute, this sometimes leads to cramped waiting areas.

In many congested and constricted suburban areas, islands and refuges cannot easily be provided.

The Box Hill extension features build-outs (capes) to facilitate boarding at stops. The introduction of fleets of low-floor trams in recent years has led to a requirement to provide stops with elevated platforms (known locally as level access stops).



As one of the world's busiest networks, Melbourne's tramway transports millions of passengers to work and in their leisure activities each week (3.7m trips per week, or 500 000 per day, in July 2014). As such the tramway forms a crucial part in the lives of many – 73% of passengers travel more than once a week, and 55% ride four or five times per week. Demand for trams has increased 3.9% when comparing year-ending 2010 patronage to year-ending 2013, equating to an additional seven million trips per year.

Recently, two areas of the inner city experiencing significant growth each received a boost in capacity:

- Route 11, serving the Victoria Harbour precinct, now has capacity for an extra 103 000 passengers/week.
- Route 12 from St Vincent's Plaza to Victoria Gardens has capacity for 90 000 extra passengers/week.

Other developments and changes across the network include:

- Capacity increase of 45 000 extra passengers per week on Collins Street between Spring and Spencer Streets, enabling more efficient travel along a major business and retail corridor.
- Capacity for an extra 2500 people on Route 48, created by introducing an extra high-capacity, low-floor tram in the morning and afternoon peaks.
- Route 11 is a full-time route with 1423 peak and off-peak trips per week between West Preston and Victoria Harbour.
- A new full-time Route 12 has 1382 trips per week between St Kilda and Victoria Gardens.
- Frequency adjustment on Collins Street provides a 1.5-minute frequency in peaks.



ABOVE: Domain Interchange, a key hub of the system, underwent an AUD10.5m (EUR7.2m) redevelopment over two weeks in 2013.

LEFT: Alstom-built C Class 3033 at Box Hill terminus; the 2.2km (1.4-mile) extension, which cost AUD28m (EUR15m) and opened on 2 May 2003, serves the busy Box Hill shopping centre and local hospitals.



ABOVE: The upgraded route 12 increased capacity by over 90 000 passengers per week.



ABOVE: One of Yarra Trams' latest E-Class vehicles on Spencer Street, passing the main regional railway station, Southern Cross, which is under the wavy roof in the background.

History

Melbourne's first cable tramway, the Spencer Street – Richmond line opened on 11 November 1885. The first electric tram began operation on 14 October 1889 between the suburbs of Box Hill and Doncaster. The service was abandoned less than seven years later and it took until October 1906 for another electric service to begin from St Kilda Station (now Stop 132 on Route 96) to Brighton.

Alongside the private operators there were municipal operations, amalgamated in 1919 into the Melbourne & Metropolitan Tramways Board. In 1983 the Metropolitan Transit Authority took over, and became part of the Public Transport Corporation (PTC) in 1989; networks were privatised in 1999.

The Melbourne tramway network was divided in two, and National Express Group won the Swanston Trams franchise. In October 2001, National Express rebranded Swanston Trams as M>Tram (as well as Bayside Trams to M>Train).

The National Express Group withdrew from operations in Victoria in December 2002 and the State Government took over operations. In 2004 the Government reached an agreement with Yarra Trams to operate the tram networks as a single company. Yarra Trams was established in October 1997 when Met Tram was split into two business units in preparation for privatisation of the Public Transport Corporation in August 1999.

After the collapse of M>Train and M>Tram, the State Government expressed interest in creating one metropolitan train operator and one tram operator. On 18 April 2004, Transdev TSL assumed operation of the whole Melbourne tram network, trading under a new Victorian State Government-owned brand, Yarra Trams. After a long tender process, Keolis Downer, a partnership between French-based public transport operator Keolis and Australia's oldest rail company Downer, won the franchise to operate Melbourne's tram network for 15 years. The franchise started on 30 November 2009.

A full history of Melbourne's trams can be found at yarratrams.com.au

Simplifying the network

In consultation with Public Transport Victoria, Keolis Downer implements timetable changes twice per year. A number of overarching principles are followed to improve the service offering to passengers.

International best practice is to deliver strong, long trunk routes through major activity centres, which in Melbourne is the Central Business District and St Kilda Road. Trams operating to lower frequencies in areas with lower patronage merge within the activity centre to provide high frequencies. Ideally, all routes feeding into the same corridor will have the same frequency to give a reliable and even service.

The best example of this in the new timetable is Collins Street. Former Collins Street tram frequencies were:

- Route 112 = four minutes
- Route 109 = five minutes
- Route 48 = six minutes

The new Collins Street frequencies are six minutes for Routes 11, 12, 48 and 109.

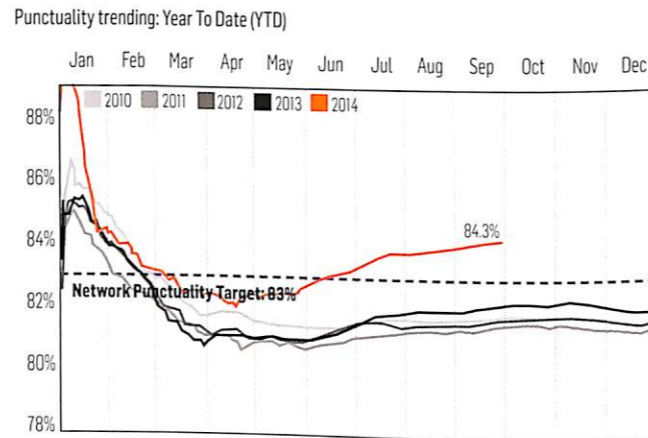
As a whole the July 2014 timetable delivered great benefits to passengers in terms of simplifying the network, creating extra trips and capacity in inner-city areas and more reliable frequencies. The new tram timetable adds 471 trips per week, which means capacity for 34 000 extra passengers per week.

Keolis Downer and PTV want catching a tram and knowing where it is headed to be as simple as possible to improve links between communities. Having a combination of part-time and full-time routes makes it difficult for infrequent passengers, and potential passengers, to understand exactly where trams may be headed.

The recent removal of part-time routes 24, 31, 79 and 95 is offset by adding capacity to the network where it is needed most. Removing low-capacity part-time routes simplifies the network because people know when trams operate and where they go.

Melbourne's tram network achieved a punctuality rate of over 86% in June 2014, its best performance result in over ten years. The trend continued in subsequent months.

The significant improvement in performance can be largely attributed to the introduction of Team Manager, Drivers. Drivers are supported and now receive timely and direct feedback on their performance and are continually coached on ways on how they can improve their results.



ABOVE RIGHT: Graph showing Yarra Trams' rolling performance average including 2014 year-to-date figures compared with previous years' results.

A tricky operation to run

Lisa Hosking, MD Australia, The UIC, looks at how Kestrel has helped Yarra Trams analyse and improve its network.

Software is only as good as its user. This is particularly true of software designed for the reporting, analysis and improvement of operational performance, i.e. punctuality and reliability or, put another way, delays and cancellations. Keolis Downer, as a private sector operator, is closely monitored and contract managed by Public Transport Victoria. So, as well as professional pride in running a slick operation, there are 'commercial consequences' if targets are not met.

The targets are comparable to many heavy rail operations running on dedicated, closed networks. Keolis Downer has to meet targets or Network Service Level Guarantees of 77% punctuality (0.59sec early to 4min 59sec late) and 98% reliability (services run compared with the timetable).

This is in a context of a highly complex network, the vast majority of which is shared with motor vehicles.

So what part does my business play in this?

We are a small part in a number of initiatives. The Universal Improvement Company (the UIC) has amongst its products performance reporting, analysis and improvement software called Kestrel. Kestrel has an eclectic mix of users including the Docklands Light Railway in London, TransLink, the passenger transport division of the Queensland Government, and, of course, Keolis Downer which included Kestrel when bidding for the franchise.

At its simplest, Kestrel imports the timetable, imports what actually happened on the day, and then compares the two. This is somewhat more complicated than it might at first seem. For example, delays can be caused by a massive number of factors: a tram in an urban environment can experience many small delays in a short period of time – cars parking, car drivers turning right in front of the tram, traffic light sequences, passengers loading and unloading, and so on.

Then there is the usual plethora of other delays – rolling stock faults, infrastructure problems such as auto-points and overhead lines. On top of that, Melbourne has an impressive programme of sporting and cultural events that can impact on the service. Kestrel allows analysis of these factors and many others, not only reporting these but also allowing analysis by variables such as day of the week, season, tram class, location, time of day and many more. This is delivered through a series of standard modules – dashboards, reports, enquiries and analytical tools.

As mentioned earlier, software in general – and Kestrel in particular – is only as good as its user, and Keolis Downer is an excellent client to work with. Our main point of contact is Ian Cushion, Manager Network Performance. Ian and his team work closely with my colleagues to identify system requirements that we then build for the organisation. That is where Kestrel differs from many software products. Each version is fully customised for the client – data sources, performance regimes and, essentially, everything else.



ABOVE: tram 2060 working Route 86 along Smith Street in Collingwood.

Taking one simple example, Keolis Downer has recently introduced new positions at each of its depots – Team Manager, Drivers. A key element in thinking around this role is the recognition that drivers on an urban tramway have far more autonomy, and hence a greater impact on performance, than say a driver on a heavy rail network. Therefore the level of performance reporting and analysis needs to be pushed down to a level of detail that allows the Team Manager, Drivers – and indeed the drivers themselves – to see what is impacting on performance, thus identifying improvements. My colleagues have been out at the depots scoping the next set of reporting tools. Keolis Downer managers are busy people, and features in Kestrel need to be intuitive and straightforward to use.

An example of an initiative that has come out of this approach is managing early running. In a variable environment with timetables derived from historical performance, it can be easy to run early on quiet days. By ensuring the data is available to see the who, when and where, the Team Manager, Drivers can work with his or her team to improve results in this fundamentally controllable area. Rolling this up to a network view, Keolis Downer can see improvements from around 8% punctuality lost to early running prior to the introduction of Team Manager, Drivers, and these reports, to around 3% now. This has played a key part in the significant improvement in results, and is only available through the combination of managerial work and data that is transformed into decision-making information through Kestrel.

We at the UIC look forward to continuing our working relationship and playing our small part in ensuring a highly complex operation runs smoothly.

The Universal Improvement Company has consultants based in Australia, the Netherlands and the UK.

For more details visit www.theuic.com
Contact: info@theuic.com



EFFICIENCY!

The comprehensive solution for tramways



MFH 5500 RR
The compact sweeper that keeps grooved rails clean and safe.



UNIMOG RR
The Mercedes reference for maintenance of tramway networks and traction of rolling stock.



CMAR
The French rail-road tailor-maker



COMET
Small and easy to handle. For shunting rolling stock. Electricity powered.

Discover us on:

cmar.fr





CMAR - Z.A. Pont-Rame, 3 rue Denis Papin - 49430 DURTAL (France)
Tél. : +33 (0)2 41 76 31 62 - Fax : +33 (0)2 41 76 32 38 - Email : contact@cmar.fr

Organisation/reorganisation

Organisational change within the past five years has been a crucial component of the record performance now being delivered. The three main pillars are structure, systems and managerial leadership, with the principles of each underpinning the work of every employee.

Changes to structure mean that 'dotted lines' to more than one manager, too many or two few layers of reporting, are a thing of the past. Every employee is clear about who their manager is and their role, while managers are able to add value to their employees and provide the necessary support and leadership.

Systems and processes are being developed to ensure consistent and repeatable application of principles and standards across the whole organisation, fostering an environment of trust and fairness.

An example of the change in managerial leadership can be seen at the eight depots in relation to over 1200 drivers who keep Melburnians moving. The creation of the role Team Manager, Drivers changed the ratio of manager to drivers from 1:140 to 1:40; drivers receive regular feedback and coaching on their driving skills, performance, safety, customer service and wider business updates, while also providing a direct channel to recommend improvements.

The personal interaction between managers and their drivers is regarded as a key contributor to record levels of punctuality, customer satisfaction and significant improvements to employee satisfaction.

Keolis Downer has introduced more than 70 team manager roles during the past three years in order to increase the level of support to its frontline employees.

Thanks to a variety of networks that it runs in 15 countries, Keolis shares its unparalleled expertise and best practice with Keolis Downer directors and key personnel in regular contact with other Group partners to share processes and learning.

Significant effort has been spent defining the scope of network control and how best to use resources to

deliver consistency and improvement. A reorganisation of the Operations Centre structure enables a single co-ordinator to manage the real-time prioritisation, control and cross-organisational response to incidents.

Centralised control and dispatch of response teams has yielded more consistent and better prioritised response to incidents, while rapid escalation and transparent reporting have provided the tools to enable learning and identification of areas for improvement. Major incident escalation and senior management involvement have quickly released and re-allocated resources to better support drivers and controllers in managing vehicle and passenger movements.

A holistic view of network control and incident management has provided the right balance of safe operation and effective transport service provision, as well as a positive customer experience.

The Operations Centre accesses real-time information via the Automatic Vehicle Monitoring application (AVM) and is increasingly using this data to drive internal and external communications. This data is also critical in determining the overall performance of the network during extreme weather patterns so the operator can determine any effects on individual lines and make appropriate decisions when incidents arise.

The restructuring of the Operations Centre has also resulted in more effective feedback on real-time performance and enhanced the ability to respond to variations in the performance of the network.

As a result of this new approach to incident management, the operational teams are better able to control the tram network, minimise disruption and restore normal operations far quicker than in the past.

Yarra Trams now also uses a simulator from Sydac (see page 19) to assist in heightening driver hazard perception and training them to act accordingly. This is particularly appropriate as trams (unlike Metros and EMUs) intermingle with other road users.

BELOW: Changes to the operational structure of the Yarra Trams organisation have seen improved network performance and increased customer satisfaction ratings through greater interaction and visibility of customer-facing staff.



LEFT: The Operations Centre has been reorganised for greater efficiency.



RIGHT: Peter Navascus is just one of Melbourne's 1200 tram drivers.

Advising Gold Coast

The Keolis Downer Gold Coast joint venture brought to the table not only the Keolis Group's vast international experience, but also know-how specific to the Australian market garnered from operations in Melbourne. Keolis Downer's former Director of Operations spent three months on the Gold Coast in an advisory role to provide expert knowledge on best practice and implementation.

The new Gold Coast Light Rail project opened in July 2014 and is operated by Keolis/Downer joint venture KDR, as part of the GoldLinQ partnership. The AUD1bn (EUR700m) project is Queensland's first LRT network and covers 13km (eight miles).

Other key employees from across the business were also temporarily deployed as required to provide valuable insight and advise on operational requirements for a successful light rail system. Experts from global operations were sent to Queensland to ensure that the most relevant solutions were proposed.



Braking and air conditioning specialists



Quality System
Quality Endorsed Company
Reg. No. QEC 13637
AS/NZS ISO 9001:2000

Dressage Engineering Pty Ltd has over 19 years specialising in the repair, maintenance and servicing of public transport vehicles, including tram braking systems and rail cars. Dressage Engineering has grown to become the main servicing company for the Melbourne transport industry. We are suppliers of Bosch Rexroth, Stauff, IFM Efector, Hydac and Ryco.



Dressage Engineering Pty Ltd
32 Goodyear Drive,
Thomastown, Victoria 3074 Australia
Phone: +61(03) 9466 3365
Fax: +61(03) 9465 7423
Email: dressageengineering@netspace.net.au
Website: www.dressageengineering.com.au



The fleet

The more modern operating fleet comprises six principal types, with sub-classes. Oldest is the Z-Class, divided into sub-types Z1, Z2 and Z3, built 1975-84 by Commonwealth Engineering of Dandenong. There were initially 100 Z1 cars (1-100) and 15 of class Z2 (101-115), both of which featured two-door bodywork; the final 130 Z3 cars (116-230), were built to three-door configuration.

Between 1984 and 1987, Commonwealth supplied a further 70 bogie cars of improved design; classified A-Class, the first 28 (A1, 231-58) were delivered with trolley-poles whereas the remainder, A2, arrived with pantographs from the outset. An articulated version of the A-Class was developed in the mid-1980s for use on the former broad-gauge suburban railway lines to St Kilda and Port Melbourne that were to be regauged, converted to light rail and integrated with the city tramway. These two B1 cars were followed by a production series of 130 (2103-2132) that feature air conditioning and are now to be found throughout the system.

From 2001, low-floor cars were imported from Europe, starting with a batch of 36 three-section *Citadis* cars (C-Class 3001-3036) built in France by Alstom. Next came a short (three-section) *Combino* from Siemens in Germany and the 38 cars of this class (D1) became 3501-3538. There were subsequent deliveries of five-section *Combino* cars (class D2). To augment the low-floor fleet five cars came from Mulhouse, France. These *Citadis* cars (C2) are known as *Bumblebees*. The latest Bombardier *Flexity Swift* cars are known as E-Class, with 16 of this type in service as of January 2015.

The W-Class trams introduced in 1923 are an icon of Melbourne and in 2011 the State Government committed AUD8m (EUR5.5m) over four years to restore a limited number as a trial for continuing the type in service. They are being restored to as close to their original appearance as feasible, while meeting modern safety standards and having improved passenger comfort, performance and reliability. The end result is effectively a brand new vehicle.

The refurbished W-Class trams will operate on the City Circle tram route.

Yarra Trams vehicles

Total number of trams in the fleet: 503



W-Class (single section): 38 trams



Z-Class (single section): 147 trams



A-Class (single section): 70 trams



B-Class (double section): 132 trams



C-Class (three sections): 36 trams



C2-Class (five sections): 5 trams



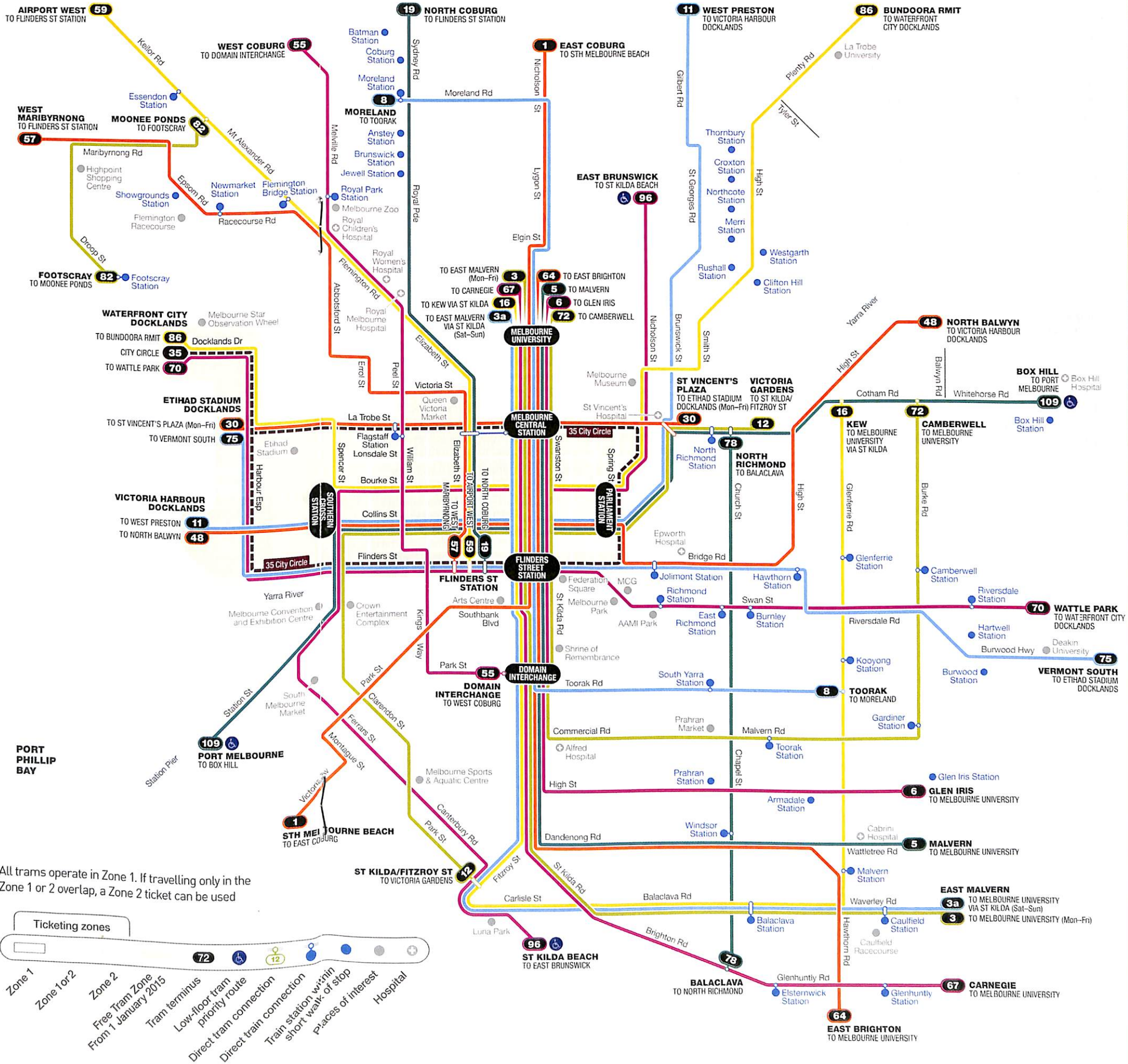
D1-Class (three sections): 38 trams



D2-Class (five sections): 21 trams



E-Class (three sections): 16 as of 01/15



Modernisation and investment

In partnership with Public Transport Victoria (PTV), Keolis Downer is committed to delivering the level of service expected of a world-class asset manager and tram network operator. To achieve this PTV has made, and continues to make, significant investment in infrastructure. Since 2010, more than AUD300m (EUR205m) has been dedicated to modernising and expanding Melbourne's tram infrastructure, with further plans for ongoing investment.

Population growth, densification and a subsequent demand for public transport naturally results in a need for a focus on sustainable transport modes; this has implications not simply from a transport perspective but more broadly from a city design perspective.

As such, Keolis Downer is working closely with PTV on the development of the latter's on-road network plan, which will outline the principles by which Melbourne's tram network will grow over the next 30 years.

New Bombardier E-Class trams have been progressively rolled out since 2013 as part of PTV's Tram Procurement Program, which will deliver more than AUD800m (EUR550m) of rolling stock and infrastructure improvements directly related to improving operational effectiveness, passenger comfort and service reliability. The AUD303m (approx. EUR207m) contract involves 50 new vehicles by 2017, with an option for 100 more. The *Flexity Swift* vehicles are assembled locally at Bombardier's plant in Dandenong, a suburb of Melbourne.

BELOW: Two of the newest low-floor trams, E Class 6003 and 6007 pass on Route 96 at the busy intersection of Bourke Street and Elizabeth Street in central Melbourne.

The E-Class trams each carry 210 passengers when full, and allow for the cascade of other higher-capacity, low-floor trams to other routes on the network where they are needed most.

Route 96

The Tram Procurement Program also incorporates the Premium Line 96 Project, which provides for associated upgrades and new infrastructure to accommodate the E-Class vehicles. Route 96 is the flagship route for developing and delivering the Premium Line vision to Melbourne's tram network, being delivered in partnership with PTV and VicRoads.

Keolis Downer firmly believes communities should not just be connected and liveable, but inclusive to all. A key corporate project is delivery of the Premium Line strategy, which will transform the way Melbourne's tram network operates.

The East Brunswick – St Kilda Beach route was selected as the first route to receive the new low-floor trams as it is one of Melbourne's busiest tram routes, carrying 16 million passengers per year along a 14km (nine-mile) corridor. More than 170 000 jobs are located within walking distance of the route.

As well as the vehicles, the Premium Line 96 Project provides faster and more reliable services and new accessible tram stops. The intention is to maximise the real and perceived benefits from the investment by focusing on initiatives that improve the fundamentals of public transport – safety, reliability and journey time. These fundamentals have the greatest effect



LEFT: Melbourne's waterfront area has seen significant development in recent years; B-Class 2058, dating from 1990 but refurbished by Yarra Trams in 2000 is on a Route 86 service at Waterfront City terminus with the Melbourne Star observation wheel in the background.

BELOW: D1 *Combino* 3519 on Swanston Street shortly after receiving the smart new PTV livery that is gradually being rolled out across much of the Yarra Trams fleet.

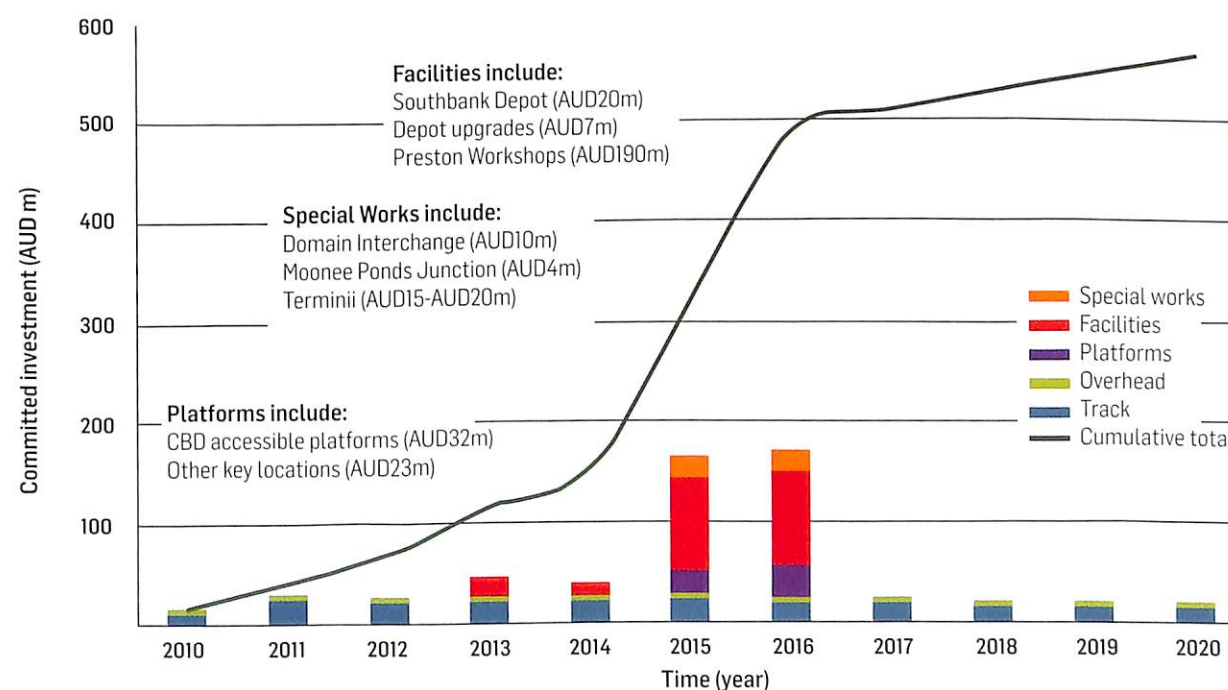
on customer satisfaction, revenue and costs. By concentrating investment funds onto a single route, the benefits are more apparent, more measurable and can provide an example for future development.

With 80% of Melbourne's trams operating in mixed traffic – significantly higher than other cities around the world – it is one of the world's slowest networks. It has been calculated that 17% of tram travel time is spent waiting at traffic signals, meaning an average speed of 16km/h (10mph), but which can drop as low as 11km/h (7mph) in the Central Business District.

Level access stops help to improve efficiency through increasing tram speeds and reliability by reducing conflicts between trams and motor vehicle traffic. They provide a clear demarcation between trams and other vehicles.



Infrastructure Investment Renewal and Rehabilitation, Special Works and Projects



Voestalpine and Melbourne: 20 years of partnership

It's 20 years since the first batch of grooved rails was shipped from Voestalpine Schienen in the Austrian Alps to Melbourne. For the manufacturer, one of the world's leading suppliers of rail for light and urban rail systems, grooved rails are a speciality.

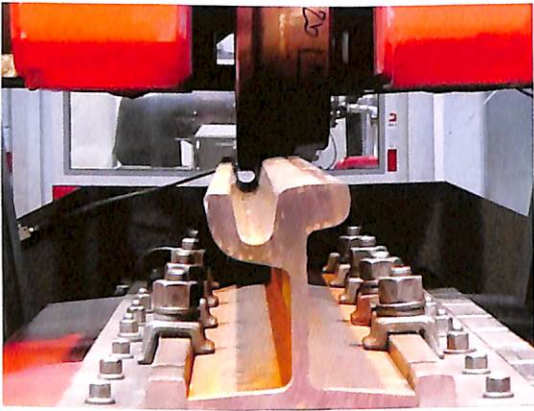
The unique selling point is the distribution of heat-treated grooved rails, which extend the operational life while reducing maintenance costs.

Over time the main profiles in use are Grooved Rails (RIGOR1), PTC41 and Head Hardened Rails (HSH® Head Special Hardened). As they feature a minimum hardness of 290BHN these rails exhibit a long-standing history of excellence. Yarra Trams and Voestalpine Schienen are currently successfully performing track tests to show both short- and long-term economic benefits compared to standard rail grades.

The partnership has not only been based on a continuous and reliable rail supply, but also through development of products and procedures, an example of which was the development of a new Grooved Rail Profile (RI57A). Due to the new Groove Rail Profile the pavement had a tighter and smoother surface which created a safer path for bicycles.

This technical development is an ongoing process and the implementation of further advanced rail steels with improved weld-ability and higher wear resistance for lower lifecycle costs is planned for the year to come. With a guaranteed C-content of maximum 0.5% this advanced rail steel offers ideal metallurgical conditions for deposit welding in track.

The development of this relationship has enabled the exchange of experience relating to tramway construction, operation, maintenance and identifying the importance of these rail systems. Yarra Trams was in full support of Voestalpine Schienen working together with the construction and operation teams in the Gold Coast, Adelaide and Christchurch (New Zealand), where Voestalpine Schienen also delivered rails and technical services.



LEFT: Grooved rails for Melbourne's tramway being rigorously tested at Voestalpine's Austrian facility.



LEFT: Yarra Trams engineering staff are working with Voestalpine on constant development of new products and processes.

Upgrades to Route 96 demonstrate a 'whole of route' approach to modernising the network. By concentrating upgrades along a single route, the project will aim to provide a measurable example of how prioritising the movement of people on trams can improve the capacity, reliability and efficiency of the transport network.

Work has also been taking place to create new power substations to support the redistribution of the larger vehicles, with significant investment to ensure the increased power needs of the network are delivered.

In the coming years, more E-Class trams will be deployed on the network as further power upgrades take place, and the operator and PTV are working closely to prioritise which routes are next to receive new trams and finalise the cascade of other trams across the network.

Renewals savings and effective disruption management

The current approach to renewals has produced significant savings that will be passed on to the State.

Improvements to the asset management plan since taking over the franchise mean Keolis Downer will improve 37% more track than originally planned, and importantly at no extra cost to the taxpayer. This has been achieved through strategic procurement of materials, contract methodologies, use of multiple contractors to create competition in the market, and risk-based approach to renewals.

Keolis Downer works closely with VicRoads to minimise disruption to motorists and provide alternative routes during infrastructure projects. These plans are monitored throughout the duration of the project and changes are implemented as necessary to ensure optimal traffic flow.

A weekly meeting co-ordinated by the operator's Special Events team ensures organisational visibility of every event that may affect tram operations. This includes infrastructure project upgrades, but also third-party events such as sports, street festivals or music concerts.

A stakeholder engagement strategy ensures community members are informed about upcoming projects. This includes residents, businesses, road authorities and local councils. Relationships with councils ensure their input is considered from a community perspective as well as Yarra Trams' operational needs.

Preston upgrade, decentralised maintenance

Construction of a new Preston Depot on the site of the existing Preston Workshops, as part of the E-Class programme, will move forward throughout the year ensuring requisite facilities are provided to maintain, store and operate the next generation of Melbourne's trams.

Development of the historic Preston Workshops site is being undertaken by Victoria-based Coleman Rail in an AUD190m (EUR131.5m) contract due to be complete in 2016. Work includes revamping maintenance facilities, providing a new tram wash, wheel measuring facility and substations, extending buildings and laying 7km (four miles) of track. Careful project management will ensure continued operation alongside this work.



LEFT: Two of Melbourne's busiest tram routes come together on Spencer Street; E-Class 6003 (right) on a southbound route 96 service with Alstom-built C-Class 3017 heading northbound to Box Hill on route 109.

With 12 operating tram types, each individual class has its own maintenance regime, which creates a complex system when managing a multi-class fleet. During 2014 a significant change was moving to a preventative maintenance regime, which replaced the centralised system previously used.

The preventative regime delivers greater effectiveness in relation to tram availability requirements:

- Scheduling maintenance according to availability of facilities and employees (rather than operational requirements).

- Designed to cope with the worst situation (rather than an expected workload) 'under control'.
- The distribution of different tram classes across the network/depots created barriers in providing efficient and timely preventative and corrective maintenance.

The decentralised model was made possible due to a joint AUD12m (EUR8.3m) investment between Keolis Downer and the Victorian Government to upgrade facilities at six depots. Examples of upgrades include:

What do Melbourne, Phoenix and Berlin have in common?
It's very simple: HSH® grooved rails from voestalpine Schienen.

HSH® Performance up – Cost down

voestalpine Schienen GmbH
www.voestalpine.com/schienen

Glad to be working with Yarra Trams for the last **20** years.

voestalpine
ONE STEP AHEAD.



- Deeper maintenance pits to accommodate larger trams.
- Increased spacing between tracks to accommodate larger trams.
- Installation of elevated walkways to allow access to equipment on tram roofs.
- New fall prevention systems, safety fences and gates to improve employee safety.
- Installation of travelling gantry cranes to assist with heavy lifting.
- Reconfigured offices, workshops and storage space to provide a modern working environment.
- Refurbishment of mess rooms, toilets and shower rooms to provide modern employee facilities.

ABOVE LEFT: Victoria Parade and Nicholson Street interchange works underway in October 2014.

ABOVE RIGHT: The completed intersection works took less than a week, with teams working in 24-hour shifts.

The implementation of the decentralised model has also enabled tram depots to specialise in preventative maintenance for the trams they operate. This has produced efficiencies by reducing transportation of trams and increasing productivity by having the right workers in the right place at the right time.

A thorough review of workforce rostering compared with maintenance schedules has also produced a higher level of productivity as more trams are being serviced during off-peak times, which means better availability of rolling stock to meet timetable requirements.

The decentralised maintenance model forms part of Keolis Downer's wider Rolling Stock Management

Plan, which integrates programmes addressing organisational structure and leadership, fleet strategy and maintenance strategies.

The Rolling Stock Management Plan ensures that the Melbourne tram fleet is reliable, safe, clean and available for the delivery of passenger services, while providing value for money to stakeholders.

Keolis Downer has worked closely with PTV on its asset management and fleet strategy that provide best value for money decisions for each asset now and beyond the current franchise agreement.

IT applications and tools track all 503 trams across eight locations, to provide raw data to inform decisions about tram maintenance programmes. This data also enables the operator to identify trends and carry out preventative investigations where necessary, as well as implement sufficient maintenance to ensure that the safety and reliability of the tram fleet is not unduly compromised.

An example is a response to an out of shape wheel: an automated measurement machine detects a tram wheel that may have become out of shape after wearing over time on tracks. Information about the impending repair need is used to alert maintenance crews, who complete the work and can record all details on a mobile tablet. The repair log is compared to previous wheel repair logs and used to schedule preventative maintenance.

Melbourne and Prague: Using the same crossings and turnouts

The Czech Republic may be three times smaller than Victoria, let alone Australia, but its capital Prague has something in common with Victoria's State capital, Melbourne. In both cities, trams run over crossings and turnouts produced by a company founded by Prague's transport authority more than 100 years ago: Pražská strojírna a.s.

Prague's tramway (which opened in 1875, so is of a similar vintage to Melbourne which opened around a decade later), has 950 trams, and now transports 366m passengers over 142km (88 miles) of track, with 900 turnouts. Melbourne, the largest tramway in the world, has some 1250 turnouts on its system.

The years of development and experience, and the background of owning a large tram system, have given Pražská strojírna the power to expand; over the past 20 years the company has become one of the world's leading manufacturers of tramway track components.

Following a trial period of using Prague components in Melbourne, the supplier-customer relationship between Yarra Trams and Pražská strojírna has now grown into a fully co-operative partnership, with both sides offering support in system and technical development.



New substations

Since the 2000s, more than 20 substations across the Yarra Trams network have been upgraded by ABB, a company that has worked with Melbourne's tram operators since the early 1980s.

Upgraded facilities have included traction rectifier substations located at Deepdene, Clifton Hill, Northcote, Holden Street and Preston. ABB delivered a full turnkey scope for this project, which included the design, manufacture, delivery, installation and commissioning of the substations from the Medium Voltage supply to the termination points of the outgoing dc cables.

Beyond the construction of the substations, the upgrades also included removal of asbestos and mercury and upgrading the buildings to current safety standards. In some cases, construction of new buildings was necessary; in order to keep costs to a minimum, certain other buildings were reused.

One of the emerging trends in tramway operation is regenerative braking, and energy management systems provide a solution that stores and recovers the surplus braking energy, feeding it back to the power line to assist in the acceleration of the train.

In addition to substation construction, the firm also assisted Yarra Trams in the replacement of new SCADA Remote Terminal Units (Network Management Technology). The designs gradually introduced the replacement of hard-wired traditional links with state-of-the-art serial communication links.

RIGHT: Z3 168, delivered in 1981 and converted from trolley pole to pantograph in 1995, outside Preston Workshops in 2007.



BELOW RIGHT: Work underway on the AUD190m (EUR131.5m) redevelopment of Preston Workshops in late 2014.



Proud to be involved.



Prague/Melbourne = Pražská/YarraTrams

Both city tram systems have much in common. Founded by the Prague Public Transport Authority (DPP) more than 100 years ago, over the last 20 years Pražská have become one of leading manufacturers of tramway track components in the world. Pražská strojírna has a very strong supplier-customer relationship with Yarra Trams which has seen a continued partnership with both sides supporting the system and technical development. Regardless of the distance between the Czech Republic and Australia, the partnership and communication between Pražská strojírna and Yarra Trams both ensures the contribution for maintenance and development of both tramway systems goes from strength to strength.

www.pstroj.cz
Tel: +420 283 112 230

Pražská strojírna a.s.
Mladoboleslavská 133, 190 17 Praha 9, Czech Republic

Safety and accessibility

Simulator

Safety is the highest priority for Yarra Trams and a simulator is an efficient way to introduce critical safe driving techniques to new drivers before they progress to on-road training. The state-of-the-art full cab simulator virtually represents, in high detail, 25km (15.5 miles) of Melbourne's tram network.

The use of such a high-tech system frees up ten trainers who are now available to drive timetabled services, improving the level of service; it also allows drivers to review and reinforce training techniques learnt in the classroom and experience common scenarios in the safety of a training environment.

The simulator lets trainee drivers practice the subjects they have learnt during classroom activities (for instance defensive driving). Trainees use a full-sized, fully-equipped cabin, the simulator recreating the same conditions they will face on the road. These include railway crossings and reserved tracks, as well as intermingling with other vehicles.

The simulator project began in early 2013 with the full-scale driver's cabin installed at Preston Workshops that October.

Beware the Rhino

As part of Yarra Trams' 'Zero Harm' philosophy, the 'Beware the Rhino' awareness campaign was launched in 2011 to reduce the number of tram-to-pedestrian collisions. The campaign was based upon the premise that a tram is the equivalent of 30 rhinos travelling along the street on skateboards. This successful campaign reduced pedestrian collisions by 27% year on year – and has been recognised by a Most Significant Safety Initiative at the annual Light Rail Awards.

A second campaign in 2013 focused on targeting motorists to stay clear of the yellow lines (safety markers or kerbing) and to always look for trams when making a turn.

In March 2014, raised safety kerbing was installed in Collins Street resulting in a 47% decrease in tram-to-vehicle collisions. Collins Street has traditionally been a hotspot for this type of collision, and Keolis Downer and PTV are now evaluating the use of this kerbing to improve safety on other parts of the network.

Accessible stops

There are now more than 380 accessible tram stops in Melbourne. An improvement programme now in its final stages has standardised the height of these stops across the city to further improve accessibility, overcoming legacy issues resulting from different operators in the 100-plus year history of the network.

Accessible stops now come in several different designs rather than the earlier twin-platform configuration and have been heralded by customers, authorities and operators as a positive innovation delivering customer benefits and operational efficiencies. The stops feature a raised platform to allow easy access, real-time information, high quality shelters, and in many cases, ticket machines.

Further research is required into new tram stop designs to improve accessibility and safety, while maintaining or improving tram performance with minimal implications for other road users.

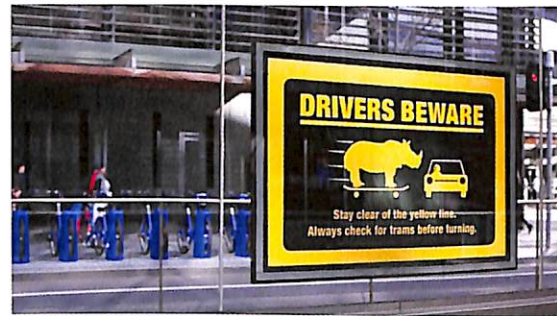
ABOVE

RIGHT: Sydac has supplied an AUD1.7m (EUR1.2m) full cabin simulator to the Preston Workshops.



BELOW

RIGHT: The 'Beware the Rhino' campaign featured print and system-wide ads, online videos and customer liaison.



Keeping passengers informed

Yarra Trams' communication plan includes information through a range of channels, including mainstream and social media, community letters, onboard brochures, posters and announcements and on-system channels such as passenger information screens. It also includes:

1. tramTRACKER®

The free tramTRACKER mobile app provides real-time arrival information. Key features include:

- Displays for the next three real-time arrivals for every route.
- Full text message alerts for disruptions and service updates to assist with journey planning.
- Ability to view upcoming stops and predicted time of arrival.
- Details of nearby connecting services, and points of interest.

2. Automated announcements

In 2013 59 D-class trams were upgraded to provide automated next stop messages, of particular benefit to visually-impaired passengers or those unfamiliar with Melbourne's extensive network.

The detailed announcements provide information including connectivity with other trams, destination and direction, and whether the tram is turning left or right at an intersection. They also

reassure passengers that they are on the right track, allow them to press the stop request button in advance, and assist visitors.

3. Social media

Keolis Downer can communicate passenger information in real-time, providing an additional avenue to open a dialogue with customers.

4. Customer Information team

A dedicated Customer Information team in the Operations Centre can distribute real-time announcements including disruptions, changes to service and special events.

5. Passenger Information Displays at stops

Announcements regarding services, tram times and route information are displayed in real-time.

6. Dedicated front-line staff

Front-line staff includes customer service employees deployed to work at busy stops and liaise face-to-face with customers.

7. Communications material

Communications plans (letters, visits, posters, on-board brochures) are developed to inform passengers, residents and businesses of infrastructure projects.



Road Crossings.



Pedestrian Crossings.



Cut-to-fit.

ROSEHILL CITY RAILWAY & DEPOT RUBBER CROSSING SOLUTIONS

Available in various grades for tram stops, depots, and pedestrian applications.

Solid rubber panels can be cut-to-fit on-site to fit around existing infrastructure.

Single panels can be removed and replaced from anywhere within the crossing area.

Easy to install baseplates connect the panels together.

Visit us at Railtex 2015
Stand K31 · 12 - 14 May 2015
NEC, Birmingham - UK



Nunnery Depot, Sheffield Supertram.

ENGINEERED FOR SIMPLICITY

APPROVED BY NETWORK RAIL

To contact the Australian distributors, or for more information about Rosehill Rail's rubber crossing systems, please call Peter Anderson on +44 (0)1422 317 482, or email info@rosehillrail.com

rosehillrail.com

Sydac Light Rail Simulators

- Full fidelity driver training simulators deployed in three continents.
- Advanced traffic & pedestrian simulation
- Superior construction and replication of light rail driver consoles
- The very latest in computer generated imagery (CGI)
- Enhanced realism via patented Live3D™ Technology
- 2-6 DOF motion base variants
- High fidelity spatial audio simulation

www.sydac.com.au



**Karlsruhe
GERMANY**



**Melbourne
AUSTRALIA**



**Suzhou
CHINA**

