

Directions for On-Street Transit

White Paper

October 2023





Acknowledgement of Country

Transport for NSW acknowledges the traditional custodians of the land on which we work and live.

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal people and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Table of Contents

Introduction	5
What is the On-Street Transit White Paper?	6
On-street transit today and in future	7
What is on-street transit?	
Key challenges	8
Key Moves	16
Key Move 1 Evolve services and infrastructure over time	17
Key Move 2: Grow network demand and capacity	21
Key Move 3: Deliver new permanent, high-quality routes	28
Key Move 4: Grow the city along permanent, high-quality routes	31
Key Move 5: Create enabling funding and partnerships	35
Final thoughts	39



Introduction

Directions for On-Street Transit is a White Paper that articulates the role and potential of on-street transit. It is released to stimulate discussion and debate of key issues and potential solutions and to call for the community to build on the ideas in this paper. This debate will help the NSW Government formulate a new direction for on-street transit.

On-street transit refers to all forms of mass transit using the street network including light rail and buses. It is our second largest mode of transport, accounting for 45% or over 240 million trips annually across NSW.

Everyone is a potential bus passenger: there are over six million people living within 800 metres of a bus stop across the Six Cities today, representing 97.5 per cent of the population. If the system is well-funded and upgraded, more people will find value in using it.

Within the next 20 years, about two thirds of Greater Sydney's population will live in Central River and Western Parkland Cities. Lower Hunter and Greater Newcastle City and Illawarra-Shoalhaven City are expected to grow at double the rate of the Eastern Harbour City. Yet only the Eastern Harbour City has an All-Day Frequent Network. Only 17 per cent of people living in the Western Parkland City live within reach of a rail station.

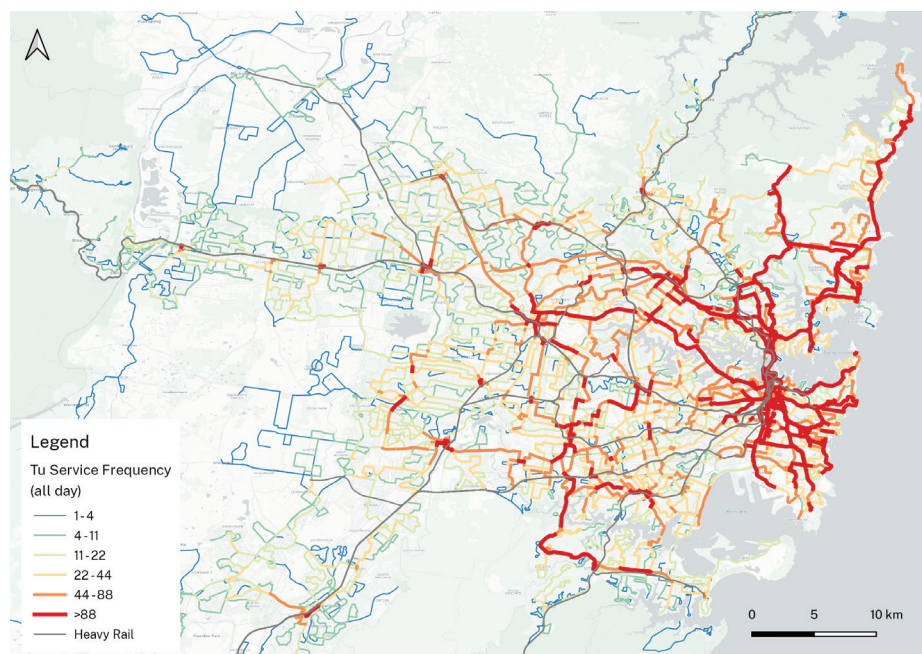
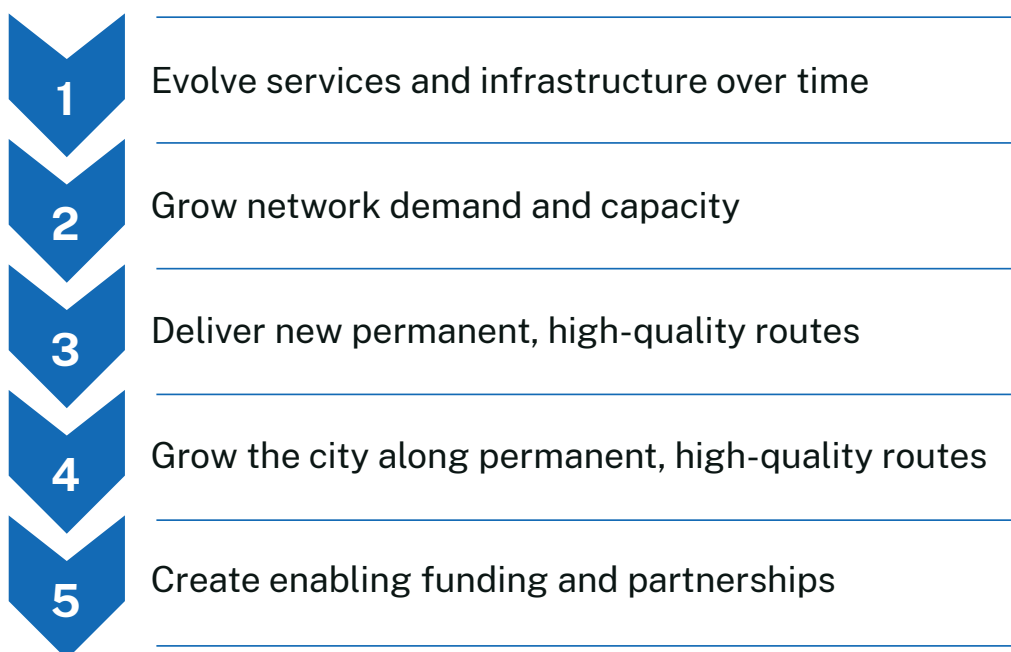


Figure 1: Preponderance of high frequency (red) services in Eastern Harbour City, relative to the Central River and Western Parkland Cities. Source: GTFS, September 2021, using Tuesday service data.

Investment in on-street transit is key to improving social equity and addressing the housing deficit in our growing Cities. However, to do so, steps need to be taken to modernise on-street transit: improve the reliability, frequency and legibility of services, and shield buses from road congestion.

On-street transit is a system. As such, planning should consider all stages of the end-to-end journey, guided by passenger needs. This includes not only planning for on-road infrastructure but also the treatment of bus stops and precincts, and to the information systems used on-and off-board.

There are five key moves that could transform on-street transit:



The case studies in this paper demonstrate that on-street transit provides the small to medium, scalable interventions that allow the network to extend and adapt to growth over time and cost-effectively.

Failing to improve on-street transit carries a cost to people and the economy of NSW. Today, 'lost person time', which is the delay passengers experience due to slow operation of congested buses, already costs Greater Sydney inhabitants \$53 million per year. By 2036, this cost will rise to \$140 million per year, and \$230 million in 2056.

What is the On-Street Transit White Paper?

This paper provides information and insights for the wider community and aims to stimulate discussion to assist the NSW Government formulate a response.

The paper:

- articulates the role and potential of on-street transit
- maps challenges and proposes directions on how to improve on-street transit for our passengers and the community
- provides case studies that illustrate good practices that could be applied further.

On-street transit today and in future

What is on-street transit?

On-street transit refers to all forms of public transport using the street network including:

- light rail
- articulated, bi-articulated and double-decker buses
- standard buses
- midi and minibuses

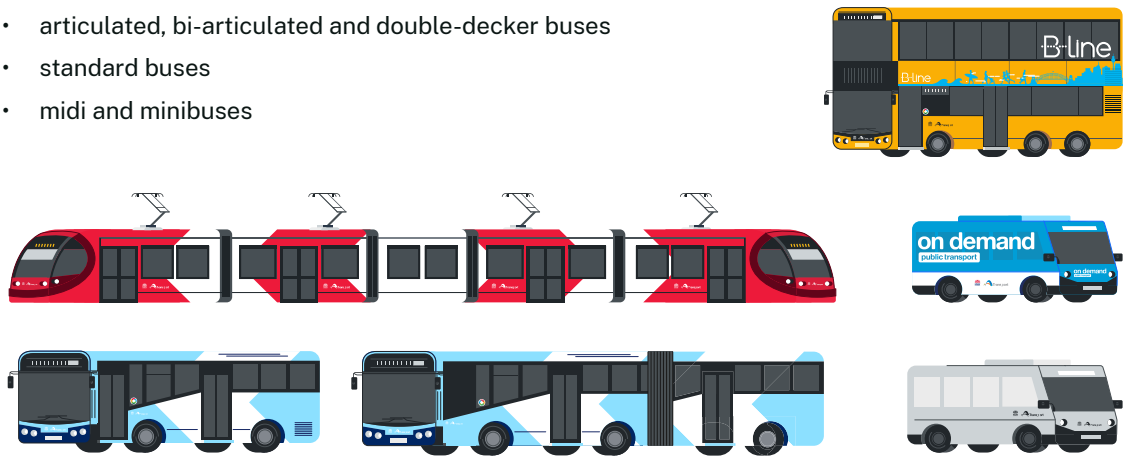


Figure 2: On-street transit in NSW today

Their role in the network is to provide:

- medium capacity, direct services linking major destinations
- cross-city services, providing connection to high-capacity modes
- local services, network reach and coverage for most of the population
- on-demand and night services, for situations of low demand
- school and community services, targeted at specific populations

On-street transit accounts for 45% or over 240 million public transport trips state wide annually (Figure 3) and covers a much greater area than metro or rail. Buses in their simplest form can be deployed faster at a lower cost and offer greater flexibility to respond to the changing travel needs of passengers. They are recovering fast from patronage decline since the Covid pandemic.

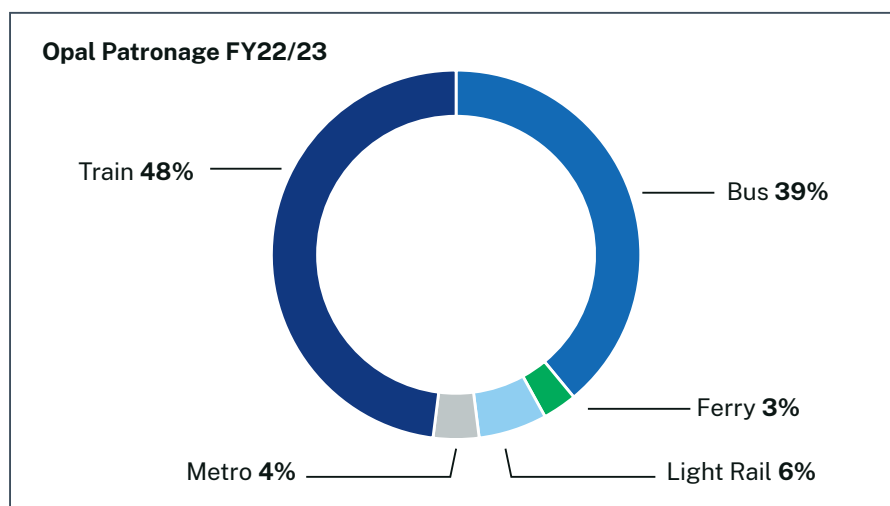


Figure 3: Bus is our second largest mode

Key challenges

Improving social equity

There are differences in bus service coverage and frequency across the Six Cities. This creates barriers in accessing jobs, education and services, which is particularly detrimental to socially and economically disadvantaged communities. During the COVID years, service rationalisation in some areas supported service improvements in growth areas, however this is not sustainable moving forward.

As the Six Cities Region approaches 9 million people by 2056, almost half of its population is expected to be in the Central and Western Parkland cities. In the next decade alone, the population is expected to grow by one million. Growth will concentrate in existing centres such as Ryde, Parramatta, Blacktown, Burwood, Gosford, Wollongong, Maitland and in the Southwest and Northwest growth areas of Sydney. In the long term, the Aerotropolis to Liverpool corridor will accelerate.

Employment growth is closely tied to population growth. The Sydney CBD and the global economic corridor from Sydney Airport to Macquarie Park remains a strong focus of employment within Greater Sydney. Jobs in central and western Sydney (Parramatta, Sydney Olympic Park and Liverpool) will continue to grow with medium to long term growth expected in Aerotropolis and Greater Penrith Eastern Creek corridor.

When compared to the Eastern Harbour City, the other five Cities are less well served, lacking mature all-day networks and cross-regional links. Areas of these Cities already rate the lowest on liveability measures and have the highest concentrations of economic and social disadvantage. If service provision does not improve and keep up with growth, this inequity will become further entrenched.

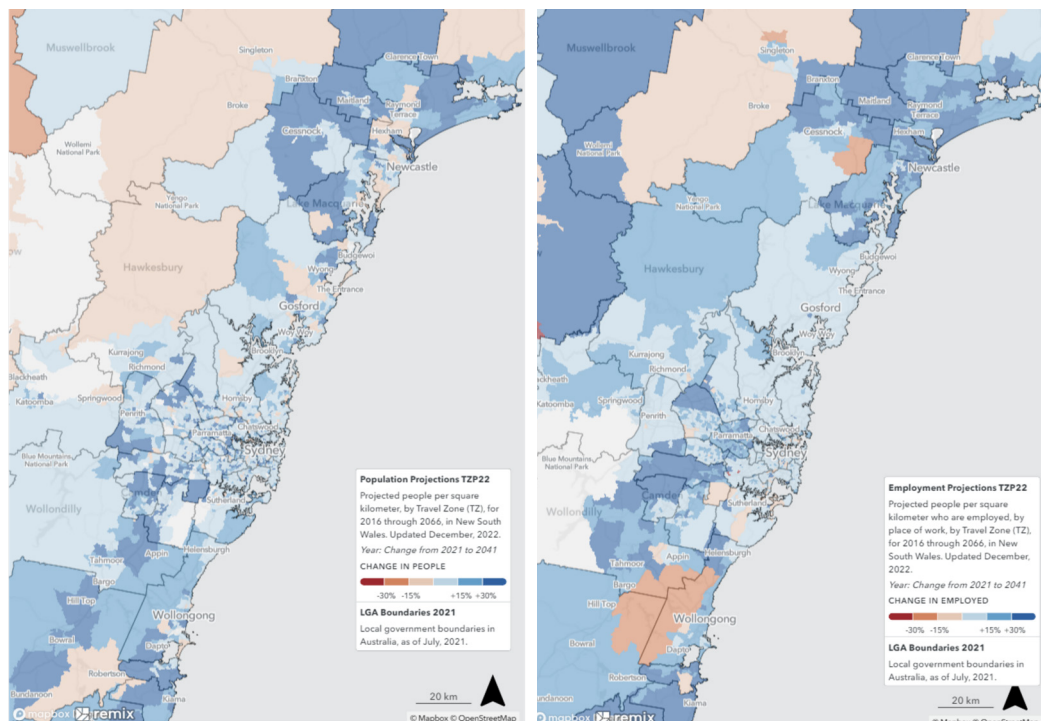
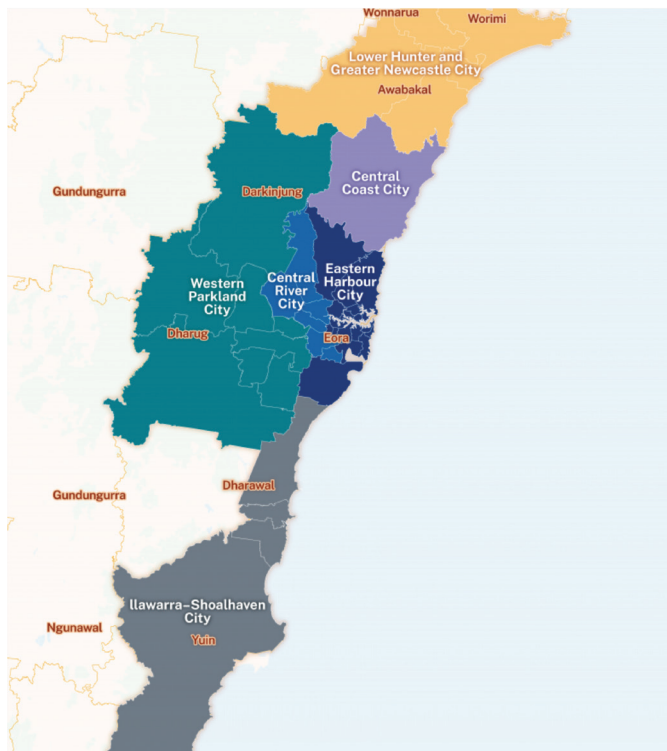


Figure 4: Population and employment density change in the Six Cities 2021 to 2041 (TZP22).

Figure 5: The Six Cities megaregion



The Greater Cities Commission Six Cities Region Discussion Paper introduced the concept of a Region of Six Cities. This concept helps us understand the imbalance in the distribution of growth and benefits across the region, and seeks to align land use, transport and infrastructure to reshape the region into a series of unique, connected and more equal Cities.

Each City has its on-street transit challenges. The Eastern Harbour City has established infrastructure and above average density of services. But traffic congestion erodes travel time and reliability for bus passengers and there is little cross-regional connectivity to places other than Sydney CBD.

The Central River City requires support to maintain its momentum as a growing city and better north-south connectivity so residents can travel more directly within the city.

The Western Parkland City covers a large area and is characterised by dispersed residential development and employment centres. Residents travel long distances and services and infrastructure are sparser. The challenge is to design new communities in a way that enables transit (street lay-out, bus priority lanes and densities), provide services as soon as they are established and scale transport up in line with growth.

The Central Coast City is a topographically challenging area, with a mix of greenfield development and urban consolidation. Most residents have public transport services focused on train connections but some have poor service coverage and frequency and many journeys are slow due to a congested road network.

The Illawarra-Shoalhaven City stretches along the coast, with large greenfield development underway in the West Dapto area. Wollongong has some acceptable bus services but public transport services in general compare poorly with all other Regions.

The Lower Hunter and Greater Newcastle City has large areas of greenfield development in the areas surrounding Maitland and Cessnock. The bus network is fragmented: areas around Newcastle have an acceptable service whilst other areas need new or improved services.

Table 1 Snapshot of current on-street transit in the Six Cities

Eastern Harbour City	Central River City	Western Parkland City
1,440 km2	930 km2	8,000 km2
2.25m people	1.6m people	1.15m people
1.62m jobs	656,000 jobs	412,000 jobs
89% trip containment 32% PT JTW	51% trip containment 25% PT JTW	60% trip containment 4% PT JTW
2 Light Rail	1 Light Rail (in progress)	0 Light Rail
1 Rapid route (B-line)	2 T-way corridors (part)	1 T-way corridor (part)
17 Frequent bus routes	0 Frequent bus routes	0 Frequent bus routes
2 on-demand bus services	1 on-demand bus service	1 on-demand bus service
17 bus depots/2 LRT	15 bus depots	6 bus depots
10 bus contract regions	8 bus contract regions	5 bus contract regions
Central Coast City	Illawarra-Shoalhaven City	Lower Hunter and Greater Newcastle City
1,681 km2	5,656 km2	4,050 km2
347,000 people	422,000 people	611,000 people
134,000 jobs	175,000 jobs	288,000 jobs
80% trip containment 7% PT JTW	80% trip containment 2% PT JTW	84% trip containment 7% PT JTW
0 Light Rail	0 Light Rail	1 Light Rail
0 Rapid route (B-line)	0 Rapid route (B-line)	0 Rapid route (B-line)
0 Frequent bus routes	0 Frequent bus routes	0 Frequent bus routes
0 on-demand bus services	0 on-demand bus service	1 on-demand bus service
4 bus depots	11 bus depots	10 bus depots/1 LRT
3 bus contract regions	9 bus contract regions	5 bus contract regions

The disparity of public transport accessibility within Sydney can be highlighted by the ability to access different modes and levels of service as shown in Figure 6. The all-day frequent network is only available in the Eastern City while in the Central and Western Cities there is a rail network that is focused on the Sydney CBD, and local buses, typically with lower frequency and span of hours. In the Western City, the rail network is sparse and only 17 per cent of that City's population live within reach of a rail station.

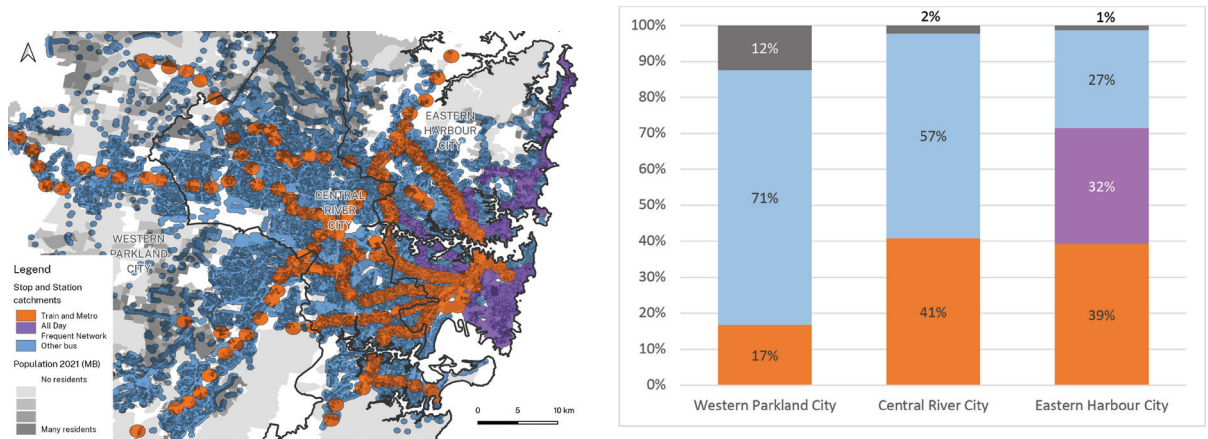


Figure 6: Public transport accessibility (source: GTFS Oct 2022 and Census 2021)

Delivery of Western Sydney Airport Metro and Parramatta Light Rail are a step forward to support Western and Central Cities. However, more is required within the next decade than can be rapidly delivered by capital intensive modes. Better on-street transit is the affordable and cost-effective alternative that can help bring equitable access to a wider cross-section of Cities, ahead of other longer-term options.

Case study: Parramatta Light Rail

Construction is underway on the \$2.875 billion Stage 1 project, which will connect Westmead to Carlingford via the Parramatta CBD with a two-way 12-kilometre track and 16 light rail stops. It is expected to open in 2024 and will support Western Sydney's growth: creating new communities and connecting places, with around 28,000 expected passengers each day by 2026.

Stage 2 will connect Stage 1 and Parramatta's CBD to Sydney Olympic Park via the growing communities of Camellia, Rydalmere, Ermington, Melrose Park and Wentworth Point and bring the vision of a '30-minute city' closer to reality. It will feature a 10-kilometre two-way track and 14 light rail stops.

Planning is underway and delivery will be staged, starting with a new bridge over Parramatta River connecting Wentworth Point and Melrose Park. Bridge construction is expected to start in 2024, subject to planning approval. The 2021-22 NSW Budget committed \$602.4 million (\$26.2 million in 2022-23) towards detailed planning and bridge enabling works.

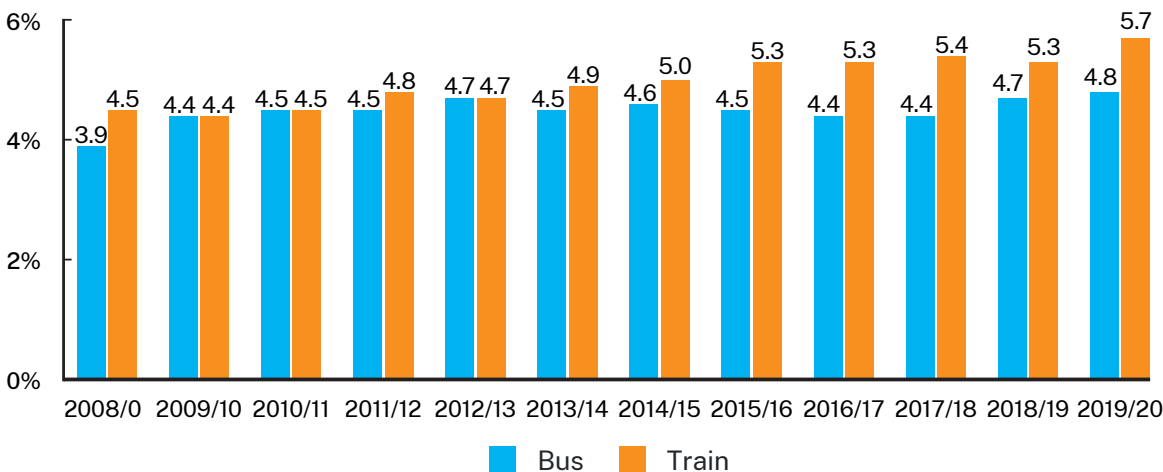


Restore reliability and increase patronage of on-street transit

Passengers expect better service levels and a better experience at stops and on board. Passenger research shows that passengers believe the bus network is complex, confusing, unreliable, indirect, and infrequent. Travel experiences across the network can vary dramatically with respect to timeliness, convenience, information and comfort, leading to its relatively poor attractiveness as a transport option.

People’s travel behaviour backs this up: the mode share of on-street transit has not increased across Greater Sydney in the last decade. Mode share for buses has hovered between 4.4 per cent and 4.8 per cent between 2008 and 2020, while rail has grown from 3.9 per cent to 5.7 per cent following a substantial capital investment in this mode during this period.

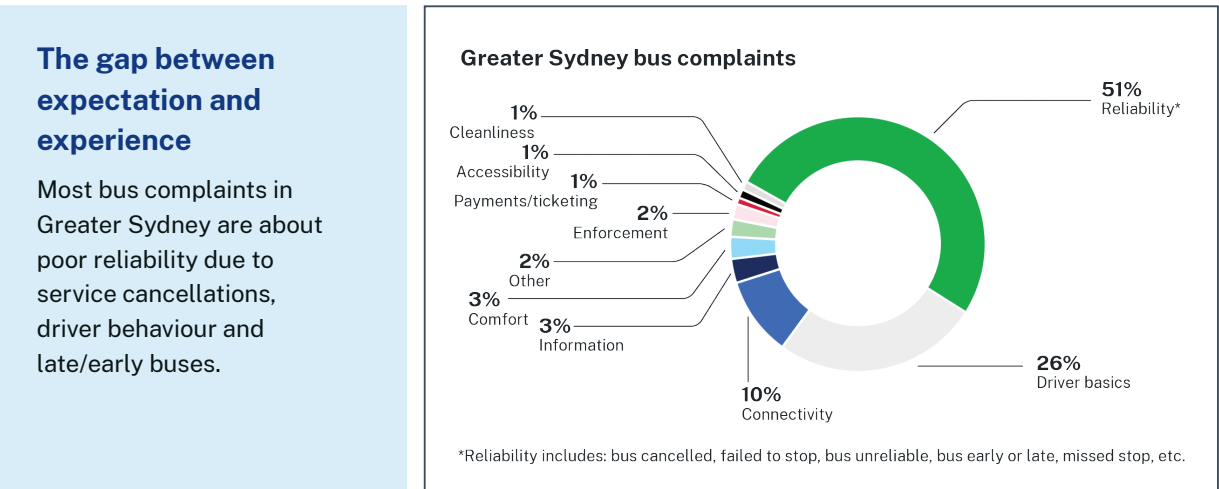
Figure 7: Bus and rail mode share in Greater Sydney, all purposes (Household Travel Survey)



Where there has been investment, such as with the Northern Beaches B-Line, service ridership has increased by 22 per cent, resulting in a 5 per cent mode shift.

There are elements of these solutions – **reliability, frequency, legibility, stop amenity** – that, if applied progressively across the network tailored to product and need, could improve passenger perceptions of on-street transit and attract new ridership.

Figure 8: Bus passenger complaints (Nov 21-Oct 22)



Case study: issues faced by people with a disability using on-street transit

A network that caters for people with a disability is also better and more legible for all.

Pre-planning

- Do I have access to detailed or specific information on the accessibility of the transit stop and first mile/last mile connections?
- Can I access the information in my preferred formats e.g. large print or easy read, high contrast versions in both hard copy and electronic format?

At stop

- Can I get to the stop? Are there safe crossing points for me to get to the stop?
- Is the stop accessible and does it have relevant features such as hardstand, tactile and so on?
- Is it identifiable as the right stop with high-contrast signage and no visual clutter?
- Can I readily identify the next service or find timetable information?
- Am I notified about disruptions or changes to normal running?
- Can I notify operators that I have an accessibility need or that I may need assistance to board the service?
- Do waiting areas and facilities provide safety and comfort?

On-board

- Does the bus meet my needs for accessible boarding and de-embarkation?
- How do I know where I am on my journey and when my stop is approaching?
- Are there facilities on board for me and how do I get priority?
- Do staff and other passengers have disability awareness?
- How do I alert someone if there is a problem or if I need assistance?



Reconfiguring how people travel on our streets

On-street transit shares the use of a finite resource – the road network – with other users: private vehicles, road freight, service vehicles, taxis, bicycles. With growth, this finite resource will need to be used increasingly more efficiently. A dedicated transit lane can carry at least three times more passengers than a mixed traffic lane.

As the Cities grow, a shift from private vehicles to on-street transit enables a greater number of people to travel through a corridor. However, on-street transit will need to be shielded from the deterioration in road performance brought about by congestion.

Currently, only 70 per cent to 75 per cent of services run on time during peak hours when the road is congested. Without bus priority, this will deteriorate in the future with increased congestion. It will create a financial burden on society and satisfaction with services will likely decline, on-street transit will be used less and this in turn will further increase congestion – an unsustainable scenario.

How can we invest effectively in bus priority? An increasing level of differentiation of on-street transit products will help target bus priority where it can be most effective. Rapid and frequent routes need a corresponding greater level of priority and segregation from general traffic. We need to increase the number of rapid and frequent routes across the Six Cities, and support these with priority.

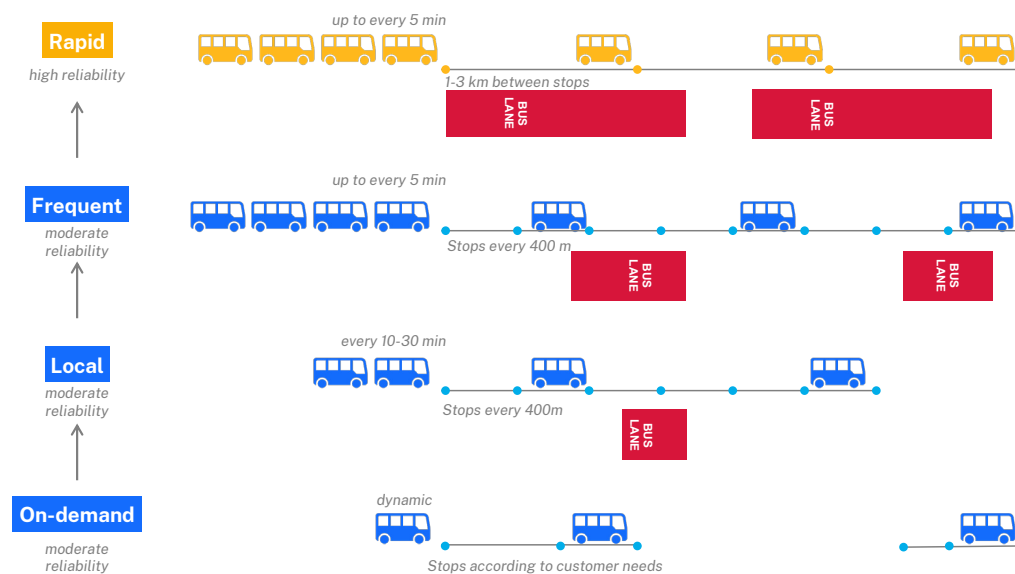


Figure 9: Characteristics of bus service types

Solutions need to scale up in line with changes in land use. In new precincts and outer metropolitan areas, where demand will build over time, the first priorities are equitable coverage and local access to public transport for all passengers as precincts start to develop. Later, and in already established areas, greater demand and more diversified needs will arise. Rapid routes can be planned for progressive delivery and help shape all Six Cities.

Plan for growth on streets designed to enable transit

Across the Six Cities, over 6 million people live within 800 metres of a bus stop, compared to the 1.45 million people who live within 800 metres of a train or metro station. Most people rely on active and on-street transport to reach transport hubs. There is great potential to accommodate growth and transform the urban form along upgraded on-street transit corridors. As greenfield suburbs are established, designing streets, bus stops and footpaths integrated with transit-oriented land use can help realise this potential.

Historically, land use uplift to medium density housing has been slow to materialize along the T-Ways due to insufficient design and lack of engagement with private developers. We can do better moving forward. Upgrading routes to Rapid can not only support connectivity in low density areas but also deliver medium density housing, better amenity, and the creation of strong local centres around rapid bus stops.

Examples in Australia and around the world have shown already that development and activity can be stimulated near on-street transit when investment in well-designed stops, effective wayfinding and technology signals a permanent and high-quality service. Light rail and high-quality buses are converging in design and both can serve this function.

On-street transit can support delivery of much needed medium density housing. It would be a missed opportunity to invest in high-quality routes without redesigning precincts to deliver housing, amenity and economic activity.

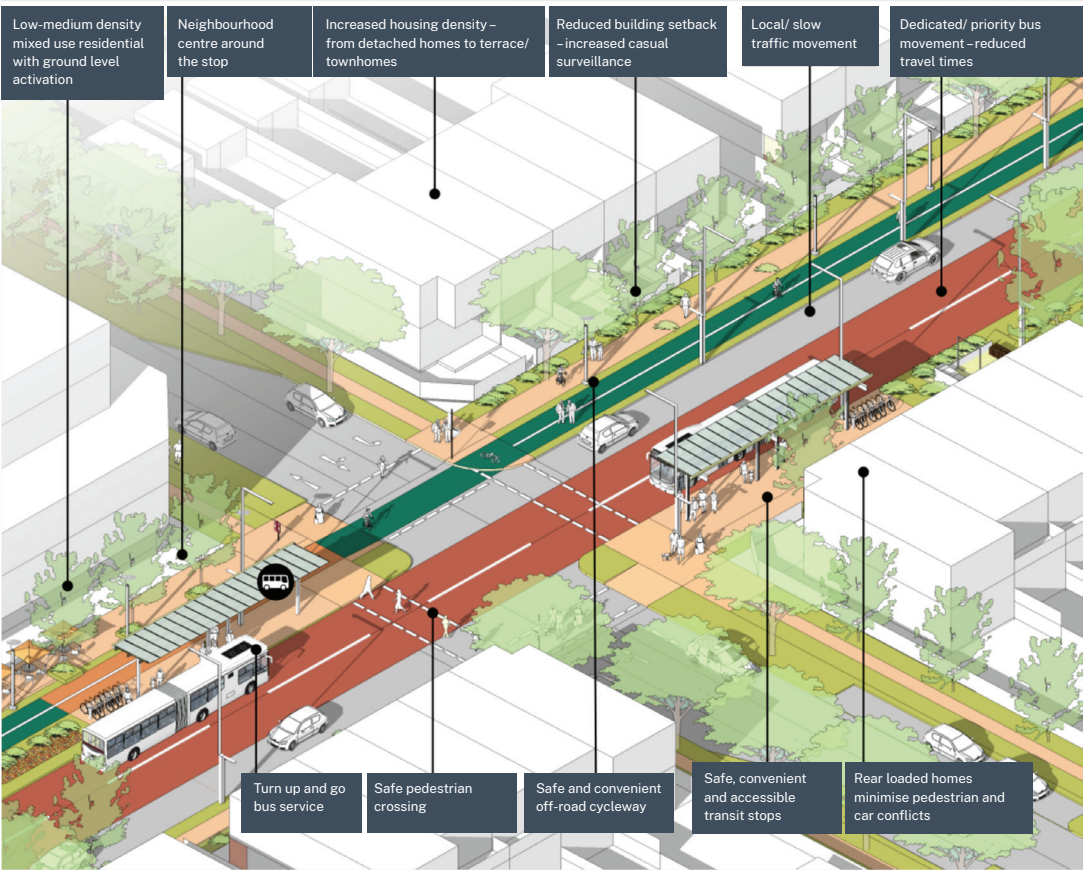


Figure 10: A street designed to integrate transit and urban development

Key Moves

To fulfill the potential of on-street transit and achieve a step-change in equity, reliability and liveability for passengers and people in the Six Cities, a series of moves could be made.

Key Move 1:

Evolve services and infrastructure over time

Improve service quality and quantity, so that on-street transit becomes a mode of choice and attracts more passengers. This will include applying the hierarchy of rapid, frequent, local and on-demand products to services to improve legibility.

Key Move 2:

Grow network demand and capacity

Grow the fleet to provide improved frequencies in the all-day network and sustain services. Increase fleet capacity and resolve network bottlenecks through a combination of improved priority and operations design.

Key Move 3:

Deliver new permanent, high-quality routes

As more people use on-street transit, it is fundamental to invest in infrastructure so that services are shielded from traffic congestion during peak times. The focus is to improve reliability, reduce travel time, improve passenger outcomes and operating efficiency.

Key Move 4:

Grow the city along permanent, high-quality routes

In the medium to long term, the growing population will live within reach of high-performing rapid routes.

Key Move 5:

Create enabling funding and partnerships

The focus here is to maintain sustained investment over time and improve coordination of the workforce, operators and other levels of Government.

Key Move 1

Evolve services and infrastructure over time

1.1 Grow the network to support a growing city

The Six Cities are growing, driven by a significant amount of greenfield development in the Western Parkland City, the Central Coast, Greater Newcastle and the Illawarra-Shoalhaven and residential intensification in the Central and Eastern cities. Funding is required for new or expanded transit services for these new communities. A cost-effective approach to providing essential public transport services to people that need it is to stage investment and scale up infrastructure and services over time.

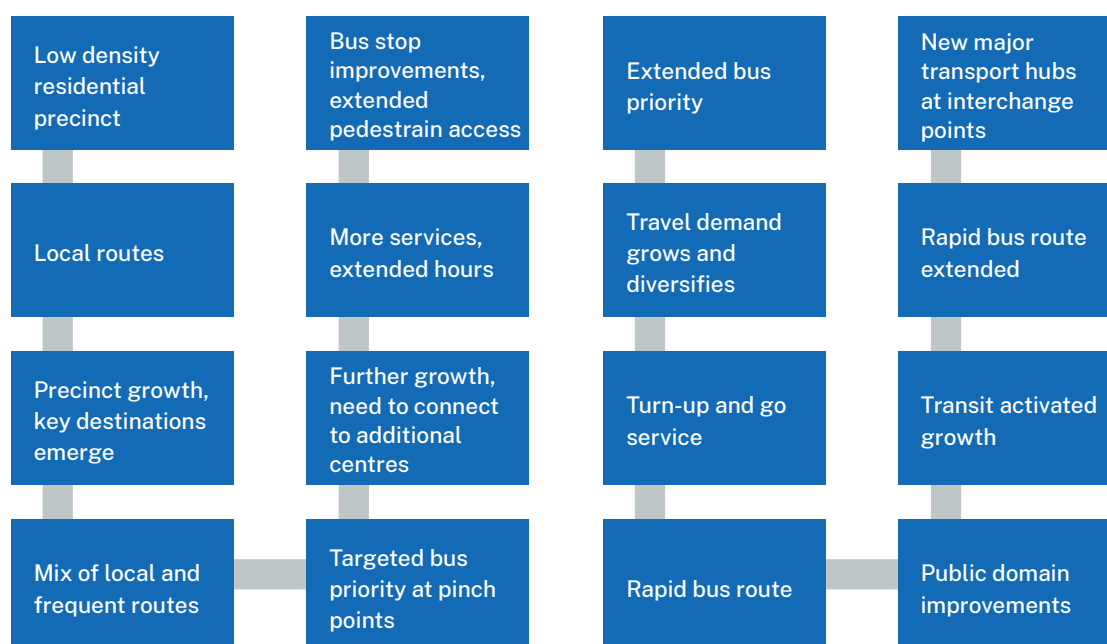


Figure 11: Scaled solutions: transit services evolving with urban development

Providing infrastructure and services ahead of demand is necessary to accommodate future expansion and establish sustainable travel behaviours from the start, but excessive early provision can create unnecessary financial strain. Staging can help split a large commitment into a series of smaller ones, enabling long-term flexibility. Staging allows for optimising solutions to changing project drivers and future-proofs decision making. In short, staging provides the flexibility to deal with the uncertainty ahead.

Bus transport is well placed as part of a staged solution because of its shorter implementation timeline and the possibility to provide initial services with minimal infrastructure. A staged project requires a long-term view. Quick delivery of stages that solve short-term issues should help achieve long term aspirations.

1.2 Improve legibility and progressively redesign the network

On-street transit networks are major assets. There are around 575 regular bus routes operating in Greater Sydney and more than 20,000 bus stops. Poor legibility can make it difficult for passengers and the community to understand such a large system.

The implementation of a clear product hierarchy provides the opportunity to simplify the network so that it is more legible and efficient. A simple, clear and easy to understand network supported by user-friendly maps is more legible. Increased knowledge and awareness of the system among the community attracts passengers.

Network redesign and review

Network reviews occur at least every eight years, such as at service contract renewal, or with the introduction of new rail lines. Network reviews are an opportunity not only to simplify the network, but also to match it to the changing travel patterns and lifestyles of the community and incorporate the value propositions.

Network redesign also provides the opportunity to roll-out the bus product hierarchy. The top tier in the hierarchy is the Rapid Bus (Figure 12), which provides an experience as legible as light-rail or metro: dedicated fleet, distinctive bus stops, passenger information systems, bus priority and turn-up-and-go services.

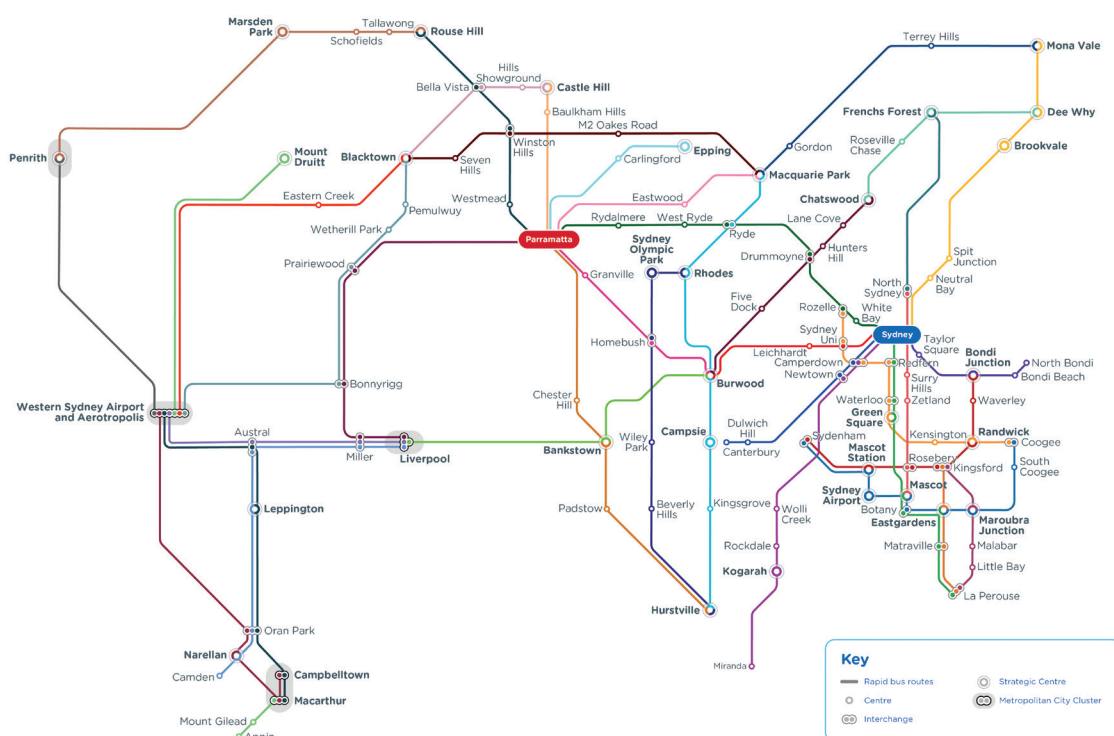


Figure 12: Indicative Greater Sydney rapid bus network

Seamless interchanges in resilient networks

A tiered on-street transit network will only become attractive if interchanging is made easy and seamless. Minimising the walking distance between connections, reducing wait times, and providing great interchange comfort, excellent wayfinding, and real-time information are part of the solutions.

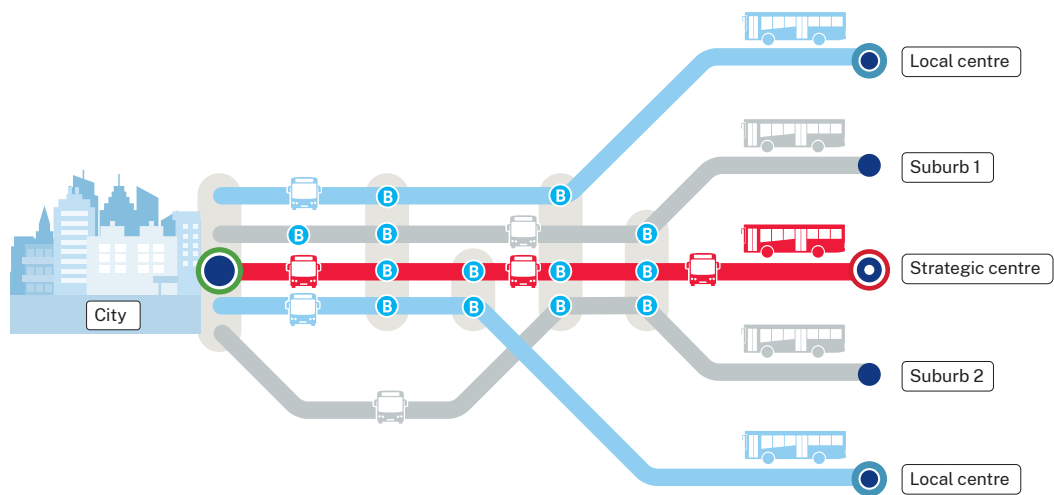
Passenger information

Legibility of the network should also be improved through better information. We will continue upgrading our travel planning channels to help more passengers easily plan and book services on a wider range of transport modes through more personalised and real-time information.

Case study: Network simplification

This is an example of a network of cross-regional routes that provide interchange rather than multiple route variations and duplication of services. Cross-regional routes increase choice for passengers and deliver network resilience. Network simplification was part of the 2020 network review across the Eastern Suburbs following the introduction of the South-East Light-Rail to Randwick and Kingsford. This simplification enabled a new network with 11 frequent bus routes.

Radial, trunk-and-branch structure is prevalent along busy corridors



Trunk-and-feeder or hub-and-spoke structure on a busy corridor

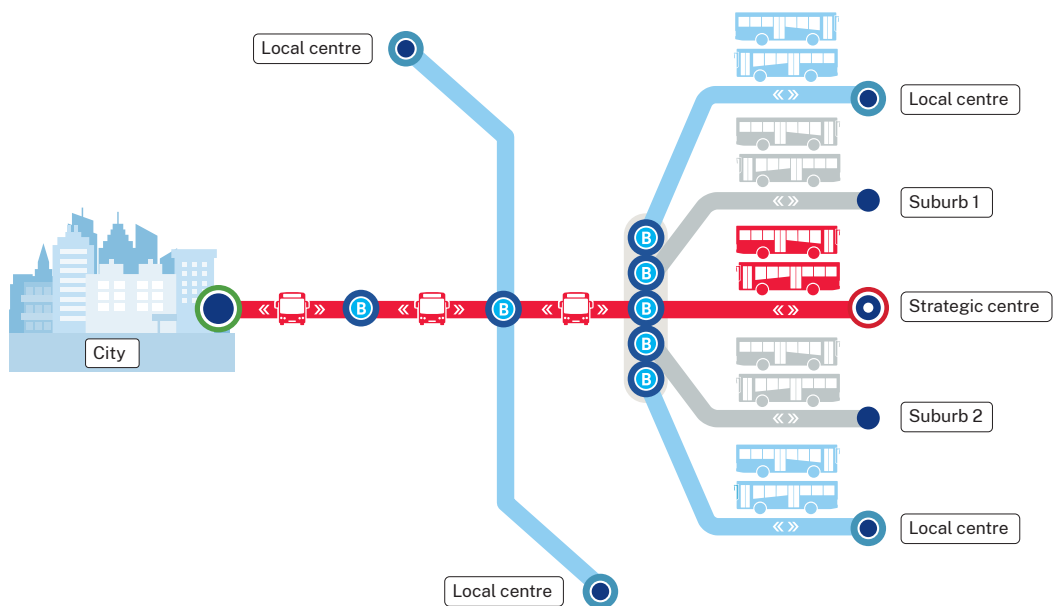


Figure 13: Schematic of current dispersed 'one seat' network versus proposed consolidated trunk and feeder network

1.3 Develop innovative solutions for first and last mile journeys

For most passengers, particularly those living in outer suburban areas, using public transport is unattractive because there is a challenging gap in their first and last mile journey: between their origin/destination and a major transport hub. This gap can be filled with walking, cycling, a local bus service, on-demand services or private vehicle.

First and last mile journeys by walking, cycling and local buses can be particularly challenging in car-based suburbs and business parks because these places were designed and built for private vehicle usage and deprioritise pedestrian permeability. In addition to walking to your nearest transport stop, other solutions expected to play an increased role in the first and last mile include emerging and new technologies.

Transport for NSW has developed on-demand services across Greater Sydney to address first and last mile challenges including Keoride on the Northern Beaches and Cooee Norwest On-demand to connect to Sydney Metro Northwest stations.

There is an opportunity to also include consideration of local buses and on-demand services through service planning and network reviews. This could improve access by passengers living in regional and outer metropolitan areas. Existing examples, such as Flexibus in Bega and Moree On-demand in the State's Northwest region provide essential connectivity to regional centres.

Innovative solutions to first and last mile journeys have the potential to improve the attractiveness of public transport usage and lead to more sustainable travel patterns.

Case study: Keoride

Keoride in the Northern Beaches is a point-to-hub on-demand service designed to connect people to the B-Line at Mona Vale, Warriewood and North Narrabeen.

Additional hubs were introduced to assist with essential travel in response to COVID-19, which included 5 local shopping and medical hubs. The service is using a mixed vehicle fleet and passenger surveys show overall satisfaction at 97 per cent.

This solution works well in a small defined area with lower demand for regular services and roads difficult to service with regular sized buses.





Key Move 2: Grow network demand and capacity

2.1 Deliver bus priority across the Six Cities

On-street transit is the most efficient mode of on-road passenger transport. A dedicated transit lane can carry at least three times more passengers than a mixed traffic lane. As the city's population grows, providing priority access for on-street transit is critical to making the most use of scarce road infrastructure, optimising the network, and stabilising vehicle kilometres travelled.

Bus priority is essential to maintaining bus reliability, which is a major issue identified by passengers. Bus priority will make buses faster, more reliable and more competitive in relation to car, which will increase satisfaction and ridership. Bus priority is also beneficial for more efficient operations results. With quicker end to end cycle times, additional services can be delivered with the same number of buses.

Bus priority can be achieved with road space allocation (bus lanes) and traffic signal priority at intersections, with best results when both are jointly implemented. The Bus Priority Infrastructure Program (BPIP) has successfully implemented a range of small scale bus priority measures in Sydney with other programs delivering bus priority across the Six Cities.

However, more needs to be done to improve on-street transit performance and shift travel behaviours. There are immediate opportunities, for example with signal priority, which is only activated in 10 per cent of intersections across Greater Sydney. Dynamic kerbside management presents opportunities to adjust road space allocation to changing needs, such as by the time of day or in response to real-time needs.

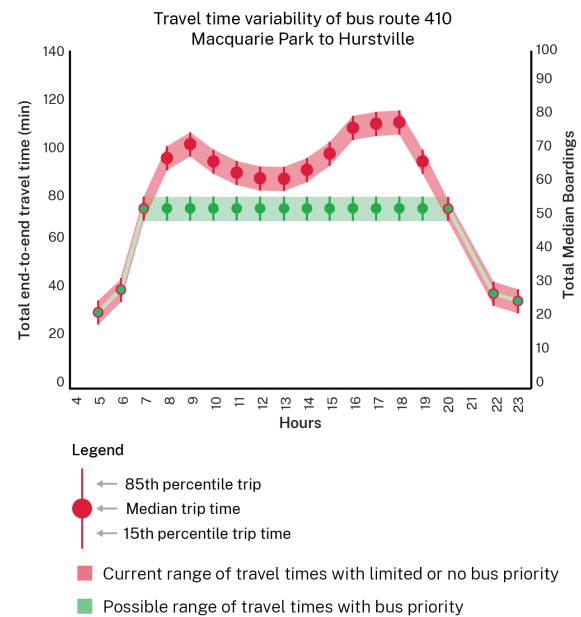
The Movement and Place framework provides guidance on how to allocate road space to different road users and establish modal priorities. Now, more needs to be done in practice. While reallocating road space can be difficult, it can be done with collaboration between all parties interested in the road and kerb side allocation, including active transport and freight users, and with clear criteria and thresholds. Case studies demonstrate that bus priority can benefit all road users.

Case study: Route performance - variability and reliability

Route 410 (approximately 31 km long) shows higher journey times during the AM and PM peaks. Median travel times in the inbound direction towards Hurstville between 6 pm and 7 pm are more than 20 minutes longer than the same trip in the middle of the day.

Within one hour, journey times also vary greatly, with differences of 9 minutes or more over most of the day, and over 15 minutes during the afternoon peak. This means that passengers have uncertainty on how long their journey will take. This results in the need to commence the journey earlier to arrive at their desired time.

Passengers lose about 2.8 million hours every year across the network because of travel time variability.



Source: Bus Opal Assignment Model (BOAM) dataset March 2019, August 2019, November 2019

Figure 14: Travel time variability of bus route 410 (Opal, March / August / November 2019)

Case study: Bus priority on the B-Line

The Northern Beaches B-Line (B1) connects the Eastern Harbour City CBD with the Northern Beaches suburb of Mona Vale. The 27-kilometre rapid bus line runs mostly on dedicated lanes, supported by bus signal priority at selected intersections and headway management.

After implementation, during the weekday morning peak in the inbound direction, end-to-end bus travel times were reduced by approximately 14 per cent, and travel time variability reduced by 20 per cent.

This, along with the high frequency, dedicated branded yellow double decker fleet, and the high-quality stops, provided an attractive solution to passengers, who switched from cars to buses.

Between 2016 and 2019, patronage on the Northern Beaches trunk bus route has increased by 20 per cent, linked to a 5 per cent mode shift from cars. The corridor transports 10 to 13 per cent more people in 2019 compared to 2016, with a positive impact on general traffic speeds.



2.2 Align fleet type with demand and needs

A diversified fleet strategy is required to ensure vehicle types align with demand, and trip characteristics including capacity, seating-standing ratio, easy access, passenger comfort and information. Key considerations:

- Fleet purchases must support NSW's goal of net zero emissions by 2050.
- Buses must be fit for purpose for their role in the network, recognising the service, network and customer outcomes may require different types of buses.
- Higher capacity vehicles (double deckers, articulated, bi-articulated buses and light rail) may be necessary on the trunk network while smaller buses may be better suited in areas of low demand or constrained street environments.
- Increase use of high-capacity vehicles to deliver efficient reorganisation of the network, reduced dwell times and increased capacity of the corridor.
- Undertake route and stops assessments to ensure any impacts from high-capacity vehicles are managed and mitigated.

Table 2 Typical bus types

Type	Role and function
Small buses (12+ seats)	for use on specific services requiring smaller vehicles for access or for low patronage services such as On Demand
Midi 10.5 metre 2 door	use on feeder services (e.g. Lower North Shore, Edgecliff, Inner West) where required by road layout and aligned with low demand
Rigid 12 metre 2 door	use on most bus routes
Rigid 12 metre 3 door	use on short and busy city and inner suburban services (Inner West, Eastern Suburbs and Lower North Shore) with the seating/standing ratio optimised for the services operated
Double Decker	use on busy, longer distance routes (with few stops) with higher seating requirements where standing is less desirable and dwell time is less important
Long Rigid 14.5 metre	use on busy routes where articulated or double decker buses are not suitable
Articulated 18 metre 3 or 4 door	increase capacity on frequent bus routes with short journey times (allowing high standing loads), frequent stops or significant passenger turnover along the route to minimise dwell time
Other higher capacity vehicles such as bi-articulated or light rail	investigated for use when capacity cannot be met using existing fleet types

Case study:

Bi-Articulated Buses – Brisbane Metro

High capacity electric bi-articulated buses have the potential to provide a rail-like customer experience with similar levels of comfort to light and heavy rail, without the need for heavy capital investment into fixed infrastructure.



Several cities around the world are now using bi-articulated buses as a cost-effective option to other modes such as light rail. An Australian example is Brisbane Metro, commencing operations in late 2024, which will see the introduction of 60 bi-articulated vehicles that aim at unlocking the capacity of the Brisbane busway network.

Each 24.5-metre-long Metro vehicle is based on a light rail vehicle design and can comfortably accommodate up to 150 passengers (up to 170 in event configuration), around double the capacity of a standard bus.

As with other electric buses, Metro vehicles are expected to provide a comfortable and quiet journey experience due to substantial reduction in noise, vibration and harshness compared with existing diesel-powered buses. Metro vehicles are battery-powered and can be flash-recharged in under 6 minutes between trips using a pantograph.

While best suited to operation on a dedicated busway network, Metro vehicles can operate on other parts of the road network, unlike other modes that are restricted to fixed infrastructure. When coupled with other investments in high quality stations, passenger information systems, dedicated infrastructure and modal priority, this type of fleet could provide a high quality, high capacity on-street transit solution.

This concept could be a scalable and cost-effective solution across the Six Cities and could readily be implemented using existing bus infrastructure such as the Liverpool-Parramatta T-Way, North-West T-Way, as well as future Rapid bus routes.

Case study: Zero emissions buses and fleet

The NSW Government is transitioning the entire Greater Sydney fleet of 4,000 buses to zero emission technology by 2035.

The program will be delivered in stages to allow local industry time to prepare, and technology advancements to be assessed and adopted along the way. The first stage of transition will introduce 1,200 new electric buses for Greater Sydney by 2028. As part of this first stage, 11 existing bus depots will be upgraded to support the new fleet and a new bus depot will be built in Macquarie Park.

This initial investment of more than \$3 billion will reduce emissions from the public transport network by 78 percent, key to achieving NSW Government targets for 50 percent carbon reduction by 2030 and net-zero emissions by 2050.



2.3 Leverage readily available technology

While not a universal solution, technology can improve all aspects of on-street transit. The bus sector is lagging other modes in terms of technology and digital systems. This affects not only the operational performance of buses but also the experience of passengers and drivers and overall perception of buses.

The key challenges experienced today include:

- **Passenger experience:** the lack of accurate and consistent real-time information (via apps or Passenger Information Displays, available in less than 5 percent of our fleet) is a key pain point for passengers and needs to be addressed urgently. Real-time information is a key element to mitigate unreliability of buses by helping passengers to make informed decisions.
- **Operations:** our Public Transport Information and Priority System (PTIPS) is aging. Renewal provides the opportunity for new telematics and driver's aids that can improve operations, safety and reduce fatigue for the driver.

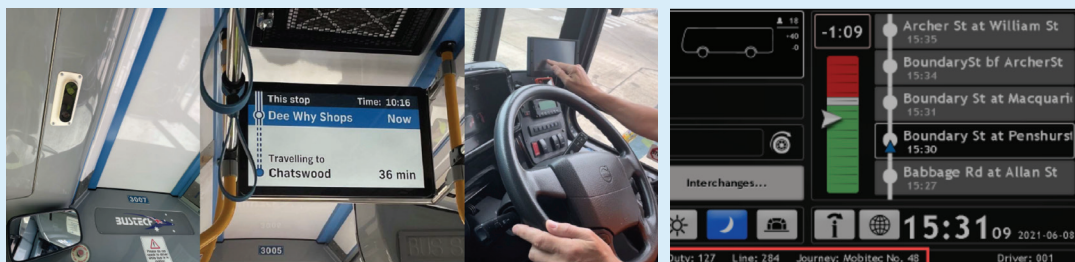
A powerful, scalable and integrated intelligent system to plan, operate and monitor buses will ensure the operation of services are more reliable and efficient and that the passenger experience is enhanced. These should be aligned with other programs including Opal Next Gen, Zero Emission Buses and Real Time Information uplift. Human-centred design should ensure driver comfort is factored into these programs.

Any short-term technological upgrades for buses will also need to be balanced with a view to the long-term approach for connected and automated mobility.

Case study: Transport Connected Buses

Transport Connected Buses deployed in regional areas are examples of a modern system that integrates key capabilities such as scheduling, automated vehicle location and control, navigation aids for drivers, headway or schedule adherence management, signal priority, real-time passenger information, and Opal.

In Sydney, only specific routes, such as the B-line, include additional capabilities, such as headway management. There is a trial underway on route 160X testing real-time information and telematics, which could be expanded if successful.



With the need to replace PTIPS, there is an opportunity to consider the wider technological needs for a fully integrated system across Greater Sydney. This could be retrofitted into existing diesel buses, and procurement of ZEB should also be future-proofed.

Example: Leveraging of technology on routes - Transit Signal Priority

What is the issue?	Realizing the full potential of our network using transit signal priority (TSP) to improve reliability and travel time.
Why is this important?	TSP has shown positive benefits for passengers, operators and the environment – without additional capital investment.
Examples	<p>TSP has been implemented and tested in various hardware and software systems within several corridors in Greater Sydney, demonstrating significant travel time savings.</p> <p>CBD and Southeast Light Rail (CSELR): since the implementation of TSP for CSELR, the travel time has been significantly reduced. When the line opened in December 2019, the journey time was 55 minutes. However, with the activation of TSP, the current travel time has been reduced to 32 minutes. Figure 15 shows improvement in end-to-end journey times of approximately 10 minutes across 58 intersections.</p>
Principles	TSP activation is particularly effective for corridors with relatively long signal cycles or long distances between signals.
Where else could be applied?	At the time of writing, only limited intersections across Greater Sydney are enabled for providing priority. However, the infrastructure required to enable priority through SCATS for most intersections in Greater Sydney is already available and can be utilised to rollout transit signal priority easily and at a low cost.

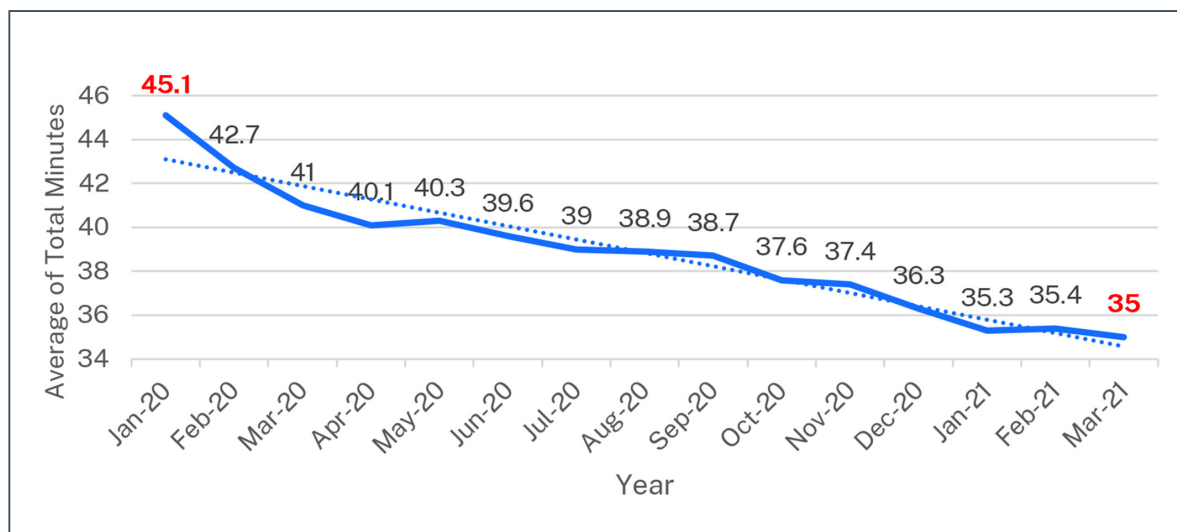


Figure 15: Average travel time by month from Randwick to Circular Quay between Jan 2020 to May 2021

2.4 Increase awareness and change perceptions

While overall satisfaction for bus passengers is good (93 per cent) and on par with other public transport modes, buses are poorly perceived by the community. Buses are the most negatively perceived public transport mode, compared to trains, light rail and metro, and are seen as slow, unreliable and confusing.

The lack of a clear value proposition limits both the potential patronage of the network and its broader community appeal. People derive their understanding of bus value largely based on what they can see in their local area, current or previous experiences, media coverage, or anecdotes from friends and family.

There is an opportunity to create a voice that actively communicates the value and role of bus travel, to increase the social licence of buses in Greater Sydney. Ultimately, Rapid bus stops could become a local community focus point, like rail stations.

The role of communication and marketing

Transport for NSW has the potential to raise the profile and communicate the value and potential of buses. For both non-users and users, the value they ascribe to the bus network can be enhanced through two methods:

- Develop consistent branding and passenger experiences for key passenger touchpoints, such as on-street transit fleet and stops, to impact passenger perception of value.
- Launch marketing and communications campaigns to raise awareness and perception of the bus network and to accompany changes.

Transport for NSW has done successful branding and marketing campaigns in the past, raising awareness on new products, communicating changes in the network and promoting travel behaviour changes.

Case study: B-Line roll-out and marketing campaigns

When B-Line was launched in the Northern Beaches with its distinctive yellow livery and bus stops, extensive marketing and advertising campaigns were launched in support of the new service.

These campaigns, communicating the improved infrastructure, services and technology implemented on the route, have contributed to a very strong outcome in terms of behaviour change. An assessment of passenger throughput pre (2016) and post (2019) B-Line at specific screen line locations along the route indicated that an average mode shift of approximately 5 per cent to bus from private vehicle was achieved.



Key Move 3: Deliver new permanent, high-quality routes

There are 39 Rapid Bus routes identified through strategic planning in Greater Sydney, and work is underway to design routes for all Six Cities. Rapid Buses are a top tier bus product aimed at increasing regional connectivity. They are similar to light rail, with turn-up-and-go services, and quality stops that are distinctive, legible and well integrated with the urban environment. They enable growth around transit stops.

The proposed Rapid network is designed to complement and integrate with planned and already established rail and metro lines. The network effect is critical to helping passengers get to their destinations quickly. Upgrading the existing T-Ways connecting Liverpool and North-West Sydney to Parramatta and connecting these to new links are quick wins that can demonstrate the benefits of a connected rapid bus network.

For discussion

Of the 39 Rapid Bus routes, shown on figure 12, which ones should be prioritised for delivery? What criteria should be applied to prioritise these routes?

Considering the need to balance services across the three cities, potential to support population growth, the need to provide new connections to underserved areas and the potential to transition to rapid soon, potential initial priorities could include:

- Western Sydney City Deal Rapid Buses
- Sydney to Parramatta (Parramatta Road and Victoria Road)
- Liverpool to Burwood via Bankstown
- Campbelltown to Liverpool
- St Marys to Rouse Hill
- Upgrade T-Ways to new standard

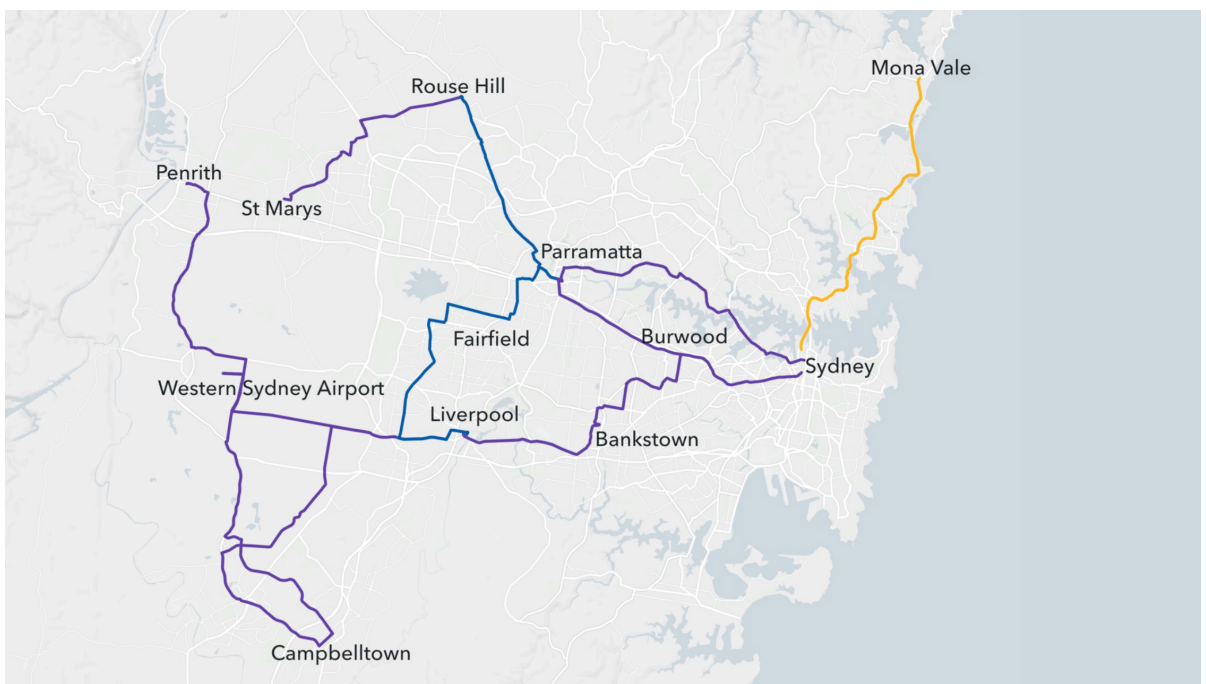


Figure 16: Potential tranche of Rapid Bus Routes for investigation (shown here connected to existing T-Ways (in blue) and the B-Line (in yellow))

Case study: Western Sydney Rapid Bus Project

The Western Sydney Rapid Bus Project will establish the foundation bus network for the Aerotropolis. The project will introduce new and improved bus routes and services in stages to provide services in time for the opening of the airport in 2026, which together with the Sydney Metro Western Sydney Airport and Sydney Trains services, will form the key elements of the integrated public transport network for Western Sydney.

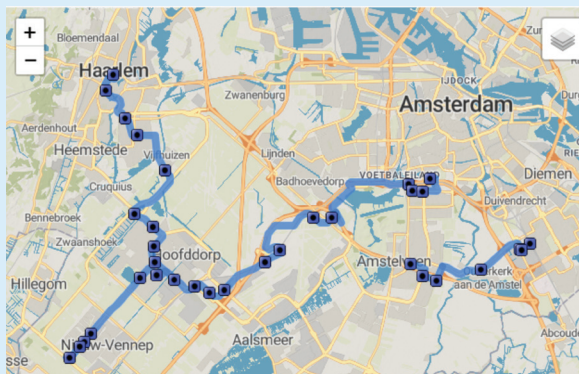
The new bus routes will connect the activity centres of Penrith, Liverpool and Campbelltown with the Western Sydney Airport and Bradfield City Centre. New bus routes and services will be introduced in stages to match demand as activity at Western Sydney Airport increases and Bradfield City Centre grows. Rapid bus services will operate on key corridors and bus lanes will provide reliable journey times.

Features of the new bus services will include accessible access and shelters with seating and customer information to provide a high level of passenger amenity.



Case study: R-Net – Amsterdam to Haarlem via Schiphol Airport

R-Net (formerly Zuidtangent) located in the Randstad region of The Netherlands began operating in 2002. The R-Net BRT connects several destinations including a series of cities and towns, major employment centres and the Schiphol Airport. The R-Net sought to relieve congestion on the road network, improve the quality of public transport and fill the gap between regular buses and light rail. R-Net is today characterised by high frequency, comfort and reliability. The system also connects at several stations with other modes of transport such as existing rail networks. Park-and-ride facilities are also available for bicycles and private vehicles.



(photo: Karl Fjellstrom, fareast.mobi)

Example: Victoria Road – how can we upgrade existing corridors over time?

What is the issue?	Scarce road space and competitive funding priorities makes it difficult to deliver rapid bus routes.
Why is this important?	Rapid bus routes are crucial to increase the capacity of our existing road network, to improve the quality of our bus network and to attract more people to public transport. If nothing is done as the City continues to grow, congestion will worsen which will make road space reallocation and rapid bus delivery even more crucial in the future.
Examples	Victoria Road rapid bus route could be staged responding to specific triggers and opportunities in terms of existing demand, bus performance and urban renewal.
Principles that can be derived	<ul style="list-style-type: none"> • Staging considerations could include existing demand and expected benefits from travel time improvements, future growth and changes in land use. • Rapid bus projects and their staging should use a place-based approach that considers the whole street from property line to property line. • Rapid Bus and land use uplift opportunities should be considered conjointly to maximise investment.
Where else could be applied?	Across strategic corridors in the Six Cities, in areas with established bus demand and/or potential for growth.





			
Mix - several routes	Frequent w/limited stops - frequency and capacity	Rapid - premium service to Sydney CBD	Rapid - premium service extended to Parramatta CBD
Stage 1 Improved Services Triggers <ul style="list-style-type: none"> • West Connex opening • Growing demand • Urban development Actions <ul style="list-style-type: none"> • Bus priority upgrades to improve reliability • More services across more of the day • Bus stop accessibility and wayfinding upgrades Benefits <ul style="list-style-type: none"> • Faster, more reliable trips • More morning, evening, late night and weekend services • Accessible, comfortable and safer bus stops • Better customer information 	Stage 2 Frequent Bus Parramatta to Sydney CBD Triggers <ul style="list-style-type: none"> • West Ryde upgrade • Western Harbour Tunnel • High density development Actions <ul style="list-style-type: none"> • More services including new limited stop services • Bus priority upgrades from West Ryde to the City • Integration with active transport networks and places Benefits <ul style="list-style-type: none"> • Faster, more frequent and more reliable trips • 'Turn up and go' services • Increased corridor capacity • Supports urban renewal and better place-making 	Stage 3 Rapid Bus West Ryde to Sydney CBD Triggers <ul style="list-style-type: none"> • Sydney Metro West opening • High density development • Urban renewal opportunities Actions <ul style="list-style-type: none"> • Rapid Bus services from West Ryde to the City • Integrated active transport network along entire corridor • Incremental bus priority upgrades from West Ryde to Parramatta Benefits <ul style="list-style-type: none"> • Faster, more frequent and more reliable trips • Premium high quality customer experience • Better place-making • Supports high quality urban renewal and place-making 	Stage 4 Rapid Bus West Ryde to Parramatta Triggers <ul style="list-style-type: none"> • Growth of greater Parramatta as metropolitan centre • High density development • Urban renewal opportunities Actions <ul style="list-style-type: none"> • Extension of Rapid Bus services from West Ryde to Parramatta Benefits <ul style="list-style-type: none"> • Faster, more frequent and more reliable trips. • Premium high quality customer experience • Supports Greater Parramatta's growth as Sydney's second CBD • Supports high quality urban renewal and place-making around Greater Parramatta

Figure 17: Four stages in the evolution of the Victoria Road corridor

Key Move 4: Grow the city along permanent, high-quality routes

4.1 Integrate land use and transport

Investment in on-street transit should take the opportunity to integrate land use change along a new or improved transit corridor. While mass transit generally supports high-density residential development and local bus services support low-density housing, on-street transit along strategic corridors can support medium-density housing.

There is a “missing middle” or a lack of medium-density housing across much of the Six Cities, with 69 per cent of housing consisting of separate houses, 14 per cent being considered high density, and 17 per cent being medium density.

Outside of Eastern Harbour City and Central River City the lack diversity in housing is even starker, with 79 per cent of housing stock consisting of separate houses, compared to only 16 per cent medium and 5 per cent high density.

This lack of housing diversity does not meet the wide range of housing needs of Sydney's population of today and tomorrow. More generally, Sydney has a shortage of housing, and affordable housing specifically. This lack of housing diversity is also seen in outer Metropolitan areas which are rapidly growing in population.



Figure 18: While Government Architect NSW has defined the missing middle as everything from semi-detached housing to manor houses, some believe the minimum threshold should be at multi-dwelling houses (Source: Government Architect NSW)

The missing middle needs to be filled, as it can help reduce the shortage of affordable housing, enable growth, and accommodate a wider range of housing demands. Potential reasons for the missing middle include land use zoning restrictions, a historical but changing preference for detached housing and financial viability.

Transit Activated Corridors (TAC) are considered the medium-density alternative to Transit Oriented Development (TOD). TACs could present a viable integrated planning framework. Bus and light rail are adequate transport solutions as part of TAC, since their medium capacity is well aligned to the demands of medium density housing while having reduced impacts compared to rail.

Challenges for bus driven TAC are a lack of capabilities and track record of industry and government to deliver TAC-suitable housing. The major challenge of noise and pollution of buses compared to rail will be mitigated by the introduction of zero-emission buses.

Example: T80 Liverpool to Parramatta – Potential future Transit Activated Corridor?

What is the issue?	Land use uplift to medium density housing has not occurred along the T-Ways due to poorly connected bus stops and lack of engagement with private developers.
Why is this important?	<ul style="list-style-type: none"> Upgrading routes to Rapid can not only support connectivity in low density areas but also deliver medium density housing and the creation of strong local centres around rapid bus stops. Rapid bus routes are a significant investment in high-quality public transport. Without rezoning of surrounding areas, the potential of the transit solution is underutilised.
Examples	In the case of T80 Liverpool-Parramatta, government owned land around the existing rapid bus stops could provide an increased supply of social housing, while supporting the development of a transit activated corridor along the T-Way.
Principles that can be derived	<ul style="list-style-type: none"> Rapid bus infrastructure projects have the potential to influence land use uplift under the right conditions. The right conditions include well thought stop placements that are well integrated with surrounding land use, including good walking and cycling connections. Stimulate developer interest by redeveloping Government owned land along rapid bus routes, such as old social housing, and include key services at interchanges. Good land use integration requires developing a precinct scale approach when designing new rapid bus routes, and the embedding of urban planning and design at the forefront of early network planning.
Where else could be applied?	<ul style="list-style-type: none"> Along existing and future rapid bus routes. A precinct scale analysis could identify opportunities for urban transformation along corridors, identifying areas that can attract investment in medium density housing.



Figure 19: Artist's impressions of social housing planned near Memorial Avenue T-Way Stop (left) and an example of a transit activated corridor (right)
(Source: <https://sbenrc.com.au/research-programs/1-74/>)

4.2 Create quality stops, interchanges and precincts

There are over 60,000 active bus stops across NSW with almost 40,000 of these located within the Six Cities region. The B-pole program has been rolled out to 18,000 stops, which has created a more consistent way of identifying bus stops and providing passenger information, however there are many other elements to consider:

- Stops can feel uncomfortable, with no seat or shelter, and sometimes dangerous due to overcrowding, lack of passive surveillance and poor lighting.
- Many bus stops are not compliant with the Disability Discrimination Act (DDA).
- Stops also often lack adequate pedestrian accessibility (footpaths and crossing facilities) and have poor integration with surrounding land uses. (Figure 25).

Stops of low amenity project a perception of impermanence of services.



Figure 20: Examples of poorly designed rapid bus stop (left image) and a well-designed bus stop (right)

Many of the issues associated with poor quality stops can be overcome by good planning. The Northern Beaches B-Line engaged with the community, local Councils and urban design professionals on placement of the stops. The key principle driving their placement was leveraging existing amenity and accessibility, allowing for easy integration with the surrounding neighbourhood.

Good stop placement can also contribute to the 15-minute neighbourhood, stimulating activity in existing or new centres, surrounded by essential services that are supported by an active transport network.

Investment in new on-street transit should be guided by clear planning and design guidelines that provide:

- a typology of stops and interchanges, supported by design principles to ensure that amenity, quality and accessibility is considered in project planning
- passenger information and wayfinding requirements for each typology
- technology at the stops (such as Passenger Information Displays, e-ink B-poles)
- integration with surroundings, including smart places.

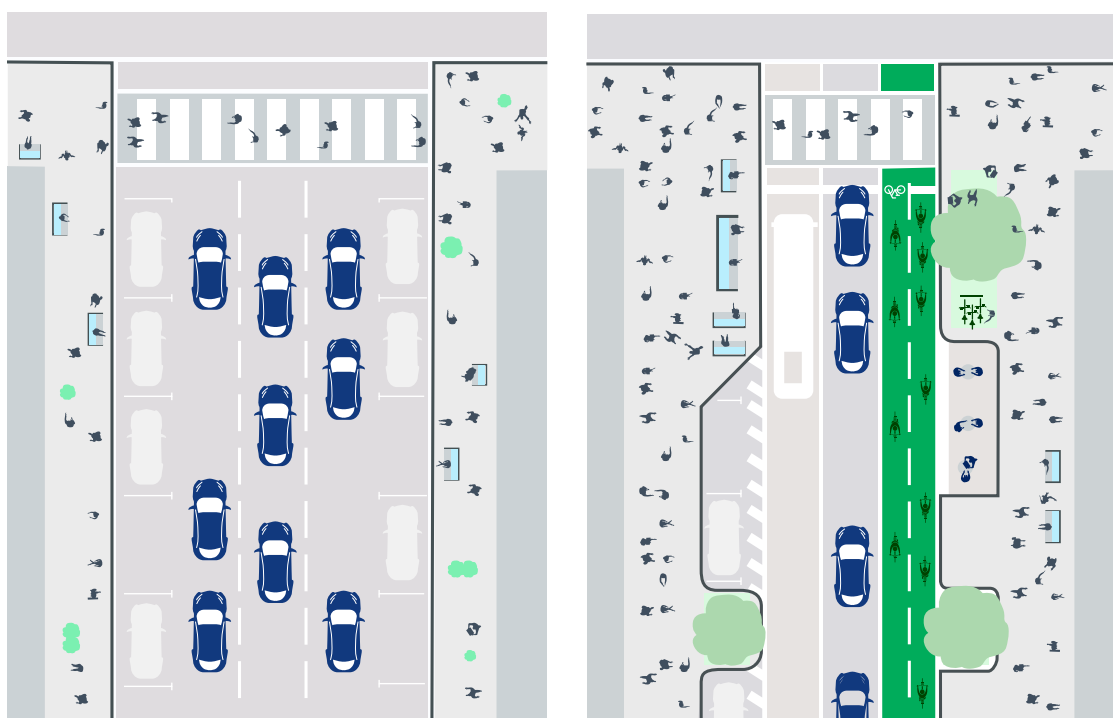
Early consideration of distance to other transport modes, existing shade trees or structures, existing active transport connections and passive surveillance can help inform the placement and design of an on-street transit stop.

4.3 Deliver public transport capable streets

When people move to greenfield developments, there is an opportunity to establish new, sustainable travel behaviours. Transport services and infrastructure need to be in place and perform effectively from the first time a passenger uses them. Recent greenfield developments have not always provided adequately for the effective delivery of on-street transit. Examples of problems include:

- roads with narrow lanes (less than 3.2 meters)
- residential development isolated from the surrounding street network resulting in long and indirect routes
- bus stop locations are planned separately from land use, resulting in long walks to bus stops
- token bus priority measures on busy main roads without consideration of the future bus customer needs

Road space needs to be reserved for public transport services to ensure services can be introduced and scaled up over time. Having an early understanding of long-term transport demand is essential when planning greenfield developments.



Car-orientated street
Capacity 12,500 total people per hour

Multimodal street
Capacity 31,100 total people per hour

Figure 21: Car orientated street design vs multimodal street design

More effective public transport in greenfield areas will require increased collaboration between Transport, bus operators, developers and Councils and a review of guidelines. The Design of Roads and Streets (Transport, 2023) as part of the Movement and Place Framework already provides guidance on fitting the design of roads and streets to its movement and place context. There needs to be a greater focus on enforcement.

Key Move 5: Create enabling funding and partnerships

5.1 Improve how services are delivered

Bus services in the Six Cities are delivered across 22 regions, (as per Figure 22). All regions are operated under a franchising model, where services are delivered by private operators under contracts from Transport. Within their region, operators are responsible for staffing, operations, fleet maintenance and fare collection, while Transport is responsible for service planning and providing funding for bus services.

Greater Sydney and Outer Metropolitan Bus Contract Regions (2024)

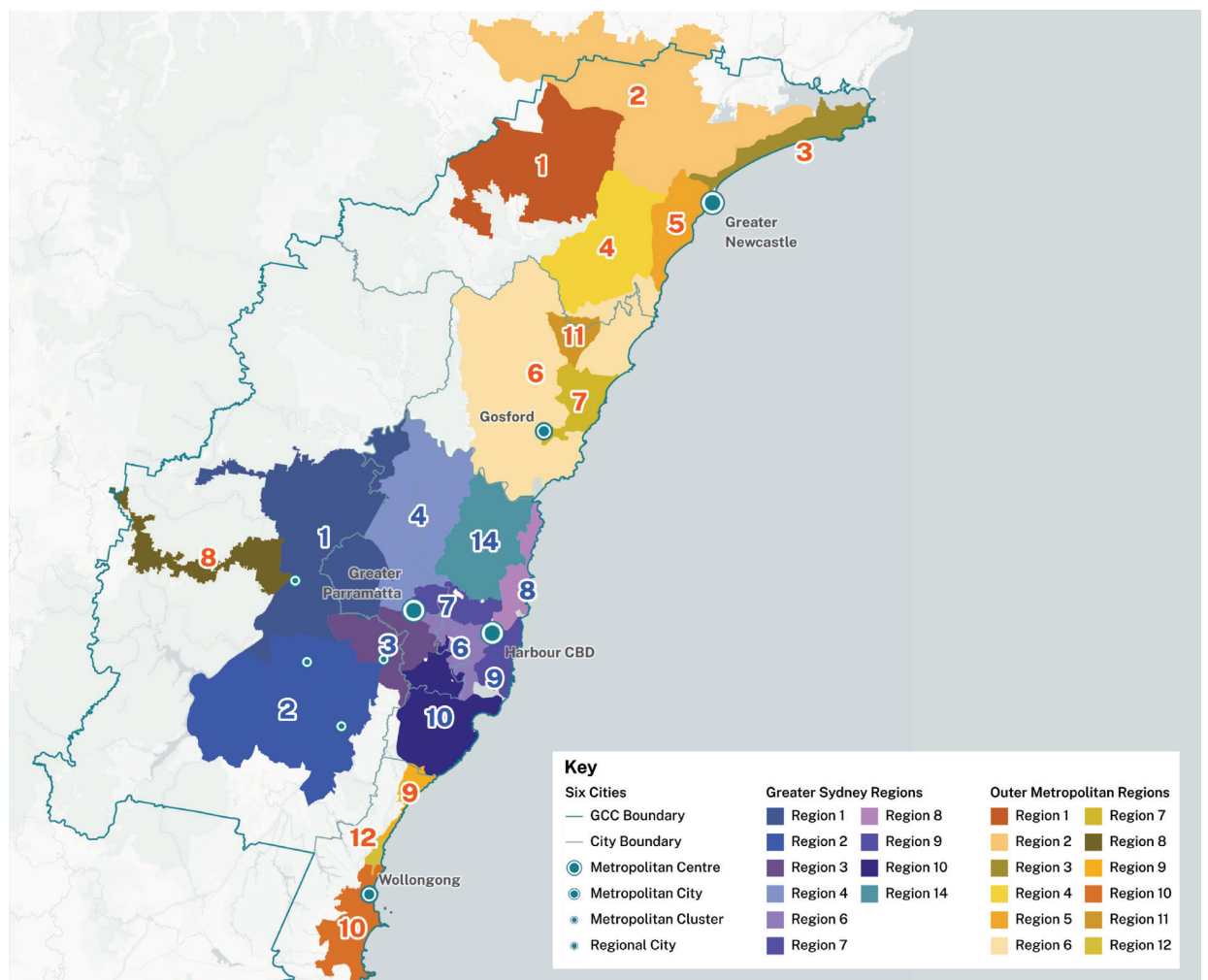


Figure 22: Contract regions in the Six Cities (including new regions by 2024)

Operators have a key role in the improvement of bus services across the Six Cities. Transport and operators can work together to develop strategies to manage driver shortage and other staffing issues that result in service cancellations, poor reliability and reductions in the level of service.

Investment by the NSW Government on bus priority, policies that allow multiple-door boarding, kerbside fare payment and real-time information further support operator performance and result in better outcomes for passengers.

5.2 Better coordinate our on-street transit assets

There are currently 5,000 buses across 53 depots in the Six Cities. Our fleet, layovers, depots, and systems are all important assets of the on-street transit system, but responsibilities are often fragmented, which leads to suboptimal outcomes.

- **Stops** - Councils are typically responsible for the footpath, bus shelter, seating and bus zone signage (Figure 23) with Transport and the operator generally responsible for signage and wayfinding.
- **Roadways** used by buses are the responsible of Councils and Transport with Transport responsible for bus priority, T-ways and traffic signals.
- **Fleets** are owned by Transport, but on-board assistance and technology is installed by the operator, leading to inconsistencies across operators.
- **Layovers** are generally on public road space and must be negotiated with competing operational, place and user needs.
- **Depots** are only partially owned by Transport with legacy ownership from private operators in some regions. This constrains long term infrastructure upgrades.
- **Systems** are not well-integrated across modes and contract regions. For example, timetables and maps are not integrated across modes and even across contract regions. Operators focus to optimise resources within their region using their preferred systems causing inefficient use of assets across the network.

There is a need to improve coordination of our asset management.

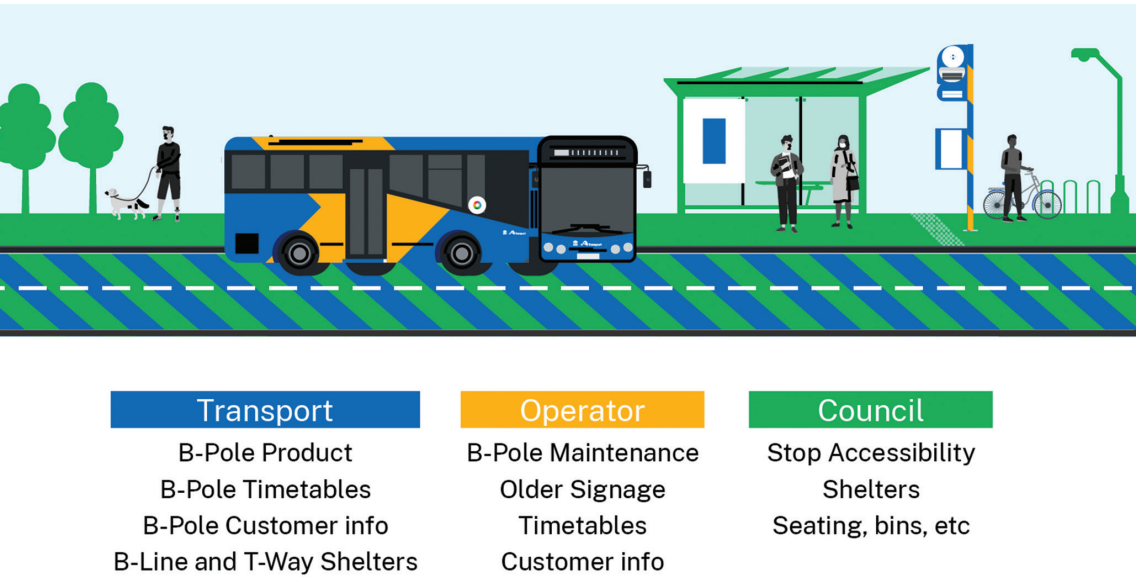


Figure 23: Shared responsibility for the on-street transport system



5.3 Provide enabling funding

As the city grows, congestion will increase and, without bus priority and rapid routes, the performance of the bus network will deteriorate over time. If we do nothing, the attractiveness of buses will decrease, which means more people will prefer to drive and this in turn will increase congestion over time in a vicious circle.

Letting this happen without intervention has a cost to the economy, to the passenger (loss of time), to the operator (increased difficulty to run on-time), and to Government (more fleet and service hours needed to meet the same timetable).

This cost is estimated to be \$53 million per year today. By 2036, this cost will rise to \$140 million per year, and \$230 million in 2056. This suggests it would be cost-effective to invest to address the problem. On-street transit is an affordable and cost-effective mode. If we invest in on-street transit, areas of growth and need can be prioritised and the system can continue to grow and improve for all.



Final thoughts

This White Paper proposes directions that can transform on-street transit into a technology enabled, legible and integrated network that can provide journeys seamlessly and provide a convenient and fast alternative to driving. It calls for greater equity in service provision across the Six Cities. It has drawn attention to poor perceptions of the mode.

However, these challenges can be overcome through small to medium, scalable on-street transit interventions that allow the network to extend and adapt to growth cost-effectively. Our challenge is to think of on-street transit corridors as city-shaping tools, and re-imagine stops as community hubs that catalyse development.

We hope this paper provides useful information and stimulates discussion in the community. This will help inform the NSW Government's responses on this issue.

© Transport for New South Wales

Users are welcome to copy, reproduce and distribute the information contained in this report for non-commercial purposes only, provided acknowledgement is given to Transport for NSW as the source.

