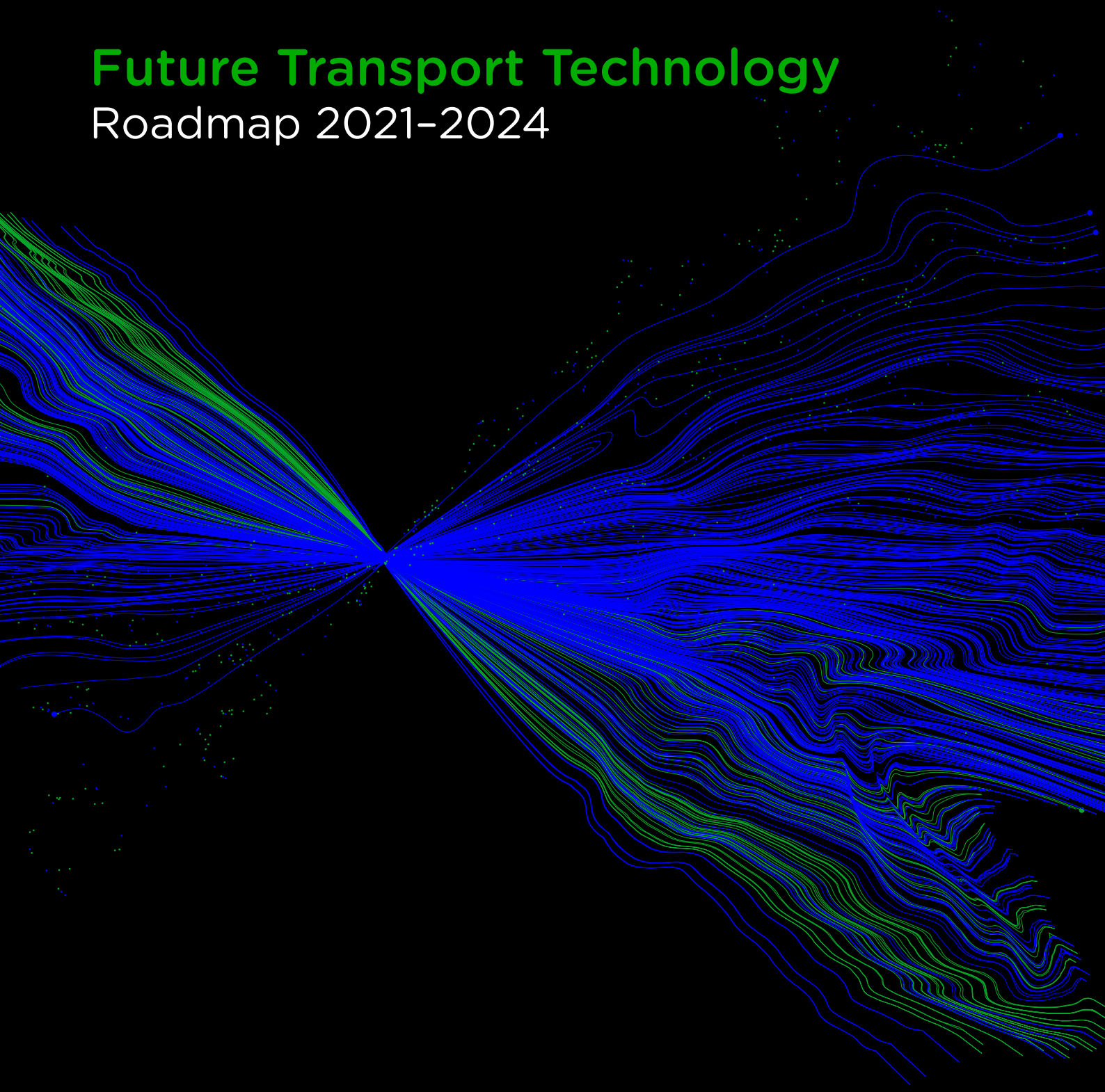
Future Transport Technology
Roadmap 2021–2024



NSW GOVERNMENT

future transport technology

30 March 2021

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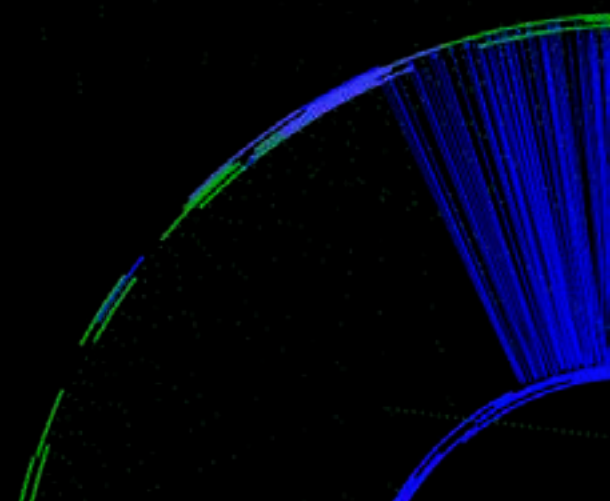


Ministers' message

NSW is globally recognised for its innovative use of transport technologies, which have improved the lives of people across the State. From COVID Safe travel notifications to our contactless public transport ticketing, we have been at the forefront of meeting the needs of passenger and freight customers, creating better communities, enhancing customer experience and unlocking economic opportunity.

We have achieved this level of success by working closely with partners – an approach we will strengthen and expand. By working collaboratively with local and international businesses, technology providers, communities, research partners, councils and other jurisdictions, we all benefit by leveraging expertise and sharing success.

Our *Future Transport Technology Roadmap 2021-2024* reveals a major uplift in the NSW Government's ambition to strengthen our global leadership in transport innovation and to create new uses of technology and data analytics for the safe and efficient movement of passengers and freight. Significantly, this Roadmap's foundations are built on the important lessons we have learnt since the release of our first Roadmap in 2016. It is pleasing to reflect on how far we have come since then and to contemplate the opportunity and benefits that lie ahead.

By utilising these lessons and prioritising the advancement of transport in NSW, we are well positioned to undertake this uplift – which leverages internationally recognised capabilities and experience, rich and open data sets and intelligent systems using the latest analytics to better manage transport networks and services.

This Roadmap is part of our commitment to elevate technology solutions alongside the building of transport infrastructure and the delivering of services to improve customer experience.

It's an exciting time for our passenger and freight customers in Greater Sydney and regional and outer metropolitan NSW as the technological improvements to our transport networks and our systems will enhance customer services and lift productivity to new levels.

And it's an exciting time for Transport for NSW and our partners as this Roadmap is delivered. We invite you to join in and help to create the best connected communities and freight networks in the world.

The Hon. Andrew Constance MP,
Minister for Transport and Roads

The Hon. Paul Toole MP,
Minister for Regional Transport and Roads

Deputy Secretary's message

Transport for NSW is in a period of immense transition and technological change. We are rapidly adapting our services and leveraging new technologies and data analytics to transition to transport of the future, and accelerate the benefits across our passenger transport and freight networks.

Transport for NSW is in a period of immense transition and technological change. We are rapidly adapting our services and leveraging new technologies and data analytics to transition to transport of the future, and accelerate the benefits across our passenger transport and freight networks.

Part of this work includes accelerating progress on the most significant transformation in decades - with the emergence of electric, connected and automated vehicles - and upgrades to the road network system to support them. We're running trials of driverless vehicles across NSW, and working towards net zero emissions by transitioning to zero-emissions electric buses, rolling out more charging points for electric vehicles and investigating greener sources of energy.

Customers will have more options to personalise their journeys, and to use real-time data to make informed decisions about when and how to travel. Customers will have a more connected and seamless end-to-end journey, with more options for how they plan, book and pay for travel. Freight productivity will benefit from a major uplift with more data, analytics and new vehicle technologies. And this will all be underpinned by intelligent systems that use rich real-time data from smart sensors.

We do this to serve our passengers and freight industry customers better, across Greater Sydney and regional and outer metropolitan NSW. As an organisation, our focus is across four transport outcomes: connecting our customers' whole lives; creating successful places for communities; enabling economic activity; and developing thriving people doing meaningful work.

Successful partnerships are at the core of our vision. We want to build on our successful track record of partnerships with industry at all stages – in early stage pilots, proofs of concept and scaled-up service procurement. We are also investing in our teams' skills and capabilities and our technology innovation agenda offers exciting and fulfilling careers.

In 2016, we co-designed our first Technology Roadmap, now we're refreshing our vision and expanding our ambitions. The *Transport Technology Roadmap 2021–2024* is a major strategy and aligns with *Future Transport 2056* and Transport's *10 Year Blueprint and Strategy on a page 2020-24*.

By leveraging each other's strengths, we are reinforcing NSW as a global transport technology leader in creating world-class mobility solutions for the people and communities of NSW. We invite you to partner with us on this journey, to help us imagine and deliver innovative solutions and experiences that our customers will love.

Joost de Kock
Deputy Secretary, Customer Strategy and Technology

Our customers' use of technology is vast

3.5 million
Installations of the **Opal Travel App**.

750 million
Trips made using Opal in 2019, including trips using Contactless.

169 million
Trip plans made on **transportnsw.info, Opal Travel app**, and the **Transport Bot** in 2019/20.

60 million
Trips made with **Opal Contactless** in 2020.

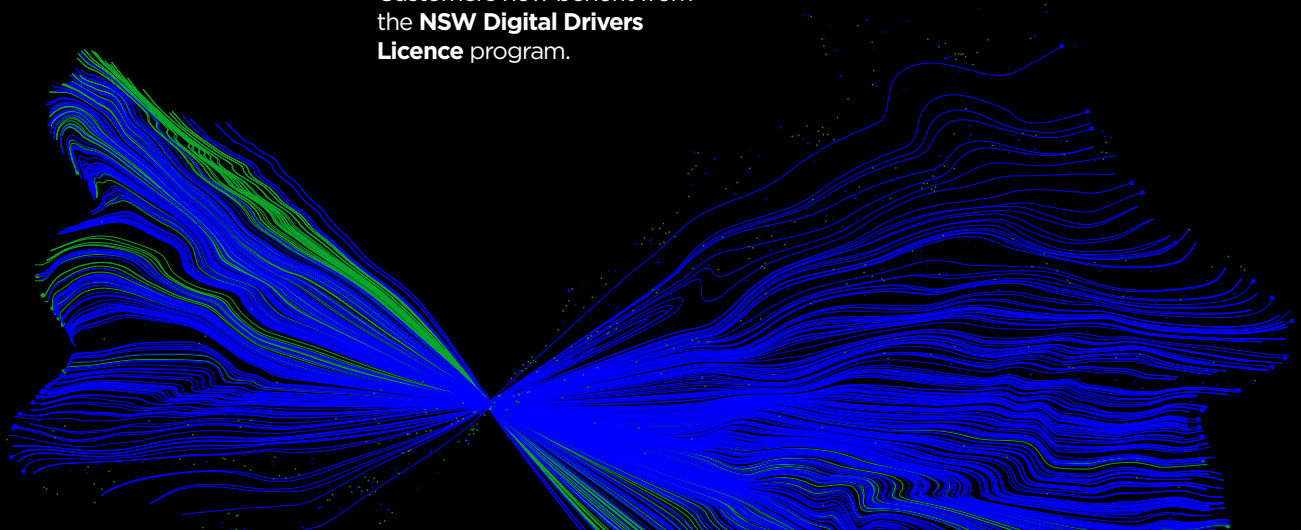
1.8 million
Regional TrainLink train and coach trips booked via TfNSW channels in 2019.

55 thousand
Sydney Coordinated Adaptive Traffic System is installed in 28 countries and over 55,000 intersections globally, including 12,800 in Australia.

8 billion
Data requests via Transport's Open Data Hub to inform customer information channels.

165 thousand
Freight customer visits to Restricted Access Mapping tools.

1.6 million
Customers now benefit from the **NSW Digital Drivers Licence** program.



1. Summary

Future Transport Technology Roadmap 2021-2024 is NSW's headline customer-focused transport technology strategy. It showcases Transport for NSW's ambitions, our strong track record, our technology toolkit and our six priority programs to transform and deliver a world-class customer experience.

NSW's first Technology Roadmap was released in 2016 and since then, we have successfully delivered many award winning projects that have provided a significantly improved customer experience.

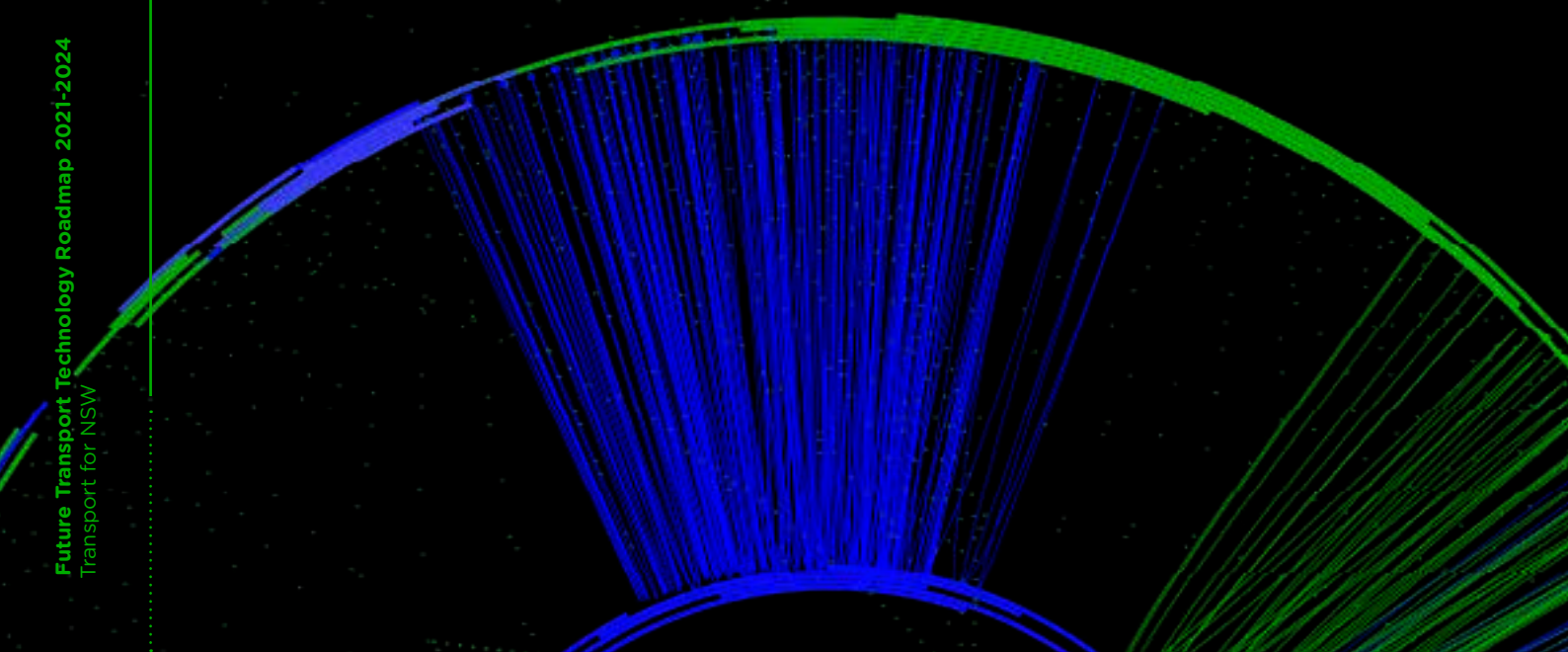
We have developed this new Technology Roadmap to share our priorities and to reflect our stronger ambitions to leverage new technology innovations and Transport for NSW's new operating model to benefit customers in Greater Sydney, regional and outer metropolitan areas, and in the freight industry.

This Roadmap demonstrates how Transport's technology capabilities work together to deliver integrated solutions that align with its long-term outcomes for the people of NSW. It also reflects on our progress since 2016 and the key lessons learnt.

This Roadmap will be regularly updated to ensure that the document keeps pace with technology developments and includes input from partners. We will measure our success against transport outcomes and track progress in delivery, with projects mapped and updated online.

Partnerships are critical to success. We welcome businesses, communities and research groups to contact us and develop collaborative partnerships that bring the Roadmap to life and transform customers' transport experience.

We are also investing in our teams' skills and capabilities and we offer attractive careers to those who are excited to work with us.



By 2024, we will deliver six priority programs that will transform the customer journey

Mobility as Service (MaaS) will deliver seamless and personalised journeys across all modes

- Opal Connect will become a single account for travel in all modes across NSW
- More partnerships with on-demand and rideshare providers to expand MaaS offering
- Digital ticketing will expand to regional NSW

NSW will be a world-leading adopter of connected and automated vehicles

- Trials will show how autonomous ride share services can integrate with MaaS
- The Future Mobility Test Centre at Cudal will test integration of vehicles sensors and infrastructure
- Government will apply policies needed for mass adoption of CAVs

Rapid transition to ZEB and EV will help NSW to reach net zero emissions by 2050

- NSW's bus fleet will transition to zero emission buses (ZEBs)
- Industry will be encouraged to adapt and supply EVs
- Our EV charging network will expand across NSW
- We will explore use of hydrogen technology to support zero emissions target

Technology will transform mobility in regional NSW

- Regional NSW will have real-time information and digital ticketing for all public transport services
- Cutting edge technology will be deployed to create smart regional cities
- Digital connectivity will be provided at transport hubs and on major services
- New mobility technologies will be tested and deployed first in Regional areas

More efficient freight through technology

- We will capture and share data to enable a more holistic view of the supply chain
- Automated and sustainable last mile freight vehicles will be trialled and rolled out
- Investigate the development of a Freight Community System to follow the container supply chain from port to intermodal terminals and distribution centres

Sensors and intelligent systems will create smart transport networks

- Smart sensors will be deployed across the network for richer customer information, service performance, and incident response
- Intelligent systems powered by AI will dynamically optimise network and predict events
- New data sources in Open Data and data exchange will enable integrated mobility solutions

Figure 1-1 – Transport for NSW's six technology priority programs

2. Our vision

As new technologies transform transport, we must innovate and update our transport services to maximise opportunities for all customers. To do this, we have an ambitious vision to expand and accelerate the use of technology and innovation across NSW.

Vision

To be a top-three global leader in the use of innovative and transformative technologies to enable convenient, personalised and sustainable transport and mobility solutions for our customers.

In order to realise our vision for NSW, we are putting the needs of our diverse customer groups at the centre of our innovations. We are analysing data and insights on customers' different needs and preferences and using human-centred design to develop solutions that suit passenger and freight customers, people with disability and communities right across NSW. We are also personalising services and offering choices that are better tailored to different customers' needs.

As part of our vision, we are delivering world-leading Mobility as a Service (MaaS) choices and convenience by offering customers tailored information and travel alerts, payment options and a range of mobility options that are brought together seamlessly. Fully integrated information and ticketing will help customers to plan, book, pay and provide feedback on a channel of their choice.

This vision includes NSW being a leading adopter in the major transition to electric, connected and automated vehicles, by trialling new mobility services using cutting-edge vehicle technologies. We will test the integration of vehicles, sensors and road infrastructure readiness at our new regional testing facility, with newer mobility services and more MaaS information and payment options.

We will also transform the sustainability of the transport sector and drive a shift towards net zero emissions with our goal to transition all 8,000 buses in NSW to a zero-emissions fleet. We will also support electric passenger and freight vehicles, and explore hydrogen technologies, particularly for long haul freight.

Our use of smart sensors and intelligent systems powered by artificial intelligence and machine learning will result in rich real-time customer information, service management, dynamic prioritisation and incident management.

Likewise, our work on technology transformations will be supported by modernising our regulatory frameworks to enable effective implementation in line with strategic policy objectives.

Freight productivity, safety and sustainability will be supported with a major technology uplift that captures and integrates real-time data along the freight industry supply chain, and applies intelligent analytics for the benefit of the sector and network optimisation.

As part of delivering our vision in regional NSW, we will also create new options for connecting regional communities and the effective movement of goods, with more real-time service information and digital ticketing options, better digital connectivity on major transport services and smart regional cities.

Our experience has shown that our vision can only be achieved by our continued investment in our peoples' expertise and skills and by leveraging innovative best practice from successful partnerships. We welcome new partnerships with businesses at all scales, researchers and communities to help bring this ambitious vision to life.

3. Progress and lessons learnt

Transport for NSW (Transport) has a strong track record of successful delivery, often in partnership with organisations ranging from local start-ups to global companies. We have introduced world-leading customer, vehicle and systems technologies since our first Technology Roadmap was released in 2016 and, along the way, we have learnt valuable lessons and insights that we have applied to guide our progress.

Since the release of our first Technology Roadmap in 2016, we have delivered programs under each of the 2016 Roadmap's five major strategies to:

- **Personalise customer interactions** by developing digital platforms that provide rich, contextual information, frictionless payment, easy navigation and two-way engagement to customise transport experiences,
- **Transform mass transit networks** by applying technologies to automated mass transit solutions, improving their efficiency, delivering better service frequency and reducing transit times,
- **Foster shared demand-responsive services** by developing flexible and shared-use transport service models based on aggregated demand to meet market needs and extending transport access,
- **Enable connected and automated vehicle platforms** by supporting adoption of vehicles and infrastructure that deploy automation to efficiently, reliably and safely move people, goods and services,
- **Create intelligent transport networks managed with data** by installing technologies and building networks that actively gather data and using AI and real-time analytics to manage demand, optimise capacity, improve flows and enable better customer outcomes.

These five strategies have provided a strong basis for delivery and remain important. This section summarises some of the key programs achieved as part of the 2016 Roadmap and lessons we have acted on, and included, as part of the delivery of this Roadmap.

This new Roadmap builds on the strong foundation provided by the 2016 Roadmap to extend new opportunities with technologies, including greater use of intelligent sensors, AI, digital twins, electric and other zero emissions vehicles and ways to personalise customer journeys.

3.1

Customer technologies

Transport has been internationally recognised for the progress that has been made involving world-leading technologies that integrate, simplify and streamline customer information and payments. The following case studies demonstrate how technology solutions help connect and personalise customers' end-to-end journeys in ways that were not previously possible, making it much easier to plan, book and pay for transport services with convenience and confidence.

Transforming the customer experience together through Mobility as a Service

Mobility as a Service (MaaS) is a framework for offering a full range of multimodal mobility services that enables customers to plan, book, pay and provide feedback for many types of mobility services, using integrated digital channels, enabling flexible, seamless and personalised services.

Our NSW MaaS platform is transforming customer experience by bringing together the trip planning, booking and payment options provided to customers for end-to-end journeys on a range of modes of public and privately operated transport. This integration gives customers seamlessly connected and personalised choices for how they travel.

The innovative Opal Connect MaaS platform helps customers link trips together, including public transport, rideshare, taxis, and commuter parking. It extends the convenience of Opal fares to flexible new On-Demand transport services, including travel credits to reward customers using On-Demand services to connect with public transport. It also enables the Opal Park&Ride program, which helps public transport customers to access free parking at train stations. Opal Connect won iTnews' 2020 Benchmark Awards for Best Mass Market Project and Best Australian IT Project.

The integrated MaaS, transportnsw.info and Opal Travel app capability uses sophisticated algorithms to offer personalised information and bookings across a range of modes. This includes trip planning for taxis, rideshare, walking and more direct, moderate and easier routes for cycling, to help customers make informed choices. For example, our automated shuttle service trial in Armidale has its service information integrated on the transportnsw.info trip planner, while the Busbot On Demand automated shuttle trialling in Coffs Harbour had bookings integration with the local service operator.

We have also integrated with Uber to launch an Uber and Transit feature so customers can select the best combination of Uber X rideshare and public transport to reach their destination. Sydney and Chicago launched the first integration of such real-time public transport data with Uber's services to provide better first- and last-mile connections to public transport.

> *This collaboration is so great, because it will help people make better decisions about getting around our city and as a result help to reduce congestion, which is a win for our transport commuters and a win for our drivers. The journey is no longer about a single mode of transport, it's about a combination of modes to get to your destination in the most convenient way.*
>
> Andrew Constance,
> Minister for Transport and Roads

MaaS integration is underpinned by a growing range of data from third-party mobility providers.

Our Open Data MaaS Data Specification enables sharing of planned and real-time information for a range of services, including bikesharing. Our Car Park API provides real-time occupancy status for Opal Park&Ride and Sydney Metro car parks. We also share a growing set of council kerb use data, including for parking, carsharing, and for bus, taxi and loading zones.

Enhancing planning and booking of travel through integrated information for seamless travel

Transport's two main customer information channels – transportnsw.info and the Opal Travel app – have been significantly upgraded to help more customers easily plan and book services on a wider range of transport modes and across more locations, including through more personalised and real-time information.

Transportnsw.info now offers more help for regional customers, with information on regional bus and school bus services, and digital bookings for NSW TrainLink trains and coaches. This information connects journeys between trains and other modes and includes trip planning for point-to-point, walking and cycling trips, to help customers make informed choices.

Transportnsw.info also provides real-time passenger capacity information for all modes of transport, a feature that won the 2019 global Real Time Passenger Implementation Award in London and the 2020 ITS Australian Excellence in Transport Data Award. In a world first, estimated and predicted passenger capacity have also been added for all modes to help customers travel on services with adequate capacity.

The Opal Travel app also streamlines trip planning, with a departure board for next services and in-trip tracking. The app offers personalised notifications and alerts across all modes of transport for trackwork, delays or incidents.

In another world first, the Opal Travel app's COVID Safe travel notifications inform customers if physical distancing is possible, based on predicted capacity on their regular train, metro, bus or ferry service. The app sends personalised proactive notifications on whether the transport service is COVID safe for travel, and won the 2020 ITS Australia Excellence in Transport Data Award.

3.5 million

Over 3.5 million customers **have installed the Opal Travel App**. Together with transportnsw.info, more than 169 million trip plans have been executed (2019/20).

The Transport Connected Bus program, which is being rolled out in regional NSW, provides real-time tracking and customer information for regional bus services, so customers can track the location of their bus, its estimated arrival time and how full the service is, which means less time waiting at the stop and more time at the customer's destination.

For customers, this will mean better trip planning as they will have access to data showing the bus location on its route and an indication of the capacity. The NSW Government is committed to delivering quality public transport and transport infrastructure and technology to regional NSW.Paul Toole, Minister for Regional Transport and Roads

We have also delivered valuable customer technologies to help specific customer groups in planning and booking travel across NSW. For example, we have made it easier for customers with disability and mobility impairments to access trip planning services and plan for more accessible journeys through transportnsw.info and transport accessibility apps. We have also developed a voice command service via the Transport Bot virtual assistant powered by artificial intelligence that can answer many common questions through Facebook Messenger, Amazon Alexa and Google Assistant. This delivers real-time service information, route maps, and information on mobility aids and travelling with assistance animals.

To further help people with disability, we are introducing a smartcard to replace the paper docket system for the Taxi Transport Subsidy Scheme and delivering a new centralised booking service for wheelchair accessible taxis with an associated app for taxi drivers to receive bookings. The booking service already accepts phone and online bookings and will soon offer more options with voice activated bookings, digital assistants and apps to assist customers save preferences and track their taxi.

To assist our boating customers, we have supported development of boating apps like Boatable and Deckee that log trips, track other vessels, map locations of boating facilities and provide information on weather, safety, navigation and fishing spots. We have also launched an interactive mooring finder map that helps boat owners easily find and apply for private moorings across NSW.

Simplifying Opal payment choices for customers

Opal ticketing has built on its foundation of providing simplified fare payments for public transport in metropolitan areas. Over time, we have added Opal ticketing for more service modes and more locations across NSW, so that more customers can share the benefits of convenient multimodal fare payments. We are now adding more options for customers to integrate Opal fares with different payment technologies, for further convenience and choice.

Opal Contactless is the world's geographically-largest contactless public transport ticketing system, and is a quick and easy way to pay for public transport. If you have an American Express, Mastercard or Visa credit or debit card or a linked device, you can pay for travel by tapping on and off at Opal readers. Contactless payments are available on public transport in the Opal network and already, more than 23 per cent of adult customers are using it. Opal Contactless payments won the Committee for Sydney Smart City Awards 2019 for Best Mobility Outcome.

The Opal Connect Mobility as a Service platform extends the convenience of Opal fares to flexible, new privately-operated mobility services and helps customers link their journeys from end to end.

For further convenience, students in regional areas and South West Sydney are trialling new Opal student bag tags that eliminate the need to tap on and off the bus with an Opal card. The Opal tag attaches to students' school bags and is automatically picked up by an RFID reader as they board the bus. This is easier for students, saves travel time as students walk straight on, and provides accurate data for planning school bus services.

10 thousand

10,000 users are **registered for Opal Connect** and have made over 40,000 connected trips.

750 million

Over 750 million **trips were made using Opal in 2019** (pre COVID-19), including over 24 million trips using Opal Contactless, growing to more than 60 million Contactless trips in 2020.

Improving connectivity for regional communities with new technologies

Regional customers and communities face different opportunities, challenges and choices to those in metropolitan areas. That is why we have ensured that our technology solutions are made available across NSW and are tested locally in a range of regional communities.

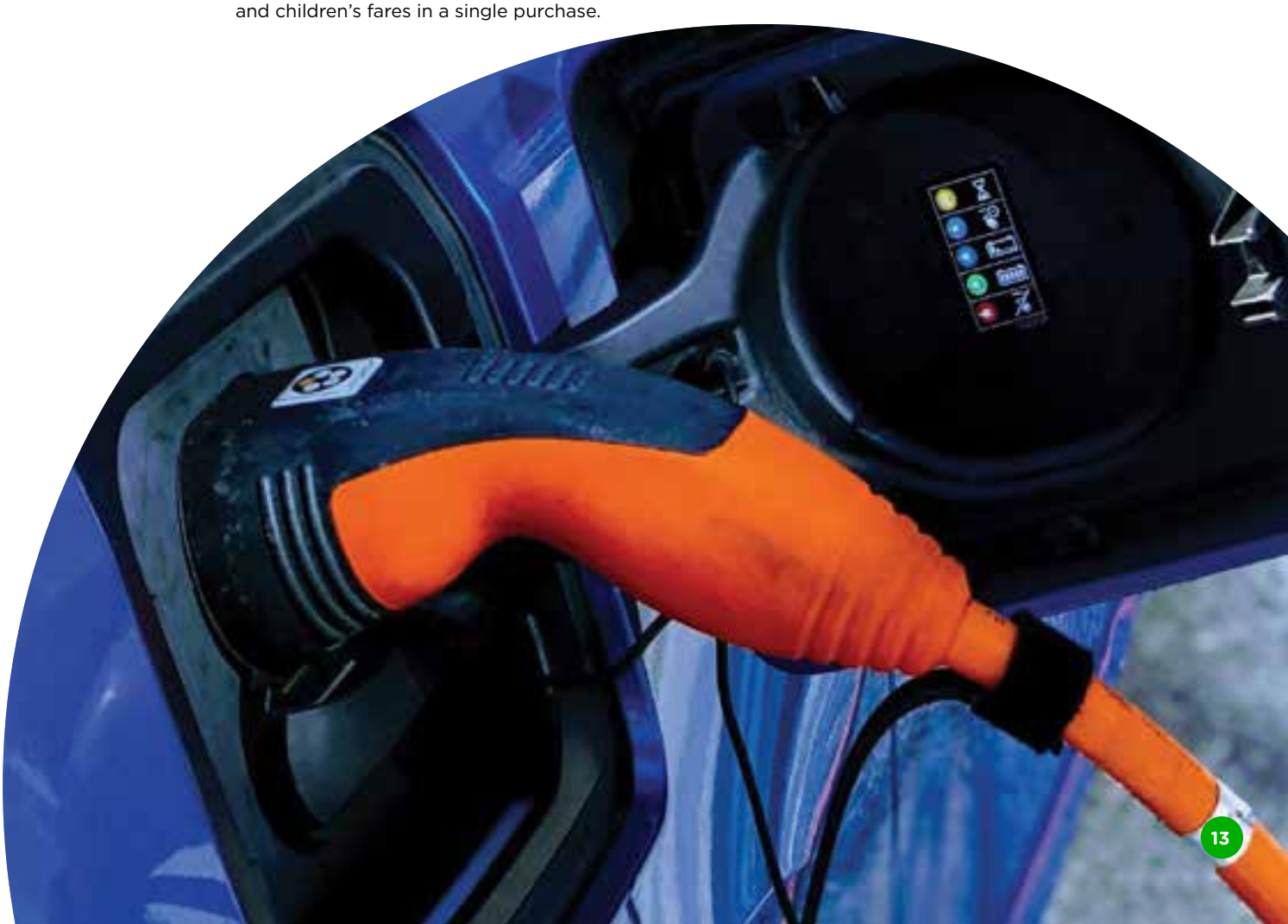
We have delivered real-time tracking and passenger counts for over 300 regional bus services, with more to follow, and over 40 rail and coach service information screens have been provided at regional stations to advise customers of exactly when their train, bus or coach is due to arrive. We have deployed CCTV and customer help points at 40 regional stations to improve safety and have improved digital connectivity with increased network bandwidth at 32 regional stations.

We have successfully trialled contactless RFID bag tags for school students to board buses more quickly and provide operational data to bus operators, and the trial will be expanded to more regional communities. Bookings for TrainLink train and coach services have been simplified with a better online booking system, and a digital Discovery Pass provides more flexibility by combining adult and children's fares in a single purchase.

The Live Traffic NSW service and app continues to provide real-time information on traffic conditions and incidents across NSW, assisting motorists and freight operators to plan their journeys, and contributing to the safe and efficient management of our roads.

We have expanded the network of electric vehicle charging stations to ensure local and visiting drivers are able to access more regional communities, and we have conducted trials of automated passenger shuttles in Armidale, Coffs Harbour and Newcastle to demonstrate new ways to connect communities within regional cities, including for retirement village residents.

More recently, we have established our new vehicle testing facility at Cudal in Central Western NSW as a regional facility for testing connected and automated vehicles and related technologies. In addition, our goal to transition NSW's 8,000 buses to zero emissions will bring local benefits for regional customers and communities, and is already bringing valuable new jobs and investment to regional centres for electric bus manufacturing.



3.2

Vehicle technologies and new services

We have achieved major progress in the single most significant transition facing transport in many generations, with the arrival of automated, connected, electric and shared (ACES) vehicles. These vehicles bring major opportunities for the community with safer, cleaner and quieter transport, and will help to facilitate the transition to a more sustainable future with net zero emissions by 2050.

Transforming mobility through automated, connected, electric and shared vehicles

The emergence of electric, connected and automated vehicles will be the most significant technology transformation in many decades to benefit passenger and freight transport and customer mobility. Electric vehicles offer significantly lower operating costs, with clean and quiet operation, while connected and automated vehicles also offer many benefits, including improved mobility and network efficiency, freight productivity, congestion mitigation and improved road safety. NSW has been actively exploring these vehicle technologies with new shared service models.

Our Smart Innovation Centre has been trialling new vehicle technologies and shared mobility solutions, including highly automated and connected Smart Shuttles at Sydney Olympic Park, integrated with traffic lights and digital bus stops to provide a regular turn-up-and-go shuttle service.

Two regional trials of highly automated shuttles in Armidale and Coffs Harbour have informed the use of automated vehicles on NSW roads, with the Armidale trial also integrating with trip planner and the Coffs Harbour trial operating with On Demand bookings capability. These trials have provided insights into the safety case for adopting automated vehicle technologies, and customers' use and attitudes towards them.

The Sydney Orbital Automated Vehicle Initiative conducted on-road trials of automated features with seven major car manufacturers to analyse interactions between vehicles and road infrastructure. We have also established a major new vehicle testing facility in Central Western NSW that will test automated safety features and connectivity with road infrastructure. These actions help us prepare for the safe adoption of automated vehicles and the development of new intellectual property in NSW.

Electric vehicles will be the first major wave of transformation in the vehicle fleet and NSW is committed to supporting their environmental and economic sustainability benefits. A total of $3 million has been co-invested to deliver 20 fast chargers in regional NSW and $2 million has been co-invested in charge points for commuter car parks in Sydney. An interactive cost calculator and digital customer information platform now helps buyers choose a suitable electric vehicle, locate charging points, and calculate cost savings and environmental benefits.

> *This $3 million investment in additional charging stations will help create the most comprehensive regional charging network in the country, opening regional NSW up to electric vehicle owners. The extended network will help further support the regional tourism economy and promote local investment in regional centres along the Newell, Barrier, New England, and Kamilaroi highways.*
>
> Paul Toole,
> Minister for Regional Transport and Roads

Significantly, NSW has a major goal to transition its fleet of 8,000 buses to zero-emissions technology, delivering a cleaner, greener, quieter and healthier future, and supporting NSW's goal of reaching net zero emissions by 2050. In the first tranche, over 50 new electric buses will operate in Sydney, with operators choosing vehicles from a range of suppliers, including local manufacturers.

> *Making the switch to an entirely electric bus fleet will deliver huge benefits to the community in terms of reducing air and noise pollution, as well as to our incredible drivers. As part of this process, we will challenge the industry to begin an ambitious transformation of our bus fleet from particulate emitting diesel to zero-emission buses.*
>
> Andrew Constance,
> Minister for Transport and Roads

3.3

Intelligent systems and sensor technologies

As a further element to the integrated technology framework with our customer and vehicle technologies, we have delivered major intelligent systems and sensor technologies across transport networks. Smart sensors gather a growing range of rich and real-time data which is consumed by intelligent systems.

These systems use advanced computing, artificial intelligence and machine learning to process large volumes of data quickly and reliably to manage and optimise road, rail, cycleways and waterway networks, so they are safer, more efficient and we can respond more quickly to congestion and incidents. Smart sensors, data analytics and intelligent systems are also critical for the future operation of connected and automated vehicles.

We have been transforming our systems technology to benefit all customers using our transport networks, by managing the networks more dynamically and to prioritise different modes of transport at different times and locations, according to local movement and place objectives and changing needs. The systems described below have been transforming our road, rail, public transport and freight services.

Optimising our networks and informing customers through smart systems

Transport has invested in major systems that optimise the operation of the road and rail networks. The multimodal Intelligent Congestion Management Program (ICMP) is an adaptive intelligent transport system that delivers real-time road status data for traffic, public transport, private motorways, emergency services, field crews, and traffic alerts to our Transport Management Centre. ICMP consumes real-time data to quickly detect traffic patterns, share live customer information with passenger and freight road users, and applies machine learning to automatically generate congestion alerts. This enables the Transport Management Centre to make informed management decisions much faster, resulting in more reliable journeys with minimised congestion.

ICMP is complemented by the Sydney Coordinated Adaptive Traffic System (SCATS) signal control system which optimises traffic flow. Intelligent algorithms process real-time data to make intelligent signalling decisions and adapt to real-time changes. SCATS provides major time and cost savings with a 25 per cent reduction in vehicle stops, 28 per cent reduction in travel times, 15 per cent reduction in emissions and 12 per cent less fuel consumed, adding up to $24 million in economic benefits each day in Sydney.

SCATS Cornerstone is a new spatial data and integration platform that ensures consistent intersection data for future ITS technologies, providing better visibility of the transport network and adaptive traffic management using C-ITS connected vehicle technology and real-time spatial data analysis.

Linked with SCATS, the Public Transport Information and Priority System (PTIPS) is an intelligent transport system used to track, predict and prioritise public transport movements through intersections. It uses machine learning to analyse and predict movements and prioritise high-capacity public transport, to improve customers' travel times and reliability. The SCATS Priority Engine is scalable and can be activated for freight and emergency services vehicles so they can reach incidents more quickly and save lives. PTIPS won the Overall Best Smart City Project at the 2017 Smart City Awards.

For the rail system, Automatic Train Protection (ATP) technology is being installed on train fleets across the electrified rail network, providing safer and more reliable services. With transponders installed in the rail corridor and on the suburban and intercity train fleet, ATP provides critical speed monitoring and signal information to the driver.

As part of the More Trains, More Services program, the Digital Systems Program replaces trackside signalling with the latest train control technology, and implements Automatic Train Operation to help drivers provide reduced and more consistent journey times. It also introduces a traffic management system to help train services to recover quickly from disruption. More Trains, More Services will increase network capacity to meet future demand, provide faster and more reliable journeys, and real-time information.

A growing set of freight data is available on the Freight Data Hub and Open Data Hub, including telematics data from heavy vehicles enrolled in the Intelligent Access Program. The Heavy Vehicle Interactive Telematics Map provides an interactive visualisation tool and valuable insights into where, when and how heavy freight vehicles are operated, to assist freight operators to optimise supply chain efficiency and to better inform freight planning.

3.4

Lessons learnt

While we have successfully delivered many customer, vehicles and systems technologies with strong customer benefits, we have also learnt some important lessons that we are applying to the development and delivery of future projects, including:

1. **Technology solutions must be developed with evolving customer needs in mind** to achieve the best outcomes. For example, we were able to successfully use our customer-centred approach to respond quickly to changing needs and travel patterns due to COVID-19. That is why we will continue to analyse customer insights, voice-of-the-customer data, apply human-centred design thinking and user testing to keep our projects agile and responsive to customers' needs.

55 thousand SCATS is installed in over **55,000 intersections in 28 countries** globally

18 thousand ICMP connects over 18,000 kilometres **of NSW's State roads** network

2. **Regional communities present unique opportunities and challenges**, with significant potential for local jobs and investment linked to technology development, and for locating start-ups in regional locations with lower operating costs and contained testing environments. This regional innovation ecosystem is being expanded with our technology trials and automated vehicle testing, which explore the value of technology to more isolated, less mobile communities. We are also addressing challenges like the different levels of digital connectivity, and tailoring services to meet regional customers' travel patterns which differ from those in metropolitan areas.
3. **Artificial intelligence (AI) has been highly successful for key uses**, such as with mobile phone detection cameras. We are trialling additional uses for AI, machine learning and edge computing to generate real-time data and predictive analytics. These detailed insights will be used on road and rail networks to improve safety, manage congestion and predict performance.
4. **There have been challenges trialling and scaling the use of automated vehicles,** where industry leaders are not yet based in Australia and travel is now restricted by COVID-19. We will reduce these barriers to build local capability through strategic partnerships, thought leadership, data sharing, co-investment, supportive policy, digital and physical infrastructure, testing facilities and community engagement. We will also collaborate with other states and national organisations on trials and the development of a national regulatory framework.
5. **Increased diversity of mobility providers and services** has delivered many customer benefits and opportunities. We will continue to expand and integrate the range of service modes and mobility providers in our information and payment systems, to offer customers seamless end-to-end journey choices, and to improve transport system safety, performance and efficiency.
6. **Data protection, governance and management are more important than ever**, so we are updating our enterprise data governance across Transport and considering data privacy, full lifecycle cost and resource implications, and investing in cyber security and staff awareness training. In addition, we will need to manage and maintain technology over its lifetime to ensure good quality data continues to be provided to inform decision making.
7. **We have world-leading local start-ups, businesses and researchers** that can accelerate and trial emerging technologies, including in high-definition mapping, LiDAR and the use of open data. We are developing more local partnerships to create rapid, tailored and cost-effective customer solutions, and support local economic growth.
8. **Multi-disciplinary collaboration within Transport, across government and with industry partners delivers quick and decisive action**, such as our role in the COVID-19 response, with shared insights and actions able to keep people and freight moving safely, and recognised as global best practice. We will expand our Transport, inter-agency and business partnerships to achieve effective outcomes.
9. **Policy and legislation need to remain fit for purpose**, outcomes-focused, technology-neutral and responsive to customer needs, which is why we are continuing to review and update our regulatory and policy frameworks.
10. **Challenges commercialising Mobility as a Service (MaaS)** have meant fewer MaaS providers entering the local market. We support providers by further developing the Opal Connect MaaS platform and in partnerships with private mobility operators offering personalised and connected journeys. We also hold regular innovation challenges to quickly deliver solutions with developers and have established open data sharing standards.
11. **Intellectual property is valuable and must be managed as an asset** as part of our technology program, so we have the ability to maintain and enhance solutions we commission or co-build with partners.
12. **Digital programs often progress faster than infrastructure and service developments** and need more flexibility to allow for project learnings, which is why we are establishing smaller-scale innovation funds that are more agile and responsive to opportunities to improve outcomes.

These lessons offer important insights for the successful delivery of customer and community outcomes. Accordingly, we have built these lessons into the exploration, design and delivery stages of all our programs, which contribute to Transport achieving its strategic outcomes for the people of NSW. We have also applied these lessons to our six priority programs contained within this Roadmap to ensure that we can leverage prior learnings to deliver and maximise the benefits for our customers across NSW.

4. Transport outcomes

Transport for NSW is working to make NSW a better place to live, work and visit by connecting people and communities, and making journeys safer, easier and more reliable.

Our transport strategies - *Future Transport 2056, 10 Year Blueprint and Strategy on a page 2021-24* - identify the outcomes we want to achieve for our customers, the community, to enable economic activity and to support our workforce. Smart use of data analytics, new technologies and strong partnerships will help us get there.

4.1

Connecting our customers' whole lives

We will focus on customers' needs and preferences, and apply technology and data analytics to deliver for our diverse customers and better connect their lives by:

- **Making transport safe for all:** developing innovative data, technology, infrastructure, regulatory and policy solutions to become the safest transport network in the world.
- **Understanding our customers:** using technology and data to build deeper insights about our customers' journeys and their diverse needs and expectation.
- **Managing demand:** proactively managing how and when people and goods are using transport networks.
- **Providing end-to-end journey solutions:** enabling effective mobility across the networks through integrated options for moving people and goods.
- **Transforming customer experience:** delighting customers at every touchpoint through excellent service and technology, every day.
- **Introducing future mobility solutions:** adopting new mobility solutions and vehicles.

Making transport safe for all

We are developing innovative, data, technology, infrastructure, regulatory and policy solutions to become the safest transport network in the world. For example, we are continuing to focus on our 'Towards Zero' goal of no fatalities on our roads, and NSW's Road Safety Plan prioritises the uptake of new safety technologies in the vehicle fleet, including automated and connected safety features. We have also implemented innovative technologies like our world-first mobile phone detection cameras to reduce driver distraction.

Figure 4.1 – Transport for NSW's four transport outcomes

A robust safe systems approach also applies to rail and maritime operations and all aspects of freight, with Automatic Train Protection technology providing rail safety benefits. Our Maritime Safety Plan 2017-2021 aims to reduce the rate of fatalities and serious injuries on NSW waterways to achieve zero fatalities and zero serious injuries by 2056.

Safe transport also delivers broader safety benefits, as recognised in Sydney's 24-hour Economy Strategy which identifies the need for frequent, reliable and safe transport after hours as critical to developing a vibrant night-time economy.

Our technology programs are valuable tools for supporting late-night transport choices and safety, mobility planning, parking options and safe end-of-trip connections. We will continue to develop solutions such as our Safety After Dark program, which includes work with the University of Wollongong to develop an artificial intelligence algorithm to detect threatening behaviours on the network.

Understanding our customers

Customers are at the centre of everything we do. We are investing in technology and data analytics to build deeper insights about our customers' journeys and their diverse needs. We know that our customer groups have different experiences, expectations and requirements from those in metropolitan, outer metropolitan and regional areas, to people with disability, and freight customers. It is important that we offer value for all key customer groups and have clear insights of their needs, across regional and metropolitan communities and across all modes – whether they are driving, using public transport or moving freight.

When developing our new technologies, we engage with customers and use human-centred design to make sure their needs are addressed. Through voice-of-the-customer data and regular customer satisfaction surveys, we also track how customers value convenient information and payments to help them to travel more easily and with confidence. These customer technologies help improve services by providing planners and network managers with data on transport use and insights about customers' preferences. Trialling technologies, with trials often first occurring in regional areas, also provides valuable customer feedback for further project design and delivery.

Managing demand

As well as adding network capacity with major investments in infrastructure and services, Transport helps customers make optimal travel choices that suit their needs and save time and money with off-peak fares. Travel demand management programs enable us to spread customer demand more efficiently across the day by encouraging customers to use alternative modes of travel or to reducing their need to make trips, which results in less pressure on the network during peak periods.

We have also worked to manage demand on transport services in response to COVID-19. The pandemic has demonstrated the ability for travel demand patterns to significantly change. To help manage those changes to demand, Transport's COVIDSafe Travel Choices team works with organisations to help their staff decide on when and how best to travel, which redistributes journeys more efficiently and sustainably. Technology solutions help to facilitate these choices, with more convenient connections for walking, cycling and first- and last-mile connections to public transport.

Providing end-to-end journey solutions

We understand that customers' end-to-end journeys often combine multiple trips, like walking to the bus or train, or using rideshare or taxi services at other times. We are working to enable effective movement for people and goods across the network through better integrated options.

Enabling economic activity

Thriving people doing meaningful work

In focusing on seamless, connected journeys, we are using technology and data for improved customer information and payment options to help customers understand all their transport options for completing their journeys in the most convenient way. Our real-time information for transport services and live traffic information enable customers to plan their journeys and adapt their travel to avoid incidents. We also be investigating further opportunities to improve customer experience through improved delivery of public transport.

Further, we are providing a major uplift for regional customers to access more services, for more transport modes in more areas. Our freight technology trials will also look at ways to capture data on freight trips across modes, and to share the data with freight businesses so these businesses can plan a more seamless supply chain.

Transforming customer experience

We recognise that customers and communities rely on transport each day and that there are many ways we can transform that experience to be more positive. By taking a customer-first approach, we deliver priority programs that address key customer needs and preferences and delight customers at every touchpoint.

In the first of our priority programs, we will deliver seamless and personalised journeys across all modes, with a comprehensive Mobility as a Service capability. It is also a major priority for Transport to provide more ways customers can opt in for personalised notifications so they receive targeted information that is relevant to their individual needs.

For example, the COVID Safe travel notifications on the Opal Travel app that use advanced algorithms to inform users if physical distancing is possible on their regular service, with over 1.2 million notifications sent to subscribers in the two months from November 2020[1]. We will develop further ways to personalise information and service choices to suit customers' preferences.

We are piloting the Opal digital card to make Opal payments even easier and more convenient. Our customers' strong uptake and use of new information and payment services has demonstrated the utility of, interest in and satisfaction with those solutions.

We are also adding more technology solutions to help people with disability and mobility impairments, such as the new smart card to make trips easier for members of the NSW Taxi Transport Subsidy Scheme and a new wheelchair taxi booking service with an associated app for taxi drivers to receive such bookings.

Introducing future mobility solutions

A further way we connect customers' whole lives is with new mobility solutions and vehicles. Electric, connected and highly automated vehicles are already transforming the way we build infrastructure, deliver mobility services and regulate service providers to deliver safer, cleaner, more efficient and sustainable passenger and freight journeys.

In two priority programs, Transport is taking action to be a world-leading adopter of connected and automated vehicle (CAV) technologies with further automated vehicles tested, trialled and used in passenger and freight services. We are also preparing for the rapid transition to electric and zero-emissions vehicles by investing in charging points, providing information to vehicle purchasers, and transitioning to a zero emissions bus fleet to help NSW reach net zero emissions by 2050.

CAVs offer many benefits to road services and users, including improved mobility and network efficiency, freight productivity, congestion mitigation and improved road safety. Transport is delivering additional trials and larger scaled pilots of CAVs, and aims to develop a ridesharing pilot using automated vehicles integrated with digital customer information, booking and payment systems as part of a MaaS offering.

Transport is also exploring the integration of newer mobility services like ridesharing, car sharing, micro-mobility services and MaaS. Using Opal Connect as a foundation, we can integrate customer information and payment technologies to streamline future mobility services.

1 As at 17 January 2021.

4.2

Successful places for communities

Along with our focus on mobility, we develop transport solutions that enhance the character and identity of successful local places with a focus on enabling access for all. This includes contributing to making public spaces in cities and towns smart, attractive, sustainable, accessible and economically successful. NSW's Movement and Place Framework recognises that streets are not just about moving people and goods; they are places for people to live, work and spend time.

To deliver successful places for communities across NSW, we will harness smart sensors, technologies and analytics and provide transport solutions that make places more liveable, accessible and sustainable. We will encourage an increase in the use of public transport, walking and cycling, based on customer insights and feedback, to better understand and cater to local communities' needs and preferences, so that by 2024 NSW is:

- **Contributing to place making:** creating transport solutions that enhance the character and identity of local communities and enable access for all.
- **Towards net zero emissions:** accelerating the switch to alternative sources of energy and adoption of zero-emissions vehicles.
- **Protecting the environment:** placing the environment at the forefront of design, service delivery and operations.
- **Strengthening regional connections:** creating new options for connecting regional communities and effective movement of goods.
- **Increasing network resilience:** strengthening our network and assets to minimise disruptions from extreme events.
- **Enabling active lives:** making walking and bike riding a real option for our customers and communities.
- **Engaging respectfully with communities to deliver transport solutions:** consulting and listening to all communities, including Aboriginal communities, where our staff and contractors work.

Contributing to place-making

Technologies and data help make successful places smarter and more responsive to changing needs. NSW's Smart Places Strategy and Smart Infrastructure Policy commit Transport to embedding sensors and technology into all major infrastructure projects, sharing data and insights to drive better informed decisions, and improving the productivity, liveability and resilience of centres. Smart places are technology enabled people-friendly public spaces, with high-quality amenity, easy access for pedestrians and cyclists, and that are accessible for a diverse range of people.

Smart places have digital technologies tailored to local needs, including dedicated communications networks; smart CCTV, smart lighting, predictive analytics, and emergency systems to reduce crime; SCATS smart traffic signalling and real-time route planning to reduce congestion; and real-time intelligent sensors to monitor air quality and the movement of people and vehicles, including freight.

We are working on smart kerbs and streets that use technologies to support smart places and place making objectives, including street designs that are ready for electric, connected and automated vehicles and related services. It is also possible to integrate smart places and data driven digital engineering processes into digital models like a Digital Twin, being a 3D and 4D digital spatial data model of our built and natural environments, to improve community engagement, planning, construction, operations and maintenance of places.

Protecting the environment and moving towards net zero emissions

The transport sector is the second largest, and the fastest growing, source of greenhouse gas emissions and creates air pollution impacts on communities. NSW is placing the environment at the forefront of design, service delivery and operations, and is accelerating the switch to alternative sources of energy with the adoption of zero-emissions vehicles to support NSW's Net Zero Plan goal to reach net zero emissions by 2050. Transport's Future Energy Strategy and Action Plan commits to securing our transport energy needs from sustainable sources and supports the transport sector's transition to net zero emissions by 2050.

Electric vehicles offer major cost savings for households and businesses with cleaner, quieter operations, and could account for 50 per cent of new car sales by 2030[2]. Already, over 68,000 motorists have opted for an electric or hybrid vehicle[3], decreasing greenhouse gas emissions by up to three tonnes per car each year.

Transport has already supported additional charging points for electric vehicles and aims to transition its entire fleet of over 8,000 mainly diesel buses to clean and quiet zero-emissions buses, powered by net zero energy. Over 50 electric buses have been ordered and plans are underway to expand the transition across metropolitan and regional areas. As the first Australasian port to join the International EcoPorts network, the Port of Newcastle has committed to integrating sustainable practices, including its transition to a fully electric vehicle fleet.

NSW's Electric Vehicle Infrastructure and Model Availability Program provides financial incentives to help fleet managers for businesses, councils and not-for-profit organisations purchase light passenger and commercial electric vehicles and install charging points. With NSW's large fleets, these incentives encourage importers to offer more affordable models into the Australian market.

Light and medium electric commercial vehicles are now available and more electric heavy vehicles are being trialled. While the technology is not yet advanced, hydrogen fuel cell vehicles could transform the heavy freight sector and use hydrogen produced from renewables with low or zero emissions. Transport will investigate opportunities for electric and hydrogen fuel cell buses and freight vehicles.

In addition, Transport will roll out new hybrid diesel-electric regional passenger trains from 2023 and investigate further opportunities to capture regenerated energy on electric rail. There are also opportunities for strategic collaboration with electricity distributors to integrate energy and transport networks, such as vehicle-to-grid (V2G) energy exchange using smart meters, battery storage, and expanding the use of renewable energy as it comes on line. For example, Sydney Metro has committed to offsetting 100 per cent of its operational electricity. Metro North West Line has a power purchase agreement with the Beryl Solar Farm, which operates 355,000 solar modules in Central Western NSW.

Further sustainability improvements will flow from new services that use vehicles and transport networks more efficiently, including MaaS where customers can combine private, shared and public transport, rather than rely on a private car. MaaS and On-Demand shared services combined with electric and automated vehicles, offer more customer choices, convenience and affordability with better community amenity, while minimising vehicle numbers on the road, congestion and environmental impacts.

Walking, cycling and micromobility options, such as electric bikes, help lower emissions for short trips and can provide connections to public transport. Intelligent Transport Systems - the control and information systems that use integrated communications and data processing to improve mobility, increase safety, manage congestion and incidents - also support sustainability by improving traffic flow and reducing energy consumption on road and rail networks.

Strengthening regional connections

Our vision for regional NSW is to create new options for connecting regional communities and for the effective movement of goods. *Future Transport 2056's Regional Services and Infrastructure Plan* commits to providing safe and reliable travel options and supporting regional investment by connecting manufacturers and producers to domestic and international markets.

As a priority program by 2024, Transport is committed to a major technology uplift to transform passenger and freight mobility in regional NSW, with technologies delivering real-time service information and digital ticketing across all public transport services, cutting-edge technologies that contribute to smart regional cities, and improved digital connectivity at transport hubs and on major train services.

Regional areas will have more charging points for electric vehicles and will host more trials of automated vehicles. We will add regional data to the Digital Twin to help plan further improvements and pave the way for the adoption of emerging services like ridesharing and MaaS, for cleaner and more liveable regional centres and for more efficient delivery of freight.

2 Energeia (2018), Australian Electric Vehicle Market Study.
3 As at 31 December 2020

Regional freight customers will benefit from increased efficiency at multimodal facilities, more real-time information and improved rail freight traffic management with telematics and freight routes optimised to reduce network disruption.

Increasing network resilience

Transport is strengthening the transport networks and assets to minimise disruptions from extreme events such as bushfires and COVID-19. These events require us to quickly respond and adapt, while remaining focused on how we deliver for our customers and communities.

We quickly responded to COVID-19 by using reporting tools to track daily patronage, run capacity modelling and offer digital customer information to support physical distancing in, or near to, real time. Our predictive and personalised COVID Safe travel notifications on the Opal Travel app use advanced algorithms to inform customers if their regular service is safe for travel and our live traffic information is now integrated with current bushfire status information from the Rural Fire Service.

We applied capacity checking tools on the Trip Planner and other travel apps, such as Opal Travel, TripGo, NextThere, AnyTrip, TripView, Citymapper and Google Maps, showing real-time capacity on bus, train, metro and light rail services. We also developed an Interactive Travel Insights Tool that shows the latest travel trends for each mode on the public transport network across Sydney, Newcastle and Wollongong.

Further technology applications like drones and CCTV are monitoring network assets and provide situational awareness for daily operations and management, to minimise the impacts of disruptions and provide more reliable journeys. We are also investigating technologies to assess assets needing replacement, to achieve more reliable, flexible, cost effective and resilient solutions.

Another important aspect of network resilience is the protection of our related digital and data network assets. NSW recognises the value of data as an asset and has adopted the principles and guidance of the NSW Infrastructure Data Management Framework. Transport will continue to work towards the consistent management of infrastructure data across the infrastructure asset lifecycle.

Enabling active lives

Transport is delivering on the vision to make walking and cycling more attractive options, particularly for shorter trips and connections to public transport. Walking and cycling are integral to our transport system and contribute to successful places with over 1.1 billion trips a year made on foot or by bicycle in NSW, including around 600 million trips associated with a public transport journey. Transport's 2020/21 Walking and Cycling Program is designed to make walking and cycling the most convenient option for short trips, to reduce congestion, and for health and environmental benefits.

This is why we have added technology programs that give walking and cycling options across NSW, with more insights from sensors to track usage, intelligent systems granting priority through the network, and expanded information and choices for customers. Technology also supports customer information on pop-up cycleways, expanded digital information for bicycle riders, touchless pedestrian crossings, and notifying motorists of lower speed limits to provide a safer environment.

Engaging respectfully with communities to deliver transport solutions

Transport is committed to engaging with, and listening to, the views of all communities to develop successful places that are more liveable and sustainable.

We have applied more digital tools for community engagement with environmental assessments and approvals on interactive platforms. The community is able to access detailed technical information more readily to better understand how infrastructure delivery and operations will impact and benefit them, and to provide feedback particularly where face-to-face engagement is not possible or convenient.

4.3

Enabling economic activity

To support economic activity across NSW, we are embedding technologies in all new and upgraded infrastructure, with data-enabled digital engineering practices, to gain a better return on investment in networks and services and to support successful places. Transport is doing this by:

- **Delivering and planning future assets:** delivering portfolio of projects and strengthening long range planning processes to maximise available assets and funding.
- **Managing our assets and resources effectively:** introducing new approaches to gain more from assets and resources across the whole lifecycle.
- **Moving goods productively and sustainably:** using technology and data to improve supply chains and local area distribution.
- Smarter financial decision-making: reshaping how investment is prioritised and driving effective procurement and commercial outcomes.
- **Modernising mobility regulation:** creating the best regulatory environment to facilitate growth and innovation in the transport sector.
- **Opening up economic opportunity through transport solutions:** connecting regional NSW to markets, employment and investment.

Delivering and planning future assets

Transport will harness rich, real-time insights from sensor data and intelligent systems to strengthen planning processes and maximise value from available assets and funding. NSW's Smart Places Strategy and the Smart Infrastructure Policy commit to embedding technology and data-driven solutions in all new and upgraded infrastructure, to improve community outcomes and provide the best return on NSW's infrastructure investments. This includes responding to changing customer needs, life cycle costing and technology innovation.

Transport will also supply the Digital Twin with a growing range of rich datasets on network assets, services, performance and customer use, which can be used by intelligent systems' decision engines to improve transport planning, operations and delivery. They can also be used to test and predict future scenarios, and create 3D spatial representations that can visualise 4D past and future temporal changes. By visualising transport assets, services, performance and customers' travel patterns in a shared location, we can enable better planning and operational decisions which deliver safer, faster and more reliable journeys for customers.

Managing our assets and resources effectively

Our smart sensors and intelligent systems generate and process data to help us better manage our network assets, services and resources more efficiently and effectively and to optimise operations and management for better customer outcomes. Drones and other sensors also help to monitor asset condition for more effective maintenance and repair programs across the asset lifecycle.

This includes the use of digital engineering processes to generate 3D Building Information Modelling, time, scheduling, cost, and asset data to analyse past and predict future operational and asset performance, in line with Transport's Digital Engineering Framework.

Moving goods productively and sustainably

Another major priority for Transport is the use of technologies and data analytics to facilitate more efficient freight movements with improved supply chains and local area distribution. Transport's *Freight and Ports Plan 2018-2023* supports the movement of goods for increased economic growth, productivity, safety and sustainability. There are valuable co-investment and partnership opportunities for the use of more data and technologies to facilitate a safer, more efficient and sustainable supply chain.

Transport will explore emerging automated and electric vehicles for urban deliveries and the role of automated vehicles for regional freight. Electric and hydrogen-fuelled vehicles support cleaner and quieter freight operations, which may enable more flexible and efficient deliveries, particularly for last-mile freight. Electric freight vehicles should also reduce operating costs for light and medium commercial vehicles.

Our commitment is that our entire truck sales range will be fossil-free by 2040 at the latest.

Roger Alm,
President of Volvo trucks

We will collect richer data on freight trends to better plan precincts and services with a more holistic view of the supply chain. We will also investigate the use of the SCATS and PTIPS to offer priority for heavy vehicles on primary freight corridors.

As a priority program, Transport will deliver a major technology and data uplift across the freight network to facilitate more efficient operations and help strengthen the economy, and will work with industry partners to ensure that goods are moved more safely, productively and sustainably.

Smarter financial decision-making

Transport is reshaping how investment is prioritised to achieve our four Transport outcomes in Figure 4.1 above, and how we drive effective procurement and commercial results. Technologies and data analytics will be key to gaining a better return on investment in infrastructure and services and for better measuring the effectiveness and efficiency of service provision.

This includes applying whole-of-life costing and cost benchmarking to support better planning, design, delivery and operations and maintenance of the transport network, in particular for infrastructure assets where major investments can be optimised.

Modernising regulation

Transport is investigating opportunities to create the best regulatory environment to facilitate growth and innovation in the transport sector.

Emerging technologies can require regulatory updates to support the opportunities and benefits of new technologies, while mitigating against unintended consequences. That is why Transport is proactively managing its regulatory frameworks so they remain fit for purpose, technology neutral, outcomes-focused and responsive to customer and community needs. For example, legislation was passed in 2017 for the safe trialling of automated vehicles on NSW roads, including driverless vehicles.

Further, we will work proactively with other jurisdictions to develop and harmonise national laws, regulations and standards, where applicable, to ensure the benefits of technology across the transport sector are realised. For example, the ongoing work with the National Transport Commission to develop a national automated vehicle regulatory framework.

Similarly, in the point to point industry, including taxis, ridesharing and hire cars, technology developments have changed the nature of the services and business models and has provided

Case study

Electric vehicles bring jobs and manufacturing to regional NSW

With increased confidence from NSW's goal to electrify all of its 8,000 buses, two NSW bus suppliers and other Australian suppliers are investing locally in jobs and business development.

Nexport and investment group TrueGreen have partnered to establish a $700 million facility in NSW's Southern Highlands for local production of electric vehicles, including buses. The advanced manufacturing facility in Moss Vale is expected to generate more than 2,000 new jobs over the next five years, and plans to be fully operational by late 2021.

Custom Denning is also gearing up to supply Australian designed and built electric buses, including battery electric and hydrogen fuel cell electric buses and has commenced a trial of the first NSW-built electric bus. The company is based in Western Sydney and aims to enhance local advanced manufacturing skills and jobs. Bustech Group is also looking to establish a NSW-based manufacturing facility.

Figure 4.2 - NSW will benefit from a local electric bus manufacturing facility

more consumer choice, improved products and services, safety and productivity benefits. In response to these changes, NSW established the Point to Point Transport Commission which operates as the industry regulator and investigates how technology can improve the efficiency and effectiveness of regulatory operations and works with industry to improve safety systems with technologies. The Commission's online portal allows industry to manage routine regulatory transactions, and provides real time information to help service providers meet their driver and vehicle safety obligations. The portal will link with NSW's Tell Government Once interface, with a digital taxi licence planned to be available.

Opening up economic opportunity

Building smart technologies into infrastructure and services opens up further economic opportunities by making freight more productive, creating jobs for the future and providing valuable business development opportunities. Under its COVID-19 Recovery Plan, NSW is investing in major road, rail and freight infrastructure, with the added value of embedded technologies, such as sensors, Intelligent Transport Systems, real-time data analytics and smart motorways. NSW is also digitising transactions that save time and costs by replacing manual processes. Already, the NSW Digital Driver Licence has a 28 per cent uptake (or 1.6 million drivers).

Future mobility technologies provide economic opportunities for NSW businesses to develop and commercialise new components and systems. For example, the expected increase in electric vehicle uptake is estimated to have major direct economic benefits, including a $2.9 billion increase in Australian real gross domestic product and the creation of 13,400 jobs by 2030, while saving consumers $1,700 each year in ownership costs[4].

As a major customer for technology suppliers, Transport works with advanced manufacturers in NSW who provide the most valuable and skill-intensive stages of production, including high-tech design and development, innovative research, product customisation and support services. We also procure technologies at scale to improve cost and operational efficiencies, and minimise costs to taxpayers.

Greater use of transport technologies aligns with NSW's trade and investment goals to strengthen our economic leadership by supporting local businesses and attracting multi-national corporations to establish local headquarters, including in regional areas.

NSW aims to be one of the top 10 start-up ecosystems in the world and to leverage the growing transport technology sector.

4 PwC (2018), *Recharging the economy: The economic impact of accelerating electric vehicle adoption*

4.4

Thriving people doing meaningful work

Our Transport team have strong capabilities in collaboration, co-design, development and delivery of innovative technologies at all scales, from pilots and proofs of concept, to scaled procurement and deployment.

Transport is making important changes to the way we work and setting us up to deliver on the outcomes in our *10 Year Blueprint and Future Transport 2056*. We will do this by:

- **Keeping our people safe:** embedding consistent, best practice safety processes and systems across Transport.
- **Evolving how, when and where we work:** equipping our people with the tools they need to do their job and build people and capability for now and the future.
- **Working smarter:** establishing ways of working that promote collaboration, agility, efficiency, diversity of perspectives, and empowerment.
- **Growing capabilities and careers:** fostering the right plans, career pathways and learning opportunities for our people.
- **Creating great people experience:** ensuring everyone is engaged in the work they do.
- **Building our workforce diversity:** removing barriers and creating opportunities to help people reach their full potential.

We are investing in our teams' workforce skills and capabilities to enable a successful transition to our future vision, and working with industry, government agencies, community and research partners to do so. This includes exciting career opportunities in the use of more workplace technologies, collaborative project development and delivery through co-design and agile approaches, and use of digital engineering processes.

We engage our staff in innovation processes, such as our *Bright Ideas: Pitch to the Panel* program, which enables Transport staff to pitch their ideas for doing things better for customers. The top ideas are then selected and staff work with industry partners and Transport experts to further develop their ideas to delivery, supported by a mentor. Several valuable solutions identified by staff have been funded and developed to deliver customer benefits, with the program extended to run annually in 2021 and 2022.

We are also using data analytics, new technologies and partnerships to deliver on Transport's long-term strategies. These programs are built on our six main technology toolkit capabilities, outlined in section 5, which work together to deliver integrated solutions for customers.

5. Technology toolkit

We have analysed emerging and proven technologies to understand opportunities to integrate digital technology and data solutions into our network that best deliver for customers and communities. We have identified six key technology capabilities in our toolkit that work together to deliver integrated solutions across Greater Sydney, outer metropolitan and regional NSW, and for freight.

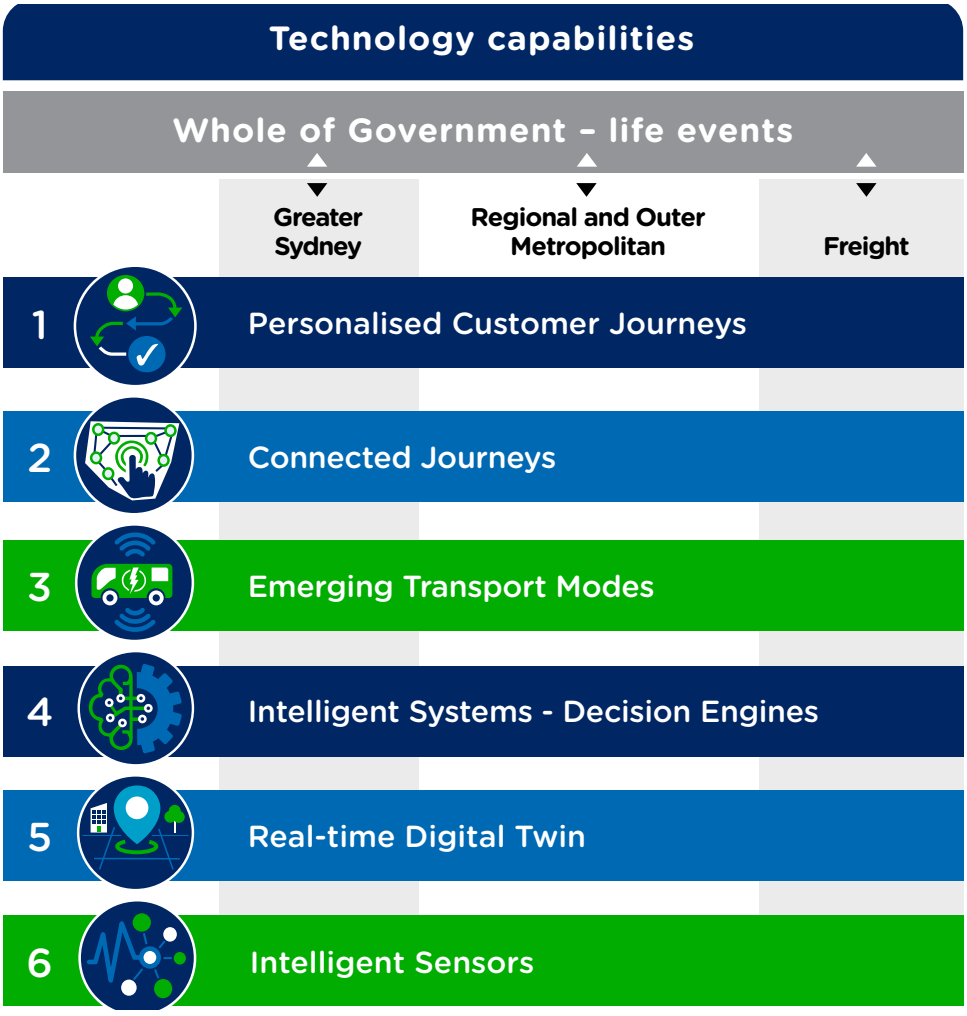


Figure 5-1 – Technology capabilities work together for better customer journeys

Technology and data create exciting new possibilities for how mobility is delivered and experienced. Transport needs to be at the forefront of innovation to confidently navigate and shape this future.

10 Year Blueprint

These technology capabilities work together to delivery personalised and connected journeys which, along with emerging modes like connected and automated vehicles, provide tangible benefits for customers' mobility. The intelligent sensors that provide real-time data to the Digital Twin and intelligent systems work collectively to support the technology stack and make the customer benefits possible.

While utilising these capabilities, Transport is also prioritising the integrity of technology and associated data to ensure it is protected from cybersecurity attacks and complies with the required privacy and confidentiality requirements.

Increased dependence on cyber connectivity and infrastructure requires the strongest cybersecurity policies, risk management and assurance processes. Accordingly, Transport will continue to maintain strict compliance with privacy requirements to protect our customers' personal and private information. We will continue to work closely with NSW's Information and Privacy Commissioner and design strong privacy practices into our information systems' development, decision making, business processes, products and services.

In delivering these integrated solutions, we recognise the diverse needs of our different customer groups in metropolitan, regional and outer metropolitan areas, and of freight customers. We apply these common and tailored technology capabilities to develop and deliver solutions that are appropriate to different customer groups.

We will also integrate transport information into the NSW Life Events website to provide support related to key life changes, to help people to navigate government services more easily.

5.1 Personalised customer journeys

We will deliver world-leading Mobility as a Service (MaaS) choices and convenience with technologies that offer seamless and personalised journeys across all modes.

As a major priority for Transport, this includes real-time, proactive transport choices and personalised notifications, payment options and a choice of mobility services that are brought together seamlessly and conveniently. It gives customers the power to define the information and services that are more valuable to their own needs.

Where customers opt-in, intelligent systems will use artificial intelligence to anticipate their needs and send personalised information that is relevant to customers' choices and preferences before and during travel. Customer information will be more personalised, with service alerts, trip planning, capacity information, customer feedback, lost property information and Opal account management tailored to customers' preferences.

5.2 Connected journeys

This technology and data analytics capability focuses on connecting customers for seamless journeys, by providing convenient and seamless information and payment systems to plan, book, pay, travel and give feedback across the widest range of services. Opal Connect will be the foundation of MaaS, as a convenient single payment account for travel on all modes across NSW.

We will expand information available online and through apps for driving, public transport, newer on-demand services, point-to-point, taxi and rideshare services, commuter car parking, walking and cycling. This will help customers choose how and when they travel, in ways that suit their needs and local transport options. By connecting more services and building partnerships with more service providers, better connected journeys help build the platform for more personalised MaaS.

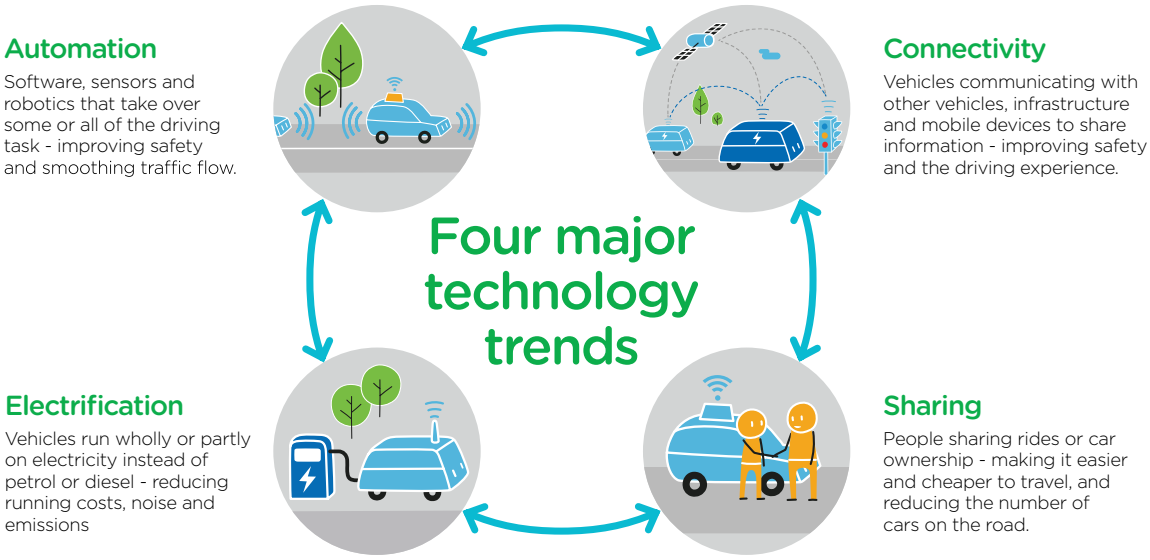


Figure 5.2 - Automated, connected, electric and shared mobility

We will continue to improve customer information digital channels, including transportnsw.info, Opal Travel app, Transport Bots, Open Data Platform and others, to deliver real-time public transport information, self-service options and a seamless experience. We will make our digital channels accessible to all, including customers with a disability, Aboriginal and Torres Strait Islanders and culturally and linguistically diverse communities.

Technology, and insights from mobility data, will transform mobility in regional NSW with real-time information and digital ticketing for all public transport services. Regional and rural customers will benefit from digital information, booking, ticketing and better digital connectivity at transport hubs and on board major rail services for accessing real-time service information. We will also expand the Transport Connected Bus Program as part of Transport's 16 Regional Cities Services Improvement Program for real-time location and capacity information for customers, bus operators and planners.

For freight customers, we will work closely with industry to investigate more efficient end-to-end multimodal freight connectivity and support economic activity by sharing real-time data for a holistic view of the supply chain.

5.3

Emerging transport modes

NSW will be a world leading adopter of connected and automated vehicles, and transition rapidly to electric and zero-emissions vehicles to help reach net zero emissions by 2050.

We are leading Australia's transition to zero-emissions buses and supporting the uptake of electric vehicles by co-funding electric vehicle charge points in metropolitan commuter car parks and in regional centres. We will explore using electric vehicles and emerging modes for urban deliveries, leading to customer, productivity and environmental benefits.

We are also trialling the use, and exploring further opportunities for the trial, of connected and automated vehicles in a ridesharing service, integrated with MaaS service information, bookings and frictionless payments. We will use the new Future Mobility Test Centre at Cudal to test integration of automated and connected vehicles with sensors and infrastructure. We will also work with other government jurisdictions in harmonising national laws, regulations and standards where applicable to ensure that the benefits of connected and automated vehicles are realised and to prepare for their mass adoption.

We will trial new forms of automated vehicles for last-mile freight and passenger services in urban and regional areas and investigate opportunities with both hydrogen fuel cell and more highly automated heavy vehicles.

We will expand real-time data sharing capabilities from connected vehicles and cooperative intelligent transport systems, which allow vehicles to communicate with other vehicles and infrastructure, for processing data into better information and services for customers, fleet operators and network managers. The network and vehicles will be able to operate more safely and efficiently by sharing information on safety, congestion and infrastructure, and – combined with the development of digital and physical assets – will support the creation of a road network that is ready for connected and automated vehicles.

Our Smart Innovation Centre will expand partnerships with industry and research groups to develop new technologies and their application through trials, challenges, simulations and digital assets that encourage innovation and build pathways to deployment in NSW.

5.4

Intelligent systems - decision engines

This technology capability is critical to supporting customers, services, vehicles and networks. It involves ingesting data from intelligent sensors into intelligent systems and decision engines that use artificial intelligence (AI) and machine learning to provide immediate, targeted and actionable insights, to optimise service delivery and network management.

A major uplift in the Intelligent Congestion Management Program (ICMP) and operational systems will better manage the network and react to incidents before their impact spreads, minimising inconvenience and disruption for customers. The ICMP will integrate related systems and data analytics into an operations platform that coordinates all modes and provides accurate real-time information to customers.

Transport will expand traffic signal priority for public transport, freight and emergency vehicles using the SCATS and PTIPS systems to ensure that these systems are prepared for connected and automated vehicles. As part of this expansion, we will also trial Bluetooth and other sensors on the road network using AI analytics to optimise road management and enhance decision making capability.

Transport will also explore more opportunities with smart motorways to use real-time information and integrated smart traffic management systems to smooth traffic, ease congestion, manage incidents and improve road safety.

In the freight sector, we will develop a business case and funding pathway for a Freight Community System that will follow the container supply chain, including from port to intermodal terminals and distribution centres and ultimately back to port. This will explore ways to integrate data and systems across the supply chain to improve the efficiency and quality of information transfer and to better understand the touchpoints and movement of goods throughout the supply chain.

This will enable supply chain participants and government to see and exchange reliable information quickly and easily for better network management, reduced administrative costs, a more efficient supply chain and time and cost savings for customers

Port and rail management systems will also be digitised to improve efficiency and encourage freight to be moved by rail where viable.

As part of the More Trains, More Services program, the Digital Systems Program replaces trackside signalling with the latest train control technology, implements automatic train operation to help drivers to reduce journey times and introduces a traffic management system to help train services to recover quickly from disruption. These programs integrate with the:

- Rail Timetable Solution, which delivers efficiencies and cost savings in rail timetable production and provide data to the Digital Systems Program,
- Rail Prioritisation System, which enables improved prioritisation of passenger and freight rail movements to reduce delays, and
- Technology Enabled Workforce (Train Crew) program, to provide frontline crew with real-time information about service performance, disruptions and workforce planning.

5.5

Real-time digital twin

Real-time data from intelligent sensors is already aggregated and shared for use by customers, operators and network managers, via our Open Data Hub and the NSW Data Analytics Centre.

NSW is also developing a Spatial Digital Twin, with a digital 3D model of cities and communities that facilitates better planning, design and modelling for future needs. This spatial visualisation platform integrates information on property boundaries with transport, utilities, planning, natural resources, environmental and emergency management data. The platform can also integrate Transport's digital engineering enabled assets that integrate data and live data feeds for transport assets, services, travel patterns and network performance.

Transport will build a digital twin and supply the NSW Spatial Digital Twin with more datasets, which are used by intelligent transport systems to improve planning, operations and delivery. It can also test and predict future scenarios, using 3D spatial representations, that can also visualise past and future temporal changes, as well as asset data to inform decisions across the asset lifecycle.

The Transport Digital Twin will be able to visualise freight, roads and public transport mapped to infrastructure, and scenarios for improving customer experience and network efficiency. The Digital Twin also supports development of Smart Places by integrating transport data with other localised data, such as to support dynamic management of road and kerb space.

5.6

Intelligent sensors

The foundation of our technology toolkit is the use of real-time intelligent sensors – including cameras, telematics, Bluetooth, WiFi and drones – supported by AI and machine learning. These sensors enable the digital transport system to detect real-time network conditions, deliver information automatically to decision support systems, and enable safer, more efficient network management and optimisation. Intelligent sensors supply rich real-time data insights for customer information channels to improve services.

Smart sensors will be deployed across road and rail networks for improved customer information, service performance and incident response.

We will trial drones for monitoring assets and to help manage unplanned disruptions. We will use sensors in partnership with the freight industry to understand environmental impacts and assess freight train noise. Transport will use CCTV and automated number-plate recognition to track freight movements at Port Botany, to optimise the use of network capacity and improve the efficient movement of cargo.

Regional customers will gain real-time information on bus services, and bus operators can plan and deliver improved services. Customers in Greater Sydney will have more information to decide on the best time to travel without crowding and help balance demand across the day. Freight and logistics providers will be able to analyse safety, performance, efficiency and productivity, including informing drivers of conditions and telematics to improve travel times.

For network and service managers, intelligent sensors deliver real-time operational insights to inform planning, operation and management. Data quality and reach will be improved to better inform service development outside metropolitan areas.

Expanded sensor data will also be supplied to the Digital Twin for visualisation of real-time information and to prepare for the transition to electric, connected and autonomous vehicles.

Together, these technology capabilities are helping to transform the daily travel experiences of our customers on our road, rail, public transport and freight networks across NSW and will be critical in supporting delivery of our six priority programs, outlined in section 6 below, in our roadmap to 2024.

6. Our Roadmap to 2024

In the next three years, we will see a transformation in the use of technology across NSW, particularly for regional and freight customers. We are working with all the capabilities in our technology toolkit to deliver an integrated portfolio of six priority programs that offer personalised, seamless, efficient and sustainable mobility.

By 2024, we will deliver the following six world-leading priority programs that deliver a fully integrated approach and good value for customers across NSW:

- MaaS will deliver seamless and personalised journeys across all modes to enable customer convenience and choice across NSW by bringing together a single Opal Connect payment account on all modes, together with more partnerships with on-demand and rideshare mobility service providers.
- NSW will be a world-leading adopter of connected and automated vehicles (CAVs) to prepare the network and lead adoption of CAV vehicles in a service environment by trialling use of autonomous vehicles in a rideshare passenger service that integrate with our MaaS platform, testing integration between vehicles, data sensors and road infrastructure at the Future Mobility Test Centre in Cudal, and developing policies needed for mass adoption of CAVs.
- Rapid transition to zero-emissions buses and electric vehicles will help NSW to reach net zero emissions by 2050 and will help NSW reach its emissions target and provide cleaner, more sustainable communities by transitioning NSW's bus fleet to zero-emissions buses, encouraging industry to supply and consumers to purchase electric vehicles, expanding our electric vehicle charging network across NSW and exploring the use of hydrogen technology.
- Technology and data insights will transform mobility in regional NSW by providing real-time information and digital ticketing for all public transport services, deploying cutting edge technology to create smart regional cities, providing digital connectivity at transport hubs and on major services and testing and deploying new mobility technologies in regional areas first.
- More efficient freight through technology to deliver better efficiencies, safety and sustainability for freight operators and local communities to better connect regional communities and transform customers' choices by progressing the capturing and sharing of data for a more holistic view of the supply chain across modes, trialling and scaling more automated and sustainable last mile freight vehicles, and investigating a Freight Community System to follow the container supply chain to optimise the movement of goods across modes.
- Sensors and intelligent systems will create smart transport networks to support better customer information, service management and incident response, with improved predictive and planning capabilities by deploying smart sensors across the network and new data sources shared in Open Data to enable data modelling and artificial intelligence systems.

Beyond these priority programs, we are delivering a comprehensive portfolio of integrated programs for customers across NSW, in Greater Sydney metropolitan area, regional and outer metropolitan areas and for freight customers. This demonstrates a commitment to transform mobility for all our major customer groups, using the full range of technology capabilities in our toolkit.

6.1

Statewide technology programs

We have major programs in progress across NSW to extend and integrate Opal Connect and Opal Contactless payment platforms to a wider range of public and privately operated transport services, payment schemes and customer preferences. This means more flexibility and seamless journeys for customers. We are also continuing improvements in real-time customer information and feedback systems, to make it easier for customers to plan their end to end journeys and receive personalised information.

These programs are the foundation for Mobility as a Service, which is at the core of offering customers more personalised and convenient choices, and preparing our systems for the future integration of ticketing concessions.

We will conduct more trials of connected and automated vehicles on a range of services and test integration with customer information, booking or payment capabilities to bring connected and automated vehicles into the transport and mobility system. There are even options to trial an automated rideshare service. We are also making regulatory, policy and technology changes so NSW will be ready for connected and automated vehicles.

We will continue to support the adoption of electric passenger and freight vehicles with additional charging points in regional centres and in commuter car parks. We are also transitioning the entire NSW bus fleet to zero-emissions technology for cleaner and quieter communities.

We are upgrading the rail timetable planning system to improve efficiencies and provide data to intelligent rail systems such as the Digital Systems Program.

We are delivering further projects to digitise and streamline driver licensing and vehicle registration, saving time for millions of customers. We are also helping customers with disability who are members of NSW's Taxi Transport Subsidy Scheme to travel more easily by developing a smart card to replace the paper docket system, and by providing a new booking service for wheelchair accessible taxis that use a range of technologies to meet customers' individual needs and preferences. We also have further programs to share maritime safety data with other agencies to keep users of waterways safer.

We are exploring new ways to capture customer insights at more points along multimodal journeys. We understand that life can be complicated at certain times, and we will integrate transport information into the NSW Life Events website to provide support related to key life changes, including on transport, to help people to navigate government services more easily.

We are also investigating further programs to improve road and rail prioritisation to reduce delays and improve reliability, and to integrate real-time data into a Digital Twin for spatial visualisation, improved planning and for a platform for transport innovation.

Ref	Statewide technology programs	Priority alignment
We will deliver:		
T001	**Opal Next Generation** Continuous improvement of the Opal smart ticketing system and other payment services (such as by using credit cards or devices) to create a seamless experience for customers when they plan, book and pay.	
T002	**Digital Customer Information Service Enhancements** Continuous improvement of our digital assets, including apps, social media and websites, to enhance the customer experience and add new services and features.	
T003	**Upgraded customer feedback system** Upgrade the Correspondence and Customer Feedback System used to more efficiently manage large volumes of correspondence and feedback, including a virtual assistant to interact with customers and provide useful information at first point of contact.	
T004	**CAV ready NSW** Delivery of necessary regulation, policy, infrastructure, technology changes and community engagement to make NSW ready for the deployment of connected and automated vehicles (CAVs). This includes strategic partnerships and initiatives to support development of a local ecosystem and to reduce barriers to entry for international CAV developers.	
T005	**Zero-emissions buses** Transition the NSW bus fleet to zero emissions technology, with over 50 zero emissions buses (ZEBs) ordered and investigations underway to scale to 8,000 ZEBS across regional and metropolitan NSW.	
T006	**Rail Timetable Solution** A modern, end-to-end operational planning system that will deliver efficiencies and cost savings in rail timetable production, and provide data to intelligent systems like the Digital Systems Program.	
T007	**Taxi Transport Subsidy Scheme smartcard** Replacement of outdated paper dockets with a new smartcard to help people with disability who receive subsidised taxi fares through the NSW Taxi Transport Subsidy Scheme to travel more easily.	
T008	**Wheelchair accessible taxi centralised booking service** Provision of a new accessible taxi booking service for people with disability that will start with phone and online bookings, and will be supplemented by voice recognition software, digital assistants, instant messaging and mobile applications to provide estimated vehicle arrival times and driver tracking capabilities.	
T009	**Digital Renewal Notices (jointly with Service NSW)** Delivering greater value for millions of customers by enabling registration renewal notifications and alerts to occur via digital channels, allowing people to manage their registration.	
T010	**Digital photo card** Customers with a NSW photo card can opt to access an electronic 'card' for visual and digital verification, to sign in at participating venues and as another form of identity for people experiencing homelessness.	
T011	**Mobile safety check inspection** Technology to develop and implement a digital mobile application that enables expansion of the Mobile Pink Slip trial state-wide for light vehicles allowing vehicles to be inspected at a time and place of the customer's choice.	
T012	**Maritime safe systems data excellence program** Consolidation of maritime data sources and data sharing capability between Transport's Centre for Maritime Safety, NSW Police, NSW Health, and the Royal Life Saving Society in relation to alcohol incidents.	

Table 6.1 – Future technology programs for NSW

Key to priority alignment

- Mobility as a Service (MaaS)
- Connected and automated vehicles
- Zero emissions vehicles
- Regional mobility
- Freight efficiency
- Sensors and intelligent systems

Ref	Statewide technology programs	Priority alignment
We will also investigate:		
T013	**CAV rideshare service** A fully automated rideshare service trial that is integrated with customer digital channels (such as booking apps) and payment systems such as Opal	
T014	**PTIPS Priority SCATS expansion and enablement program** Upgrading our traffic management software to enable greater prioritisation of buses, which will reduce delays and enable more reliable customer journeys using turn-up-and-go services.	
T015	**Rail Prioritisation System** Upgrading our rail traffic management system across NSW to enhance evidence-based prioritisation of passenger and freight rail movements to minimise conflicts and reduce delays.	
T016	**Voice of the customer** Technologies that enable the capture of voice-of-the-customer at touchpoints across the customer journey and an ongoing mechanism of engaging with our communities.	
T017	**Streamlined life events** Supporting NSW's 'tell us once' approach for using government services by integrating some transport transactions with Service NSW, so customers can request multiple types of services from one place	
T018	**Digital Twin program** Integration of real-time data into a Transport Digital Twin that will interface with the NSW Spatial Digital Twin for use by whole of government and as a platform for transport innovation.	
T019	**Transport licensing and registration system modernisation and optimisation (known as DRIVES)** Modernising our DRIVES licensing and registration systems to improve data and insights on regulatory performance and user experience and customer service, deploy contemporary technology and future-proof the system and support future changes to regulation and regulatory safety outcomes.	
T020	**Edge computing and sensors** An artificial intelligence-enabled sensor network that uses edge computing to process information at the data source, reducing response times to incidents and making journey times more reliable.	
T021	**Digital bus stop timetables** Installing digital displays for timetables and operational running time information for high commuter volume bus stops.	
T022	**Dynamic digital customer information solution** A real time and responsive wayfinding and information system to better direct and inform customers and manage precincts across different operating modes.	
T023	**CAV ready metropolitan and regional networks** Identify, plan, develop and implement physical and digital infrastructure that will accelerate the readiness of metropolitan and regional road networks for CAV technology and fast tracking customer benefits.	
T024	**Research impact of COVID-19 on travel** Three university research projects in partnership with iMove CRC to examine: • how travel behaviour has changed and implications for the Strategic Travel Model which is used for future transport investment and travel forecasting. • how flexible working can be encouraged to assist with travel demand management to remove peak congestion and make customer travel more enjoyable, and • how COVID-19 has impacted on freight logistics, including new freight trends that may become permanent and can be used for future freight modelling and prediction.	
T025	**Virtual reality research to explore customer preferences in movement and place** University research to provide better direction in planning road and pedestrian spaces that customers prefer, balancing road safety outcomes with best practice place making.	
T026	**Cybersecurity reputation costs research** University research on evidence to assess economic cybersecurity parameters for Cost Benefit Appraisal guidelines.	
T027	**Community transport research** iMove CRC and university research to bring forward innovative local transport solutions that address community needs, focussed on using technology in the near term to tackle transport disadvantage.	
T028	**Research to improve workplace flexibility for frontline staff** University research to understand the barriers for frontline workers having more flexible working, and exploring solutions that could easily improve workplace flexibility, including technology solutions.	

Note: The project information provided can be subject to change, particularly for projects still in investigation.

6.2

Greater Sydney technology programs

In addition to State-wide technology programs, customers in the Greater Sydney metropolitan area will benefit from a major uplift in all areas of technology, particularly for public transport and freight activity.

We will integrate Opal Connect payment with our Park&Ride commuter car parks and will investigate ways to book parking spaces to make it easier for customers to connect to public transport services. We will also install electric vehicle charging points in more commuter car parks to help customers recharge their vehicles while parked and to support uptake of electric vehicles and cleaner, quieter and healthier communities.

We will provide contactless methods for customers with disability to pay for public transport services, using hands-free technology such as RFID tags to make travel much easier.

We will upgrade critical system technologies for road and rail network operations to help optimise public transport and freight services and balance demand with dynamic prioritisation for faster, more reliable journey times. We will also trial priority for heavy freight vehicles at traffic signals on primary freight corridors to support efficient freight deliveries and better access to ports and intermodal facilities.

We will support smart places in Western Sydney with a digital smart kerbs pilot that gathers sensor data on kerb usage by different groups. This data will inform decisions on where and when kerb space could be used differently to provide better access. We will also expand compliance monitoring of taxi ranks to ensure they are used legally and safely.

Transport will deliver and investigate the following programs for customers in Greater Sydney:

Ref	Greater Sydney technology programs	Priority alignment
We will deliver:		
T029	**Park&Ride with Opal Connect** Park&Ride commuter parking via Opal Connect, for frictionless entry and exit of commuter car parks using number plate recognition.	
T030	**Electric vehicle charging points in commuter car parks** Installing charging points in dedicated spaces in commuter car parks at key stations, to help commuters charge their vehicles while they use public transport.	
T031	**Seamless access for people with disability** Using contactless technology to provide people with disability with hands-free access to the public transport network.	
T032	**Transport Management Centre systems development program** Continuous improvement of systems used to manage congestion and incidents across Greater Sydney. This will reduce the severity of disruption caused by incidents and enable operations to provide timely and accurate travel advice to the public.	
T033	**Digital Systems program** Replacing current signalling and train control technology with modern, internationally proven, intelligent systems, to help improve reliability, increase capacity and enhance customer experience on Sydney's railways. Completing the initial rollout and seeking to extend to the entire Sydney rail network.	
T034	**Multimodal Operations Integration** Integration of systems and processes used by our road and rail operations centres to plan for and manage day of operations, to enable a more coordinated approach to managing the transport network.	
T035	**Sydney Coordinated Adaptive Traffic System (SCATS) rebuild** Enhancements to the SCATS traffic management system and uplift in roadside intelligence and devices, to better model traffic demand, prepare for connected autonomous vehicles and provide digital reporting and data API services.	
T036	**Intelligent Congestion Management Program** A world-leading, multi-modal transport management system that will enable our operations centres to make faster, more informed decisions about how to improve customer journey reliability and reduce the cost of congestion.	

Table 6.2 – Future technology programs for Greater Sydney

Ref	Greater Sydney technology programs	Priority alignment
T037	**Digital Smart Kerbs Pilot** A smart places pilot with a digital inventory of kerb space allocation and usage in Western Parkland City that uses sensors to measure multimodal kerb usage in real-time to inform kerb management decisions.	
T038	**Taxi Rank Compliance** Stage 2 edge computing trial to monitor compliance of rank and hail taxi passenger service providers.	
T039	**Transport Contract Operational and Performance Systems** Updating of bus operator contract management systems for bus operations to improve customer information, day of operations processes and performance management.	
We will also investigate:		
T040	**Replacement bus services program** Adding real-time tracking and customer payment and information services to non-Opal replacement buses to improve customer and operators experience during disruptions and save operational expenses.	
T041	**Drone capability for roads and virtual variable messaging system** To monitor traffic congestion and crowd numbers in real-time using drones. This will enable operations centres to provide timely and accurate travel advice to the public using variable messaging signs.	
T042	**Connecting emergency vehicles to traffic management systems** Using traffic management software to prioritise emergency vehicles (such as ambulances) on the road network to improve response times to emergency incidents.	
T043	**Technology Enabled Workforce (Train Crew)** Enable Sydney Trains' frontline crew to receive up-to-date information about service performance, network disruptions, and workforce planning via mobile devices to allow crew to spend more time carrying out customer facing activities, such as proactively identifying where and when to assist customers with reduced mobility.	
T044	**Cycleway Usage Metrics** Install technology to measure and analyse how customers use cycleways to improve operation of active transport routes in Greater Sydney. This data will also inform the planning and design of new routes, including integration of walking and cycling into all new transport infrastructure.	
T045	**Cybersecurity Uplift** Upgrades to cybersecurity protections for public transport systems and enhancing our responsiveness to threats or attacks, which will strengthen our ability to provide safe services and minimise disruption.	
T046	**Smart Motorways** Installing road sensors, smart traffic cameras, ramp signals, and overhead gantries along motorway corridors to better manage traffic, improve incident response times, move more people and support the development of a CAV-ready road network.	
T047	**Quantum computing applications** Research and testing with an Australian based start-up to identify transport applications for quantum computing such as dynamic scheduling.	

Note: The project information provided can be subject to change, particularly for projects still in investigation.

Key to priority alignment

- Mobility as a Service (MaaS)
- Connected and automated vehicles
- Zero emissions vehicles
- Regional mobility
- Freight efficiency
- Sensors and intelligent systems

6.3

Regional and outer metropolitan technology programs

Customers across regional NSW and in outer metropolitan areas have different transport needs, preferences and choices to those in metropolitan areas. Acknowledging there are both challenges and opportunities in regional areas, customers will see a major technology uplift that transforms their mobility, with the ability to more easily drive and plan, book, pay and track a wide range of services in real time, for better convenience and reliability.

Using Transport Connected Bus technologies, customers will be able to access real-time information on where their service is and when their next service connects. We will also investigate the rollout of Opal Contactless ticketing to provide convenient frictionless ticketing on all public transport across NSW, with cash and paper tickets maintained where needed.

We are also expecting to trial further uses of automated vehicles in regional cities with more mobility technologies tested and deployed in regional areas first, including at our new Future Mobility Test Centre at Cudal, in Central Western NSW. Automated vehicles are expected to improve safety, increase mobility options and help stimulate the local economy by attracting industry to the regions.

We will continue rollout of additional electric vehicle fast chargers in regional cities to help drivers of electric cars and vans reach more parts of NSW, and we are planning the transition to clean and quiet zero emissions buses in regional cities.

We will enable regional and outer metropolitan smart cities, with a range of sensor technologies that provide real-time transport and travel information and alerts about road incidents. This data provides real-time customer information and can also be used to prioritise walking and cycling and inform place making decisions.

To improve customer experience, we will investigate ways to improve WiFi digital connectivity at key transport hubs and on board major rail services so that customers can stay informed and connected while they travel. This will support real-time information and efficient mobility along with the information and payment system improvements, to help make public transport a more attractive option.

We will explore ways to expand rail service and safety information for front line staff, using multiple data sources to proactively manage customer information, network reliability and safety benefits.

We will also support local partnerships with regional businesses, universities and transport innovation partners, where we can support local skills and business development opportunities and attract investment to regional communities.

Transport will deliver and investigate the following programs for regional and outer metropolitan customers:

Ref	Regional and outer metropolitan technology programs	Priority alignment
We will deliver:		
T048	**Transport Connected Buses** Vehicle tracking and automatic passenger counting technology to give regional customers the real-time information needed to make informed travel choices, while providing planners and bus operators with the right information to improve services.	
T049	**Expanding automated vehicle capacity for the regions** More trials of automated vehicles in regional cities and a new Future Mobility Test Centre at Cudal, to support faster adoption of automated technologies in the regions. Automated vehicles are expected to improve safety, increase mobility options and help stimulate the local economy by attracting industry to the regions.	
T050	**Electric vehicle charging stations** Installing a network of electric vehicle charging stations in regional NSW to enable people to reliably travel to Broken Hill, Moree and Bourke, and to connect to major routes in Queensland and South Australia. This program is being delivered in collaboration with the NRMA.	
T051	**Technology to create smart regional cities** An uplift to the technology capability in regional and outer metropolitan cities to transform how transport is provided, including trials of AI cameras, Bluetooth sensors, support for CAV trials and video analytics to provide real-time information and alerts about road incidents. This data can also be used to prioritise active transport and inform place making decisions.	
T052	**Regional customer digital ticketing and booking solution** Integrate customer information and ticket booking system for regional trains and coaches to create a seamless online experience, and expand digital ticketing to regional buses.. This will also help us improve our service delivery by providing a complete view of customer journey patterns.	
We will also investigate:		
T053	**Safety information for front line rail staff** Strengthening our ability to ensure the safety of customers and workers by digitising safety critical information, which will make it easier and faster to share information between railway operators and maintainers.	
T054	**Connected transport hubs** Fast Wi-Fi at select transport hubs to keep customers connected when interchanging between modes and services.	
T055	**On-board connectivity on regional transport services** Rollout of expanded infrastructure to enable a high-performance media streaming capability for customers taking regional and intercity services.	
T056	**Zero emissions buses in the regions for sustainability** Identifying pathways to transition our regional fleet to zero emissions buses, using technologies like electric and hydrogen vehicles.	
T057	**Regional rail operational systems update to improve service delivery** Updating and integrating operational systems to let customers plan, book and pay for regional rail services with more information about bus and rail services and service delays, and options to provide feedback, to help customers transferring between modes.	

Note: The project information provided can be subject to change, particularly for projects still in investigation.

Collectively, the delivery of, and investigation into, these programs will provide customers in regional and outer metropolitan areas with a significant improvement in service information, convenience, reliability and personalisation of services.

Table 6.3 – Future technology programs for regional and outer metropolitan NSW

Key to priority alignment

- Mobility as a Service (MaaS)
- Connected and automated vehicles
- Zero emissions vehicles
- Regional mobility
- Freight efficiency
- Sensors and intelligent systems

6.4

Freight technology programs

Transport will deliver a major uplift in technology to facilitate more efficient operations across the road and rail freight network and help strengthen the economy. We will work in partnerships with industry on these projects to enable the safe, productive and sustainable movement of goods.

We will conduct trials of traffic priority for heavy freight vehicles using 5G vehicle-to-infrastructure communication between trucks and the traffic management system. Trials will test the ability to prioritise the movement of goods on primary freight corridors to support efficient deliveries and more reliable access to ports and intermodal facilities.

We will also trial new options for last-mile freight deliveries, including small electric vehicles for last-mile urban deliveries, offering cleaner and quieter operations that lower fuel costs, support successful places and may enable flexible delivery hours. Trials will identify improved freight and environmental outcomes.

In an important step to better use of freight related insights, we will collect more data on freight trends to improve forecasting models that will better inform the design and delivery of freight infrastructure and servicing, including place-based precinct planning. We will investigate more approaches to collect and analyse freight data to provide a holistic view of end-to-end freight journeys and to help find more efficient and effective ways to move freight.

We will develop a business case and funding pathway for a Freight Community System that will follow the container supply chain, including from port to intermodal terminals and distribution centres, and back to port. This will explore ways to integrate live data and systems across the end-to-end supply chain to improve the efficiency and quality of information transfer, and to better understand the touchpoints and movement of goods throughout the supply chain.

We will also explore more use of automatic number plate recognition cameras to track container movements to distribution centres and intermodal terminals in Sydney, and we will investigate network utilisation data collected via telematics combined with NSW's road and rail asset data, to improve network management decisions including smarter access, maintenance and investment decisions.

Transport will deliver a major technology uplift to support freight tasks across NSW in support of the *NSW Freight and Ports Plan 2018-2023*:

Ref	Freight technology programs	Priority alignment
We will deliver:		
T058	**Freight signal priority trial** Trialling 5G vehicle-to-infrastructure communication between heavy freight vehicles and the traffic management system, to prioritise the movement of goods on primary freight corridors.	
T059	**Last-Mile Urban Freight** Exploring alternative delivery approaches and modes, including electric/hybrid vehicles for urban delivery. Trials will identify options for improved environmental and deliveries outcomes.	
T060	**Better places through better data to inform planning** Modernising and improving planning for freight in building and precinct design. This program collects data on freight trends and develops forecasting models which can be used by industry and government stakeholders to inform the design of freight infrastructure and servicing activity during place-based planning.	
We will also investigate:		
T061	**Cameras in Sydney metro area provide freight performance data** Expand rollout of Automatic Number Plate Recognition cameras to follow the container supply chain in Sydney, including from port to intermodal terminals and distribution centres and back to port. Visibility of this freight task improves road access, network management and rail policy decisions.	
T062	**Freight Community System** Investigate a Freight Community System that will follow the container supply chain, including from port to intermodal terminals and distribution centres, and back to port. This will explore ways to integrate live data and systems across the end-to-end supply chain to improve the efficiency and quality of information transfer, and to better understand the touchpoints and movement of goods throughout the supply chain.	
T063	**Machine learning analytics on heavy vehicle movements** Use machine learning software and cameras to track heavy vehicle movements in order to measure compliance, optimise road usage, and proactively manage risk by, for example, giving an alert to drivers of over-height vehicles to nearby tunnels or low structures and identify alternative routes	
T064	**Telematics and freight data uplift** Combine NSW road and rail asset data with network utilisation data collected via telematics, to improve network management decisions including smarter access, maintenance and investment decisions.	
T065	**Remote asset monitoring and compliance** Expanding the use of sensors and other emerging technologies to monitor assets critical to the freight network such as bridges and compliance of users to load restrictions through sensor and video technology.	
T066	**Automated freight vehicles** Developing trials of the use of automated vehicles for both first and last mile deliveries, as well as heavy freight, to improve productivity	

Note: The project information provided can be subject to change, particularly for projects still in investigation.

This Roadmap program demonstrates an ambitious commitment to transform mobility for all our major customer groups, using the full range of technology capabilities in our Toolkit. These capabilities work together to provide integrated solutions, particularly for our six major priority programs.

Table 6.4 – Future technology programs for freight

Key to priority alignment

- Mobility as a Service (MaaS)
- Connected and automated vehicles
- Zero emissions vehicles
- Regional mobility
- Freight efficiency
- Sensors and intelligent systems

7. Measuring success

With such an ambitious vision for NSW's passenger and freight customers and a commitment to elevate technology solutions, we will be monitoring and evaluating each of our priority programs to ensure the people of NSW experience the benefits and reap improved community, economic and environmental benefits.

Transport takes an outcomes-based approach to prioritising, investing, monitoring and measuring its work. Already, technology programs contribute to Transport's measures of success:

- NSW has one of the safest transport ecosystems in the world.
- Customers are delighted with the mobility choices across all locations.
- Increased public transport, walking and cycling.
- Transport solutions make places more liveable and sustainable.
- Strong reputation for engagement, innovation and delivery.
- Transport solutions contribute to the NSW economic and productivity growth.
- Investments are prioritised by outcomes and deliver strong economic returns.
- Transport is a great place to work.
- We have one of the safest workplaces.

We will evaluate the successful delivery of *Future Transport Technology Roadmap* 2021-2024 programs against the Transport measures above, as well as against technology-specific measures. The technology measures will be focussed on tracking the delivery of projects, the rate of technology uptake and usage by our customers, and customer satisfaction with their use.

Based on the experience with recent technology projects, we expect strong results with the delivery, uptake and usage of projects, but are prepared to be agile to any changes that might be needed to achieve success. This approach keeps customer outcomes at the centre of our work.

To match our ambitious vision, we will aim for top-three global standing in international indices for future mobility and technology innovation, including UITP's Urban Mobility Innovation Index which evaluates progress on urban mobility and innovation in cities across the world.

We will also share our progress with customers, communities and our partners by publishing progress updates on our Future Transport Technology site. This includes an interactive project map and a searchable list of technology, infrastructure and services projects in the one location.

8. Partner with us

We want to partner locally and globally with industry, communities, researchers and other jurisdictions to harness talent and bright ideas. Partnerships enable us all to benefit, by leveraging off each other to deliver the best outcomes and reinforce NSW as a global leader in transport technology.

We welcome start-ups, scale-ups, local businesses, multinationals, universities and other research organisations, investors and governments to join the transport technology roadmap to help transform NSW. Those partnerships develop local industry, jobs and skills that stimulate NSW's economic development and future growth.

Partnership Portal

Want to provide input on *Transport's Technology Roadmap 2021-2024*, create partnerships that suit your interests and register for updates?

> Register at future.transport.nsw.gov.au/technology/partner-us/partnership-portal

Transport Digital Accelerator

Want to know how we can create new connections between businesses, government agencies, researchers, entrepreneurs and start-ups to fast track better customer experiences?

> Visit future.transport.nsw.gov.au/technology/roadmap-in-delivery/digital-accelerator

> Contact our Future Transport Concierge at digitalaccelerator@transport.nsw.gov.au

Lighthouse and Innovation Projects

Want to create new projects and partnerships to showcase cutting-edge technologies?

> Visit future.transport.nsw.gov.au/technology/roadmap-in-delivery/transport-digital-accelerator/digital-accelerator-partnerships

> Contact us at futuretransporttechnology@transport.nsw.gov.au

Smart Innovation Centre

Want to know more about our collaborative development projects on emerging vehicles and transport modes?

> Visit transport.nsw.gov.au/projects/programs/smart-innovation-centre

Research Hub

Want to know more about how we develop research projects with universities, the wider research sector, industry and government agencies to develop new insights and solutions?

> Visit transport.nsw.gov.au/data-and-research/research-hub

Open Data Hub

Want to know how we make transport data available for the development of apps and other solutions that our customers value? Or use that data yourself?

> Learn more and register at opendata.transport.nsw.gov.au

Support for business

Want to know more about NSW Government support for strong local businesses to stimulate innovation and economic growth across NSW?

> Find out more at business.nsw.gov.au/support-for-business

Transport technology careers

Want interesting, challenging and rewarding work, in a respectful environment centred on career progression, development and flexibility?

> Explore professions and search for a role at https://jobs.transport.nsw.gov.au/go/Technology-Jobs/4636510

9. Supporting documents

The Technology Roadmap supports NSW's longer term transport vision in *Future Transport 2056 and 10 Year Blueprint*. You can read more in Transport's strategies and key plans below:

- Future Transport 2056
- 10 Year Blueprint
- Greater Sydney Services and Infrastructure Plan
- Regional NSW Services and Infrastructure Plan
- Connected and Automated Vehicles Plan
- NSW Electric and Hybrid Vehicle Plan
- Future Energy Strategy
- NSW Freight and Ports Plan 2018-2023
- Towards Zero Road Safety Plan 2021
- Maritime Safety Plan 2017-2021 and Maritime Infrastructure Plan 2019-2024
- Transport Infrastructure Pipeline 2025
- Older Persons Transport and Mobility Plan and Disability Inclusion Action Plan 2018–2022

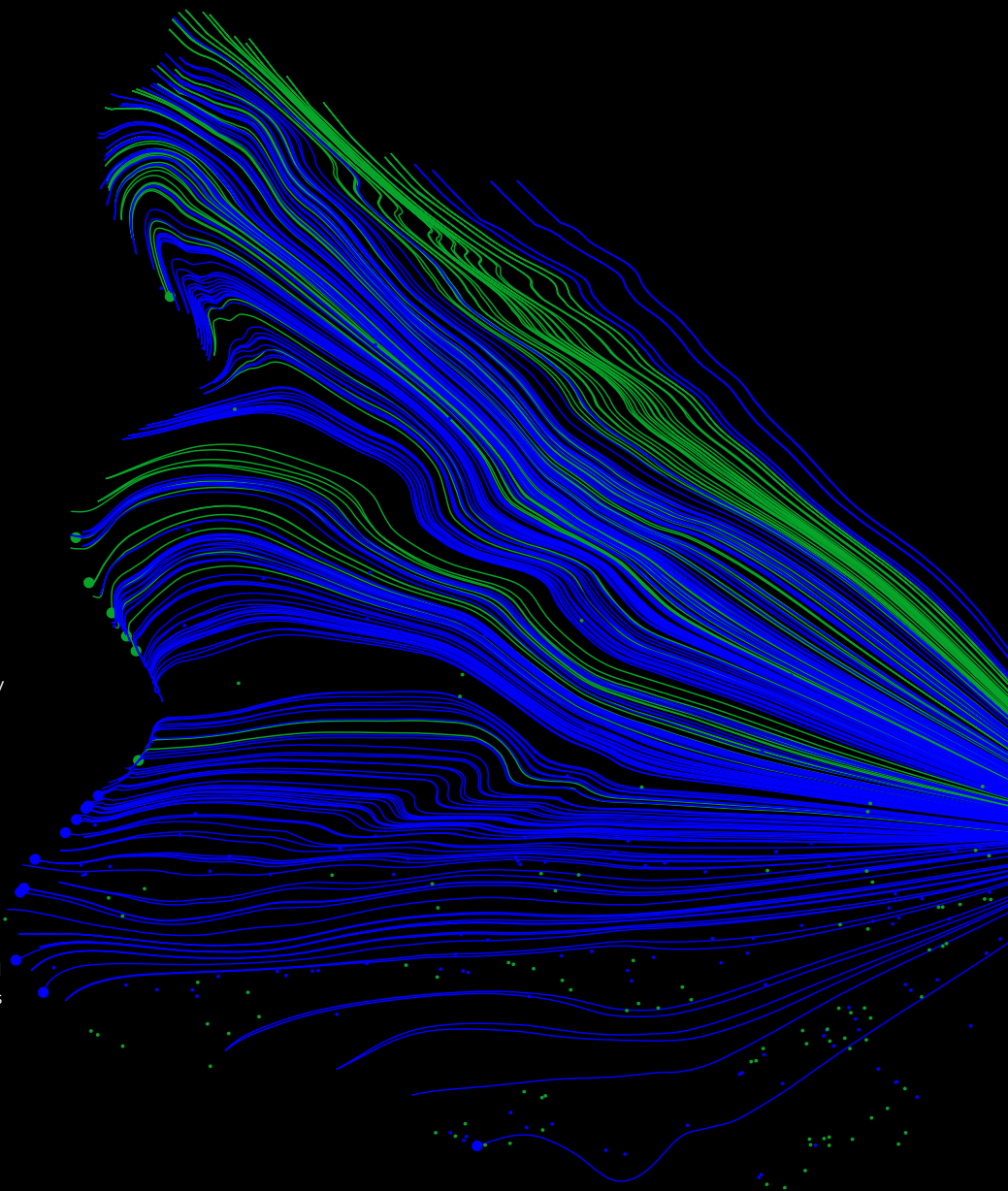
Related NSW government strategies

- NSW Premier's Priorities – which focus on well-connected communities with quality local environments, and 'Government made easy', using technology and data to better integrate and improve the quality of government services.
- COVID-19 Recovery Plan – to reflect changes in transport demand and freight logistics, and that digital technology is vital infrastructure.
- Future State Intergenerational Report – including workforce 'virtualisation' as an enabler of regions; better customer services and infrastructure using technology and data; and future transport with new modes, more efficient networks and improved regional connectivity.
- Greater Sydney Region Plan: A Metropolis of Three Cities – including infrastructure to adapt to technological changes, like demand responsive transport, electric vehicle charging, and car parks and drop-off bays adapted for autonomous vehicles.
- 20-Year Economic Vision for Regional NSW – including digital disruption and leveraging opportunities with entrepreneurship in regional areas.
- State Infrastructure Strategy – including digital connectivity and technology linking transport infrastructure, services and technologies, improved connectivity and treating data as an asset; and innovative service delivery models for innovative consumer-centric services.
- Smart Places Strategy and the Smart Infrastructure Policy – embedding technology and data-driven solutions in new and upgraded infrastructure, to improve communities and provide the best return on government's infrastructure commitments.
- Net Zero Plan – to reach net-zero emissions by 2050, with support for electric and hydrogen-powered vehicles – and the NSW Decarbonisation Innovation Study with electrified and efficient mobility, digitally connected automated networks, shared mobility services and low-emissions freight.
- NSW Innovation Strategy - to boost innovation, stimulate economic activity and drive shared prosperity, including support for the knowledge economy and entrepreneurs.
- Beyond Digital – including focus on MyServiceNSW accounts and linking services under Tell us Once, cyber security and data centre reform, supporting the Data Analytics Centre and Digital Twin, the Digital Restart Fund and TfNSW's Digital Accelerator.
- Digital Government Strategy and Cyber Security Strategy – identifying digital priorities and a risk-based approach for safeguarding citizen data and critical government services.
- Jobs for the Future – to nurture growth in start-ups and digital innovation, and to skill up for the knowledge economy – and Trade and Investment Action Plan – including strengthening NSW's economy by leveraging the transport technology sector.

Glossary of terms

Term	Description
Cooperative Intelligent Transport Systems (C-ITS)	Systems that allow vehicles to communicate with other vehicles and infrastructure, such as traffic signals, that are fitted with the same system. Drivers then receive alerts about upcoming hazards and traffic signal information. Connected vehicles are part of the C-ITS system.
Digital Twin	A digital model of cities and communities which can visualise infrastructure, services and travel patterns in 3D and 4D to facilitate better planning, design and modelling for NSW's future needs.
Edge computing	A distributed IT architecture with decentralised processing power, which enables mobile computing and Internet of Things technologies. Data is processed by the device itself or by a local computer or server, rather than being transmitted to a data centre, improving bandwidth, latency, resiliency, and data sovereignty.
Electric vehicles (EVs)	Passenger and freight vehicles with an electric motor, including battery electric, plug-in hybrid, hybrid and hydrogen fuel cell vehicles.
Intelligent Congestion Management Program (ICMP)	Transport for NSW's multi modal transport management system that provides visibility and situational awareness across all modes of transport on the road network. ICMP supports decision making and improves incident response and clearance times, It proactively manages and minimises congestion, to improve customer journey times, reliability and satisfaction.
Intelligent Transport Systems (ITS)	The application of communication, data processing and electronic technologies for in-vehicle, vehicle-to-vehicle, vehicle-to-infrastructure and mode-to-mode systems to improve transport safety and sustainability, manage congestion and improve the performance of transport networks.
Internet of Things (IoT)	Network of objects that are embedded with sensors, software, and communications technologies that exchange data with other devices and systems over the Internet. IoT systems can deliver more efficient mass transit to increase system capacity and enhance passenger safety and comfort, while lowering costs and risks.
Light detection and ranging (LiDAR)	Sensing technology that pulses low-power, eye-safe lasers and measures the time it takes for the laser to complete a round trip between the sensor and a target. The resulting aggregate data provides both spatial location and depth information to identify, classify and track moving objects.
Machine learning	A method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention.
Micromobility	Small, lightweight vehicles operating at low speeds typically below 25 km/h and driven by users personally. Includes bicycles, e-bikes, electric scooters, electric skateboards, shared bicycles, and electric pedal assisted bicycles.
Mobility as a Service (MaaS)	A framework for offering a full range of multimodal mobility services that enables customers to plan, book, pay and provide feedback for a full range of mobility services using integrated digital channels, enabling flexible, seamless and personalised services.
Quantum computing	A field of developing computer technology based on quantum theory principles, where information can be encoded in new ways that enables significantly greater computing power to process exponentially more data than classical computers. Useful where large volumes of data require processing at super-fast speeds, such as with artificial intelligence and machine learning.
Radio-frequency identification (RFID)	An RFID system uses electromagnetic fields to automatically identify and track tags attached to objects and consists of a tiny radio transponder, a radio receiver and a transmitter. When triggered by a nearby RFID reader device, the tag transmits digital data back to the reader, enabling tracking without contact.
Sydney Coordinated Adaptive Traffic System (SCATS)	Transport for NSW's intelligent adaptive traffic management system that synchronises traffic signals to optimise traffic flow across a city, region or corridor. It allows for the implementation of complex, objective-oriented, traffic management strategies and includes a priority engine to provide efficient journeys for public transport, emergency vehicles and freight.
Virtual reality (VR)	Computer-generated simulation of a three-dimensional image or environment that can be interacted with a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.
Zero-emissions buses (ZEBs)	Buses powered by battery or hydrogen fuel cell electric motors, with zero tailpipe emissions.

future transport technology



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