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Minister for Transport and Infrastructure
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David Thodey
Chair
CSIRO and JobsNSW

Andrew Stevens
Chair
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Kate Burleigh
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Michael Pratt
NSW Customer Service Commissioner
Message from the Secretary

Tim Reardon
Secretary
Transport for NSW

Tony Braxton-Smith
Deputy Secretary
Customer Services

Clare Gardiner-Barnes
Deputy Secretary
Freight, Strategy and Planning

Future Transport Technology | Roadmap 2016
Executive Summary

There are four potential scenarios that may emerge in the next two decades as the uptake of these transformative technologies changes and disrupts consumer behaviour (see the diagram on page 8). To accommodate the range of possibilities that may arise, a flexible strategic framework and Roadmap will be implemented to transform service delivery, better connect communities and enhance the customer experience as these technologies mature.

Five strategies will be executed with the aim of shaping the most customer-centric, innovative, digitally-enabled transportation system in Australia. By incubating new uses, and trialling and adopting new, world-class technologies as they emerge, Transport for NSW will:

• Develop and connect real-time digital information, navigation, payment and engagement platforms so they are simpler to understand, easier to use and can give personalised services relevant to individual needs and preferences.

• Transform mass transit networks to improve their efficiency, deliver better service frequency and reduce transit times, increasing the attractiveness of these services for customers.

• Foster shared, demand-responsive services to offer customers a greater variety of mobility options and flexibility of choice that matches their particular needs.

• Pursue national standards for the road infrastructure, systems and regulatory frameworks needed to adopt greater levels of vehicle automation earlier, and identify how best to deliver community benefits that autonomous vehicles will bring.

• Create intelligent transport networks, managed with data, that enable increasingly efficient, flexible and dynamic service delivery with improved safety, availability, reliability and responsiveness.
The Future Transport Technology Roadmap (see the diagram on page 60) sets out the suite of next step, ‘no regrets’ initiatives – those that will add value to our services, regardless of how the future plays out. The longer-term enduring technology ‘game changers’ for each of these five strategies have also been visualised so that this Roadmap can be adjusted as these emerging technologies advance and evolve.

To implement the Roadmap, Transport for NSW will adopt the practices of technology leaders in other sectors. Innovative solutions will be co-developed with a broad range of industry partners. Investments in core transport technologies will be aligned, in-flight programs will be optimised, and solutions brokered and integrated collaboratively. Where needed to enable early and safe adoption, planning and regulatory frameworks will be adjusted, and rules and standards amended.

A Transport Digital Incubator will be established to cultivate a ‘global hotspot’ for transport data sciences. To stimulate opportunity for data scientists and developers to innovate, core systems will be further digitised and more data sets opened up. Within the Digital Incubator, leading practices will be adopted to enable rapid prototyping and development of a portfolio of specific opportunities for new digital applications (see Appendix A for details), all with a relentless focus on the customer.

Transport agencies in NSW will also change how they work internally, developing new capabilities, changing business practices and driving cultural change so that innovative technology-enabled solutions can be delivered sooner, at lower cost, and with greater benefits for citizens across the state.

My (autonomous) car is (still) king
Individual point-to-point trips in personally owned units

We’re all in this together
Aggregated demand, shared-use and network optimisation

Super-commuting with public, active and shared transport
A lifestyle based on mass transit, flexible and active transport

Why travel so much?
Technology reduces demand for mobility
Purpose of the NSW Future Transport Technology Roadmap

Transport is a technology business. The purpose of this NSW Future Transport Technology Roadmap (referred to as our Technology Roadmap or the Roadmap) is to set out our vision for a technology-enabled transport future and:

- Clearly identify the strategies we will implement, the initiatives we will take and the investments we will make to put innovation and technology at the centre of how we operate.

- Explain how those initiatives and investments will deliver service outcomes that better reflect customers’ personal preferences and priorities – that is, how we will personalise transport – and allow us to unlock the full value of our transport networks.

- Set the direction for Transport for NSW and Transport Cluster agencies, as well as signal to industry how we will do business in the future.

This Roadmap has been produced with extensive input from industry, stakeholders and thought leaders. We now seek to engage further to sharpen this Roadmap, and to identify concrete opportunities that will contribute to delivering the next steps and the personalisation of transport for our customers.
How we developed the Roadmap

The Minister for Transport and Infrastructure, Andrew Constance, launched the Future Transport program in February 2016. Our aim has been to uncover the next generation of technology development that will revolutionise the state’s transport system and harness the benefits for customers. As Minister Constance explained:

“As well as building new infrastructure, we need to look at smarter systems and technology-driven solutions to cope with demand. We need to stay ahead of the game so it’s time we ask, what are the next big ideas? What are the next systems and technologies that are going to challenge us and shape the transport system in NSW?”

Kicking off the program, the landmark Future Transport Summit held in Sydney in April 2016, assembled some of the brightest Australian and international thought leaders, technology specialists, innovators, entrepreneurs, academics and stakeholders from more than 150 organisations. Ideas from this event, a Youth Summit in September, and engagement with NSW Transport Cluster staff through the Intrapreneurs’ program, have helped inform our analysis, along with ongoing industry engagement and workshops with Transport Cluster executives. We have also conducted a comprehensive leading-practice scan, which identified emerging applications of new technologies that are delivering exceptional transport customer experiences in Australia and internationally. Finally, we have examined innovative delivery models in other technology-led sectors.

The formulation of the Roadmap, along with the underpinning analysis, has been guided by a Leaders Panel, co-chaired by David Thodey, Chair of the CSIRO and JobsNSW, and a former Chief Executive Officer of Telstra; and Andrew Stevens, Chair of the Advanced Manufacturing Growth Centre and former Managing Director of IBM Australia and New Zealand. The panel also comprises senior representatives from government and the private sector. This reflects our desire to open up, embrace new thinking and benefit from the expertise of market leaders, collaborate with strategic industry partners, and rigorously test Transport for NSW’s plans and programs.

Give us your feedback

Following publication of this Roadmap, we will engage further with industry and stakeholders to gather feedback and suggested refinements, along with recommendations on how best to execute the initiatives. Your input and feedback is now invited in the period to 31 January 2017, after which this Roadmap and a 2017 Implementation Plan will be finalised, and work will be programmed.

We envisage regularly updating the Roadmap to reflect emerging uses of technology, ongoing industry engagement, and the additional customer insights we will gain as we deliver service improvements.

We are particularly interested in feedback on the following topics and questions:

**Chapter 1**
- Are there any refinements to our analysis or other factors in the broader environment that should be considered in formulating a customer-focused Technology Roadmap?
- Are there technology applications that you would include or exclude from the list of those with greatest impact on the future of mobility?

**Chapter 2**
- Are there other technology-driven disruptive changes to behaviour that need to be considered in any of the four scenarios?
- Are there other emerging technologies that have potential to significantly influence mobility behaviours in any of these scenarios? If so, what are they and what will be the impact?

**Chapter 3**
- What adjustments or refinements would you recommend to the five technology-enabled strategies to personalise transport?
- Are there any other high-level strategies that we should consider, and if so, what would be the key recommended next-step, ‘no regrets’ initiatives?

**Chapter 4**
- Are there any specific measures you would recommend to optimise in-flight initiatives to take account of recent developments with emerging technologies?
- Are there any modifications or refinements to the next-step, ‘no-regrets’ initiatives that you would recommend?
- How would you refine the vision of the enduring long-term technology ‘game changers’?
- How else could transport be personalised?
Chapter 5
• Are the key changes that need to be made in the way we engage with industry being addressed? What other matters should be considered?
• Are there specific measures to enable the delivery of this Roadmap faster, at lower cost, or with greater benefit compared with ‘business as usual’?

Chapter 6
• What steps need to be taken to set up the Transport Digital Incubator?
• What specific measures need to be considered, and what foundations should be laid, to foster a transport data science hotspot in NSW?

Anything else?
• Is there anything else that should be considered in finalising this Roadmap?

Options for providing feedback
Comments and feedback are invited up to 31 January 2017. The options for providing input are:

• Via our moderated online forum. Join the conversation on our ideation platform, where you can discuss your feedback with our team and your peers. Open discussion will be encouraged until 30 November 2016, after which the conversation will be refined to focus on the key themes.

• Via our website. Use the feedback form at future.transport.nsw.gov.au to send us your analysis and comments on the Roadmap.

• At an industry engagement session. You can also request a person-to-person industry engagement meeting, which will be scheduled in January 2017.

Click the ‘Get Involved’ button below.

GET INVOLVED
Innovation Proposals

Do you have something specific that is in development, or available now or in the next 12 months, that will enable the implementation of one or more of the initiatives in our portfolio, set out in Appendix A? Or is there something else that fits this description that we should consider including? If so, you are invited to submit a brief outline summarising the specifics of your Innovation Proposal addressing the criteria opposite. Proposals must be submitted by 31 December 2016.

At its sole discretion, Transport for NSW will select proponents for face-to-face meetings to further understand and consider the Innovation Proposals it receives.

An Innovation Proposal should:

- Identify the specific initiatives in this Roadmap for which the solution is proposed.
- Outline the specifics of the proposal, explain the unique features of the solutions offered, and how a proof of concept is proposed to be delivered.
- Set out how the solution would be scaled and further developed.
- Explain the customer benefits or other benefits to transport, consistent with the objectives and outcomes for customers set out in this Roadmap.
- Give a brief overview of the organisations putting forward the proposal; the key contacts and contact details; the prior relevant experience of the entity and of key individuals.

All innovation proposals should be submitted online. Click the ‘Get Involved’ button below.
1.1. The new era of personalised transport

We live in a ‘digital first world.’ Connected devices, like smartphones, allow us to reach way beyond physical boundaries in the way we communicate, consume and otherwise live our lives. We use them for a great variety of purposes.

We can get an alert when it’s time to leave home for an appointment; we can check, in real time, whether our train is on time; we can use the journey time to have a video chat with a friend, or shop for shoes that are on sale overseas.

We also live in a world where there has been an explosion in choice as markets have increasingly competed for business by developing products and services that better respond to the needs and preferences of potential customers. The convergence of the digital and service economies has given businesses the opportunity to create even greater variety in customer choices, tailoring what they offer – and how that is delivered – to the level of individual preferences. This has also given customers unprecedented choice to determine exactly what they want to buy and how they will access it. As a result, many industries now offer seamless and personalised experiences that could never before have been imagined.

Transport in NSW, too, is rapidly being transformed. New ridesharing service models have reshaped the market for point-to-point travel. Drivers no longer consult a printed street directory, they speak to the GPS in their cars. Rather than pushing paper tickets through a turnstile, people use Opal cards to tap on and off and the system automatically calculates the correct fare. A range of real-time mobility apps puts information in the hands of customers, giving them more choice and flexibility in how they move around and more control over how they spend their time. Ports and distribution centres are fully automated, and freight movements are tracked electronically at every step.
In this decade, landmark transport projects around Sydney and NSW will give customers countless more travel options. These include the Sydney Metro, light rail and bus rapid transit services, significant investments in fleet and additional services, as well as much-needed upgrades to the heavy rail and road networks state-wide.

The NSW Government is committed to maximising the value of this transformation by deploying new and emerging technologies to personalise transport services.

Our vision is to enhance the customer experience, transform service delivery, and better connect communities as we apply these new and emerging technologies to personalise transport.

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Our vision is to enhance the customer experience, transform service delivery, and better connect communities as we apply these new and emerging technologies to personalise transport.

Our opportunity: using emerging technology to deliver our core objectives
1.2. Planning mobility for a rapidly evolving community

New South Wales is experiencing rapid population growth, with population forecast to grow from 7.7 million to 9.4 million by 2031. Growth is likely to be unevenly spread, with some regions experiencing much higher rates of net population growth than others. There will be a marked demographic shift during this period, with increased life expectancy and an ageing population. These factors will drive shifts in the patterns of demand for mobility.

The broader environment in which transport operates is also changing at an increasing pace. Around the Greater Sydney Metropolitan Area, there is Parramatta’s emergence as a second CBD, and a proposed future third city around Western Sydney Airport, with a plan for them all to be ‘thirty-minute cities.’ Across the state, population growth and a thriving economy are driving commercial development, creating new opportunities for people and communities, and enabling the delivery of new economic and social infrastructure.

For the first time, NSW is taking an integrated approach to planning for the future, by developing an integrated set of land use, transport and infrastructure plans. This Roadmap supports the development of an updated set of strategic transport plans to be produced in 2017.

These strategic transport plans align with the State Infrastructure Plans being prepared by Infrastructure NSW. They also align with District Plans being prepared by the Greater Sydney Commission, which will shape future land uses in Sydney. Together, these documents will lay out long-term plans for a transport system that supports the NSW economy and meets the community’s future mobility needs.

In the next 50 years, there will almost certainly be more change than in the last century, both within NSW and beyond. This necessitates a flexible approach to the implementation of these plans and strategies, and requires definition and delivery of a pipeline of initiatives suitable for the range of scenarios that may emerge. This Roadmap is produced to suit these requirements.
1.3. Delivering mobility in a rapidly developing transport system

Since 2011, the NSW Government has embarked on an ambitious infrastructure program to inject much-needed capacity into the transport system. Work is already complete on the South West Rail Link and widening the M5 West and M2 motorways. Major new projects have commenced, including both stages of the Sydney Metro; light rail networks in the Sydney CBD and South East, Parramatta and Newcastle; bus rapid transit for the Northern Beaches; the NorthConnex and WestConnex motorways; and duplicating the Pacific Highway. A once-in-a-generation investment in additional fleet capacity is also underway. This includes a new intercity and suburban fleet on the heavy rail network; new metro and light rail vehicles; new ferries and buses; and replacement of the fleet that services regional NSW.

Capacity enhancements of this nature must continue, ensuring that NSW responds to ongoing shifts and growth in mobility demand. While there will be a continuing need for infrastructure investment, it will present a range of challenges. These include long lead times; substantial funding; complex environmental and land use issues; and service disruption during construction. These conditions mean there is ample opportunity to apply emerging technologies to unlock greater value in both current and ongoing investments in transport networks.

The potential range of applications for technology-enabled solutions is broad – from optimising available capacity and making more efficient use of it; to better network flows and resilience; to improvements in the safety, reliability and efficiency of networks, assets and services. By embracing technology and innovation, NSW will open up an exciting future of personalised transport for customers, and fully unlock the value of investments in the network.
1.4. Unlocking value in the transport system

The disruption in transport is similar to that occurring across a range of industries. Few offer greater lessons than the manufacturing sector, where technology has radically transformed the value-added profile of products and services. The Advanced Manufacturing Growth Centre has highlighted the findings of numerous researchers, who have identified how, across the components of the manufacturing value chain, reductions in the value added through tangible, production activities have been more than offset by increases in the value added through:

- research and design, offering more customised and specialised products to individual customers
- new services, with more flexible and responsive delivery profiles that fit with the usage needs of those individual customers (see the diagram opposite).

Product and service customisation in the manufacturing sector has been achieved through innovative application of technology, well beyond the boundaries of traditional manufacturing.

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In the same way, technology can be applied across the value chain of transport planning, infrastructure and service delivery to maximise the value of ongoing investments (see the diagram opposite). For example, transformation of the core ‘production’ of transport is already underway through technological advancement and functional automation. There is still considerable opportunity to apply new and emerging technologies to make transport services safer, more productive, and more efficient, reducing the unit costs of supply. Similar to the ‘mass customisation’ approach taken in manufacturing, there is also the opportunity to apply combinations of emerging technologies to offer more choice and flexibility in service delivery, unlocking new customer value.

As with manufacturing, beyond core operational technology there is significant potential value to be unlocked in transport by harnessing innovation across the spectrum of the transport value chain. In the ‘pre-production’ phase, new data and digital technologies have the potential to better connect communities by shaping a more customer-centric transport network and service design. Likewise, in ‘post-production’ activities such as the customer service interface, technological developments offer new opportunities to enhance the transport experience by delivering information and services that are rich, interactive and finely tailored to customer demand.

This Roadmap aims to move beyond the traditional narrow focus on applying technology to service production and enable value to be unlocked across the entire transport value chain.
1.5.

New and emerging transport technologies

The April 2016 inaugural Future Transport Summit identified many new and emerging technologies that have the potential to underpin a new era of personalised transport in NSW. At a high level, these comprise:

Customer interface technologies
• Digital and social, personalised engagement with customers using online interactive channels in real time.
• Dynamic demand management systems that help match capacity with demand.
• Frictionless access, payment and identification so customers can quickly board services or validate an entitlement and no longer have to manage multiple cards or accounts.
• Mobility-as-a-Service platforms that facilitate shared or personal transport on demand.

Data and insight technologies
• Advanced analytics and real-time decision support tools that generate insights from smart network infrastructure and customer service systems.
• Open data and intellectual property to facilitate private sector collaboration and innovative solutions to key challenges.

Smart infrastructure technologies
• Smart transport infrastructure, sensors and devices that allow more efficient congestion, capacity and traffic management.
• Next-generation information and communication technology that allows for real-time digital management, increasing the flexibility, connectivity and security of transport assets, while reducing cost and risk.

Vehicle technologies
• Connected and automated vehicles that make public, private and shared fleets intelligent, and improve safety with minimal driver input.
• Personal mobility devices such as pods and powered bikes that offer new options for first- and last-mile travel. (That is, travel between the customer’s starting point, like their home, and key public transport nodes.)
• Alternatively fuelled vehicles, which can deliver greater sustainability and a quieter ride.

Other technologies
• Technologies that reduce demand for mobility, such as virtual reality, videoconferencing, telehealth, online learning and 3D printing.

See Appendix C for a more detail about new and emerging technologies and Appendix D for our leading practice scan of transport innovation around the world.
New and emerging transport technologies

The uncertainties arising from the fast pace of technology-driven change – along with uncertainty about how the nature of the state’s demographic profile will impact on transport demand – means that we need to adopt scenario planning approaches to test a range of possible outcomes. The scenarios that have helped to inform development of this Roadmap are set out in Chapter 2.

Adoption and applications of these technologies will be shaped by a range of factors beyond technology maturity, including their social acceptance, their cost to end users, and government interventions.

<table>
<thead>
<tr>
<th>Advanced analytics and real-time decision support tools</th>
<th>Digital contextualised and personalised customer engagement</th>
<th>Connected &amp; automated vehicles</th>
<th>Personal mobility devices</th>
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<tbody>
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<td>Dynamic demand management systems</td>
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<tr>
<td>Open data and open IP</td>
<td></td>
<td>Mobility-as-a-Service, on-demand, and shared use</td>
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<td>Frictionless identity, authority, access and payment</td>
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<td>Smart network infrastructure, sensors and devices</td>
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<td>Next generation enterprise technology infrastructure and communications networks</td>
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<tr>
<td>New technology that reshapes and reduces demand for mobility</td>
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These trends embody technological innovation but disruption only happens when humans adopt or respond to these technologies.
Future scenarios

The convergence of technologies identified in Chapter 1 leads to multiple possibilities for how personalised transport could unfold. Many of these technologies are large-scale and highly complex. They could take some years to mature. The timing and trigger-points for shifts from limited trial to wider-scale adoption are not certain. The impacts of the demographic and other changes identified in Chapter 1 contribute to this uncertainty. For these reasons, this Roadmap uses a scenario planning approach.

Four different scenarios have been developed. Each of the four scenarios assumes that a different subset of the 12 technologies is the predominant focus of future development and becomes the driving force for change. This helps to identify key issues and consequences that may need to be addressed, given the range of different outcomes made possible by the impacts of these emerging technologies.

These scenarios adopt a longer-term time horizon by considering the future of transport beyond 2030. This puts the focus on the impacts of different technologies, rather than the rates of adoption.

Ultimately, it is the human response to technology that results in disruptive behaviour, and shifts patterns of production and consumption across society. Therefore, the focus of each scenario is on how people are likely to respond to different combinations of these 12 technologies, how individual behaviours might shape future social patterns, and the potential consequences that would have for the transport system.
Four possible scenarios for the future of transport

Our assessment is that the evolution of these technologies will likely generate a broad spectrum of human responses, so the scenarios are not mutually exclusive. Rather, they represent ‘use-cases’ that are likely to co-exist. While we consider that these scenarios are the most likely to eventuate, others cannot be ruled out. It also remains unclear which, if any, scenario will become the dominant paradigm for future mobility. Consequently, strategies are needed that accommodate this end-state uncertainty and enable multiple potential outcomes.

My (autonomous) car is (still) king
Individual point-to-point trips in personally owned units
Customers have access to more personal point to point transport options using connected and automated vehicles that are increasingly customised to their needs (e.g. cars, pods)

We’re all in this together
Aggregated demand, shared-use and network optimisation
Customers access a broad range of automated (shared and personal) on-demand and mass transport modes with dynamic demand management and integrated payments

Super-commuting with public, active and shared transport
A lifestyle based on mass transit, flexible and active transport
Customers use an extended public transport, active and flexible shared-service network. Autonomous vehicles are for specific high-productivity uses only

Why travel so much?
Technology reduces demand for mobility
Customers choose where they wish to work, shop, learn, socialise and be entertained. Technology enables travel to be minimised as services are ‘delivered’ in or near the home

To respond to this uncertainty we need a strategy that will prepare us for multiple different futures
In this scenario, most Australians retain a strong attachment to their own cars. Driving continues to offer maximum flexibility and convenience, and the level of vehicle ownership is maintained or increases as fully-automated vehicle technology in electric-powered vehicles becomes affordable and attainable. Strong competition dramatically lowers their costs, aided by new business models that allow people to offset purchase costs by making their vehicle available when not in use. As a substitute for cars, some customers embrace point-to-point options such as powered bikes.
The utility of the mass public transport system is mainly confined to direct journeys along high-density corridors, where it is the only viable option for moving large numbers of people travelling at the same time, such as between central cities and key suburban centres. Its relevance has fallen away in other environments. This is particularly the case for short first- and last-mile trips connecting to train, metro and light rail services, where the benefits of connected and automated vehicles outweigh all other transport modes.

Connected and automated vehicles become the dominant means for the transportation of goods. This applies equally over long distances, as platoons of automated trucks provide a high proportion of the inter-city freight task, and over short distances, with automated drones providing last mile delivery services for a broad range of goods. The adoption of connected and automated vehicles by the freight sector involves a 1:1 displacement of conventional heavy and light trucks, but also the introduction of a fleet of new smaller vehicles for last mile delivery. Automation also significantly reduces the cost of last mile delivery, but induces a wave of new demand for home delivered goods and services.

Even though connected and automated vehicles can travel closer together and at higher speeds – and even though a portion of this fleet is shared-use – the fundamental shift in the economics of providing point-to-point transport has made these services relatively cheap, inducing new demand. More people travel in private vehicles on a heavily used road network, driving strong demand for additional road capacity.

All of this makes smart management of the transport network vital. A central transport management hub coordinates technologies and data sets to predict congestion, manage traffic flows and prioritise fleet movement. Dynamic demand management systems are used to better match capacity with demand. As a result, almost all deliveries now occur late at night, when other use of the road space is lowest, making full use of network capacity over the 24-hour cycle. Transport service providers use advanced algorithms to aggregate demand to match it to available capacity. This involves loading goods or conveying people in the same vehicles travelling at the same time and in the same direction.

Truck ‘platooning’ in connected and automated vehicles increases the productivity, efficiency and safety of freight traffic over long distances. Investment in smart motorways, initially necessary to support the adoption of vehicles with lower levels of connection and automation, can now be reduced because ubiquitous in-vehicle connectivity means that trucks and cars are constantly communicating with each other, and the network management centre, via the cloud.

In rural and regional areas, transportation choices are more limited as at present. The uptake of high-level automation takes longer as technology providers focus on boosting adoption in denser, urban areas. Through innovative service delivery strategies, technologies that enable demand-responsive community transport services are gradually created to better serve less mobile customers. These replace some existing public transport services. Higher-speed rail services also increase connectivity between regional towns.
Scenario 1: My (autonomous) car is (still) king

Connected, automated personal mobility

Future mobility is heavily automated with more single use, point-to-point trips

The travel experience will improve with increased comfort, privacy and productivity during their journeys, converting travel time to work time.

Ownership of connected and automated vehicles becomes increasingly affordable at an individual ownership level.

Customers highly value convenience and comfort of individual-use travel services and vehicle customisation.

Customers accept the increased travel times as travel becomes more productive with fully automated vehicles.

Customers will have access to more personal point-to-point transport options using connected and automated vehicles that are increasingly customised to their needs (e.g. cars, pods).

High acceptance and trust of automated vehicle technology.

Customers accept the increased travel times as travel becomes more productive with fully automated vehicles.

There will be more options for same-day/next-hour delivery of freight using unmanned automated vehicles.

Future Transport Technology I Roadmap 2016
2.2 Scenario two: We’re all in this together

In this scenario, technology disrupts the model of individual vehicle ownership with a strong shift towards shared mobility-on-demand services, combined with autonomous vehicle technologies. Customers access a mix of different transport options including cars, mass transit and personal mobility devices such as powered bikes and pods, depending on cost, convenience and their particular needs and preference. In urban areas, public transport remains the backbone, though people increasingly use shared car fleet services for short first- and last-mile trips to and from transport hubs, substantially reducing the demand for feeder bus services. Meanwhile, in rural and regional areas, more flexible mobility options gradually replace fixed route bus services, providing a more personalised service.
The sharing economy has continued to gather strength, reducing the need for private car ownership. Most people are concerned about minimising the cost of travel and being able to get where they need to be as quickly as possible. Growing concern about sustainability and increased awareness of the impact of travel choices on the environment reinforces widespread community preferences to spend their money on other things, like experiences, rather than buying and maintaining one or more vehicles. Technology aggregates demand for transport services and is used to create shared journeys. Dynamic demand management systems and subscription-based pricing schemes help match capacity with demand and influence mode choice during peak (such as the morning and afternoon commuter peaks and the weekend crunch).

Instead of using private cars, people increasingly organise their travel through integrated ‘mobility service’ accounts. Through an app on their mobile device, they choose from a variety of public and privately-operated transport services, found using an algorithm that considers price, travel time and other personal preferences. On the same single platform customers can make all mobility payments, get wayfinding information and provide real-time service feedback. The system intelligently and dynamically adjusts based on relevant information in real time. For example, if rain is forecast, it automatically switches from electric bike to shared shuttle for the customer’s transfer from station to home. In addition, customers can ‘befriend’ each other for the purpose of sharing a ride, and those with similar transport needs can be matched.

The same principle applies to transporting goods. A shift in industry thinking leads to major freight providers pooling capacity on major trunk routes and line hauls, and differentiating at the collection and delivery stages. Freight movements are aggregated at key distribution hubs, leading to more efficient load allocation on shared-use commercial vehicles. As in scenario one, most heavy deliveries are scheduled to occur late in the evening and at night when the demands on the road and rail networks are at their lowest, maximising the efficient use of the network. This provides some relief from traffic congestion during commuter peaks.

In this scenario, fully connected and automated vehicles are relatively expensive, but shared fleets offer relatively cheap point-to-point services. Centralised dispatch systems efficiently deploy vehicles to where they are needed, and use pricing to segment the market.

These vehicles can pick up multiple passengers prepared to share a trip and split the fare, pushing down travel costs even further. This growing trend reflects the rising popularity of services like UberPOOL today.13

In the freight sector, automated truck platoons achieve similar productivity and efficiency gains, so fewer vehicles are required to move people and goods around. At the same time, the lower cost of shared transport and more available space on the roads encourages some additional trips that may not otherwise have been made.

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13. UberPOOL now accounts for 20 percent of all Uber trips globally. See https://techcrunch.com/2016/05/10/uber-says-that-20-of-its-rides-globally-are-now-on-uber-pool/
Scenario 2: We’re all in this together
Mobility is collaboratively managed

Customers will be able to easily access a broad range of demand responsive transport services (mass, shared & personal) with seamless, frictionless payments.

Customers benefit from the convenience of point-to-point transport along with the cost savings of shared transport.

Moderate acceptance and trust of analytics to select optimal travel plans ('the algorithm knows best').

Customers embrace shared ownership and, multi-person transport modes.

Customers highly value their time and seek to minimise travel time.

Customers are used to multi-mode journeys and modal changes are seamless.

Digital platforms and transport providers manage customers’ transport requirements and provide a complete mobility solution for customers.
2.3. Scenario three: Super-commuting with public, active and shared transport

In this scenario, both in cities and regional centres, dramatic improvements are made in public transport coverage, efficiency and service provision, with sustained levels of superior customer experience, all delivered through a wave of next-generation technology investments. The public transport network is underpinned by data and analytics to the point where daily dynamic timetabling is possible, with adjustments made to accommodate real-time fluctuations in demand caused by weather and events. This flexibility allows operators to create additional capacity to respond to demand. In addition, services run more frequently and reliably due to the investment in connected and automated technology across the mass transit fleet, including heavy rail, light rail, metro and bus services.
Many more people access the public transport network as the speed, reliability and availability of services improves. This results in a growing new breed of technology-savvy public transport ‘super commuters.’ Customers receive personalised and contextualised communications on their smartphone about all aspects of network services. They also use technology to arrange seamless, short first- and last-mile trips connecting to and from mass transit hubs. Mobility on-demand applications allow customers to make real-time requests of transport service providers, such as automated shuttle bus operators. In addition, data analytics and machine learning allow these providers to accurately predict where and when these services will be required on a daily basis.

Integrating public transport with active and semi-active transport is a key element of this scenario. There is extensive investment in facilities supporting active transport built into each mass transit hub, and safe paths for a growing number of active transport users who walk and cycle. Train stations and major bus interchanges uniformly offer facilities and locker space to store bikes, clothing and personal possessions, as well as facilities where customers change and freshen up. Personal mobility devices such as pods and powered bikes have dedicated lane spaces to connect with mass transit hubs without impinging on the safety of other active transport users, such as pedestrians.

Customer productivity while travelling on public transport has increased. The design of the mass transit fleet includes professional working and meeting zones, equipped with the latest communications technology. Enjoyment of these facilities is possible as demand-responsive scheduling ensures that services are not overcrowded. Productivity zones also take pressure off peak hour services by allowing professional commuters to stagger their travel time. The need to be on duty at 9am (or still there at 5pm) is greatly reduced. Flexible working is a standard practice. Demand peaks have spread, services are highly utilised at all times of the day and, with automation, this has driven significant cost efficiencies.

The sharply increased use and popularity of public transport reduces personal car journeys. While connected and automated vehicle technology in electric-powered vehicles is accepted by the public, ownership is largely confined to business and shared fleet operators. Moreover, they are most often used for high-density point-to-point services, such as first- and last-mile connections, and by the freight industry. By contrast, access to connected and automated vehicles by individuals is primarily through car-share schemes. Dedicated, personal use autonomous vehicles are limited to sparsely-populated non-urban areas.

Despite this, road network remains important as it continues to fulfil its economic function in enabling the freight task, as well as providing the capacity for operation of a broad range of public and shared transport services. The local road network is used for delivery of goods and services and short trips in flexible transport service vehicles. The higher capacity arterial and highway network is used to support the central role of buses in delivering mass transit, and the movement of freight and services providers. Ongoing investment has continued to upgrade and complete this network, and embed the latest technology. This delivers efficiency gains in the end-to-end supply chain, with the core road network augmented by freight rail and intermodal terminals that rely on high degrees of automation and other technologies to be internationally competitive.
Scenario 3: Super-commuting with public, active and shared transport

Superior public transport experience through next generation technology

Future mobility is data driven and personalised through the use of data and demand driven services

Customers receive personalised and customised communication on their smartphone

Mass transit hubs and services are designed with productivity in mind

Customers value their time and want to reduce wasted travel time and increase productivity

Customers are health conscious and want to combine exercise with their daily commute

Customers manage their lives in real time using smart devices

Mobility on-demand services for first and last mile are available to customers to make real time bookings

Customers routinely use active and semi active transport to connect to mass transit hubs

Future Transport Technology | Roadmap 2016
The final scenario is based on a society where personalised services delivered door-to-door have improved dramatically and become significantly more affordable, reducing the need for people to travel as much in the first place. The spread of cloud computing and digital presence technologies has given people more flexibility than ever to choose where they work, learn and play.
Citizens have responded to this environment by choosing to do as much as they can at, or nearer to, their homes. For example, patients consult with doctors remotely rather than in person, and wear connected devices to monitor their health and wellbeing. Automated mobile units bring more complex patient care to the home. Online learning has supplanted traditional schools and universities, offering students a better experience and more time to work outside class.

Both in education and in the workplace, advances in videoconferencing, and virtual and augmented reality technologies, substitute for most face-to-face group and one-on-one interactions. Most students and employees work some days a week from home, or from remote activity-based hubs in their local communities where they can use a range of advanced technologies that need multiple users to justify the costs. This trend reduces costs for employers, as hubs provide a subscription-based service, replacing the cost of fixed real estate. This results in a shift in the balance of land use between residential, office, commercial and other uses.

People place a high value on their time and are sensitive to the costs of travel on their lifestyles, but advanced demand management systems also play a role in better matching service demand with network capacity. Other than for high-value trips, people minimise the time they spend travelling. When they do travel, they are more oriented towards the most time-efficient mode, resulting in moderate levels of owned and shared service personal transport. Mass transit is confined to the higher volume corridors. As a result, traffic from personal travel on the road network has not reduced as much as forecast. The reduced demand that does occur is offset by an increasing number of vehicles moving goods and services, and the road network is more oriented towards fulfilling its economic function on a user-pays model.

Advanced technologies in other fields related to the production of goods and services have led to a change in the overall freight task. Advanced manufacturing technologies such as 3D printing allow goods to be produced closer to their destination market, reducing transportation distances and the overall freight burden. At the same time, automation technologies have made same-day and next-hour deliveries inexpensive, further fuelling the popularity of online shopping. As a result, while the overall freight task may remain similar in terms of total goods consumed, the task has become much more focused on the last mile, spreading demand more evenly across the local and main road network and potentially increasing the total number of freight and delivery vehicles on the road.

Overall, the flattening of demand in this scenario moderates the pace of investment in transport infrastructure, compared to the other scenarios, where the intensity of demand remains and the mix of investment is adjusted in accordance with the requirements for additional capacity.
Scenario 4: Why travel so much?

Technology and planning reduces demand for mobility

Mobility loses its relevance

- The need to travel is minimised as services are delivered in the home through sophisticated augmented and virtual reality (e.g. health, education, work)
- Customers will be able to choose where they wish to work, shop, learn, socialise and be entertained from and have more flexibility than today
- Virtual presence accepted as a substitute for some face-to-face and in-person activities
- Customers continue to be willing to adopt new technologies rapidly
- Customers can order goods that are manufactured closer to them (e.g. via 3D printing) thus reducing the freight distances travelled
- Broad embrace of home delivery services as a time and effort saver
- In addition urban and district planning is focused on bringing services closer to communities
- Customers will be able to choose where they wish to work, shop, learn, socialise and be entertained from and have more flexibility than today
- Virtual presence accepted as a substitute for some face-to-face and in-person activities
- Customers continue to be willing to adopt new technologies rapidly
- Customers can order goods that are manufactured closer to them (e.g. via 3D printing) thus reducing the freight distances travelled
- Broad embrace of home delivery services as a time and effort saver
- In addition urban and district planning is focused on bringing services closer to communities
2.5. What does this scenario approach tell us?

The scenarios presented in this chapter illustrate the high level of uncertainty over how technology and, therefore, transport could unfold. As noted at the outset, these scenarios are not mutually exclusive. They represent the spectrum of different potential individual and collective responses to emerging technologies that will shape the demand for mobility. While government can exert some influence over how these future scenarios unfold, the overriding responsibility is to enable a dynamic market environment that responds to the needs of customers and the community, by crafting a strategy that accommodates the range of possibilities and will deliver value in all scenarios.
As explored in Chapter 2, there is uncertainty about how technologies may evolve and impact on the way people, goods and services move. It is even more difficult to predict how customers and businesses may respond to new services built on technologies that are yet to be conceived. Clearly, a flexible strategic framework is needed to deliver value across a range of scenarios.

Having identified the key technologies that will shape the future of the transport system, and considered the range of potential human responses to these technologies in different future scenarios, we have concluded that there are five key technology strategies needed to personalise transport. These strategies are to:

• Personalise customer interactions.
• Transform the mass transit network.
• Foster shared, demand-responsive services.
• Enable connected and automated vehicle platforms.
• Create intelligent transport networks, managed with data.
Five technology strategies that respond to potential future scenarios

In the rest of this chapter, each of the five strategies are explored and explained in more detail.

- **My (autonomous) car is (still) king**
  Individual point-to-point trips in personally owned units

- **We’re all in this together**
  Aggregated demand, shared-use and network optimisation

- **Super-commuting with public, active and shared transport**
  A lifestyle based on mass transit, flexible and active transport

- **Why travel so much?**
  Technology reduces demand for mobility

- **Create intelligent transport networks, managed with data**
  Install technologies and build networks that actively gather data. Use AI and real-time analytics to manage demand, optimise capacity, improve flows and enable better customer outcomes

- **Personalise customer interaction**
  Develop digital platforms that provide rich, contextual information, frictionless payment, easy navigation and two-way engagement to customise transport experiences

- **Transform the mass transit network**
  Apply technologies to automate mass transit solutions, improve their efficiency, deliver better service frequency and reduce transit times

- **Foster shared, demand-responsive services**
  Develop flexible and shared-use transport service models based on aggregated demand to meet market needs and extend transport access

- **Enable connected, automated vehicle platforms**
  Support adoption of vehicles and infrastructure that deploy automation to efficiently, reliably and safely move people, goods and services
3.1. **Strategy 1: Personalise customer interactions**

Delivering a personalised transport experience will require a new era of highly interactive customer service attuned to each person’s individual patterns of mobility and individual preferences. We will need to invest in developing interfaces that provide tailored journey plans, early disruption notifications, and trip advice that reflects location, time of day, and the customer’s own travel preferences. These systems will have machine learning embedded to enable them to understand individual mobility patterns, and enable smart systems to serve up relevant information that helps the customer plan their journey to arrive on time given the prevailing conditions at the time.

A second aspect of personalising customer interactions involves simplifying the payments experience. We will develop a single mobility account, which allows customers to use any form of transport across NSW with the core payment method for each mode (for example, the Opal card or e-Tag). For example, instead of having separate Opal cards and e-tags, payment technologies could become embedded in a customer’s smartphone or wearable devices, or other items they carry in their wallet or purse. Likewise e-tags may become embedded units. As part of this strategy, we will ultimately employ frictionless technologies that automatically detect presence, validate entitlements, measure usage, and collect the correct the payment with low or no customer effort.

3.2. **Strategy 2: Transform the mass transit network**

In any foreseeable future scenario there is a core role for the mass transit network. The ability of mass transit to deliver low-cost and high-capacity services along trunk routes which have high customer demand ensures that it will remain a core feature of the NSW transit network for many years to come.

In a system of personalised transport, the mass transit backbone will consist of highly automated metro, heavy rail, light rail, and bus rapid transit supported by seamless connections to local buses, ferries, and other shared and personal transport services.

To prepare for this future, we need to invest in widespread digitisation and data analytics to provide decision support that enables more efficient operation and maintenance, and better scheduling and resource management for mass transit services. This will contribute to creating additional capacity, improve on-time performance, lift reliability and reduce journey time, which are the core focus of technology investments in this strategy. Customers will also enjoy the convenience of more flexible timetables that dynamically flex and adjust to match demand.
Transport mode capacity

Mass transit – including light and heavy rail, buses and ferries – has an important role to play in the current transport network. These modes deliver very high throughput along major transport corridors. This allows the efficient movement of passengers and goods along routes where demand is high or road space is constrained.

Two major technologies will shift the balance of this equation. Shared-use technologies – such as passenger ridesharing, or freight demand aggregation and load sharing platforms – are increasing the number of people or goods per vehicle, making cars and trucks a more attractive option. At the same time, connected and automated vehicle technology will allow ‘platooning,’ reducing the space needed by each vehicle and increasing the capacity and throughput of road-based transport. Some estimates suggest that automated vehicles will increase highway lane capacity by up to 100 per cent once automated vehicles make up the majority of road users.

While these technologies will improve the throughput of private road vehicles, cars and trucks will still not compete with mass transit when there is a need to move a very high volume of people. The cost of delivering equivalent capacity by increasing road space to accommodate a greater shift to autonomous vehicles will be prohibitively high, and the overall feasibility is uncertain. As a result, mass transit is expected to remain a significant part of the future transport network.

Passenger throughput by transportation mode

<table>
<thead>
<tr>
<th>Transport Mode</th>
<th>Passengers per lane per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car (current technology)</td>
<td>0</td>
</tr>
<tr>
<td>Car (autonomous)</td>
<td>0</td>
</tr>
<tr>
<td>Car (autonomous ride pooling)</td>
<td>0</td>
</tr>
<tr>
<td>Bus (current technology peak)</td>
<td>10,000</td>
</tr>
<tr>
<td>Light Rail</td>
<td>25,000</td>
</tr>
<tr>
<td>Train (current technology)</td>
<td>30,000</td>
</tr>
<tr>
<td>Train (automated metro service)</td>
<td>40,000</td>
</tr>
</tbody>
</table>

Note:
- Passenger throughput from rail assumes 15 trains per hour each carrying 1,500 passengers.
- Passenger throughput for bus assumes 60 buses per hour, each carrying 75 passengers.

Source:
Transport from NSW, Infrastructure NSW, L.E.K. research and analysis.

Sydney’s peak hour flow on buses over the Sydney Harbour Bridge is 16,000
Sydney’s current suburban trains can reliably carry 24,000 people an hour per line.
3.3. Foster shared, demand-responsive services

Transport services have traditionally been constrained by a lack of information about customer demand. Customers essentially had two options: either mass transit with fixed routes and timetables or individual transport services, such as a personal car, taxi, or rideshare, which provided flexibility in route and timing, but at higher cost to customers and inefficient use of road capacity at times when demand is highest. New technology offers much greater flexibility in managing transport service provision by being demand responsive in real time. The future of personalised transport will involve customers being able to book flexible, on-demand local services to make first- and last-mile connections to and from mass transit hubs.

To prepare for this future, we need to incubate systems that enable customers to use a mobile device to book services that will arrive, on time, at convenient nearby locations, and support provision of vehicles that operate on the basis of sharing with others on the same pick-up path. Some systems are likely to be developed specifically for cities and denser urban areas. The same core value proposition can be offered in rural and regional areas, but systems are likely to be configured differently to meet mobility needs specific to customers in regional centres and remoter areas. Applications will also be developed for the freight sector, promoting greater efficiency in delivering goods and services.

Responding to this, we will incubate and encourage the growth in shared-use services, provided either by government, private operators, or the community itself. This will include supporting the safe operation of collaborative production and consumption models in which customers can use their own vehicles to provide rideshare services. As the adoption of connected automated vehicle technologies increases, we will foster ventures that use automated vehicles to meet the demand for shared transport options.

The opportunity space for flexible last-mile services

[Diagram of transport modes showing route flexibility and capacity, including personal car, taxi, ride pooling, bus, light rail, and heavy rail]
3.4. Strategy 4: Enable connected and automated vehicle platforms

Significant investments have been made over the past five years in developing next-generation connected and automated vehicles technologies, supported by both new technology companies and vehicle manufacturers. This technology is being rapidly prototyped and refined across personal vehicles, mass transit and freight vehicles, and industry is looking to these technologies to support new service models that are more attractive for customers. Regardless of the shape the future takes, it is expected that autonomous vehicles will be a part of the future transport system. A strategy is needed that enables the community to benefit from early adoption of these technologies. Trials and tests are needed to understand the technology systems requirements, the human response to the technology, and the safety and regulatory implications. Based on learnings, appropriate standards and regulations can be shaped.

NSW can then seek to influence outcomes that are nationally consistent and enable interoperability between states.

Trials also need to be designed to inform development of plans to modify the existing road network to accommodate fully connected and automated vehicles, and retro-fit any specific infrastructure requirements. Field trials need to be complemented with the development of a target operating model and transition plan that enables broader scale adoption of automated vehicle platforms.

Of particular interest in the field of connected and automated vehicle technologies are new applications available in the short term that can contribute to improved road safety or ease congestion. We will pursue development of applications of technologies that provide solutions to these objectives.

3.5. Strategy 5: Intelligent transport networks, managed with data

Personalised transport will be built on a foundation of data from customers, networks, infrastructure and vehicles, as well as from an increasing number of industry and third party sources. It is essential that we harness this data to manage and optimise the capacity of the transport network, improve flows, better utilise resources, enable better decision making, and improve the quality of the service that we provide to customers.

Responding to this, we will digitise our networks and assets, and augment them with a network of sensors and devices that will ensure that our transport infrastructure is ready to support the next generation of intelligent vehicles and services. In the near term our focus will be on installing this network of sensors, but also on creating the system capability to manage and process the data they generate and using that data to enable better decision making.

3.6. Delivering customer outcomes

As shown in the diagram on the following page, these five strategies focus on delivering specific customer outcomes. Implementing these strategies will be focused on delivering these outcomes. Specifically, through creative and innovative implementation of these five strategies, customers will be able to:

- Make easy, well-informed transport choices based on their personal needs and preferences.
- Have more public transport services delivered more reliably.
- Get from door to door more easily with flexible transport connections and seamless transfers.
- Enjoy the benefits of the latest automated vehicle technology reliably and safely.
- Fulfil their mobility needs efficiently and sustainably.
- Manage their mobility costs and pay for services simply and conveniently.
Using our technology strategies to deliver customer outcomes

These customer outcomes are at the core of our goal to personalise transport, and provide us with a reference point for implementing our five strategies. As noted in Chapter 2, uncertainties remain about how the future will unfold. Accordingly, we will be flexible in its pursuit of specific initiatives and investments, ensuring they keep pace with technologies as they evolve, but remaining firmly focused on delivering defined customer outcomes aligned to this framework.

**Objectives**

- **Enhance Customer Experience**
- **Better Connect Communities**
- **Transform Service Delivery**

**Technology-enabled strategies**

- **Personalise customer interaction**
  Develop digital platforms that provide rich, contextual information, frictionless payment, easy navigation and two-way engagement to customise transport experiences.

- **Transform the mass transit network**
  Apply technologies to automate mass transit solutions, improve their efficiency, deliver better service frequency and reduce transit times.

- **Foster shared, demand-responsive services**
  Develop flexible and shared-use transport service models based on aggregated demand to meet market needs and extend transport access.

- **Enable connected, automated vehicle platforms**
  Support 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**
  Install technologies and build networks that actively gather data. Use AI and real-time analytics to manage demand, optimise capacity, improve flows and enable better customer outcomes.

**Customer outcomes**

- Make easy, well-informed transport choices based on their personal needs and preferences.
- Have more public transport services delivered more reliably.
- Get from door to door more easily with flexible transport connections and seamless transfers.
- Enjoy the benefits of the latest automated vehicle technology reliably and safely.
- Fulfil their mobility needs efficiently and sustainably.
- Manage their mobility costs and pay for services simply and conveniently.
The NSW Transport Technology Roadmap

The NSW Government will deliver the five key technology-enabled strategies for personalised transport through a coordinated development program and a prioritised initiatives portfolio. Specifically, strategies will be implemented by:

• Continuing to invest in our own existing core technology platforms and collaborating with existing and emerging partners in the broader ecosystem of technology and data.

• Making selected, next step investments and pursuing prioritised initiatives that deliver value to transport customers, regardless of how the future evolves, though an approach based on co-development, proof of concept trials, as well as prior decisions to scale and roll-out.

• Being flexible and embracing new initiatives and developments, ensuring the program remains focused on capturing early benefits from long-term technology game changers.

Prioritising the full range of current, planned and potential investments contained in this Roadmap will require a different way of working within transport and with partners. In Chapters 5 and 6, we explain how we will strengthen our engagement and collaboration with external stakeholders and reform our organisational culture.
Three investment pillars to personalise transport

**A**

Continue investing in our own core systems, integrating them with the emerging ecosystem

- Continue investing in our own core technology platforms to equip us to leverage the emerging opportunities.
- Configure our systems to enable integration with key partners and emerging players in the broader technology ecosystem.
- Review and sharpen the focus of in-flight initiatives to align them to the technology-enabled strategies and target customer outcomes.

**B**

Make selected ‘no regrets’ initiatives, and stimulate trials and early adoption with new initiatives

- Make selected, new ‘no regrets’ initiatives that build new technology-enabled capability and deliver key business outcomes.
- Create the right settings to attract key players in emerging technology to NSW to pilot them under ‘test and learn’ conditions.
- Develop a set of blueprints that set standards and enable further investments and developments to align with longer range objectives.
- Make key investments to ‘change the game’ in each of the technology enabled strategies.

**C**

Change the way we engage and work with industry, disrupt established operation principles to become more agile, create a new management mindset and foster innovation

- Engage in open collaboration with industry, and reform procurement to harness innovative ideas from private sector partners.
- Shift our internal mindset to actively scan for new opportunity, adopt faster more flexible delivery cycles, and foster innovation.
- Enable the deployment of new technologies that will drive efficient, flexible and adaptable service delivery.
4.1. Core Future Transport technologies

The framework opposite shows how the core technology platforms that will deliver personalised transport need to be organised, developed and connected. This provides the reference point for identifying an action plan that coordinates which technology developments are needed to deliver any given new initiative.

Essentially, the digital platform accessed by customers in a world of personalised transport must be able to provide personalised information, aid navigation, collect payments and enable two-way engagement. Interfaces will need to be based on real-time information, current network conditions, and settings that optimise each individual’s journey according to their needs and preferences. A sophisticated, data-driven system will sit on top of the core operational technologies and enterprise platforms, delivering the information and services that customers want.
To deliver the target outcomes, each technology ‘layer’ will require continued investment, from our information communication technology backbone and core operational technologies to the systems that interface with customers. The proposed future focus for each of these technology layers is summarised below.

• **The Information Communication Technology and Enterprise Technology backbone.** Continue in-flight programs to upgrade our core enterprise technology platforms, ensuring there is an ability to scale and move quickly to accommodate future emerging technology add-ons.

• **Operational technologies.** Upgrade operational systems that support service delivery and asset maintenance, with a focus on automation, increased capacity and improved flow rates, reliability, availability, and safety.

• **Digitised networks.** Deploy fully digitised systems and processes for planning, delivery, operation and maintenance of infrastructure and assets, connecting them through digital engineering to enable a transport Internet of Things that generates rich data and enables intelligent network management.

• **Data generation.** Invest in systems that generate real-time and other data, as well as the framework of standards, systems and processes for generating, storing and sharing data.

• **Analytics and machine learning.** Develop advanced data analytics and artificial intelligence capabilities to generate and apply insights that will guide better decision making and facilitate real-time or near real-time management of network capacity and demand.

• **Applications.** Create dynamic demand and capacity management mechanisms that allow us to measure, aggregate and respond to customer demand.
4.2. Integrating with the broader transport technology ecosystem

Transport agencies’ systems do not stand alone. They are increasingly connected across organisational boundaries with the systems of a growing number of technology partners for exchange of data or to provide end-to-end technology solutions. It is clear that we cannot try to do everything ourselves. Rather, it will be essential to engage with an increasing range of partners.

A significant number of stakeholders will be involved in sharing the data needed to deliver transport in the future, from other government agencies, to technology companies, payment services providers, network owners, private transport operators, and vehicle manufacturers. The Transport Open Data and Innovation program is designed to catalyse the growth of this ecosystem, with over 2,000 third parties already working on transport data sets to deliver an array of new transport data applications.

Capturing best value from the increasing level of interconnectivity and shared solution development requires a fundamental shift in our overall operating model. Historically, we have taken a ‘design-build-run’ approach to delivering technology solutions in an operationally-focused environment. To accommodate new ways of working in an ecosystem of partners collaborating and sharing data, this must shift.

We need to play more of a ‘broker-integrate-orchestrate’ role, where we will mobilise a range of parties, bringing them into the ecosystem to co-develop a joined-up solution (‘broker’); create standards and processes to integrate their various systems (‘integrate’); and then coordinate them to deliver an outcome for customers (‘orchestrate’).
4.3. Alignment of in-flight initiatives

To improve services for transport customers, the NSW Government is investing more than $2 billion in core enterprise platforms, operational technologies and digital information and transaction platforms. For example, the Customer Channel Transformation program is integrating disparate transport websites built on last-generation technology, into a new, fully responsive digital platform that incorporates technology that will deliver more personalised information to customers. A major investment is also being made in a new Rail Operations Centre, which will transform the control systems for managing timetables, responding to incidents and serving customers with real-time information. New technology will soon be installed at the Transport Management Centre to equip it with the latest generation operational systems for real-time road network management.

These, and a range of other in-flight initiatives, are critical enabling investments that provide stepping stones to the deployment of the technologies that will personalise transport. The suite of in-flight programs, summarised in the diagram on the following page and described in more detail in Appendix C, have been aligned with the five key technology-enabled strategies detailed in Chapter 3. It is vital that the outcomes they deliver align fully with the core systems, processes and data requirements in this Roadmap. In the next phase of the Future Transport Technology program, the scope of each initiative will be reviewed to assess the degree of alignment with the Future Transport framework and identify any measures that may be needed to fully realise the value of their contribution.
### In-flight initiatives

#### Technology-enabled strategies

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>In-flight</th>
<th>Roadmap: Planned, possible, potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalise customer interactions</td>
<td>Transform the mass transit network</td>
<td>Customer Channel Transformation Program</td>
<td>Sydney Metro, Light Rail, and B-Line Programs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trial Contactless Card Payments on Opal</td>
<td>Sydney Trains Rail Operations Centre</td>
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<td></td>
<td></td>
<td>Digital Drivers Licence</td>
<td>Sydney Trains DTRS; ATP/ATO pilot</td>
</tr>
<tr>
<td></td>
<td>Foster shared, demand-responsive services</td>
<td></td>
<td>New suburban rail, intercity rail, bus and ferry fleets</td>
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<td>Enable connected, automated vehicle platforms</td>
<td>Point to Point Transport Reforms</td>
<td>Freight Safety (CITI) &amp; Priority Pilot (Premier’s Initiative: Cohda)</td>
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<td>Rural &amp; Regional Community Transport booking system</td>
<td>PTIPS system upgrade (v2.0)</td>
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<td>Create intelligent transport networks, managed with data</td>
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<td>Trials of C-ITS tech</td>
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<td>Open Data Program</td>
<td>Rollout of Smart Motorways</td>
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<td>Enterprise platforms upgrade (ERP, EAM)</td>
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Create intelligent transport networks, managed with data

Transform the mass transit network

In-flight initiatives
4.4.

The next step, ‘no regrets’ initiatives

Building on existing in-flight projects, we have identified a series of initiatives that we have concluded are the next steps in implementing each of the five core technology strategies. These are termed ‘no-regrets’ initiatives, as they will deliver value to transport customers, regardless of how technology developments play out. The three major groups of ‘no-regrets’ initiatives for each of the core technology strategies are summarised in the diagram on the following page and described in more detail in Section 4.6. The portfolio of potential projects is at Appendix A.

We have avoided overly prescriptive definitions of each initiative so we can develop a more detailed view through further industry engagement, prior to finalising this Roadmap. Likewise, a deliberate decision has been made to avoid using timescales, as we seek industry input on the best way to scope, develop, stage and deliver these initiatives for maximum early benefit. It is intended that work commence on some of these initiatives in 2017. However, we have not determined which initiatives to prioritise so we can seek industry input and guidance on the optimum approach, including the likely effort required, time horizons, risks and potential benefits.

Some of these proposed initiatives extend existing customer channels or operational systems to meaningfully improve the customer experience. For example, one of our aims is to extend the operation of the Opal card to facilitate payment for mobility services outside of its current footprint. With the development of complementary applications, payment solutions leveraging off the Opal platform could cover other mobility services, as well as regional public transport services. Other ‘no regrets’ initiatives apply technology to disrupt long established traditional transport systems and processes, such as timetabling and traffic modelling. These will require piloting under ‘test and learn’ conditions, with further scaling to occur once an effective solution is developed.
‘No regrets’ initiatives

Technology-enabled strategies

Personalise customer interactions
Transform the mass transit network
Foster shared, demand-responsive services
Enable connected, automated vehicle platforms
Create intelligent transport networks, managed with data

In-flight

Review and refine in-flight programs to align to and support strategy

‘No regrets’ initiatives

Integrate and transform digital channels for tailored, two-way interactions
Extend Opal functionality to create a state-wide mobility payment platform
Develop a single integrated account for mobility services
Automate networks and optimise timetable planning, service delivery and performance
Use analytics to optimise end-to-end customer journeys, routes and interchange
Create the blueprint for highly automated and fully digitised mass-transit networks
Trial on-demand transport services
Pilot a customised service model for regional centres that includes on-demand services
Incubate new ventures that encourage shared mobility services
Activate the Smart Innovation Centre for advanced transport technology
Foster development of the regulatory environment to support automated vehicles
Develop a blueprint and operating model for automated vehicles on network
Set up a Transport Data Science Incubator and expand Open Data
Trial AI applications that improve network management and/or customer service
Integrate predictive analytics into network asset management and maintenance

Future Transport Technology I Roadmap 2016
4.5. Beyond the next steps: the enduring long-term technology ‘game changers’

Beyond the next step, ‘no regrets’ initiatives, the complete transformation needed to personalise transport will require a new suite of technology applications. Again, we have identified the major developments that are needed to ‘change the game’ in each of the five technology-enabled strategies. While more enduring in nature, these longer-term technology-enabled game changers are less well defined because significant research and development is still needed, and they will only be possible with further maturity of new technology applications. For example, frictionless payments systems are in early trials but not yet proven. Despite the uncertainties, it is our assessment that collectively mature systems with these characteristics will deliver our vision of personalised transport.

These game changers provide a strategic framework through which we can identify and assess potential future initiatives and periodically revise and adjust the Roadmap.
Technology game changers for NSW transport

Technology-enabled strategies

- Personalise customer interactions
- Transform the mass transit network
- Foster shared, demand-responsive services
- Enable connected, automated vehicle platforms
- Create intelligent transport networks managed with data

In-flight

- In-flight programs

‘No regrets’ initiatives

- ‘No regrets’ initiatives

‘Game changers’

- ‘Game changers’

- Fully customised, smart digital mobility platforms
- Fully integrated information, ticketing, payment, and customer service systems
- Frictionless access and payments
- Dynamically adaptive timetables
- Increased automation of service delivery and maintenance systems
- Predictive tools for network planning, maintenance and service optimisation
- Flexible first-mile and last-mile services
- Dynamic demand aggregation and capacity management platforms
- Advanced demand-management mechanisms
- New applications of connected and automated vehicle technologies
- National automated vehicle standards and regulations
- Economically efficient use cases for connected and automated vehicle take up
- Systems and applications that enable data driven decision-making
- Widespread automated network management using real-time data and analytics
- Intelligent end to end transport networks, interchanges and logistic hubs
4.6. Outline of next-steps and game changers for each strategy

**Strategy 1:** Personalise customer interactions

Customers face two challenges in how to find information, navigate the network and interact with the transport service providers. First they rely on our generic, one-way communications interfaces, which do not respond to customers’ individual needs. The second is a fragmented landscape for payments that complicates access to the full range of transport modes, making it difficult for them to understand and manage their total spend on all forms of mobility. This strategy directly addresses these challenges.

**Next step, ‘no regrets’ initiatives**

- **Integrate and transform digital channels for more tailored, two-way interactions.**
  Use leading edge digital customer service technologies to integrate existing information and communication systems and create more personalised communication platforms that include digital navigation and two-way engagement.

- **Extend Opal functionality to create a state-wide mobility payment platform.**
  Enable Opal to be used as a payment platform for a broader range of mobility services across the entire state, make it work on other devices and integrate it with mainstream payment technologies.

- **Develop a single, integrated account for mobility services.** Integrate the back-end charging and payment systems to establish a single account for all public transport, registration and toll payments and enable other mobility service providers to integrate into it.

**The long-term ‘game changers’**

- **Develop fully customised, smart digital mobility platforms.** Leading edge technologies to personalise communications to a customer’s needs, incorporating real-time, predictive, journey-specific and situation-specific information, integrated in the one platform with digital navigation and feedback.

- **Fully integrated information, ticketing, payment, and customer service systems.** A single intelligent digital platform for all information, payment, navigation and service needs with full customisation, predictive capability and automated alerts.

- **Frictionless access and payments.** Devices that automatically recognise customers at point of payment with a single identifier and a single mobility account for all payments.

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Future Transport Technology  |  Roadmap 2016
Strategy 2:
Transform the mass transit network

While the customer experience will be more personalised, mass transit will remain a key component of service delivery. Major investments underway across the state lay the groundwork for transforming these networks. Completing the transformation requires higher levels of automation, with systems that enable dynamic management to improve operational efficiency and provide customers with more services where and when they need them, as well as reduced journey times.

Next step, ‘no regrets’ initiatives

- **Digitise networks and optimise timetable planning, service delivery and performance.** Use detailed passenger data and analytics to optimise rail timetables for customers, reduce end-to-end journey times and manage resources efficiently. Increase digitisation and use new technology applications and automation to enhance decision making and improve network performance, asset maintenance and service delivery.

- **Use analytics to optimise end-to-end customer journeys, routes and interchange.** Apply advanced analytics to Opal data, and data from other sources, to analyse end to end customer journeys, and apply the insights to better configure bus routes and networks, reduce interchange time and create a dynamic platform for setting and adjusting timetables to more closely match customer demand patterns.

- **Create the blueprint for highly automated and fully digitised mass-transit networks.** Plan the deployment of latest-generation technologies to lift the efficiency and reliability of networks. Develop a plan for facilitating real-time remote monitoring and operational management of mass transit modes, supporting continuous, rich, real-time service information for customers.

The long-term ‘game changers’

- **Dynamically adaptive timetables.** Predictive capability and highly automated planning and service delivery systems that enable timetables and schedules to respond dynamically to changes in demand, and adjust to changes in the external environment.

- **Increased automation of service delivery and systems maintenance.** Automated technologies for operation and maintenance of mass transit networks that improve the safety, reliability and availability of services, and reduce end-to-end journey time.

- **Predictive tools for network planning, maintenance and service optimisation.** Systems and technology-enabled tools that enable better decision making and more efficient resource uses for planning, maintenance, operational, traffic and network management.
Strategy 3:

Foster shared, demand-responsive services

Shared-use services provide an opportunity to personalise transport for customers, reduce pressure on road networks and make use of latent transport capacity. The rise of the ‘sharing economy’ indicates this could be a strong growth market. The initiatives in this strategy are based on organising pilots to demonstrate the viability of these types of service, better understand the nature of demand and reduce the risks inherent in new markets. This is intended to encourage the entry of new private providers, bringing further innovation to transport service delivery in NSW.

Next step, ‘no regrets’ initiatives

- **Trial on-demand transport services.** Co-develop and pilot new service models with delivery partners to create on-demand services connecting to major mass transit projects like the Sydney Metro, light rail and B-Line and, potentially, other services.

- **Pilot a customised service model for regional centres that includes on-demand services.** Develop and pilot a customised transport information and payment platform, including options for flexible, on-demand services, to gauge the benefits for regional communities.

- **Incubate new ventures that encourage shared mobility services.** Establish a program that fosters shared-use service models, including ridesharing and car-pooling, by partnering to develop any required enabling platforms and adjusting regulatory settings to enable service delivery.

The long-term ‘game changers’

- **Flexible first-mile and last-mile services.** Flexible service models for connecting customers to the mass transit networks from their origins and destinations, optimising the supply chain and enabling more efficient delivery of goods and services.

- **Dynamic demand aggregation and capacity management platforms.** Systems and platforms that support shared-use services, demand pooling and capacity optimisation for the movement of people, goods or services.

- **Advanced demand-management mechanisms.** Digital customer channels and other mechanisms that shape transport demand and match it to supply.
Strategy 4:

Enable connected and automated vehicle platforms

Vehicles with higher levels of functional automation, along with the development of other specific technology solutions, offer potential gains in road safety and reliability. Connected and automated vehicles will require nationally consistent regulations as well as standards that are compatible with emerging technology platforms. In the early stages, it is important to gain an understanding of the interactions between connected and automated vehicles and infrastructure, as well as the human responses triggered by automated vehicle technology. This will point to the regulatory settings that may be needed, as well as the infrastructure and operational requirements. The actions outlined here aim to create a low-risk, attractive environment for testing, trial and adoption, and to gain an understanding of how best to harness the benefits of the technology for the community in NSW.

Next step, ‘no regrets’ initiatives

- **Activate the Smart Innovation Centre for Advanced Transport Technology.** Establish and extend collaborative partnerships with research, industry, funding and innovation partners to develop technology applications that improve road network safety and reliability, as well as develop, test, and trial connected and automated vehicles and the enabling infrastructure and systems in a controlled environment.

- **Foster development of the regulatory environment to support automated vehicles.** Take a leading role in shaping and influencing a national legislative and regulatory framework that supports the introduction and early adoption of connected and automated vehicles, provides market clarity to support confident investment, and stimulates interest from global players.

- **Develop a blueprint and operating model for automated vehicles on network.** Model the options for migration of automated vehicle operations onto road networks, evaluate the implications for traffic flows and network management, determine the behavioural and economic implications and develop options to foster early adoption where there is greatest benefit for the NSW community.

The long-term ‘game changers’

- **New applications of connected and automated vehicle technologies.** Increasing adoption of vehicle automation technologies that improve road network safety and reliability, with early adoption likely occurring on open highways and in dedicated lanes.

- **National automated vehicle standards.** A set of nationally consistent connected and automated vehicles standards, protocols and regulations that enable interoperability.

- **Economically efficient use-cases for connected and automated vehicle take up.** Specific use-cases for automated vehicles on the open network that improve economic, environmental and social outcomes, with a supporting market environment that enables early adoption.

### In-flight

- Freight Safety (CITI) & Priority Pilot (Premier’s Initiative: Cohda)
- PTIPS Bus Priority Pilot
- Trials of C-ITS tech
- Draft NSW DoI Electric Vehicle Strategy

### ‘No regrets’ initiatives

- Activate the Smart Innovation Centre for advanced transport technology
- Foster development of the regulatory environment to support automated vehicles
- Develop a blueprint and operating model for automated vehicles on network

### ‘Game changers’

- New applications of connected and automated vehicle technologies
- National automated vehicle standards and regulations
- Economically efficient use cases for connected and automated vehicle take up
Strategy 5:  
Create intelligent transport networks managed with data

To unlock the value of technology-based applications that use data to manage the transport system, we need to bring together the right partners, capabilities, data sets and systems. The immediate focus in this strategy is to tackle the bigger operational challenges facing our transport network. These include better management of network capacity, improved traffic flows, more effective disruption management, improved asset maintenance and condition, and better decision support tools to improve service performance or better connect communities. These advances will be matched to enriching information available to customers. New developments in machine learning and artificial intelligence are also likely to emerge in the near term. The strategy will be to incubate new applications, trial new uses and become early adopters, particularly where there are opportunities to enhance the customer experience or personalise service.

Next step, ‘no regrets’ initiatives

- **Set up a Transport Data Science Incubator and expand Open Data.** Partner with data science organisations to set up a Transport Data Science Incubator, implement measures to expand use of the Transport for NSW Open Data Platform and stimulate innovative applications of a variety of high-volume complex data sets.

- **Trial Artificial Intelligence applications that improve network management and/or customer service.** Partner with third parties to develop, test and trial applications that enable improved management of network operations and provision of services to customers.

- **Integrate predictive analytics into asset management and maintenance.** Test and trial new technology applications and techniques that improve asset management and maintenance practices to increase asset uptime, reliability and safety assurance.

The long-term ‘game changers’

- **Systems and applications that enable data driven decision-making.** Overlays and upgrades to operational systems that enable mass transit networks to be managed with real-time data being drawn from a range of internal and external sources.

- **Widespread automated network management using real-time data and analytics.** Advanced data-driven network management systems and tools that can be deployed to increase the automation of network management functions, optimise capacity, improve flows, or enhance network resilience.

- **Intelligent end-to-end transport networks, interchanges and logistic hubs.** Use of sensors, data, artificial intelligence and automation technology for the movement of people, goods and services that provides coordinated end-to-end mobility, without the need for human input.
The NSW Transport Technology Roadmap for 2017 onward

**In-flight**

- **Personalise customer interactions**
  - Customer Channel Transformation Program
  - Trial Contactless Card Payments on Opal
  - Digital Drivers Licence

- **Transform the mass transit network**
  - Sydney Metro; Light Rail Program
  - Sydney Trains Rail Operations Centre
  - Sydney Trains DTRS; ATP/ATO pilot
  - New suburban rail, intercity rail, bus and ferry fleets

- **Foster shared, demand-responsive services**
  - Point to Point Transport Reforms
  - Rural & Regional Community Transport booking system

- **Enable connected, automated vehicle platforms**
  - Freight Safety (CITI) & Priority Pilot (Premier’s Initiative: Cohda)
  - PTIPS system upgrade (v2.0)
  - Trials of C-ITS tech

- **Create intelligent transport networks managed with data**
  - Open Data Program
  - Rollout of Smart Motorways
  - Enterprise platforms upgrade (ERP, EAM)

**‘No regrets’ initiatives**

- **Integrate and transform digital channels for tailored, two-way interactions**
- **Automate networks and optimise timetable planning, service delivery and performance**
- **Trial on-demand transport services**
- **Freight Safety (CITI) & Priority Pilot (Premier’s Initiative: Cohda)**
- **Open Data Program**
- **Enterprise platforms upgrade (ERP, EAM)**

**‘Game changers’**

- **Fully customised, smart digital mobility platforms**
- **Dynamically adaptive timetables**
- **Flexible first-mile and last-mile services**
- **New applications of connected and automated vehicle technologies**
- **National automated vehicle standards and regulations**
- **Economically efficient use cases for connected and automated vehicle take up**
4.7.

The strategy and roadmap for freight

‘Freight’ is shorthand for the set of business activities that enable the movement of goods and delivery of services across the transport network. It benefits citizens of NSW directly, through the delivery of these goods and services, and it benefits enterprise by enabling trade and commerce. An efficient and effective freight network is vital to the economy of NSW. As the scenarios in Chapter 2 outline, the application of emerging technologies has potential to reshape the way goods and services are produced and consumed, with significant implications for the future of the freight sector.

This Roadmap is designed to encompass initiatives focused on applying new technologies to the freight sector, as well as personal mobility. Technology can customise the way freight works for its customers, enabling suppliers to personalise goods and services. The five future technology-enabled strategies will be applied to the freight sector in a slightly modified form as follows:

• Customise freight services and transactions.
• Transform the core elements of the supply chain.
• Foster shared, demand-responsive services.
• Enable connected and automated vehicle platforms.
• Create intelligent freight transport networks, managed with data.

The overarching objectives of innovative applications of new technology and the execution of these strategies for freight are to enhance the capacity, efficiency, effectiveness, competitiveness and sustainability of the freight sector.

As freight operates principally on shared transport networks, the intent in this Roadmap is to ensure that each of the ‘no-regrets,’ next step initiatives deliver benefits and outcomes for both personal mobility and freight where it is relevant. Transport agencies will also continue to work collaboratively with freight sector customers to develop and execute specific technology-enabled initiatives in this Roadmap that will deliver on these objectives.
4.8. Fostering innovation

Experience in other sectors shows that innovation also occurs in ‘corner cases’ that are not the main focus of a program to adopt new technologies. It is vital we remain open to potential high-value innovation around the fringes of the Roadmap.

Transport recently established an innovation program for employees (called the Intrapreneurs’ Hothouse), and with developers (via the Open Data Hub and Innovation Challenges).

As well as allowing for creative ‘left field’ thinking, these innovation programs are focused on delivering smaller-scale initiatives that use new technologies to deliver practical, incremental improvements in an aspect of the everyday customer experience of transport.

There is a new wealth of concepts in an ‘ideas bank’ from contributions at the Future Transport Summit and from the Open Data Program. Some have been progressed through the Innovation Challenge program. They focus on a specific transport opportunity (for example, creating a digital version of the learner driver logbook, which is currently in incubation). Digital entrepreneurs from start-ups are invited to pitch concepts, and the most promising three to five are then co-developed.

Recognising Transport Cluster staff have valuable insights on how to better serve customers, an internal innovation program has also been established. In June 2016 the first Intrapreneurs’ Innovation Challenge invited our own people to put forward ideas about how to use technology available today to address a transport challenge and deliver an improved customer outcome. Over 500 employees put forward their concepts which were filtered and, in some cases, combined to provide a portfolio for priority development. These are being rapidly advanced through to an initial prototype using customer-centred design-thinking. After an executive pitch for sponsorship, selected prototypes move to development of a proof-of-concept for a pilot or trial, with the support of an Intrapreneurs Innovation Micro-fund.

As well as stimulating rapid development of customer-focused technology-driven innovation, this program provides team members with valuable ‘learning by doing’ experience in a new framework for developing solutions. Having learned some of the disciplines of human-centred design thinking, they take this knowledge back to their day jobs and to their teams. This seeds the use of new techniques to improve internal processes, cut red tape and be more agile in pursuing other opportunities to improve transport for customers.

As part of Roadmap implementation, it is intended to strengthen these programs and broaden their reach. The aim is to stimulate further innovations that will, potentially, lead to solutions to the bigger challenges, while making smaller-scale advances in enhanced service delivery and customer experience.
Our Intrapreneurs’ Hothouse

In our Intrapreneurs’ Hothouse, a human-centred design-thinking process is used to explore the customer view of the problem, and a prototype solution developed using agile methods. Teams are made up of three to five employees, mostly from the front-line and from a blend of disciplines across the Transport Cluster, bringing a diversity of thinking and perspectives. These teams are the originators of the concept and become the ‘product managers’ for its development.

Following design-thinking techniques, the teams focus on understanding the customer view by talking to customers and observing behaviour. They develop and then test their prototype solution with customers to validate their concept and get first hand feedback. They also create a plan to take the prototype through to a Minimum Viable Product (MVP) and an initial product roadmap for future developments. After this three week process, teams showcase their work the Transport Executive and pitch for sponsorship and funding for the next stage of their roadmap. The prototypes are then either supported for development or placed in a ‘parking lot.’ In the first three months of its operation, 10 prototype concepts have secured support for further development. A lean UX (User Experience) team will develop these concepts under the guidance of the product managers to ensure the vision is delivered.

Real-time passenger information displays on buses. The ability to provide ‘next stop’ information

Eye in the sky. Use drones to monitor the network to address congestion management or monitor track maintenance

Take a seat. An app that helps customers to find where there are available seats on the train

Safety first. An app using data analytics and camera detection capabilities to monitor and address driver fatigue

Managing congestion ‘hotspots.’ Use congestion data analytics to address key hotspots such as Sydney Airport

RMS signage register. An app to enable capture, maintenance and publishing of signage data

Speak my language. Digital multi-lingual information services to support staff customer interaction (Including Auslan)

Driver’s aid. Put a driver’s aid on the Opal console for on-time bus running and help with learning new routes

In the know. Use multi-purpose digital screens at stations and bus interchanges for advertising and customer information

Intelligent digital chat live. Integrate customer service with social media tools

Commuter car parks for commuters. A system that makes commuter car parks free for public transport user but paid by others, with a real-time information app

What’s going on? An app with information on all planned major events and network closures across the state

Opal Call-A-Bike. An app-based bicycle-hire scheme operating from selected train stations, linked to Opal cards

Safety on the water. An app with boating information and real-time weather alerts

Electronic tow dockets. A digitised system for towing and recovery of illegally parked vehicles

SMS and be safe. An SMS alert system that customers can use to provide alerts on anti-social behaviour

Be cool, car-pool. An app-based cooperative car-pooling scheme developed for transport employees across Sydney

Giving back. Reverse vending at train stations for drink containers, where the deposit scheme donates to a cause

Don’t panic app. An app that gives updates, alarms and information in an emergency situation

Household Travel Survey app. Link the Household Travel Survey to Opal, with enhanced data collection capability
The process

Intrapreneurs’ ideas

Incubator

Problem

Solution

Approve

Park it

Further scoping or concept testing

Just do it

Lean team

Lean team, co-designer or handover
Changing how we engage externally

Delivering this Roadmap will take more than identifying the right list of technology initiatives.

Due to the nature of the next-steps initiatives, there is a need for Transport for NSW to change the way it collaborates with delivery partners and the way it does business. This chapter explains the steps we will take to improve how we interact with delivery partners. Chapter 6 commits to widespread internal changes designed to stimulate development of a technology-led customer-centric culture. Both are necessary to implement this Technology Roadmap and keep pace with rapid technological change.

5.1. Collaborate with the industry and other experts

Increased collaboration with delivery partners will be vital to how we deliver this Technology Roadmap. Reforming the way we engage with industry, including technology companies, service providers and vendors, will involve:

- Engaging with industry earlier in the planning and development process.
- Being explicit about our objectives and investment criteria.
- Enabling structured dialogue between key decision makers.
- Providing structured opportunities to provide input on potential solutions.
- Being easier to deal with, by developing a more flexible and nimble approach to procurement that suits both large scale and smaller agile investments.
It is proposed to evolve our approach to procurement so that it is more oriented to specifying the outcome required, rather than prescribing the solution to be delivered. Processes will be revised to enable us to engage with industry earlier in project planning, harnessing its creativity.

A set of criteria and a process will be established that gives government the option of commissioning one or more proofs-of-concept or directly contracting for a trial of a new technology. While these approaches will need to satisfy tests of equity, transparency and value-for-money, the ultimate objective is to enable the delivery of the Technology Roadmap sooner, at lower cost and with greater benefit than would be possible by the conventional process.

5.4.
Build flexibility into our planning and delivery approaches

Transport projects typically run over multiple years, after project requirements have been documented and signed off early. Technologies that appeared risky at the time of project scoping have the potential to become mainstream by the time the project is completed and commissioned, putting us a generation behind from the start. To prevent this, planning and delivery teams must engage with vendors and actively scan for new opportunities and potential disruptors to incorporate into our technology investments.

A more flexible framework for the management of project requirements will be developed to enable incorporation of new developments after sign-off where they meet agreed criteria. Agile project delivery methods will be adopted where appropriate. Provisions will be made to manage obsolescence and to enable upgrade post-completion so that the technology remains fit for purpose and as a platform for future development.
Create a flexible, responsive and ‘agile’ regulatory framework

There is a risk that legislative reform and the regulatory environment fail to keep pace with technological change. This can be particularly problematic when legislation is too prescriptive or based on implicit assumptions regarding use of particular technologies. We will champion a legislative framework that establishes requirements and outcomes, but is technology-neutral on how these are achieved. Where government does need to define its response to technology solutions, this will be done through regulations and government policies. This has the advantage of enabling more frequent and rapid review, supported by input from external stakeholders. This will minimise the potential for regulations to impede the benefits of uptake of new technology, allowing for flexible approaches to achieving the regulatory objectives and outcomes. Our aim will be to deliver consistent, light-touch regulation and investment certainty.

While moving to this new agile framework, the NSW Government’s approach to policy and regulation will depend on its context, and have regard for the community’s expectations of its role. For example, while enabling new models for ridesharing, the community rightly expects government to provide adequate protections for safety, security, privacy and preservation of individual rights, and protection from a range of potentially undesirable or unacceptable market behaviours. Community expectations will always be solicited, understood and addressed as we make regulatory and policy changes that enable NSW to embrace the benefits of new transport technologies.

To create the right environment for rapid adoption an ‘agile’ legislative and regulatory framework is also needed

Move away from

• Focus legislation on technology-neutral requirements and outcomes, with regulation and policy for more detailed mechanisms.
• Regular industry and stakeholder consultation to support rapid review.
• Light touch regulation in a stable framework to provide investment certainty and enable appropriate controls, whilst enabling new technology to be adopted.

20+ year cycles for major legislative reforms based on traditional government processes, committees, papers and submissions.
Beyond shaping the regulatory environment, government must also make choices about the role it plays in implementing the strategies and initiatives set out in this Roadmap.

In some elements of strategic execution, government is likely to take the lead and control the process. For example, where we provide or fund mass transit services, and where government builds and maintains infrastructure, we will most likely be directly involved in piloting and rolling out new technologies. This is particularly the case where innovation is designed to improve the efficiency, accessibility, safety or attractiveness of infrastructure and services that need to be taxpayer-funded.

However, where private sector start-ups have the opportunity to create disruptive new transport models or breakthrough customer service apps, our preferred role is that of facilitator, enabler or collaborator. For example, as manufacturers seek to promote the widespread adoption of connected and automated vehicles, government can add maximum value by creating a stable, transparent regulatory and market environment, and providing clear boundaries within which unfettered innovation is able to occur. It can also facilitate cooperative trials that enable government and the private sector to better understand what each party needs to do to facilitate rapid adoption.

While government is unlikely to underwrite entrepreneurial risk, it does have a role to play in stimulating private sector innovation where new technology has potential to benefit customers. Adopting an active role in these areas may involve a defined commitment to a different approach that enables cooperative research and development, or to pilot programs that support initial deployment and concept testing. It could also mean building customer interfaces or modifying the government-owned customer interfaces to enable access to the underlying technology.

Finally, we are mindful that we cannot be the first mover in everything. We need to take a strategic view of where our presence at the outset of the innovation cycle is likely to deliver maximum benefit, as an incubator and developer of new solutions. It also means that in some aspects of the development and deployment of new technologies we will be an ‘early adopter,’ placing NSW among the first jurisdictions in the world to deploy a technology or to support it with policies and regulations. There will be other situations where we are likely to be a ‘fast follower,’ deploying technologies that are not yet widespread but where several successful use-cases already exist.
## Role and stance of NSW Government in key technology investment areas

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Our role</th>
<th>Our stance</th>
<th>Our development approach</th>
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<tbody>
<tr>
<td>Create tailored, personal, individual, interactive digital channels</td>
<td>Service provider</td>
<td>Early adopter</td>
<td>Transport Digital Incubator</td>
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<tr>
<td>Extend Opal functionality to create a state-wide mobility payment platform</td>
<td>Service provider, market creator</td>
<td>Incubator</td>
<td>Transport Digital Incubator</td>
</tr>
<tr>
<td>Automate and optimise rail service planning and delivery</td>
<td>Service provider</td>
<td>Incubator</td>
<td>Transport Digital Incubator</td>
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<tr>
<td>Create the blueprint for fully wiring and digitising the mass-transit network</td>
<td>Asset owner</td>
<td>Fast follower</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Use analytics of end-to-end customer journeys to improve routes and interfaces</td>
<td>Service provider</td>
<td>Incubator</td>
<td>Transport Digital Incubator</td>
</tr>
<tr>
<td>Pilot demand-responsive, personalised transport services on the Sydney Metro network</td>
<td>Service provider</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
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<tr>
<td>Pilot demand-responsive regional service model and customer channels</td>
<td>Service provider, market creator</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
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<tr>
<td>Incubate new ventures that encourage shared mobility services</td>
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</tr>
<tr>
<td>Establish a Smart Innovation Centre for advanced transport technology</td>
<td>Enabler</td>
<td>Incubator</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Create the regulatory environment to support automated vehicles</td>
<td>Regulator</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Run a closed-system pilot and controlled trials of automated vehicles</td>
<td>Regulator</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Deploy advanced analytics for intelligent network management</td>
<td>Regulator</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Deploy advanced analytics for intelligent network management</td>
<td>Service provider, asset owner</td>
<td>Early adopter</td>
<td>Adopt best practice</td>
</tr>
<tr>
<td>Set up a Transport Data Science Incubator and expand the Open Data Hub</td>
<td>Service provider, asset owner</td>
<td>Incubator</td>
<td>Transport Digital Incubator</td>
</tr>
<tr>
<td>Integrate predictive analytics into network asset management and maintenance</td>
<td>Asset owner</td>
<td>Fast follower</td>
<td>Adopt best practice</td>
</tr>
</tbody>
</table>
### The relationship between government and technology

#### Roles of government

<table>
<thead>
<tr>
<th>Regulator</th>
<th>Service provider</th>
<th>Asset owner</th>
<th>Market creator</th>
<th>Enabler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government policy, regulations, legislation</td>
<td>Delivery of transport services (both directly or via procurement from private sector)</td>
<td>Planning, construction and maintenance of assets and infrastructure</td>
<td>Use of fiscal settings to shape industry &amp; market development</td>
<td>Raise awareness of technology and facilitate adoption</td>
</tr>
</tbody>
</table>

#### Options for government stance and definitions

<table>
<thead>
<tr>
<th>Preserver</th>
<th>Fast follower</th>
<th>Early adopter</th>
<th>Incubator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pursue regulations to protect consumer safety &amp; equity of access</td>
<td>Eases existing legislation or regulations for trials and collaboration</td>
<td>Revises legislation and regulation to match leading practice jurisdictions</td>
<td>Introduces new legislation in support of the technology trend</td>
</tr>
<tr>
<td>Specify detailed safety and functional requirements to protect users</td>
<td>Consideration of technology is a factor in assessment framework</td>
<td>Will adopt new technology where only one or two reference sites exist</td>
<td>Technology is included in requirements and co-developed with vendor</td>
</tr>
<tr>
<td>Avoids use of non-traditional or unproven technologies</td>
<td>Trials or pilots new technologies in asset builds</td>
<td>Open to adopt new technology where only one or two sites exist</td>
<td>Engage with technology developers to co-create asset</td>
</tr>
<tr>
<td>Act to address market failures or unwanted externalities</td>
<td>Government provides some incentives to establish a market</td>
<td>Provides incentives to refine and replicate proven models</td>
<td>Collaboration, grants and subsidies to support early trials/pilots</td>
</tr>
<tr>
<td>Cautions market against take-up of new technology</td>
<td>No active role in awareness or facilitation</td>
<td>Supports collaboration with proven technologies</td>
<td>Supports partners with new technologies</td>
</tr>
</tbody>
</table>
6.1. Why we need to reshape how we work

Putting Transport for NSW at the forefront of adopting new technology requires internal transformation.

Government entities are typically designed using an organisational model that academics refer to as ‘machine bureaucracies.’ In these organisation types the imperative is to maintain a stable environment and deliver predictable outcomes with little variance. They are risk and change averse, have specialised and compartmentalised tasks, centralised authority and use command and control structures. This is well suited to maintaining the status quo, and delivering carefully managed incremental change. A different approach is needed in a dynamic, technology-enabled environment.

Transport for NSW is relatively new, having been formed in 2011. While it has cultivated a strong customer focus and initiated a range of service improvements, some hallmarks of the machine bureaucracy remain. This is important for fulfilling key objectives, such as the management of safety outcomes and ensuring compliance with standards. While sustaining practices and systems that underpin the delivery of such core objectives, internal change will be vital to realise the opportunities inherent in early adoption of new technologies.

The pace of development in its environment and the tasks that Transport for NSW must perform are driving change within our organisation. The need for quick and effective delivery of this Roadmap provides added impetus. Implementation of this Roadmap will require new ways of working. Changes will be required in core processes, capabilities and culture to transform Transport for NSW into a technology-driven business.
6.2. Set up an entity designed to enable incubation

Market leading organisations in other sectors have adopted a variety of different organisational and business models to deliver technology-driven transformation and enable innovation to flourish. Given their innovative nature, the delivery of a number of initiatives in the Roadmap is best-suited to similar methods. After examining the approaches typically used by leading global innovators, we intend to establish a separate entity designed to enable accelerated delivery of initiatives, and rapid transfer and adoption across the transport system once the viability of an initiative has been established.

This Transport Digital Incubator will be established, both to cultivate a ‘global hotspot’ for transport data sciences and to develop, prove, scale and roll-out initiatives set out in this Roadmap. Within the Incubator, leading practices will be adopted to enable rapid prototyping and development of a portfolio of specific opportunities for new applications.

Some of the practices used to manage innovation in the venture capital field will be adopted, with the setting of targets for returns, clear deadlines, go-no go criteria, and a framework for prioritising and managing a portfolio of opportunities. While developing solutions for Transport for NSW to deliver the Roadmap, we intend to identify potential broader commercial applications, and pursue them where appropriate.

The purpose in establishing this entity is to:
- Foster collaboration with industry and the start-up community, with a bias to partnering.
- Avoid Roadmap initiatives being taken over by ‘business as usual’ priorities or overly burdened by processes designed for these activities.
- Put in place simple, lean processes and practices that ensure taxpayer funds are used wisely.
- Stimulate disruptive changes in established transport systems and processes, as well as enabling new innovative products and services to be developed for customers.
- Take a portfolio approach to managing development, testing and trial of initiatives in this Roadmap.
- Draw on the talent and experience available from within the Transport Cluster and attract specific capabilities not normally found in government, as needed.
- Provide teams with the freedom to work innovatively, while ensuring outcomes are achieved.
- Take a fresh approach to delivery of solutions, develop and run them in parallel with ‘business as usual’ until proven viable and support transfer once proven.

The Transport Digital Incubator will have its own management structure. Governance will be provided by a Board consisting of Transport Cluster executives and external experts with a record of success in technology ventures or start-ups. This Board will be responsible for overseeing the portfolio approach, approving Roadmap-related investments and ensuring there is a return on those investments, whether from cost savings, improved services or commercial returns. The Board’s remit will be to oversee development of new concepts and business models; ensure disciplined management practices are in place to assess and review the feasibility and viability of potential and in-development initiatives in a pipe-line; and to ensure there is a clear pathway to rapid transfer and early adoption of successful initiatives.

Building on the existing ‘innovation engines’ of the Intrapreneurs’ Hothouse and the Innovation Challenges, additional innovation engines will be set up to support the incubation process. Small, specialised ‘blended’ teams, that bring together people from ‘business as usual’ with delivery partners in the Incubator, will be tasked to deliver time-boxed targeted innovation projects. As well as developing concepts from the Roadmap, a process will be established for industry to actively propose projects for consideration. There will be a bias towards collaboration, and intent to venture jointly on initiatives that can be rapidly prototyped and tested through a low-cost proof-of-concept. Evaluation and decision guidance will be a key role for the Board.
6.3. Treating data as a shared enterprise asset

In developing this Roadmap it has become clear that data, analytics and innovative applications built on transport data sets are keys to successful execution. Data is a critical organisational asset, and a key point of leverage. Transport for NSW is on a journey that has started to improve how data is produced, organised, distributed and shared. This will be accelerated to support Roadmap implementation. New opportunities to use of a broader range of transport and other data-sets will be seized wherever there is potential for customer value or broader business value.

This requires a shift in the way data is currently organised and managed, to treat it as an enterprise asset. Transport for NSW already has a wealth of real-time and historical data at its disposal, both structured and unstructured. Some is now available via our Open Data Hub. Other data assets remain siloed, structured and managed to serve only the program generating the data, with restrictive controls on their availability. While ensuring measures are in place to protect privacy and preserve security, Transport for NSW will:

- Establish enterprise-wide principles for using, generating and managing data.
- Implement enterprise-wide standards, controls and practices for data sharing.
- Conduct a stocktake of current data initiatives and align them to these requirements.
- Identify other high-value transport data sources for development to support Roadmap initiatives.
- Identify partners with whom to share and exchange data to deliver Roadmap initiatives.

The objective of this transformation is to foster creation of a transport data-science ‘hotspot’ in NSW, to boost the Open Data and Innovation program by making more data sets available to third parties, and to incubate data-driven applications in priority focus areas that meet business needs.
6.4. Constant active environmental scanning and research

The industry engagement, research and environmental scanning undertaken to prepare the Future Transport Technology Roadmap provides a broad view of the emerging landscape of technology-related developments and initiatives. However, this is at a point in time. The scope, scale and pace of developments and initiatives require constant monitoring and sharing internally.

This research function will be reshaped to include resources and a process for continuously scanning the environment, including industry, institutions and other jurisdictions. This will be complemented by developing a system that ensures policy, operational and project delivery teams are aware of, and able to adopt, technology developments on the horizon. This will involve:

• Regular engagement with industry and other stakeholders to identify market developments.

• Monitoring and investigation of developments in other jurisdictions.

• An active approach to external research and industry partnerships, connecting and aligning existing research activities to the Roadmap and improving collaboration across transport agencies.
6.5. Adapt transport business processes to embrace new technologies

Delivering this Roadmap will require us to rethink and redesign core business processes for developing, deploying and integrating technologies. In some cases, this will require a complete redesign of the process. In those instances, core principles and requirements that must be met will be identified, and a new process designed to enable us to rapidly and flexibly develop the technology or solution, as well as the freedom to innovate within defined parameters. Processes and practices will be modified to wind back the ‘design-build-run’ approach, and foster the application of the ‘broker-integrate-orchestrate’ model described in Chapter 4.

More broadly across the Transport Cluster, established organisational routines will be modified to ensure opportunities for application of new technology are actively identified, evaluated and incorporated. Mandatory ‘technology challenge and review’ mechanisms will be embedded into planning, resource allocation, delivery and operational processes. The aim is to create a new norm where opportunities to innovate with technology flourish. By embedding flexibility within core business routines, teams will be more empowered to adjust business practices as new technologies emerge.

We will transform the way we do transport planning, regulation and policy so we can better respond to emerging customer trends, producing plans and policy that anticipate the next wave of change and are ready to support new innovations. Just like the way technology is managed, plans and policies will be developed by agile resource-light methods, tested, and either fail-fast or be driven quickly through to build and deployment. This will produce different and readily adaptable policy and regulatory settings, and flexible plans that can adjust quickly to changed circumstances.
6.6.

Embed new technology-focused capabilities across Transport for NSW

Embracing innovation requires a workforce that actively and continuously acquires and develops the new capabilities needed in a technology-enabled work environment. Transport for NSW’s leadership will develop a plan to equip our people with the latest tools and techniques needed to be a high-performance organisation in this environment. There are three generic skill sets that, over time, will be cascaded throughout the agency:

• Customer-centred design thinking.
• Agile delivery methods and techniques.
• Collaboration and co-design principles and practices.

Initially, this will be achieved by identifying key roles that will influence the successful delivery of each initiative in the Roadmap, and how the roles and responsibilities may need to evolve. The technology-based skills and capabilities required for these roles will be defined, and development programs identified for the people in those roles. Where needed, high-quality talent will be recruited from outside the organisation to bolster the expertise and capability of existing teams.

Across Transport for NSW, the workforce will be engaged in working out how technology and innovation is likely to reshape their functional area and their role, so that individuals better understand the skills and capabilities that will be needed. The Organisational Development program will focus on investing in training and development that provides our people with opportunities to develop the skills and capabilities they need as new ways of working with technology emerge.
6.7. Evolution of organisational culture and Minimum Viable Bureaucracy

The culture within the Transport Cluster has evolved significantly since Transport for NSW’s establishment in 2011. Across Transport for NSW and the Cluster, the commitment to safety has been sustained and strengthened while agencies across the board have become more customer-focused. Transport leaders are committed to embracing greater diversity and inclusion in our workplace, attracting new talent and adopting new work practices.

However, in the recent People Matters survey of the workforce, the feedback is that transport agencies could do better at managing change, in collaborating, and in developing skills and capabilities. A recent survey of key external transport stakeholders indicates that while transport agencies in NSW are building a solid reputation for customer focus, operational delivery skills and leadership capability, their approach remains bureaucratic. Stakeholder and industry partners expect transport agencies to be more collaborative and more innovative. As we implement this Roadmap, a more change oriented, forward looking, faster paced, outcome oriented culture will evolve in which we actively pursue and embrace new opportunities presented by constant technological change.

In moving to implement the Roadmap, there is also a need to apply new technology to catalyse disruption of some long-established processes and practices. To enable this, a new approach to change management will be taken. A mix of subject matter experts and process owners will be seconded to the Transport Digital Incubator to co-develop and trial new approaches and practices, and to act as change agents in broader roll-outs. Complementing this, ‘innovation hotspots’ will be cultivated within the organisation. These will emerge in areas already highly exposed to new technologies that can serve as role models for change.

In recent developments, such as with real-time customer information apps, Transport for NSW has used an agile delivery approach by releasing a co-designed Minimum Viable Product (MVP). New digital products are also designed around Minimum Viable Use-cases (or MVU) rather than working to a standard that requires full functionality on first release. This agile approach will be extended with a new practice of ‘Minimum Viable Bureaucracy’ or MVB (to coin a phrase). A set of MVB principles will be created to establish a practice of first defining the ideal product outcome, then modifying it to remain within clearly defined boundaries for non-negotiables, such as safety, security, and regulatory compliance. An MVB philosophy will then be used to test, trial and learn. This will enable us to quickly capitalise on success or ‘fail fast’ without stigmatising future innovation.

Ultimately, the leadership is accountable for the cultural settings needed to deliver the Roadmap. This will require new ways of working and leading with a ‘breakthrough mindset.’ This is likely to be characterised by a sharper outcomes focus, accelerated decision-making, calculated risk-taking, active sponsorship of technology-enabled initiatives, and intervention to remove barriers to progress. The wider Transport leadership team will be engaged in sharpening a shared vision of these characteristics, and the measures needed to deliver them. We are fully committed to making these cultural shifts so that the innovative technology-enabled solutions in this Roadmap can be delivered sooner, at lower cost, and with greater benefits, for citizens across the state.
This chapter explores in more detail how customers will experience personalised transport in the future given the implementation of this Roadmap, with a vision of how mobility in NSW may work in 2020. While we cannot be precise about how technological advances will change the current reality, and must be flexible on how it is developed, there is clarity on the specific outcomes we seek.

As previously outlined, the technology enabled strategies aim to ensure that customers can:

- Make easy, well-informed transport choices based on their personal needs and preferences.
- Have more public transport services delivered more reliably.
- Get from door to door more easily with flexible transport connections and seamless transfers.
- Enjoy the benefits of the latest automated vehicle technology reliably and safely.
- Fulfil their mobility needs efficiently and sustainably.
- Manage their mobility costs and pay for services simply and conveniently.

The objectives for the movement of goods and services are to enhance the capacity, efficiency, effectiveness, competitiveness and sustainability of the freight sector.
7.1. Planning the journey

Information and services will be tailored and relevant to each individual’s experience on the transport network. Customers can expect systems to serve them with personalised journey plans, and to get proactive notifications and real-time trip advice that is directly relevant to them. Information updates will be provided automatically to customers through their chosen social media channels and digital platforms, tailored to their particular travel patterns. They will be able to provide feedback via digital and social channels and get a prompt service response, including help while on the move.

The system will monitor network conditions and, if a customer’s usual daily service is likely to be changed or delayed, it will let them know automatically in advance. Importantly, it will offer alternatives that get them to their destination on time. Customers will be able to choose to give this system access to nominated events in their calendar or diary so it automatically serves up journey plans. It will learn individual preferences and journey habits over time, and adapt the information it provides accordingly. When a customer searches events around NSW, the system will remember them and serve up relevant transport services information. If a customer has accessibility needs, it will remember that and ensure the customer is advised about services with the features they require.

What will the Roadmap mean for how customers travel in the future?

<table>
<thead>
<tr>
<th>Less about</th>
<th>More about</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Accessing generic information</td>
<td>- Information tailored to my needs</td>
</tr>
<tr>
<td>- Specialised information channels</td>
<td>- In my preferred digital and social channel</td>
</tr>
<tr>
<td>- A different payment account for every mode</td>
<td>- A single account for my mobility</td>
</tr>
<tr>
<td>- Drive or take a taxi to the station</td>
<td>- Shared autonomous service to interchange hub</td>
</tr>
<tr>
<td>- Limited public transport options</td>
<td>- More public, shared and active transport options</td>
</tr>
<tr>
<td>- Set timetables that I organise myself around</td>
<td>- Timetables that adjust to changes in demand</td>
</tr>
<tr>
<td>- My car is a simple machine</td>
<td>- My car is smart and helps me drive better</td>
</tr>
<tr>
<td>- Encountering changes and disruptions</td>
<td>- Proactive alerting of issues and options</td>
</tr>
<tr>
<td>- Unproductive time in traffic</td>
<td>- I can do what I want while on the move</td>
</tr>
</tbody>
</table>
7.2. Paying for the journey
Payment systems will converge so that customers can use Opal to pay for a range of other services. As well as smart-cards, other payment options will be available, embedded in the customer’s chosen smart devices (including mobile digital wallets and on wearable devices). The journey planning and payment systems for transport services will merge and the Opal system will be extended across NSW, so all citizens have one convenient, personalised, information and payment system for all transport.

Customers will receive a single mobility account that includes vehicle registration and road tolls. Other mobility service providers, like commercial car share, bike share, and car-pooling services, will also be able to integrate payment for their services with the mobility account.

7.3. Travelling on the public and shared transport network
A range of service providers will offer Mobility-as-a-Service, including ridesharing, car-pooling, car-sharing, and flexible on-demand mini-buses, all with varying degrees of automation. Both self-powered and electric-powered bicycle services will also be available in some areas. As well as other options, this will make for more convenient and seamless connections to mass transit services.

Unlike now, where mass transit services operate to set timetables and stopping patterns, they will become increasingly more responsive to customer needs and fluctuations in demand levels. By 2020, customers on some routes will no longer need to consult a timetable. Behind the scenes, applications of technology used for predictive maintenance, traffic flow and network management will result in customers enjoying more reliable services and less delay.

On the move on the public transport network, the customer information system will monitor a customer’s current location and automatically help the customer to navigate. Customers will be able to get information that will help them board more easily, find a seat, enjoy a more comfortable journey, and be reminded automatically when they are near their destination. Customers will have the option of receiving location-based goods and services offerings in transport precincts.

In regional areas, new, more demand-responsive service models will, potentially, completely replace fixed route bus services in some areas. They will allow customers to organise a service when they need it, providing a more personalised, door-to-door experience.

7.4. Travelling on the roads
Travel on roads will be made safer by a range of more automated technologies that assist drivers and manage the road networks. As sensors and intelligent transport systems technologies are embedded across key assets such as bridges, cameras, car parks, streets, traffic lights and toll booths, they will generate enormous volumes of new data on road conditions and traffic patterns. This information will be conveyed in real time to serve the customer and help personalise their journey.

Data will also be used in new sophisticated systems that manage network operations and prioritise traffic movements, improving overall network reliability. Smart motorways will better manage traffic flows and minimise congestion on the network. Information on the movement of customers will also be used to better manage the impacts of events and shifts in usage patterns.

Freight customers will also harness data and analytics to improve efficiency and competitiveness. Load sharing applications and platforms will combine freight loads from different network users to maximise capacity utilisation of each vehicle. Increasing automation technology at delivery centres and around intermodal terminals will help freight customers reduce dwell times in the supply chain. As technologies evolve, the freight industry will also be able to re-organise their own businesses to provide customers quicker and more convenient deliveries matched to their individual requirements.
THE FUTURE TRANSPORT TECHNOLOGY ROADMAP

1. EASILY CHOOSE
2. USE PUBLIC
3. TRANSPORT MORE
4. RELIABLE, SAFE AND
5. TRANSPORT SEAMLESSLY
   RESPONSIVE
   BETWEEN DIFFERENT
   MODES OF TRANSPORT

PLANNING the JOURNEY
BY 2020, OUR METROPOLITAN
CUSTOMERS WILL HAVE ACCESS
to Tailored Trip Planning and
Real-time Service Alerts

LESS

MORE

OPTIONS

IMPROVING PEOPLE'S LIVES

"Link calendars. What works?"

Turn UP and GO! Fully automated

Travel Social Media!

DATA

REAL-TIME

TRAFFIC DATA

HELPS FLEETS

ROADS WILL

BECOME SAFER

DATA

GPS

ALL ROAD USERS AND

FREIGHT

NEW PRODUCTS

FROM BIG DATA

NEW SERVICES

PERSONALISED

DOOR TO DOOR

EXPERIENCE

REDUCE COSTS

TRANSPORT MODE

SECRET PROGRAMME!

DATA ON CARRIERS

MORE EFFICIENT LESS TIME

PLATTFORM PEOPLE ARRIVAL INFO

FASTER TRAVEL TIMES ON TRAINS

REGIONAL NEW

POSSIBLE NEW!

DATA ON CARRIERS

MORE EFFICIENT

POSSIBLE NEW LEVEL ON TRAINS

DATA ON CARRIERS

MORE EFFICIENT

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POSSIBLE NEW LEVEL ON TRAINS

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DATA ON CARRIERS

Next steps: Action Plan

During the period from release of this draft Roadmap (November 2016) for consultation to the finalisation and release of Version One (March 2017), we will take the following actions to ensure stakeholder input is gathered and considered, to identify opportunities for planned initiatives that can be delivered sooner, at lower cost, and with greater benefits for NSW citizens; and to prepare for implementation of the plans, programs and commitments this Roadmap makes.

1. Organise and conduct engagement activities as set out in the Introduction to this document. Review, respond to and consider feedback received.

2. Prepare a summation of feedback, our analysis of it, and amend Roadmap accordingly.

3. Review, assess and make decisions on all Innovation Proposals received.

4. Conduct a high level review of in-flight initiatives to ensure alignment of scope and deliverables with the Roadmap. Identify gaps, duplication of effort and plan for any proposed scope changes.

5. Expand the Open Data platform to include Opal Data and determine the next priorities for Open Data releases. Set up the internal systems to support the Transport Data Sciences initiative.

6. Determine the approach and define the program to build core capabilities and new ways of working that embed customer-centred design-thinking; an agile regulatory environment, delivery tools and techniques; and co-design principles and practices.

7. Complete the organisational design and preparations for the stand-up of the Transport Digital Incubator as outlined in Chapter 6.

8. Workshop and finalise the implementation framework for the other internal changes described in Chapters 5 and 6 with senior leaders from across transport agencies.

9. Finalise the prioritised portfolio of initiatives to set the 2017 Roadmap implementation program.

10. Continue the Intrapreneurs’ Hothouse and Innovation Challenge programs, activate the Smart Innovation Centre for Advanced Transport Technologies and progress other announced initiatives.
Acknowledgements and thanks

On behalf of Transport for NSW, we would like to acknowledge and thank the organisations and the numerous individuals who have contributed to the development of this Roadmap. In particular we wish to record publically our gratitude to the following:

- The Future Transport supporters whose generous contributions in-cash and in-kind enabled us to stage the Transport Summit in April, the Intrapreneurs’ Hothouse in June and the Youth Summit in September.
- The 500 invitees who joined us at our Transport Summit, and the 120 young people who participated in our Youth Summit, each giving at least a day of their time to contribute to our thinking.
- Over 500 of our own employees from various NSW transport agencies who put forward their thoughts and ideas.
- L.E.K. Consulting for the generous assistance in background work and analysis that supports this Roadmap, and particularly to Monica Ryu and Jeff Forrest for tireless collaboration with our internal team.
- BCG and PwC for organising peer review sessions that further challenged our thinking.
- Various Executive Directors and senior managers from within the transport agencies who have acted as internal referees, particularly Alastair Bor and Natalie Pelham.
- Chris Bennetts, Executive Director Digital Services and Jacinta Hargan, Future Transport Program Director, who have tirelessly organised the program, ably supported by Monica Vardabasso who managed communications and events, and their very dedicated support team.
- The communications team who helped us remove jargon and express ourselves clearly (we hope).
- The external members of our Leaders Panel, David Thodey, Andrew Stevens, Kate Burleigh and Mike Pratt who gave freely of their time and provided invaluable wisdom and guidance.

All have contributed some serious intellectual effort to the development of this Roadmap, and we trust the synthesis of those contributions here justifies the investment you have made in us. We thank you for your goodwill and support on an exciting journey to date. Next comes the real fun as we implement!
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘thirty minute cities’</td>
<td>A planning principle in which citizens are able to meet the vast majority of their needs (work, shopping, socialising and leisure, services) within 30 minutes travel from their home.</td>
</tr>
<tr>
<td>‘game changers’</td>
<td>Longer term initiatives and investments that will be fundamental to shaping the future of transport over a 10-15 year time horizon.</td>
</tr>
<tr>
<td>‘no regrets’ initiatives</td>
<td>Activities that Transport for NSW is proposing to undertake that are applicable to all of the future scenarios we have identified. They are ‘no regrets’ because even though the future is uncertain we know these activities will be relevant.</td>
</tr>
<tr>
<td>active or semi-active transport</td>
<td>Refers to transport activities such as walking, running, cycling, scooters, skate boards, or vehicles with low levels of motor assistance such as electric bicycles.</td>
</tr>
<tr>
<td>application programming interfaces or APIs</td>
<td>Application Programming Interfaces. A set of functions and procedures that allow third party computer systems to communicate with each other and easily access information.</td>
</tr>
<tr>
<td>connected and automated vehicle or CAV</td>
<td>A car, truck, bus or train that uses technology to actively communicate with other vehicles and infrastructure (connected) and which can be operated by a computer system without a human driver (automated).</td>
</tr>
<tr>
<td>customer interfaces</td>
<td>Communication channels such as websites, smart phone apps, call centres, physical signage, ticket booths, etc. ‘Digital customer interfaces’ generally only refers to websites and smart phone apps.</td>
</tr>
<tr>
<td>demand aggregation platforms</td>
<td>Digital systems and customer interfaces that record demand from a number of users of the transport network, and then use computer algorithms to combine demand from similar users to create and aggregated view of total demand, and to identify opportunities for shared use. An example in the passenger space is the Uber booking platform which records bookings from Uber passengers, matches these to available drivers, and finds opportunities to combine trips for UberPOOL. Similar platforms exist in the freight industry, which aim to combine partial truck loads that are travelling to the same destination to create a single full truck load.</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>demand management systems</td>
<td>Systems, processes and activities that are aimed at efficiently allocating available capacity to meet demand or influence customers’ choices abut when, where and how they travel.</td>
</tr>
<tr>
<td>demand-responsive, on-demand</td>
<td>Transport services that are run based on the demands of customers, rather than a fixed timetable. A demand responsive service may not operate to a fixed route. Customers indicate that they would like to catch the service (via a smart phone or via wixed communication systems) and a service is despatched to collect all customers that have indicated they want to use the service.</td>
</tr>
<tr>
<td>digital engineering</td>
<td>A new way of performing engineering services (design, construction and maintenance of buildings and infrastructure) in which all plans are digital and can be loaded into augmented reality systems to provide real-time information to construction and maintenance teams.</td>
</tr>
<tr>
<td>digital presence technologies</td>
<td>Video conferences, virtual reality, and augmented reality, all of which can create a sense of being ‘present’ when a person is not, and which therefore may reduce the need for travel.</td>
</tr>
<tr>
<td>first-mile and last-mile</td>
<td>A term applied to both freight and public transport that refers to the first and final stage of the journey in which people or goods spread out to a broad range of origins or destinations. The first and last mile are the least efficient parts of a transport network (before or after people and goods can come together into more efficient and dense trunk routes).</td>
</tr>
<tr>
<td>freight task</td>
<td>An industry term for the overall volume of goods that need to be transported from A to B across the state’s economy.</td>
</tr>
<tr>
<td>frictionless access</td>
<td>Allowing customers to access the transport network with absolutely no barriers, no action required on their part, and with minimal preparation. Examples include accessing the public transport system without needing to ‘tap’ on/off or go through a barrier, or accessing the road network via number plate recognition without needing to pass through a toll gate.</td>
</tr>
<tr>
<td>intelligent transport infrastructure</td>
<td>Refers to embedding sensors and communication devices into transport infrastructure (eg. roads, bridges, rail lines, trains, buses) that allows them to take measurements and provide information about usage, congestion, asset wear and tear, and possible maintenance issues.</td>
</tr>
<tr>
<td>Internet of Things or IoT</td>
<td>A proposed development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data.</td>
</tr>
<tr>
<td>line hauls, trunk routes</td>
<td>The efficient parts of a public transport or freight network in which a large number of people or goods are all travelling to the same location and can be moved along large, efficient modes. Examples include the major heavy rail public transport routes (e.g. CBD to Parramatta) or inter-city and interstate freight hauling by road or rail.</td>
</tr>
<tr>
<td>machine learning</td>
<td>A form of artificial intelligence in which a computer system is fed a large volume of information about how people move or the transport system operates and then analyses this information to determine patterns. These patterns are then tested against new data to be measured and improved (allowing the machine to ‘learn’).</td>
</tr>
<tr>
<td>mass transit</td>
<td>High capacity forms of transport that move people more efficiently than a private car. Examples include metro, heavy rail and light rail, buses and ferries.</td>
</tr>
<tr>
<td>Mobility-as-a-Service</td>
<td>A business model for customers to access transport services in which customers can use a single account and booking interface to access a broad range of transport modes, none of which the customer owns. Examples would be allowing a customer to access public transport, car sharing and bike sharing all using the same system.</td>
</tr>
<tr>
<td>NSW Transport Cluster</td>
<td>A group of agencies consisting of Transport for NSW; the operating agencies of Roads and Maritime Services, Sydney Trains, NSW Trains, and the State Transit Authority; the state’s private transport operators; a number of project delivery offices for major transport projects; and the Port Authority of NSW.</td>
</tr>
<tr>
<td>operational systems</td>
<td>Refers to the IT systems that are used to operate transport services and manage and maintain transport assets. These include booking and despatch systems, staff management systems, bus and rail network monitoring and management systems, and enterprise resource management systems.</td>
</tr>
<tr>
<td>personalised and contextualised</td>
<td>Personalised information is information that reflects a customer’s expressed preferences and habits. Contextualised information reflects a customer’s current location, activities and the time of day (such as suggestions about which shops to use near the station they are currently standing at).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>personalised transport</td>
<td>An umbrella term used in this document to refer to a world in which technology is used to make transport services and the overall transport network responsive to the needs of customers. These customers may be individuals or companies, and they may be accessing the transport network as public transport users, road users, pedestrians, or for the movement of goods. Personalised transport means understanding the specific needs of each customer, and adapting the transport network and services it provides to suit those needs.</td>
</tr>
<tr>
<td>platooning</td>
<td>A process through which connected and automated vehicles (especially freight vehicles) travel in tight formation along a roadway. Platooning offers benefits of more efficient use of road space, lower fuel consumption due to lower wind resistance, and safer overall operations.</td>
</tr>
<tr>
<td>pods</td>
<td>Single user, electric automated vehicles designed for short range mobility needs.</td>
</tr>
<tr>
<td>point-to-point</td>
<td>Transport services that go directly from a passenger's origin to their destination. Outside of the private car, taxis and ridesharing services (Uber, Lyft) are the most common point-to-point transport modes.</td>
</tr>
<tr>
<td>predictive analytics</td>
<td>Analytical tools that produce insights that predict what will happen, rather than responding to what has happened. Predictive analytics typically uses detailed historical system and behavioural data, combined with contextual data about what is happening now, to predict what a customer or system will do in the immediate future.</td>
</tr>
<tr>
<td>real-time</td>
<td>Generally applied to either data or analytics in this document. Real time data is information about the status of the transport network and services that are completely live or have a lag of less than a minute or two. Real time analytics refers to analysis that is performed on real time data (generally automatically and without input from a human analyst) and is then used to make decisions or take action immediately.</td>
</tr>
<tr>
<td>ridesharing</td>
<td>Business models similar to Uber and Lyft within which private citizens provide point-to-point transport services to other citizens.</td>
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<tr>
<td>shared use</td>
<td>Shared use, particularly in relation to transport services, refers to services in which multiple users are brought together into a single service. Mass transit services are shared use by their very nature. Ridesharing services such as Uber are technically shared use, but the more powerful examples of shared use are services such as UberPOOL in which multiple potential Uber trips are combined and provided by a single driver. Shared use services make more efficient use of road capacity while reducing the cost per user.</td>
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<tr>
<td>smart motorways</td>
<td>Motorways that use embedded sensors, analytics and customer feedback tools to actively manage congestion and safety and respond to traffic incidents.</td>
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<tr>
<td>transport ecosystem</td>
<td>Refers to the fact that as a result of technology the transport network and the way in which services are delivered now typically involves a much larger group of organisations working together. Participants in the ecosystem include transport services operators (public and private), transport infrastructure owners, app developers, technology companies providing data, etc.</td>
</tr>
<tr>
<td>services, service delivery</td>
<td>Service in this document refers to transport services, generally mass transport services. Examples include heavy and light rail, buses and ferries. Services might also include shuttle buses and a range of privately operated transport types.</td>
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</tbody>
</table>
Appendix A: Initiatives portfolio

<table>
<thead>
<tr>
<th>Personalised Transport</th>
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<tbody>
<tr>
<td><strong>Integrate and transform digital channels for tailored two-way interactions</strong></td>
</tr>
<tr>
<td>• Develop the platform that enables an omni-channel customer experience for information, navigation, feedback</td>
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<td>and ticketing for public transport.</td>
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<tr>
<td>• Build a knowledge management system and customer service engine available through the Open Data Hub that enables</td>
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<tr>
<td>apps, messaging services (for example, Facebook, iMessage, Google Messenger) and Opal travel to provide an</td>
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<tr>
<td>automated customer service function for the provision of transport system information (that is, FAQs, events and</td>
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<tr>
<td>journey planning).</td>
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<tr>
<td>• Update the Opal Travel app to enable real-time journey planning, personalised disruption messaging with alternate</td>
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<tr>
<td>journeys plans, a function for an alert when the customer is approaching their destination, plus trip rating and</td>
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<tr>
<td>feedback capability.</td>
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<tr>
<td><strong>Extend Opal functionality to create a state-wide mobility payment platform</strong></td>
</tr>
<tr>
<td>• Add payments systems functionality to Opal so third party payments can be deducted from an Opal card balance</td>
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<tr>
<td>(for example, point-to-point services like taxis, ridesharing and carpooling, regional bus services, tolling and</td>
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<tr>
<td>vehicle licensing).</td>
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<tr>
<td>• Open Opal APIs to enable this payment system to be accessed under license by third parties.</td>
</tr>
<tr>
<td>• Work with third parties to integrate the Opal APIs so that customers can use their Opal card to pay for all their</td>
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<tr>
<td>transport needs.</td>
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<tr>
<td><strong>Develop a single integrated account for mobility services</strong></td>
</tr>
<tr>
<td>• Integrate tolling, Opal, licensing and registration accounts for customers, so that they have one account to</td>
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<tr>
<td>manage all transport.</td>
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</tbody>
</table>
### Appendix A: Initiatives portfolio

#### Leverage the mass transit network

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
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</table>
| **Automate and optimise timetable planning, service delivery and resourcing** | - With an initial focus on bus, build a proof of concept that uses Opal, timetable and real-time journey data, journey plans served, and other third party data to better match supply with current and potential demand for services.  
- Using the supply/demand insights, develop an algorithm that optimises the timetable for day-of-week, weather and planned/unplanned events.  
- Using timetable information, develop systems that enable the more efficient allocation and management of resources and activities including trains scheduling, crew management, cleaning and maintenance. |
| **Apply data and analytics to improve end-to-end customer journeys, routes and interchange** | - Establish real-time customer attitude insights for the transport network through social media and feedback channels to identify opportunities for service improvements.  
- Using transport and third party data, develop a system that provides insights into end-to-end journeys and applies them to optimise bus routes and interchanges. |
| **Create the blueprint for fully-wiring and digitalising the mass transit network, and increasing automation** | - Develop a blueprint and business case for progressive digitisation of assets and processes; define the optimum pathway and benefits to be realised; and identify opportunity areas for initial focus.  
- Identify specific opportunities to apply other advanced technologies to enable service improvements and efficiency gains on mass transit networks. |

#### Enable connected, automated vehicle platforms

<table>
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<tr>
<th>Initiative</th>
<th>Description</th>
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</table>
| **Activate the Smart Innovation Centre for advanced vehicle technology** | - Complete the expression of interest process for partners to invest in the Smart Innovation Centre.  
- Stand up the partnership and build an initial program of work focussing on accelerating the safe use of automated technology, particularly in shared mobility services.  
- Identify specific opportunities to develop and/or apply new technologies to improve road-safety; and organise controlled trials to test effectiveness and benefits. |
| **Foster development of the regulatory environment to support automated vehicles** | - Review the legislative framework and determine actions required to accommodate automated vehicles, consistent with nationally agreed standards in collaboration with National Transport Commission.  
- Create a review cycle for regulation to support innovation and evolution of the industry.  
- Establish a working group to review potential impacts of the introduction of automated vehicles on related industry sectors, and make appropriate recommendations. |
| **Develop a blueprint and operating model for automated vehicles on network** | - Conduct trials to identify and evaluate technical systems requirements and the range of human responses to CAV, to inform considerations of technical, infrastructure, safety and regulatory needs.  
- Develop a blueprint for the technical systems elements, consistent with nationally agreed standards.  
- Identify and evaluate options for initial uses and introduction of CAVs onto the road network, and complete a preliminary feasibility study on alternative approaches. |

#### Foster shared, demand-responsive services

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
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</table>
| **Pilot and trial demand-responsive last-mile transport services** | - Seek Expressions of Interest in the provision of flexible transport services for local connections in a number trials around Sydney.  
- Complete a study to assess the potential structure of a pilot program for flexible transport services in regional centres. |
| **Incubate new ventures that encourage shared mobility services** | - Conduct a scan of the current regulatory and policy frameworks to ensure other forms of shared mobility services can be incubated.  
- Develop a standard platform for payments administration for subsidised services to support an open system.  
- Conduct an innovation challenge to support development of new shared mobility services by start-ups. |

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Future Transport Technology | Roadmap 2016

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Appendix A: Initiatives portfolio

Create intelligent transport networks, managed with data

Setup a Transport Data Science Incubator and expand Open Data

- Undertake a stocktake of all data internal initiatives and complete audit of potential datasets available for Open Data.
- Formulate a prioritised Open Data release program based on feedback from industry and start-ups.
- Seek partners to enable establishment of a Transport Data Science Incubator.
- Develop an alternative to the Household Travel Survey based insights from actual transport, third party data and potential crowdsourcing applications.
- Develop a transport demand forecasting model from actual transport and third party data.

Deploy advanced analytics and AI as the next steps towards intelligent network management

- Develop a decision support tool to enable improved management of disruptions and traffic flows; and a predictive or forecasting capability for congestion.
- Develop an application to provide customers advice and alternatives to avoid forecast congestion.
- Develop a decision support tool to enable traffic flow improvement opportunities to be identified in high-demand areas of the network.
- Develop an application to enhance measurement of journey time reliability on roads; and an analytics and/or AI application to pinpoint improvement opportunities.

Integrate predictive analytics into network asset management and maintenance

- Build a proof of concept that generates predictive insights from asset data to better inform asset management and maintenance practices.
- Develop specific practices and programs to automate maintenance monitoring routines and to deliver predictive maintenance schedules.

Appendix B: Detail of in-flight initiatives

A number of technology-related initiatives are currently in flight across the Transport Cluster. As part of the next phase of the Future Transport Program we intend to review the scope of each of these initiatives, assess the degree of alignment with the Future Transport framework, and identify any measures that may be needed to fully realise the value of these initiatives.

We are also seeking stakeholder feedback on how these initiatives could be optimised to take account of recent developments in emerging technologies.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Initiative</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalise customer interactions</td>
<td>Customer Channel Transformation program</td>
<td>The aim of Customer Channel Transformation program is to improve transport customer experience and realise efficiencies by: - Empowering customers digitally to make better decisions - Driving digital adoption by building customer confidence in digital self service - Coordinating and consolidating customer channels, content, platforms, and systems.</td>
</tr>
<tr>
<td></td>
<td>Trial contactless card payments on Opal</td>
<td>A program is currently underway to trial open loop contactless payments using the Opal system. This would allow customers to use their credit card to make individual trip payments using any existing Opal infrastructure.</td>
</tr>
<tr>
<td></td>
<td>Digital drivers licence</td>
<td>As part of the NSW Government’s commitment to providing digital licensing, the digital drivers licence will deliver a world first in customer service and experience design. Customers will be able to display, apply, update and renew their drivers licences using their smartphone or other connected device, with real-time information also available. Security safeguards will be built in, so authorities can easily verify the validity of these licences and customers can continue to use them for proof of identity and entitlements checking.</td>
</tr>
</tbody>
</table>
### Appendix B: Detail of in-flight initiatives

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Initiative</th>
<th>Summary</th>
</tr>
</thead>
</table>
| **Transform the mass transit network** | Sydney Metro, Light Rail and B-Line | • Sydney Metro is leading the development of the first fully-automated rapid transit rail system in Australia, providing community focused journey planning advice and connected, value-added first and last mile services to improve convenience and increase patronage.  
• The light rail network provides a unique public transport service to the people of Sydney, linking Central Station and Sydney’s Inner Western Suburbs via Haymarket, Pyrmont, Glebe Rozelle, Leichhardt North and Dulwich Hill. Sydney Fish Markets, The Star Casino, Darling Harbour and Chinatown are all easily accessible by Light Rail.  
• The NSW Government is taking action to deliver transport improvements for the Northern Beaches, including an integrated program of service and infrastructure improvements to deliver a new B-Line bus service. The B-Line will provide more frequent and reliable bus services for customers travelling between the Northern Beaches and the Sydney CBD via a bus rapid transit model using dedicated lanes and a new high-capacity double-decker fleet. |
| Sydney Trains Rail Operations Centre (ROC) | | • Better coordination, communication, and management of ‘day of operations’ activities for Sydney Trains will be achieved through the ROC, which will co-locate teams and transform the processes, systems, and communications. |
| Sydney Trains DTRS; ATP/ATO pilot | | • The Automatic Train Protection (ATP) program will see the Sydney Trains metropolitan and NSW TrainLink intercity rail network fitted with new equipment to improve rail safety by monitoring a train’s speed and position on the network and automatically intervening or braking to ensure safe operations. |
| New suburban, intercity, bus and ferry fleets | | • The NSW Government is making a once-in-a-generation investment in new fleet. This includes around 65 new intercity trains with about 520 new carriages; six new inner harbour ferries; new double decker buses for the Northern Beaches B-Line; and replacements for 60 XPT passenger cars currently operating on the NSW TrainLink Regional network. |

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<thead>
<tr>
<th>Strategy</th>
<th>Initiative</th>
<th>Summary</th>
</tr>
</thead>
</table>
| **Foster shared, demand-responsive services** | Point-to-point transport reforms | • Point-to-point transport includes all flexible transport services that can take customers on the route they choose, at the time that suits them, including:  
  - Taxis  
  - Hire cars  
  - Tourist services  
  - Rideshare services  
  - Community transport  
• Emerging technologies and changing customer expectations have created a number of challenges, particularly for taxis. In response, the NSW Government has introduced reforms to the taxi, hire car and rideshare industry. The Point to Point Transport (Taxis and Hire Vehicles) Act 2016 is now in force. A new regulator - the Point to Point Transport Commission - is being established to manage implementation of these new reforms. |
| Rural and regional community transport booking system | | • The Centralised Trip Allocation and Booking System (CTABS) will support Community Transport to provide consistent levels of service.  
• The system will provide journey planning, booking and scheduling functionality via a single technology platform. |
### Appendix B: Detail of in-flight initiatives

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Initiative</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable connected, automated vehicle platforms</td>
<td>Freight safety (CITI) and priority pilot (Premier’s Initiative with Cohda)</td>
<td>The Cooperative Intelligent Transport Initiative (CITI) is a C-ITS testing facility south of Sydney. It is the only large-scale C-ITS testbed dedicated to heavy vehicles in the world. CITI allows heavy vehicle drivers to receive safety messages about upcoming hazards and potential crashes, using technology to facilitate communication between vehicles and infrastructure.</td>
</tr>
<tr>
<td></td>
<td>PTIPS system upgrade (v2.0)</td>
<td>The Public Transport Information and Priority System (PTIPS) uses real-time public transport vehicle location information to drive real-time traffic light prioritisation, provide real-time information to customers and support performance management. The upgrade will provide improved position accuracy, greater reliability and increased coverage. It will also allow Transport for NSW to further enrich the information offered in the Open Data program.</td>
</tr>
<tr>
<td></td>
<td>Trial of C-ITS technology</td>
<td>Intelligent Traffic Systems provide navigation, traffic signal control, variable message sign, automatic number plate recognition and speed cameras. This trial of cooperative intelligent traffic systems (C-ITS) will allow: - Prioritisation of bus and freight traffic through signals - Monitoring, live data and feedback - Advanced analytics and modelling supporting traffic prediction.</td>
</tr>
<tr>
<td>Create intelligent transport networks managed with data</td>
<td>Open data program</td>
<td>The Open Data program increases our open dialogue to tap into the collective wisdom and ingenuity of innovators and the entrepreneurial community. Under the program Transport for NSW is making a number of real-time and historical data-sets available to developers to drive innovation and deliver improved digital products.</td>
</tr>
<tr>
<td></td>
<td>Rollout of smart motorways</td>
<td>Smart Motorways use complementary technologies to monitor traffic conditions, manage congestion and respond to incidents in real time. The M4 Smart Motorway will use real-time information, communication and traffic management tools to provide motorists with a safer, smoother and more reliable journey.</td>
</tr>
<tr>
<td></td>
<td>Enterprise platform upgrades (ERP, EAM)</td>
<td>A significant program of core system upgrades are underway that will allow Transport to: - Manage end-to-end asset planning, investment, contract and lifecycle management - Be the single source of truth for assets, risks and hazards - Enable preventative &amp; predictive asset management practices - Enable and monitor compliance and certification processes - Enable mobile work force productivity and flexibility - Capture the life cycle costs of assets.</td>
</tr>
</tbody>
</table>
### Appendix C: Detail of emerging technology trends

The Future Transport Summit, and subsequent research and industry consultation conducted by Transport for NSW and L.E.K. Consulting, have identified a number of emerging technology trends that will shape the future of transport. Twelve of these technology trends were identified as the most significant or likely to have the biggest impact on delivering personalised transport. These are outlined below and have been used to shape the overall Roadmap.

<table>
<thead>
<tr>
<th>1.1 Customer interface technologies</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Digital, contextualised and personalised customer engagement using online interactive channels in real time</strong></td>
<td><strong>Mobility-as-a-Service platforms that facilitate shared or personal transport on demand</strong></td>
</tr>
<tr>
<td>• This trend involves the convergence of customer interfaces into a single platform that is fully personalised to the customer’s needs. Enablers include increased investment and use of digital platforms and social media to deliver personalised and contextualised omni-channel communications with customers. Increasingly, customers will be able to conduct all transactions and receive all information using a single, personalised interface. Applications range from crowdsourcing of ideas and service feedback through to customer care to improve safety, customer comfort, service congestion and customer satisfaction performance. Gamification can be used to improve quality, performance and safety of transport services.</td>
<td>• This trend consists of a basket of technologies including:  - Demand aggregation platforms  - Mobility-as-a-Service account-based payment and subscription pricing models  - Ad-hoc, on-demand transport services.  • Collectively these enable more shared use transport which may replace the need for individual vehicle ownership.</td>
</tr>
<tr>
<td><strong>Dynamic demand management systems such as usage-based pricing</strong></td>
<td><strong>Advanced analytics and real-time decision support tools</strong></td>
</tr>
<tr>
<td>• Detailed data from intelligent sensors enables advanced pricing and incentivisation of transport services and assets (e.g. tolls based on the number of persons in a car, direction of travel, and time of day). This may be combined with loyalty programs to manage congestion and patronage and encourage off-peak travel.</td>
<td><strong>Open data and intellectual property</strong></td>
</tr>
<tr>
<td><strong>Frictionless access, payment and identification</strong></td>
<td>• Use of historical big data and real-time data from intelligent infrastructure, combined with predictive analysis / machine learning to proactively plan maintenance and manage transport networks and respond to unplanned incidents in real time. These tools will generate insights from smart network infrastructure and customer service systems. Predictive analytics will enable operators to divert traffic, adjust routes, and adjust signals or alert customers before incidents escalate. In advanced phases, this may include automating actions and responses to incidents.</td>
</tr>
</tbody>
</table>

- **Increased open access to government and private data, delivered by a range of methods will enable rapid application development such as personalised and context specific searching, multimodal journey planning and analytics. This is coupled with increasing adoption of open IP, with public and private collaboration on software and data manipulation. Together these will encourage faster collaboration and more innovative solutions to key challenges.**
### 1.3 Infrastructure technologies

**Smart transport infrastructure, sensors and devices that allow more efficient management of congestion and wayfinding**

- Installation of a network of smart sensors and communication devices (e.g. Internet of Things, vehicle-to-vehicle and vehicle to infrastructure communication systems). This will enable two way flow of real-time data on traffic and environmental conditions between infrastructure, vehicles and other road users. This data will be used to enable advanced traffic planning, asset maintenance, incident management, and diversion.

**Next-generation information and communication technology that allows for real-time digital management**

- Advanced IT platforms, operational systems and enterprise management systems that increase the flexibility, connectivity and security of transport assets, while reducing cost and risk.

### 1.4 Vehicle technologies

**Connected and automated vehicles (CAVs)**

- Autonomous, semi-autonomous and connected buses, cars, pods, trucks that operate with varying levels of human input. Vehicles interact with each other and infrastructure to move in highly efficient platoons for both passenger and freight (long haul and last mile) transport. Other types of connected and automated vehicles such as drones will perform deliveries, asset maintenance and repairs. These technologies will collectively make public, private and shared fleets intelligent, and improve safety with minimal driver input.

**Personal mobility devices**

- Emergence of alternative modes of personal mobility (e.g. electric powered transport that is smaller than a vehicle such as pods, powered bikes, or freight moving equipment etc) that offer new options for first- and last-mile travel between homes and key public transport nodes and create a need for revised regulation and transport infrastructure.

**Alternatively fuelled vehicles, which can deliver greater sustainability**

- Development of alternative fuel sources (e.g. electric, solar) that drive transportation vehicles and power infrastructure. This technology includes not only the fuel itself but also the supporting infrastructure and services (e.g. charging stations).

### 1.5 Other technologies

**Technologies that reduce demand for mobility**

- Communication technologies that reduce the need for mobility and suppress demand for travel trips by enabling remote working (e.g. shared workspaces, video conferencing) or the remote provision of services (e.g. tele-learning, tele-health). Advanced technologies such as virtual reality and augmented reality will broaden the potential of these technologies and increase their use. Advances in manufacturing and delivery technologies (e.g. 3D printing) will increase the remote delivery of products.
Appendix D: International, leading practice scan

The purpose of this scan was to:

- Understand what is being done today and the trajectory of development in leading jurisdictions. If we aspire to be market leading in NSW, it is necessary to understand the baseline of market leadership today.
- Identify any technologies and trends not raised as part of the Future Transport Summit and subsequent engagements.
- Identify possible roles played by government and what has been successful in the past.

The scan was not intended to be exhaustive, but identified some of the major ‘hotspots’ of transport technology adoption around the world.

Key Takeaways

Technology

- London and Singapore are market leading cities in implementing transport technologies.
- However, no one jurisdiction leads across all – or most – technology areas. Instead, they appear to focus on the particular technologies, or value chain stages, in which they can achieve excellence.
- Connected and automated vehicles and Mobility-as-a-Service solutions are prevalent across a number of jurisdictions, due to the significant potential end user benefits. Most connected and automated vehicle implementations are still at trial stages, and trials vary across passenger, freight and other applications.

Role of Government

- Government’s role in the case studies varies from being a supporter, collaborator or full public sector ownership.
- For many technology trends (especially those relating to customer interfaces or new vehicle technologies) the role of government has been to support, or create room for, private sector trials.
- Mobility-as-a-Service in Finland is an example where government played an effective role as a collaborator, working with 22 other organisations to develop a comprehensive mobility service for customers.
### 1.1 Customer interface technologies

<table>
<thead>
<tr>
<th>Digital, contextualised and personalised customer engagement using online interactive channels in real time</th>
</tr>
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<tbody>
<tr>
<td>• Targeted crowdsourcing to solve transport problems (London)</td>
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<tr>
<td>• Personalised proactive messages to communicate transport disruptions (London)</td>
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<tr>
<td>• MyTransport SG Mobile app - provides customers with a wide range of real-time information (Singapore).</td>
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<tr>
<th>Dynamic demand management systems such as usage-based pricing</th>
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<tbody>
<tr>
<td>• Advanced distance based tracking for dynamic congestion pricing (Singapore)</td>
</tr>
<tr>
<td>• Smart Roads - investigating dedicated freight paths and time of day charging (Melbourne).</td>
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</table>

<table>
<thead>
<tr>
<th>Frictionless access, payment and identification</th>
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<tbody>
<tr>
<td>• Pilot of access &amp; payment via smartphone (Singapore)</td>
</tr>
<tr>
<td>• Contactless payment with bank issued cards (London)</td>
</tr>
<tr>
<td>• Proposed contactless payment with bank issued cards (Sydney)</td>
</tr>
<tr>
<td>• Trial of gateless access to public transport using Bluetooth (Germany)</td>
</tr>
<tr>
<td>• Test of biometric payments via ‘Mastercard Identity Check’ (USA &amp; Netherlands)</td>
</tr>
<tr>
<td>• Acceptance of wearables developed by Barclays Bank to access public transport (London).</td>
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</tbody>
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<table>
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<tr>
<th>Mobility-as-a-Service platforms that facilitate shared or personal transport on demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Frameworks for private car sharing initiative (Singapore)</td>
</tr>
<tr>
<td>• Government fleet to be replaced by GoGet (Sydney)</td>
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<tr>
<td>• Mobility as a Service (Finland) / Proposed start-up in Sydney</td>
</tr>
<tr>
<td>• Large city wide bike sharing systems (London/Paris/Amsterdam)</td>
</tr>
<tr>
<td>• On-demand van services - Bridj/Ford private sector (Kansas)</td>
</tr>
<tr>
<td>• On-demand public bus services - public sector (Helsinki)</td>
</tr>
<tr>
<td>• On-demand bus services - public sector (Singapore)</td>
</tr>
<tr>
<td>• On-demand pod based services (Singapore).</td>
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### 1.2 Data and insight technologies

<table>
<thead>
<tr>
<th>Advanced analytics and real-time decision support tools</th>
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</thead>
<tbody>
<tr>
<td>• Predictive analytics applied to congestion management (Singapore)</td>
</tr>
<tr>
<td>• Infrared monitoring to identify pedestrian congestion (Melbourne)</td>
</tr>
<tr>
<td>• Proof-of-concept for accident detection on highways (Melbourne)</td>
</tr>
<tr>
<td>• Integrated Traffic Analytics Network to predict where and when accidents may occur (Tennessee)</td>
</tr>
<tr>
<td>• Condition-based monitoring and predictive maintenance of joints on the Sydney Harbour Bridge (Sydney)</td>
</tr>
<tr>
<td>• Proof-of-concept enabling condition based monitoring of the Kattwyk Lifting Bridge (Hamburg)</td>
</tr>
<tr>
<td>• Void meter installed under railway tracks enabling condition based monitoring (UK)</td>
</tr>
<tr>
<td>• Predictive analytics applied to congestion management (Singapore)</td>
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<th>Open data and intellectual property</th>
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<tbody>
<tr>
<td>• Real-time access to transport data in API economy (London)</td>
</tr>
<tr>
<td>• Real-time unified API for transport services data, and collection of fault data (Boston)</td>
</tr>
<tr>
<td>• Multi-modal journey planning as a service (LA)</td>
</tr>
<tr>
<td>• Hyperlocal apps integrating transport API data (London)</td>
</tr>
<tr>
<td>• Real-time API for transport services data (Sydney).</td>
</tr>
</tbody>
</table>
### 1.3 Infrastructure technologies

**Smart transport infrastructure, sensors and devices that allow more efficient management of congestion and wayfinding**

- Prioritisation of freight trucks along transport corridors using cooperative ITS (Sydney)
- Developed and implemented a fully adaptive traffic control system (Sydney)
- Communication-based train control to reduce headway (New York)
- Transit signal priority for selected bus services (New York)
- Digitisation of infrastructure (Singapore)
- Rollout of IoT backbone for intelligent transport infrastructure (Adelaide)
- LA Express Park - in-road sensors, dynamic pricing, consumer guidance apps (California)
- Parking app showing real-time availability in government and private parking lots (Singapore)
- Fastpark smart parking system (Moscow)
- Smart parking trial with digital signage and apps providing navigation to real-time parks (Canberra).

**Next-generation information and communication technology that allows for real-time digital management**

- Not included in scan.

### 1.4 Vehicle technologies

#### Connected and automated vehicles (CAVs)

**Passenger**

- Regulation of AV - driverless vehicles (CA)
- Technology trials of AV cars and buses (Singapore)
- Trial of AV pods on dedicated tracks (Singapore)
- Trial of fully autonomous shuttle buses (Perth)
- Trial of fully autonomous shuttle buses (Switzerland)
- Initiative to have 100 fully autonomous Volvo cars driven by public by 2017 (Sweden).

**Freight**

- Successful trial of level 4 autonomous trucks in platooning mode across Europe (Europe)
- Upcoming trial of autonomous truck platoon with a driver in the lead vehicle only (UK).

**Other applications (including drones)**

- Trial of drones for last mile light-weight freight delivery by Amazon (US)
- Trial of drones for last mile light-weight freight delivery by Matternet/Swisspost (Switzerland)
- Trial of drones for last-mile light-weight freight delivery (Melbourne)
- Trial of drones by Ninox Robotics for oil pipeline asset inspection and wildlife monitoring (Qld).

#### Personal mobility devices

- Legalising use of PMDs on footpaths and shared paths (Singapore)
- Restricted legalised use of PMDs on footpaths and nature strips (Queensland)
- Hoverboards legalised for use on roads with speed limits under 35mph (California).

#### Alternatively fuelled vehicles, which can deliver greater sustainability

- Uptake of EV buses, cars and roll-out of EV chargers and swap stations (China)
- EV charge as you drive motorway (London)
- EV charging stations installed in council car parks (Brisbane).
### 1.5 Other technologies

**Technologies that reduce demand for mobility**

- Funding and support for telehealth consultations and remote patient monitoring for chronic disease management (NSW)
- NSW Dept of Premier and Cabinet has explored a range of remote working and virtual presence options for its staff (NSW)
- Queensland Government trial of flexible work centres in 2015 over a 12 month period (QLD)
- 3D printing on demand (Melbourne)
- Increasing uptake of 3D printing for personal use, being treated as a public good (Sunnyvale, California)
- 3D holographic applications that enable complete education packages to be deployed on Microsoft HoloLenses to students in remote locations (Saab, Adelaide)
- Case Western Reserve University in Cleveland USA is exploring Hololens use in teaching Human Anatomy (USA)
- Northwestern Mutual purchased 14 telepresence robots to allow their employees to work from home while having a physical representation in the workplace (USA).