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Bay of Plenty Regional Council
2017 Public Transport Technology Project Stage 1

Final Report

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1 Introduction

1.1 Background

The Bay of Plenty Regional Council (BOPRC) plans, contracts and administers bus services within the Bay of Plenty region. Currently, the Council is part of a Regional Consortium of nine regional councils that has procured a new electronic ticketing system (which will be supplied by INIT). That system is in the process of being implemented and is anticipated to be in place across the Council's network by the end of June 2018. INIT.

In addition to the new ticketing system, a number of new technological applications across the public transport system has been deployed in recent months, including:

- a 'text-a-bus' system in Tauranga which uses a static GTFS feed to return scheduled timetable information to passengers.
- a 'trackabus' system in Rotorua and Whakatāne which uses a basic AVL system (cell phones) to locate buses.
- a Journey Planner tool on Council's website (www.baybus.co.nz) which links to Google Maps to provide timetable trip information in Tauranga and Rotorua.

Council is now seeking advice to assist with its development of a Public Transport Technology Strategy. This project will identify broadly the array of technology available for public transport agencies and operators and provide a strategic pathway as to what and how Council should procure.

The technology that Council has expressed some interest in implementing initially in the western Bay of Plenty sub-region includes:

- on-bus Wi-Fi;
- a real time passenger information system;
- a mobile device application indicating when to expect buses;
- on-bus display of next stop information (visual and audio);
- digital signage at key bus stops (limited) indicating when to expect buses;
- real-time data capture for contract monitoring; and
- real-time data output that interfaces with Council's bus information website and is accessible to the public, particularly application developers.

Given the considerable expense in rolling out new technologies, along with the rapidity of change in this field, it is critical to future proof today's decisions for tomorrow's world and to prioritise investment decisions according to Council's core requirements and greatest strategic and operational benefit to Council and its customers.

The following report provides strategic insights and a 'best practice' review relating to technology-based innovations in the public transport sector, to inform future technology procurement decisions.

Recommendations have been prioritised accordingly to alignment with Council's vision and strategic transport objectives. The review and case studies may be used not only to inform investment decisions but also support

future advocacy submissions to, and potential negotiations with, NZTA to deliver best practice, integrated PT network enhancements for a seamless experience for public transport customers across New Zealand.

1.2 Project Objectives

BOPRC is seeking guidance on transit technology solutions which may be procured to deliver:

- improved real-time information for customers;
- improved monitoring, in real time, of contractor service delivery;
- an enhanced customer experience; and
- value for money.

The over-arching questions for the Stage 1 strategic investigation are:

- What transit technologies should Council consider in the short, medium, and long term?
- What systems would deliver Council's strategic objectives in a cost-effective manner?

Council plans to use the insights from this study as an input for a Council workshop in February 2018.

1.3 Project Scope

The potential range of technology options to meet various strategic and operational objectives is extensive and each application could form extensive evaluative reports in themselves. We have focussed on the applications of most direct interest and relevance to BOPRC.

Stage 1 of this project (the subject of this report) provides a high level (strategic, mostly qualitative) assessment of opportunities, and a suggested way forward on how to evaluate and procure preferred options.

Stage 2, which includes the development of specifications and procurement of technology, is not part of the scope of this project. Council may undertake further, more technical investigations in Stage 2, following consideration of this strategic advice and further discussions with key stakeholders.

While applicable to ferry operations, the focus of this investigation is Council's urban and rural public transport bus operations.

This project has not involved detailed interviews with suppliers, determination of prices of tailor-made software solutions, nor recommendations regarding the selection of specific suppliers. This would require more detailed investigations and business case assessments. The purpose of this stage is to assess the strategic benefits in pursuing a range of transit technology options and to recommend priority options for Council's consideration and further investigation.

It must be noted that this project does not review ticketing systems specifically, given the current rollout of new systems and national plans to progress a long term comprehensive integrated ticketing system for New Zealand. This is the subject matter of separate, extensive investigations. Notwithstanding, project recommendations are highly cognisant of current and proposed ticketing systems enhancements and aim to complement/supplement these ticketing and fares initiatives.

1.4 Our Approach

The key tasks undertaken as part of Stage 1 included:

- **Review of Stakeholder's Requirements**
  - This involved gathering an understanding of Council's strategic objectives, public transport network, budget, operations and performance, current and potential customers (users), along with current and proposed service enhancements initiatives. Considering the needs and requirements of key stakeholders, including public transport customers and public transport operators, is key to a successful technology road map.

- **Environmental Scan**
  - This involved a review of key emerging trends in fares and ticketing and public transport technology applications, both nationally and internationally, to identify potential opportunities for BOPRC. The jurisdictional and trend analysis scanned global and regional trends and ideas specifically related to:
    - Global megatrends shaping 'tomorrow's customer', how and when they are likely to influence customer preferences and behaviours relating to travel patterns, and the ways government and industry must respond;
    - Transit industry trends – a broad environmental scan and holistic assessment of customer insights, drivers of customer behaviour, perceptions and expectations, and research on best practices to improve the quality and attractiveness of PT service delivery.
    - Technology trends –emerging technologies and pioneering initiatives and how this may present opportunities in the delivery of passenger services to BOPRC and the broader region;
    - Product – what new products are currently being considered and rolled out by other jurisdictions and future anticipated changes, including investigating where transit agencies are no longer just providing PT trips but providing user focused mobility solutions that bundle not only multiple transport and lifestyle offerings.

- **Review of Available Technologies and Options**
  - This involved a desktop review of the available technologies and options that are available today and emerging. Given the plethora of technology applications available for a multitude of purposes, the review focussed on areas that best addressed Council's key strategic objectives, budgetary considerations, and desired outcomes.

- **Partner and Stakeholder Workshop**
  - A workshop was undertaken with representatives of the Bay of Plenty Regional Council, Tauranga City Council, the New Zealand Transport Agency and Bay of Plenty bus operators.
  - This was used to discuss and review the SWOT Assessment, Council's strategic objectives, and prioritisation of options.

- **Prioritisation of Options**
  - This involved the development of a prioritised list of strategic recommendations for BOPRC's consideration, taking in to account the following:

- BOPRC strategic and corporate objectives and Regional Public Transport Plan;
- new innovative products that will best support increased customer satisfaction and patronage;
- short to medium term priorities and longer-term technology considerations;
- the need (or otherwise) for regional/national consistency in technology roll out;
- supporting policy, funding, and delivery (procurement) considerations; and
- way forward including funding, procurement, and transitional strategies (future proofing).

The following chapters outline our key findings and recommendations arising from this investigation:

- Chapter 2 Strategic context – setting the scene
- Chapter 3 Key Drivers of Public Transport use
- Chapter 4 Environment Scan – Influencing trends (internal and external to Council)
- Chapter 5 SWOT Assessment – Strengths, Weaknesses, Opportunities, Threats.
- Chapter 6 Review of Available ITS Technologies for short to medium term applicability
- Chapter 7 Other Short to Medium Term Options
- Chapter 8 Short to Medium Term Recommendations (1-5 years)
- Chapter 9 Longer Term considerations/opportunities (6+ years)
- Chapter 10 Longer Term Recommendations
- Chapter 11 Suggested Way Forward.

2 Strategic Context

2.1 Council's Strategic Direction

A review of regional and national strategic planning documents and current projects of relevance to transit technology considerations was carried out to inform this study. The key intent is to understand Council's strategic objectives (desired 'future state') for the region's transport system and current initiatives.

Reviewing 'current state' (transit patronage trends are discussed further in Chapter 3) against desired 'future state' assists with the identification of key gaps.

Transit technology solutions and investment decisions should be prioritised to close those gaps (i.e., to take this region's transport system from where it is today, to where it should be in the future).

2.1.1 Regional Land Transport Strategy 2015 - 2045

The Bay of Plenty Regional Land Transport Plan (RLTP) sets the direction for the region's land transport system for the next 30 years. The preferred strategic option in the RLTS is an Optimised Transport System. A hierarchy of interventions is as follows:

- Integrated planning
- Demand management
- Network optimisation
- New and improved infrastructure

The Bay of Plenty has followed an Investment Logic Mapping (ILM) process to identify its short-medium term priorities for investment in the region's land transport system. The region has determined that an investment approach centred on the priorities of improved economic performance, increased safety, and improved access and resilience is the preferred option to support delivery of the region's land transport vision and objectives in the short to medium term. We note the plan prioritises the following demand management initiatives:

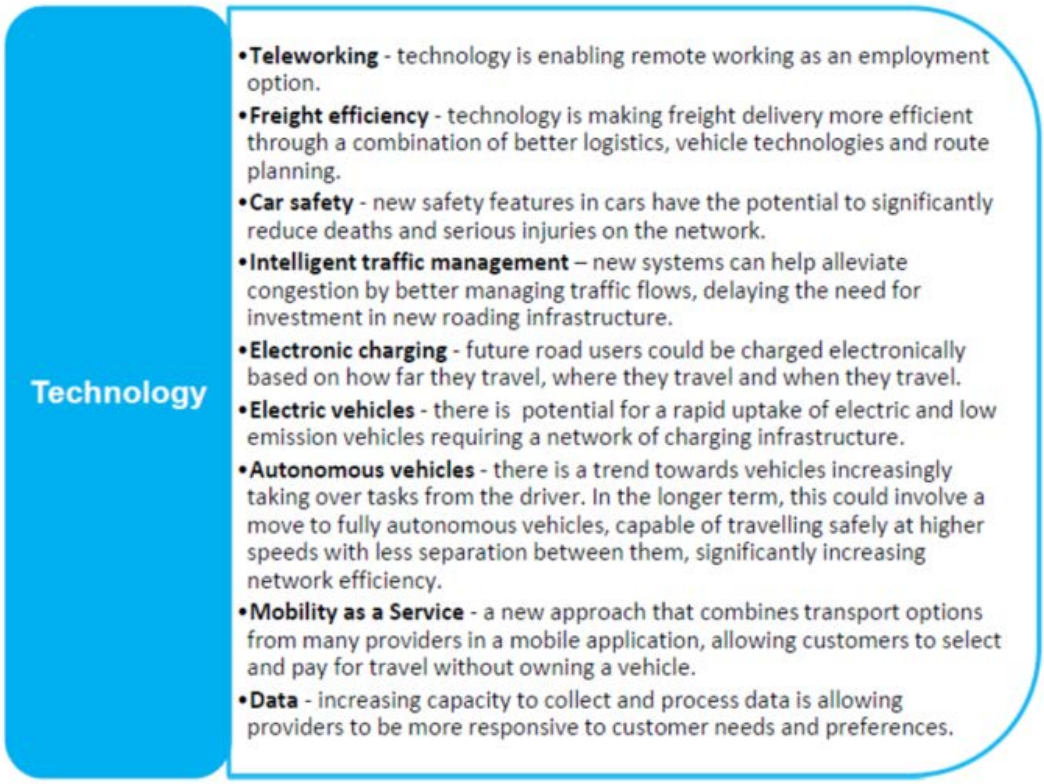
- Multi-modal connections
- Integrated ticketing
- Real-time information
- Demand responsive transport
- Priority measures for specific modes

New and emerging technologies have a role to play in each of these demand management priority initiatives, and our report will focus on concept demonstrations and suggestions for consideration to apply technologies to realise Council's strategic demand management objectives.

While emerging technologies are noted in the strategy as challenges and opportunities, the focus for future investment references primarily road applications for improved road safety. Notwithstanding, the strategy prioritises real-time information, modal priority along strategic corridors, integration, and demand responsive initiatives.

The following figure is provided in the Regional Land Transport Plan 2018, highlighting Council's key areas for consideration of new technology applications. We note, in particular, the reference to electric vehicles and autonomous vehicles and Mobility as a Service (MaaS) and we provide some general discussion on these areas in later chapters of this report**.**

Figure 2-1: Bay of Plenty Regional Council's key areas for the consideration of new technology applications



Source: Bay of Plenty Regional Land Transport Plan (2018)

2.1.2 Regional Public Transport Plan (2013)

The Bay of Plenty Public Transport Plan 2013 sets out the principles and policies to guide the provision of public transport in the region. The transit response to the RLTP's Optimised Transport System is to:

- improve the efficiency of the region's public transport services;
  increase frequencies and expand coverage on the Tauranga and Rotorua networks;
- implement real-time information, integrated ticketing, and bus priority measures; and
- consider more flexible demand-responsive services outside the main urban networks.

A key strategy is to investigate, develop and implement public transport service enhancements, including region-wide integrated ticketing, and new technology that provides real-time information to users. BOPRC also recognises that demand-responsive services are one option for connecting more isolated communities to essential community goods and services.

Given both the regional land transport and public transport plans acknowledge the importance of considering more flexible, demand-responsive services, our review will cover the application of new and emerging technologies to deliver on this priority strategy.

2.1.3 Western Bay of Plenty Public Transport Blueprint 2017

The recommended programme of investment in the Western Bay of Plenty Public Transport Blueprint (2017) focuses on improving services and infrastructure in Tauranga City with high frequencies on key urban bus routes and express buses to growth areas.

It is recognised that investment in services needs to be supported by infrastructure measures, including:

- Bus priority on major corridors;
- New or upgraded interchange facilities at key nodes;
- Improvements to high use bus stops; and
- Improved park and ride facilities.

Recommended region-wide improvements include:

- Real-time information on buses;
- Upgrades to ticketing systems;
- Transitioning to fully accessible and low or zero emission bus fleets; and
- Bike racks on buses to increase transport options.

Our report covers technology applications to enhance/enable bus priority, improve stops/interchange facilities, real time information, and achieving environmental objectives via low or zero emission public transport fleet.

2.1.4 Public Transport Operating Model and Implications for Bay of Plenty Regional Council

In 2011, the national government approved the introduction of a new framework for the provision of urban bus and ferry services, known as the Public Transport Operating Model. A key feature of the new model is an emphasis on regional councils and operators taking a partnering approach to the planning and delivery of public transport services in regions, including collaborative business planning, joint investments, and financial incentives. The Bay of Plenty Regional Council, bus operators and territorial authorities have made a joint commitment to improve value for money in the services delivered, and to promote a flexible, innovative, and responsive approach to the delivery of public transport services.

We note the commitment to collaboration. Moving forward, we recommend that future technology decisions (as per the Regional Consortium's integrated ticketing system collaboration) are considered and implemented where possible together, to progress towards inter-operability and an integrated national public transport system. We will discuss the importance of advocacy and collaboration in procurement to take advantage of economies of scale and obtain funding/delivery assistance via NZTA.

We also note that new bus contracts will take effect from December 2018 for urban and rural bus services, and January 2019 for Tauranga school services. Future contracting requirements include:

- Re-tender the Katikati and Ōmokoroa bus service (2022/23);
- Re-tender the Rotorua bus service (2023/24); and
- Re-tender the eastern Bay of Plenty bus service (2024/25).

We understand the Public Transport Committee at its August 2017 meeting requested staff to continue to progress work on deploying hybrid or electric buses as a key component of achieving a carbon neutral environment for the Bay of Plenty region. We provide some high-level insights to guide future fleet decisions in Chapter 7.

New operating contracts provide the opportunity for Bay of Plenty to consider new service delivery models and specifications/incentives to encourage provision of new/alternative fleet (electric/hybrid/hydrogen vehicles) as part of the contract. We recommend the evaluation criteria for selection include the following:

- **Proposed transport network and services integration;**
- **Potential of solutions to either improve customer services and grow patronage;**
- **Improved 'first mile, last mile' access to scheduled public transport services;**
- **Desirable sustainability features/practices; and**
- **Innovation (embracing emerging technologies) and value-added initiatives.**

2.2 Council's Current Challenges

As identified within Council's key strategic planning documents, the key challenges facing the region of particular relevance to the public transport portfolio are:

- A changing settlement pattern resulting from an ageing population, urbanisation and an increase in the region's population placing pressure on the type of transport infrastructure required and where it is located.
- The growth and the changing makeup of the economy placing pressure on key transport infrastructure networks and changing the mix of services required from them.
- For the larger urban centres of Tauranga and Rotorua, ensuring strong links with other upper North Island centres such as Auckland and Hamilton to access higher level services in these areas, and that labour from these areas can be used.
- Susceptibility to natural hazards affecting the resiliency and availability of the network.
- Coping with anticipated demand for increased provision and quality of bus services within financial constraints.
- Implementing a new region-wide electronic ticketing system and potential changes in the basis on which fares are charged.
- Implementing the relevant policies in the current Regional Public Transport Plan about concession fares in major urban areas.
- Achieving a target fares recovery of 40% over the next seven years of the Regional Land Transport Plan where it currently stands at about 30% (and has reduced in past year).
- Optimising the Tauranga urban and school bus services.
- Re-tendering the following bus contracts:
    - Re-tender the Katikati and Ōmokoroa bus service (2022/23).

- Re-tender the Rotorua bus service (2023/24).
- Re-tender the eastern Bay of Plenty bus service (2024/25).

2.2.1 Budget Constraints

Funding for passenger services is made up of a mix of Central Government funding, user fees and charges (bus fares), general funds and targeted rates.

Budget constraints impact on the type and magnitude of technology initiatives that Council can consider and also impact decisions on how solutions are procured and implemented (i.e., solely, collaboratively, and via changes to new bus tendered contract specifications).

The 2017/18 budget is summarised below:

Total Operating Revenue:

- $4 million revenue (fares/fees and charges) from the transportation group in 2017/18, with a total operating revenue allocation of $16.4 million for the year (i.e., $7.7 million in subsidies, $3.6 million in rates contributions).

Total Operating Expenditure:

- Budget for passenger transportation in 2017/18 = $21.353 million plus a transport planning activity budget for transportation group of $638,000 = $21.99 million (projected to rise to $25 million by 2022/23 in the Long Term Plan).

Total Capital Expenditure:

- Total $1.5 million in 2017/18, identified by the sub-activity as shown below: (we note that no allocation was identified in the Long Term Plan).

Table 2-1: 2017/18 capital expenditure budget

	Capital expenditure by sub activity	Type			
	Regional Passenger Transport				
0	Electronic Ticketing Rural	New	0	42	42
	Rotorua Passenger Transport				
0	Electronic Ticketing Rotorua	New	0	170	170
	Tauranga Passenger Transport				
0	Electronic Ticketing Tauranga	New	0	638	638
	Real Time Passenger Information				
0	Tauranga	New	0	658	658

The Long Term Plan identifies capital expenditure over the next five years as summarised in Table 2.2:

Table 2-2: Outline of the Long Term Plan's capital budget

	Type	2015/16 $000	2016/17 $000	2017/18 $000	2018/19 $000	2019/20 $000	2020/21 $000	2021/22 $000	2022/23 $000
Capital expenditure detail									
Electronic Ticketing (Tga)	Replacement	180	2,404	0	5	0	6	0	6
Rotorua Ticketing System	Replacement	0	444	0	0	0	0	0	0
Real Time Passenger Information	Improvement	647	0	0	0	0	0	0	0
Rural Electronic Ticketing (Capital)	Improvement	0	193	0	0	0	0	0	0
Total capital expenditure		827	3,042	0	5	0	6	0	6
Other capital funding applied									
Increase (decrease) in reserves		(752)	(1,390)	0	(2)	0	(2)	0	(3)
Total capital funding applied		75	1,652	0	3	0	3	0	4
Sources of capital funding									
Subsidies and grants for capital expenditure		75	1,652	0	3	0	3	0	4
Total sources of capital funding		75	1,652	0	3	0	3	0	4

The Long Term Plan also identifies the following Transport Planning budget: (we note a slight saving in 2017/18 budget from $697,000 to $638,000 has been identified since these estimates were published).

Table 2-3: Outline of Long Term Plan's transport planning budget

	2015/16 $000	2016/17 $000	2017/18 $000	2018/19 $000	2019/20 $000	2020/21 $000	2021/22 $000	2022/23 $000
Activity operating revenue								
Operating grants and subsidies	48	66	0	50	71	0	54	21
Total activity operating revenue	48	66	0	50	71	0	54	21
Operating expenditure by sub activity								
Transport Planning	574	667	697	728	749	728	732	778
Total operating expenditure	574	667	697	728	749	728	732	778

Investing and delivering significant transit technology-based interventions and infrastructure is challenging especially in light of the current fiscal and economic conditions faced by Council and the wider regions.

There clearly is a need to maximise the use of existing transport assets and services, identify new funding and delivery mechanisms, and ensure the transport funding distribution is prioritised to projects and services which will deliver the most beneficial outcomes for the community at large.

2.3 Key Current Transit Technology Projects

The following provides a snap shot of the key current initiatives of relevance to the Public Transport Technology Strategy. More detailed discussion of these initiatives is provided in later technical review and options development chapters of this report.

2.3.1 New Integrated Electronic Ticketing System to be Supplied by INIT

Otago, Waikato, Bay of Plenty, Manawatū-Whanganui, Hawke's Bay, Taranaki, Northland, Nelson, and Invercargill councils have been working as a consortium to secure a new ticketing system (supplied by INIT). The new system will be rolled out over six months from mid-2018.

This collaborative arrangement has meant that there will be cost efficiencies for the participating agencies. It will also provide better information about how passengers travel on the network and an improved customer experience, with travellers being able to use their smart card in the nine regions where this new system is being installed. Passengers will be able to check their balances and top-up the credit on their cards online.

The new INIT system is anticipated to be in place in the nine regions for around five years. The new INIT system will allow time for the procurement of a longer term, potentially account-based, nation-wide solution for public transport ticketing and payments. Council staff are currently working with colleagues from the other consortium councils to begin the implementation of the system.

Further discussion, particularly in terms of future technology investment decisions aligning and supporting current and planned ticketing system enhancements is provided in Chapters' 6 -10.

2.3.2 Real Time Bus Tracking

Rotorua bus users can view the current location of buses via real-time bus tracking technology on the Cityride eke-taone bus fleet. 'Track-a-Bus' technology allows anyone to view the current location of buses across any of Rotorua's 11 bus routes on their smartphones at www.baybus.co.nz. Users click their desired route to access the real-time information.

The functionality is also available on the Whakatāne Bayhopper buses and we understand Council is considering the introduction of a similar feature in Tauranga in 2018.

2.3.3 Text a Bus

Tauranga has a 'text-a-bus' system which uses a static GTFS feed to return scheduled timetable information to passengers. Tauranga users follow the information on the signs at the stops, text the number on the sign to 5005 to get the next three scheduled bus arrival times. Texts cost $0.20.

2.3.4 Radiola Real Time Passenger Information Trial

The Bay of Plenty is trialling a new type of real-time passenger information system. This temporary Radiola system is in use in Hamilton already, and it's a 'capex free' arrangement where Council pays the provider/s a month to month service fee. This includes auto reporting/monitoring and next stop prediction using Transit App, Google Live and the Swiftly system.

The company behind the new system is Wellington-based Radiola Smart Transit, part of aerospace technology company Radiola Aerospace.

Further discussion on RTPI solutions is provided in Chapter 6.

2.3.5 Passenger Wi-Fi for Buses Trial

The Bay of Plenty Regional Council (BOPRC) is trialling a free passenger Wi-Fi service onboard buses in Tauranga and Rotorua. It has 12 units in operation – six in Tauranga and six in Rotorua. The units are leased for three months (Dec – Feb) at a cost of $700 per unit (for the three months).

The units are provided by Icomera and the data is provided through Vodafone. For around a week in early December 2017 since going live, a total of 727 people used the service 973 times. Wi-Fi access is limited to one device and 40 MB per day (24 hours) for each customer. Council has very recently conducted a survey with users to inform its decision as to whether to continue this initiative. The feedback has been very positive.

Further discussion on Wi-Fi on buses is provided in Chapter 6.

2.3.6 Smart Travel NZ

Bay of Plenty Regional Council supports Smart Travel NZ which is an online platform and App that helps people find other local commuters and people to share rides with and plan your journey. Smart Travel supersedes the old Let's Carpool website, developed in 2008 to offer an alternative transport option in areas not well-supported by public transport.

The Smart Travel platform was developed by RideShark - commuter management web developer based in Ottawa, Canada. RideShark's platform is used throughout North America and in parts of Australia.

Further discussion of multi-modal transport (mobility) applications is provided in Chapters' 7 and 9.

2.4 National Ticketing Programme (NZTA)

In 2009, the NZ Transport Agency Board agreed to establish a national ticketing programme for public transport in New Zealand, and approved funding for the development of the Auckland Regional Transport Authority's integrated ticketing and fares systems as a first step.

Control of the central system aims to provide NZTA a valuable source of data to inform future investments in public transport and provide the ability to allow inter-operability and the option for multiple equipment suppliers and operators to participate in the system.

The NZTA is responsible for setting the technical standards for operation to be met by all equipment suppliers, transport operators and regional councils.

Since 2009, NZTA has been working with the public transport sector to create a national integrated ticketing interoperability standard (NITIS), a standards-based approach and a national processing system, to help improve the effectiveness of public transport.

In 2014, the Transport Agency issued a request seeking proposals for the provision of 'public transport integrated ticketing and automated fare collection technology' professional services to the Transport Agency

and regional councils. Following this, the Automated Fare Collection (AFC) Panel was established with 19 providers. In July 2017, NZTA requested proposals for a new panel to meet evolving and future AFC requirements by:

- Increasing the number of specialists for existing services;
- Expanding the services to be provided through the AFC Panel; and
- Allowing both new providers and existing panel members to apply to deliver the new expanded services.

The AFC Panel (with an initial contract of 5 years, expiring November 2022) provides the Bay of Plenty Regional Council with the opportunity to access suppliers with the understanding that a formal pre-selection process has already been undertaken. They can directly purchase from the national panel or develop their own secondary procurement process to select a supplier or suppliers from the New AFC Panel (based on their own internal process, best-fit for purpose and value for money analysis). New services added to the panel include AFC Business Intelligence & Reporting strategies.

Further discussion on supporting Business Intelligence systems is provided in Chapter 6.

3 What Drives Public Transport Patronage?

3.1 Current Bay of Plenty Public Transport Patronage Trends

Contracted bus services are provided for Tauranga, Rotorua, and rural areas with around 3.1 million passenger boardings recorded last financial year.

We note that despite fare increases at the beginning of 2017, the annual regional fare recovery ratio was 31%. This was 4% below target and 1% below the previous year. This reflects the reductions in patronage across all services as well as the high concession-fare passenger mix in Tauranga.

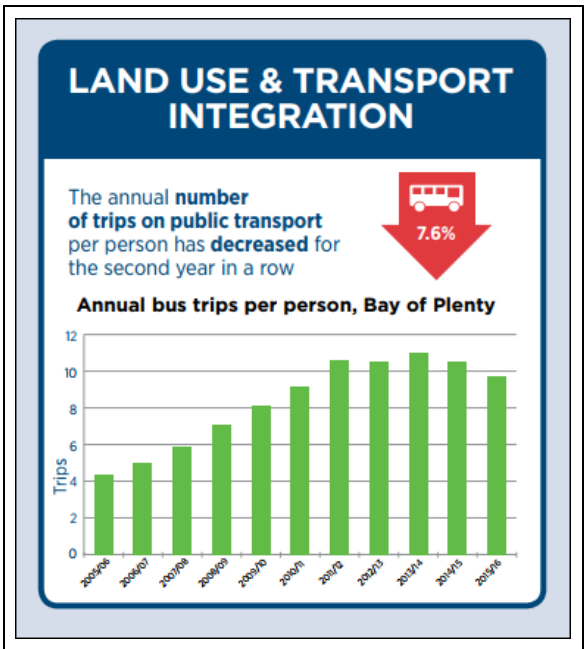
Compared to the national average of 5% mode share on local public transport[1] the current transit bus mode share for Bay of Plenty is only around 1-2%.

Table 3-1: Bay of Plenty mode shares from 2011-2014

Dataset: New Zealand Household Travel Survey: Regional results (3-year moving average)											
Region	Bay of Plenty										
Years	July 2011 - June 2014										
Measure	Sample group: People with any trips	Trip legs in sample	Km per year (million)	Hours per year (million)	Trip legs per year (million)	Mode's share of total km (%)	Mode's share of total hours (%)	Mode's share of trip legs (%)	Km per person per year	Hours per person per year	Trip legs per person per year
Mode of travel											
Total	1417	9821	3489.7	90.2	335.6	100	100	100	13132	339	1263
Car/van driver	777	5258	1972.1	45.6	178.6	57	51	53	7421	172	672
Car/van passenger	591	2666	1385.2	28.9	98.7	40	32	29	5213	109	371
Pedestrian	436	1419	35.6	9.2	43.4	1	10	13	134	35	163
Public transport (bus/train/ferry)	77	194	52.7	2.9	7.5	2	3	2	198	11	28
Cyclist	53	183	8.5	0.9	5.2	0	1	2	32	3	19
Motorcyclist	10	40	..	..	..	1	1	0	..	..	..
Other household travel	20	61	..	..	..	..	2	0	..	..	..
data extracted on 20 Dec 2017 00:03 UTC (GMT) from NZ.Stat											

[1] New Zealand Government, Ministry of Transport New Zealand Household Travel Survey 2015-2017 December 2017

Figure 3-1: Bay of Plenty bus patronage trends



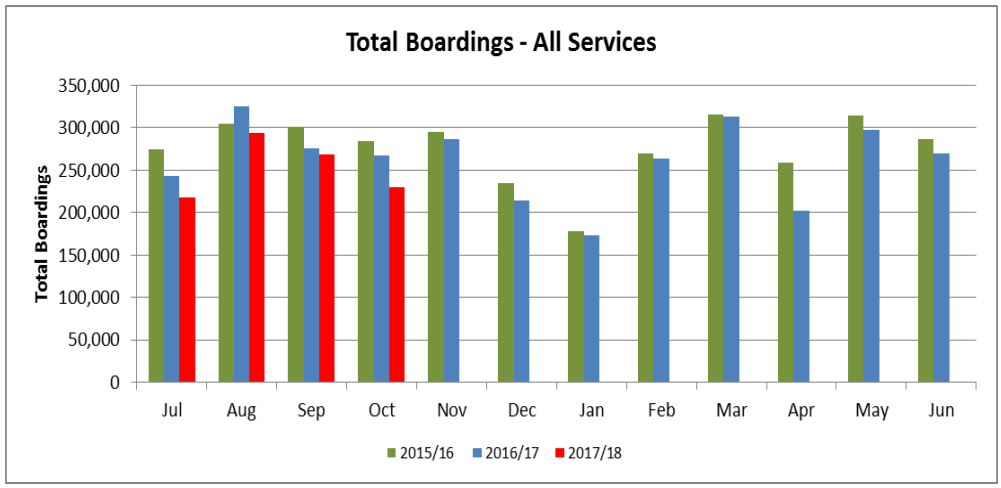
Source: Regional Land Transport Plan Annual Report Card 2015/16

These trends appear to be continuing. Comparing the July to October 2017 quarter with the same period for the 2016/17 financial year (Figure 3-2), the region's services dropped in patronage by about 9% (primarily accounted for by the Tauranga and Rotorua services). Patronage has declined across the board, but it is particularly prominent with the tertiary students. On a more positive note, patronage of the eastern Bay and Te Puke services is growing[2].

Increasing public transport mode share is particularly imperative in light of the current low public transport mode shares and recent declining patronage trends.

[2] BOPRC October 2017 Public Transport Patronage Report

Figure 3-2: Bay of Plenty PT monthly patronage trends 2015/16 – 2017/18



Source: Bay of Plenty Regional Council (October 2017) Public Transport Patronage Report

While the decline of patronage trends can in some part be attributed to external factors such as the economy and slowing rates of population growth, the conclusion may be drawn that the current public transport network and service is falling short in terms of its true potential.

The key challenge in meeting Council's strategic objective to achieve a greater shift to public transport usage (and less reliance on the private vehicle) is to close the gap between current passenger demand and the latent potential to move greater numbers of customers.

An understanding of customers (and importantly, potential customers), and their needs and expectations, is briefly outlined below, in order to identify potential service delivery gaps. This is important to understand in order to **prioritise technology investments to the areas which will close the gap on those dimensions which most influence and drive public transport usage.**

3.2 Factors Affecting Public Transport Demand

While there is no hard line separating the two, factors influencing the level of public transport usage in a particular region fall in to two main categories:

External:

- Service catchment area and population levels/growth trends
- Socio-economic profile - income levels, employment levels, age profile, private vehicle ownership
- Spatial - urban form including densification of residence and employment and topographic characteristics.

Internal:

- Service levels (quantity and quality of service)
- Transport options (mode alternatives and types of service) provided
- Pricing and ticketing systems and fares policies
- Facilities and technologies (including information)
- Marketing including education/communication
- Policies re. land use, road and parking pricing, priority to public and active transport, and travel demand management
- Road/street design
- Availability of funding/finance for public transport.

Table 3-2: Factors that affect public transport demand

Demographics	Commercial Activity	Transport Options	Land Use	Demand Management	Prices
• Number of people (residents, employees, and visitors). • Employment rate • Wealth/incomes • Age/lifecycle • Lifestyles • Preferences	• Number of jobs • Business activity • Tourist activity	• Walking • Cycling • Public transport • Ridesharing • Car • Taxi services	• Density • Topography • Walkability • Connectivity • Transit service proximity • Road and street design	• Road use prioritisation • Pricing • Parking management • User information • Promotion campaigns	• Fuel prices and taxes • Vehicle taxes & fees • Road tolls • Parking fees • Public transport fares

Internal factors are those over which Council has some control and the power to influence, and shape, the level of public transport usage.

The following section provides a brief discussion of the key drivers of demand (those factors of most importance) for public transport from a customer/community's perspective. We provide this discussion to guide the prioritisation of interventions across a myriad of potential transit technology applications that may be considered by Council.

Technology should not be implemented for implementation's sake – but to drive change in those areas that matter most to customers (i.e. to incentivise public transport use, improve cost recovery of service delivery funded by Council, and realise sustainable transport planning objectives).

3.3 Drivers of Public Transport Choice

Understanding 'the value proposition' of passenger transport for both regular and infrequent/non-users will assist in guiding Council's priorities with regard to enabling/procuring new technology applications.

Customer survey programs undertaken by the Bay of Plenty Regional Council (Urban and Rural Bus User Survey) reveal which service delivery dimensions are of most importance in addressing by the Regional Council.

We note that since 2015, satisfaction has decreased by 11 percentage points with a corresponding increase of 11% in 'neutral' rating. Combined with recent patronage declines, it is useful to review those service dimensions in which customers, on average, are least satisfied with.

In order of priority, the journey experience factors which customers are least satisfied with and thus may drive a decision to discontinue use of passenger transport include **frequency of services, reliability (punctuality), fares value and convenience of payment, and information about service delays**.

For the urban bus services, bus users aged 25-44 are more likely to be dissatisfied with urban bus service features and are more likely to mention their negative experience revolves around the bus not arriving at the scheduled time. Bus users aged 45-64 report their negative experiences to revolve around feeling unsafe and poor driving. Bus users aged 65+ are more likely to be satisfied with urban bus services. However, they are also more likely to mention negative experiences that revolve around teenagers being aggressive, the bus being difficult to use for those with disabilities and waiting a long time between services.

When prompted to provide suggested service improvements, more than half of urban bus users mention an **improvement to the service pertaining to scheduling** (refer to Figure 3-3 below). Only 9% mention bus stop improvements, with only 3% mentioning timetable information improvements. Notably, vehicle improvement mentions have decreased 31% since 2013 which suggests recent fleet improvements have contributed to a more positive experience.

For rural bus users, dissatisfaction is largely driven by **travel time, fares value/convenience of payment and frequency of services (particularly level of weekend servicing)**. Strong dissatisfaction was reported around **information about service delays/disruptions**.

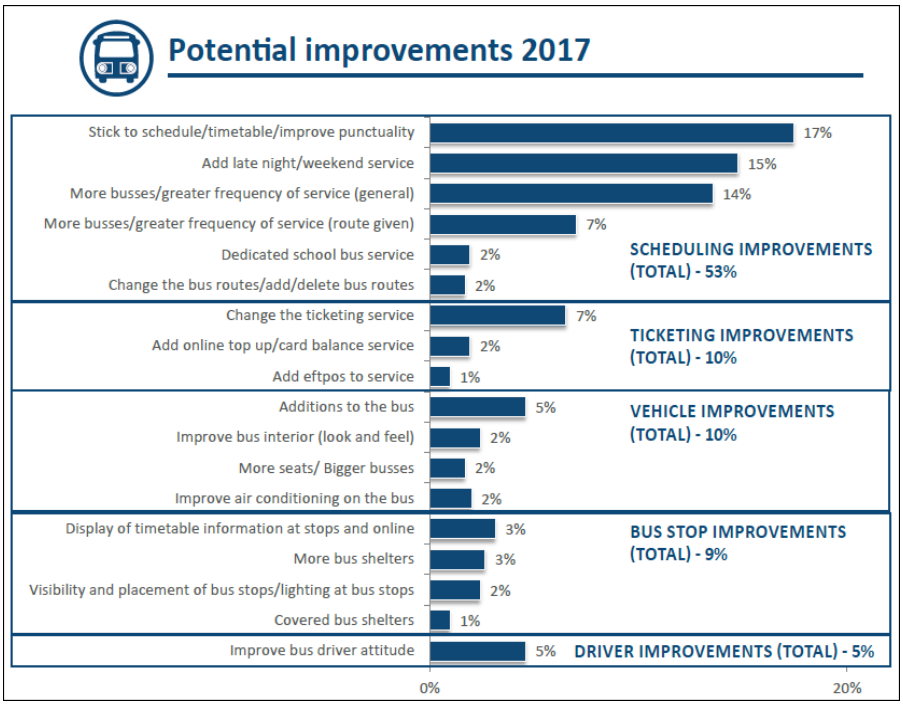
The Bay of Plenty Regional Council's recent real-time passenger information initiative will assist with improving satisfaction with information by keeping customers better informed of service arrivals. The results strongly support Council's intent to consider longer term real-time passenger information investments beyond the current Radiola trial which we understand runs until December 2018.

The proposed network reforms to be implemented by December 2018 should also be key to addressing customers' (urban and rural) concerns around frequency and weekend servicing.

We recommend the application of new and emerging technologies to enhance scheduling/network planning and to deliver new types of transit services to customers as the highest priority.

Results also suggest prioritising infrastructure improvements at stops and on bus would not be the wisest investment of time/resources, particularly given current funding constraints.

Figure 3-3: Potential improvements - Bay of Plenty urban bus survey respondents 2017



Source: Versus Research (June 2017) Urban and Rural Bus User Survey. Report prepared for Bay of Plenty Regional Council

These results are very consistent with Greater Wellington Regional Council's survey of Metlink's customers' experiences. Key areas of concern are the provision of information about service delays and disruptions and value for money. These aspects have been identified as core drivers of overall satisfaction.

Figure 3-4: Potential improvements - Greater Wellington region Metlink customers (2017)

Suggestion for Improvement	Total Sample			
	2014	2015	2016	**2017**
	(n=4,298)	*(n=4,426)*	*(n=2,361)*	***(n=4,050)***
More frequent services	8	8	7	**11**
Cheaper fares	10	7	6	**7**
Improved reliability of services – run on time/to timetable	10	10	4	**7**
Integrated ticketing/automate ticketing system	6	6	5	**6**
More buses on the route/more carriages/more seats available/reduce overcrowding	6	6	6	**6**
Cheaper fares for students	4	2	4	**6**
More/more frequent weekend/late night/holiday services	3	3	3	**5**
More informative about service delays, disruptions and changes (e.g. buses replacing trains)	3	2	1	**4**
Able to top up card at more places (online, on bus, via smartphone, more shops)	1	2	2	**3**
Friendlier drivers	3	3	3	**3**
Faster/more direct service/fewer stops/more Express services	3	2	2	**2**
Less delays/break downs	0	2	<1	**2**
More accurate Real Time information	<1	0	<1	**2**
Improve smartphone app (able to check card balance, review timetable etc.)	1	1	<1	**2**

Base: All respondents.
Table lists those improvements mentioned by 2% or more of respondents.
Orange highlighting denotes a statistically significant change from the previous year.

Source: Gravitas (August 2017) 2016/17 Public Transport Passenger Satisfaction Survey. Report prepared for Greater Wellington Regional Council.

International research findings are also very consistent with the local insights derived from the Bay of Plenty Regional Council's and Greater Wellington Regional Council's customer and community surveys.

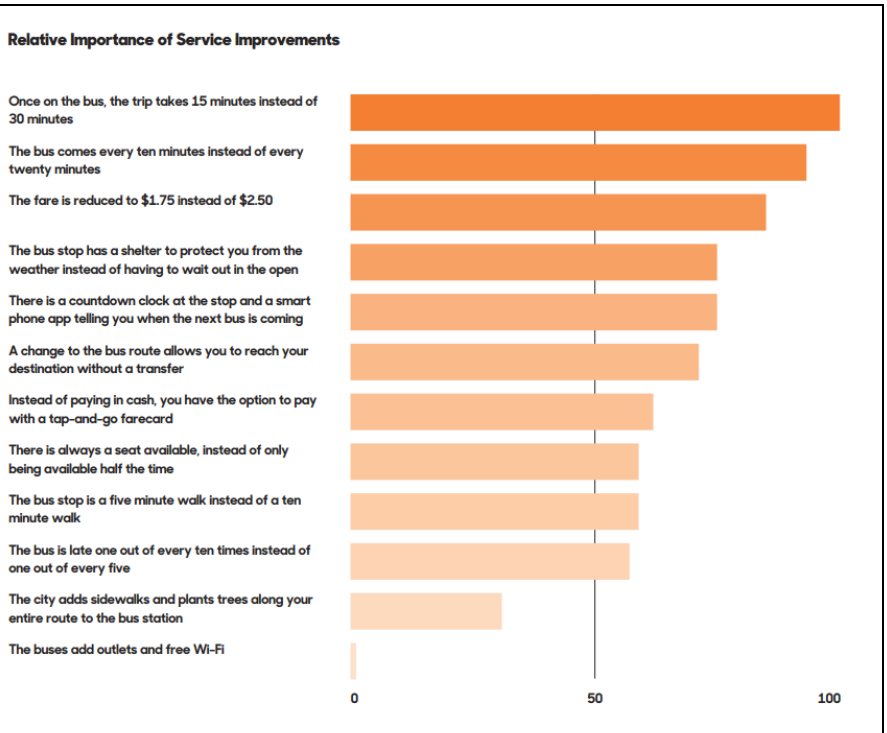
TransitCenter (a US foundation) has published a report on what transit riders really want from surveying 3,000 people from 17 different cities in the US.[3] It concludes that the major elements that are important to transit users are: (1) frequency of service, (2) travel time, (3) stop/station facilities, (4) information as to when the next bus/train is coming. The report concludes:

> *"To put it simply: What makes an unhappy transit rider? Transit service that is infrequent, slow, and unreliable, and transit stops that lack shelter and information. Addressing these deficiencies should be at the top of agencies' to-do lists."*

We note, in terms of service improvements, the least nominated ones are on-bus enhancements such as free Wi-Fi:

[3] TransitCenter (2016) Who's on Board survey report accessed at http://transitcenter.org/publications/whos-on-board-2016/#press

Figure 3-5: Most important public transport service delivery dimensions



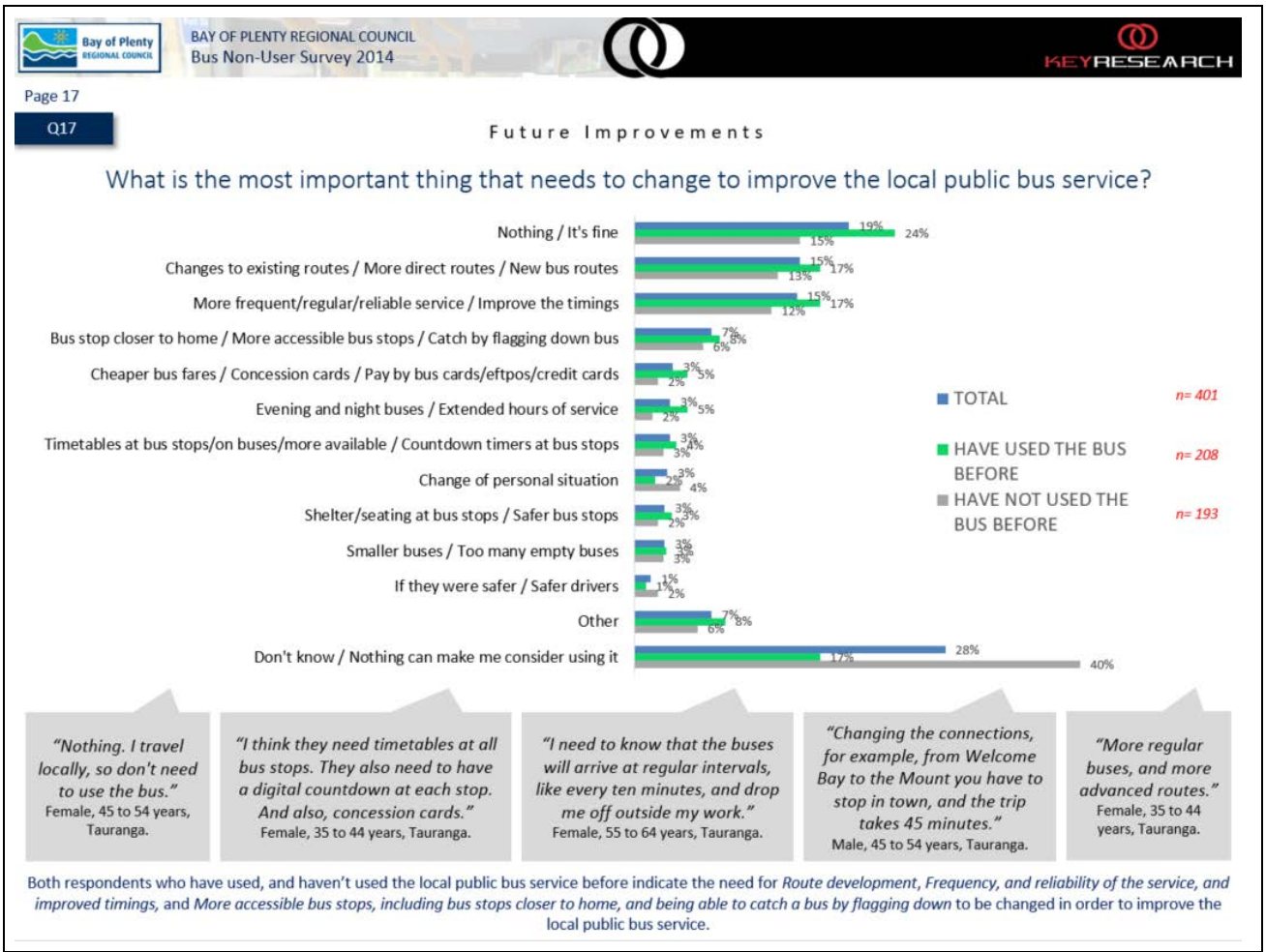
Source: TransitCenter (2016) Who's On Board.

Travel choices can also be made on the basis of perceptions, particularly where there is no or only limited experience of certain modes of transport. General community perceptions can be gleaned from the Bay of Plenty Regional Council's bus non-user survey (last undertaken in 2014).

Convenience is reported to the main reason people choose to use private transport instead of public transport (66%). The factors that make private transport more convenient include the freedom to travel where and when they want. Suggested improvements to increase the convenience of local public buses included better positioning of bus stops and more bus routes and bus times.

The key factors which may driver greater take up of public transport, as suggested by non-users, are **changes to existing routes, more direct routes, and new bus routes (15%), more frequent, regular, and reliable service, and more stops.**

Figure 3-6: Most important service dimensions reported by Bay of Plenty bus non-users



Source: KeyResearch (August 2014) Bus Non-User Survey 2014. Report prepared for Bay of Plenty Regional Council.

We note in our research that car drivers generally perceive the car's characteristics (for example, cost, travel time, ease of use) as being better than they are and consistently judge public transport, and to a lesser extent, walking and cycling, as being worse than they are. However, road transport also generates external costs: that is, costs not borne by transport users but by society as a whole. The most obvious are health impairment because of air pollution, accidents and noise, and time losses due to road congestion. These perceptions and 'hidden' costs of private vehicle use highlights the need for supporting education /information/communication strategies to supplement Council's service and infrastructure investments.

The perceived inconveniences of passenger transport by residents include poor travel time, frequency, and reliability as well as poor network connectivity in that passenger transport does not offer a viable option.

Our recommendations also cover the application of new and emerging technologies to deliver supplementary/alternative services which address directly the service delivery dimensions (drivers of choice) that matter most to current 'non-users' of the Bay's public transport offerings.

3.4 Implications for Transit Technology Investment Priorities

Recent patronage trends and results from user satisfaction tracking programs suggest that the current system is falling short in meeting the desired standards in those key areas which most influence the decision to use public transport and encourage greater use of passenger transport.

The best opportunities for growing patronage through operations are encouraging occasional users to become more frequent users through incentives along with the provision of better reliability and frequency. Many of the other factors influencing personal journey choice such as the locations of home and employment may be better addressed through longer-term land use planning and transport integration policy decisions.

Over the longer term, we consider a fundamental shift in approach is required to deliver greater flexibility and convenience.

The results from customer and community surveys would suggest that Council is certainly on the right path in terms of pursuing real time passenger information enhancements.

We also consider that investment in Business Intelligence systems to assist with service re-scheduling and network re-design is likely to arrest patronage declines more so than the application of at-stop, on-board information and communication enhancements.

Technology plays an important part in these service planning and scheduling endeavours by providing Council with better business intelligence for network planning and response.

Technology can also play a key role in the types of service offerings available to the community**.**

4 Key Influencing Trends

Several emerging trends have implications and present opportunities for the Bay of Plenty's regional public transport system. A brief overview is presented below.

4.1 Environmental Sustainability and Resilience

Parts of the transport network within the Bay of Plenty are particularly susceptible to natural hazards, which affect the resiliency and availability of the network. The long-term risks of flooding and inundation need to be factored into developing transport infrastructure and appropriate management strategies, including retreat, adaptation, or defence.

Climate change is expected to increase the number and severity of weather events, which could lead to an increase in disruptions and incidents[4]. However, through the application of integrated and connective vehicle/infrastructure/people technologies, these disruptions and incidents can be avoided, mitigated, or managed.

Addressing weather events and incidents will require infrastructure upgrades where appropriate, but also the management of the incidents themselves. In many cases, technology can be deployed to communicate with customers, both about incidents as they occur and about which routes or services to use. This includes interventions in real time to prevent disruption, prepare to withstand damages, and rapidly recover from consequences.

Furthermore, passenger transport's carbon footprint has an inverse relationship to the region's carbon footprint. This means that the greenhouse gas emissions will go down if public transport's footprint increases. We must invest in ways to reduce greenhouse gas emissions and also invest in ways to help our systems adapt to climate change.

There has been a noticeable strengthening in the global case for investment in the development and commercialisation of alternative fuels and new vehicle technologies for transit applications. While hybrid vehicles are now common, full electric vehicles are a relatively new technology. However, with advances in this area, integration of electric vehicles across the entire transport system (public and private) can be achieved over the longer term.

We recommend that Council facilitate the take up of alternative delivery models of passenger transport, enabled by emerging technologies, to reduce single-occupancy vehicle use and contribute to Bay of Plenty's desired environmental outcomes as outlined in the Bay of Plenty Regional Council's strategic issues and operating environment statement.[5]

Council should consider fuel and technology options that have the potential to reduce costs (fuel consumption), further improve the environmental benefits, as well provide the opportunity to differentiate service and service quality. Brief discussions of new fuel and fleet technologies (including electric and autonomous vehicles) for the public transport are provided in Chapter 7.

We recommend that environment standards and requirement of operators to consider/progress/implement new fleet technologies be greater components of new operator contract

[4] https://www.boprc.govt.nz/residents-and-communities/climate-change/
[5] https://www.boprc.govt.nz/plans-policies-and-resources/key-strategic-issues/

specifications and performance standards. Facilitating the deployment of new fuel and fleet technologies is a highly tangible demonstration of Council's sustainable transport objectives.

Further discussion on opportunities to embrace new fleet and fuel technologies is provided in Chapter 9.

4.2 An Ageing Population

The aged customer is becoming an increasingly significant market segment for the Bay of Plenty region, as highlighted in Table 4.1 (NZ Census Data changes). This segment is likely to have some mobility restrictions and will likely desire greater personalisation of service, greater accessibility and way finding requirements (legibility, access channels), more door to door service requirements, and an integrated end to end service.

It is also important to note that **this segment may be less 'technology-savvy' and prefer traditional channels to access public transport information and personalised face-to-face contact/customer service**.

On the other hand, whilst only 11% of the total population, the region has experienced growth in the 15-24 years age bracket – this is a key target market for public transport usage. Generational changes and implications for transport planning and potential technology applications is discussed in the following sub-section.

Table 4-1: Bay of Plenty Region – population profile

Age Group	2001 Population	Proportion of Population in 2001	2013 Population	Proportion of Population in 2013	% Change between 2001 and 2013
<10 years	38,172	16%	37,992	14%	-0.47%
10-14	20,160	8%	19,734	7%	-2.11%
15-19	15,993	7%	17,370	6%	8.61%
20-24	12,126	5%	14,220	5%	17.27%
25-29	13,752	6%	13,263	5%	-3.56%
30-34	16,128	7%	13,446	5%	-16.63%
35-39	17,940	7%	15,648	6%	-12.78%
40-44	17,925	7%	18,363	7%	2.44%
45-49	15,870	7%	18,345	7%	15.60%
50-54	14,901	6%	19,116	7%	28.29%
55-59	12,132	5%	17,421	7%	43.60%
60-64	10,986	5%	15,954	6%	45.22%
65-60	9,570	4%	14,448	5%	50.97%
70+	23,760	10%	32,421	12%	36.45%
Total	*239,415*	*100%*	*267,741*	*100%*	*11.83%*

On-demand and demand responsive services provide the aged and less mobile market segments with more personalised and flexible door to door access options.

Further discussion of opportunities to better meet the ageing population is provided in Chapters' 7 and 9.

4.3 Generational Changes

It was noted in Chapter 3, that **patronage in the tertiary market in particular has declined in the region** in the most recent years. This is of concern and is contrary to trends in other regions, nationally and internationally.

Changes in consumer behaviour of younger generations must be considered as these also introduce changes in travel preferences as well as ways to access information and services.

There are now five generational cohorts in the New Zealand workplace: Matures/Veterans (born before 1946); Baby Boomers (born 1946-1964); Generation X (1965-1979); Generation Y ('the millennials" 1980-1994), and Generation Z ("iGen" 1995-2007).

Generation Y's and Z's are part of a generation that is increasingly global, social, visual, and technological. They are also the most technologically literate and socially empowered generation. They demonstrate a preference for social entrepreneurship, applying practical, innovative, and sustainable approaches to benefit society in general.

Members of Generations' Y and Z currently use, and are projected to continue to use, passenger transport options (including public transport but increasingly more ride-share and ride-source options) at a higher rate than their older counterparts, indicating that the increased use is not temporary, and that overall investment in passenger transport should be maintained, if not increased. This change appears to be a generational effect, as opposed to an age effect.

A recent Nielsen global study found that Generation Y and Generation Z continue to be most willing to pay extra for sustainable offerings—almost three-out-of-four respondents in the latest findings. The rise in the percentage of respondents aged 15 - 20 years, Generation Z, who are willing to pay more for products and services that come from companies who are committed to positive social and environmental impact was also very strong—up from 55% in 2014 to 72% in 2015.

> *"Brands that establish a reputation for environmental stewardship among today's youngest consumers have an opportunity to not only grow market share but build loyalty among the power-spending Millennials of tomorrow, too*". [6]

Recent research undertaken by MRCagney for university master plans has also indicated that Generation Z's are also more discerning (and critical) of public service reliability and convenience. We note a shift towards the **greater use of shared services** such as ride-share (including bike and e-bike share schemes) and ride-source as alternatives to scheduled public transport, and that they find these options better alternatives for convenience and value for money (especially when travelling in groups).

This generational change necessitates a re-think of how public transport services are delivered, beyond via the provision of traditional scheduled bus services.

[6] http://www.nielsen.com/us/en/insights/news/2015/green-generation-millennials-say-sustainability-is-a-shopping-priority.html

Further discussion of shared service opportunities to address the region's recent decline in tertiary bus patronage is provided in Chapter 7.

4.4 Shifts in Car Reliance

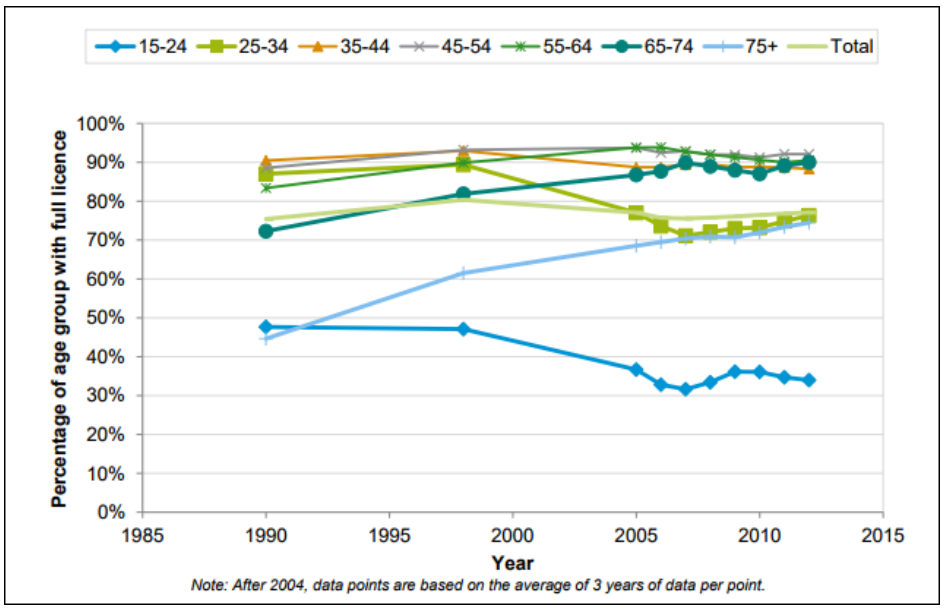
The 2013 NZ Census reported a slight decrease in the proportion of households that have no motor vehicles and a slight rise in households with access to multiple motor vehicles. The Bay of Plenty motor vehicles/household trends are consistent with the national average, with only 7% of households reporting no motor vehicle and 39% of households reporting one vehicle. We do not expect this trend to change in the immediate/short term future, but internationally there is evidence of a trend towards reduced vehicle ownership.
In a Ministry for Transport report (*Future Demand New Zealand transport and society: Trends and projections November 2014*)[7], a fall in driver licence ownership was highlighted, as shown in the figure below:

Over the longer term this trend, along with the generational change trend discussed above, indicate greater take up of passenger transport options, in particular shared services.

We recommend that Council undertakes an active role as an enable and influencer for the greater take up of shared services – via policy settings, potential partnerships with shared service providers, parking management practices, and urban design.

Further discussion of ride sourcing and shared service opportunities is provided in Chapter 7.

Figure 4-1: Percentage of people aged over 15 years old with a full car licence (from the household travel survey)



[7] http://www.transport.govt.nz/assets/Uploads/Our-Work/Documents/fd-trends-and-projections.pdf

4.5 The Sharing Economy

Rapid developments in information and communications technology have provided coordination benefits, reduced transaction costs and the need for individual contracts to be negotiated for every transaction. The sharing economy seeks to share resources in efficient ways and promises a more efficient use of slack capacity in both physical goods and labour. New entities have begun providing coordinated services, rapidly disrupting traditional business models.

Transport is a natural market for the "sharing economy". Taxis, ride-source, and car-share services connect people with drivers and vehicles when and where they need it.

In response, on-demand ride sourcing and car sharing have emerged as convenient and affordable alternatives/supplements to traditional fixed route and scheduled passenger transport services. Public passenger transport via ridesharing and app-based booking services should be viewed as another access channel for the booking of transport services (taxis and hire cars being among them).

The key opportunities arising from digital disruption and the new sharing economy are:

- Openness to shared mobility;
- Greater personalisation of service offerings;
- Improved network coverage – geographically and temporally; and
- Access to user data which facilitates the provision of dynamic on-demand services and more tailored service planning.

Uber, CityHop, Chariot and Roam in NZ, among others, provide alternative 'personal transport' models that pairs the convenience and benefits of a car, without the need for and expense of owning one. Ride-share and car-share technologies enable everyone to access the convenience and benefits of a personal vehicle, while avoiding the need for individual vehicle ownership. These services essentially deliver 'mobility on demand' and, in the process, save time and money.

Since commencing operations in 2014, the Uber ride hailing app is now well established in Auckland, Wellington, and Christchurch with more than 300,000 passengers and 4,000 active drivers registered.[8] Uber has only very recently launched in Tauranga. Changes to passenger service vehicle laws come into effect in October 2017 requiring Uber drivers to hold passenger endorsements. The changes were part of the Land Transport Amendment Act 2017, which was passed in Parliament on August 3, 2017.

Uber has now integrated with Auckland Transport's journey planner, allowing commuters to use the service to or from their public transport stop. A project called MoveNZ piloted subsidised rides for passengers travelling to Auckland's Northern Busway and Wellington's Lower Hutt Trainline.

In the next 10 years, it is likely that these new emerging models will lead to fewer cars being sold and owned in New Zealand.

Notwithstanding, shared services benefit from the scale of large, dense cities for a viable market to share a particular asset or service.

[8] https://www.stuff.co.nz/business/industries/92409872/what-are-ubers-big-plans-for-new-zealand

For the Bay of Plenty Regional Council, ridesharing (at least in the short term) can be considered as **a supplementary public transport delivery mechanism** - **providing first-mile last-mile connection options.** The per kilometre cost of ridesharing services means that it is unlikely to act as a substitute for cars or public transport for longer journeys. However, the flexibility of the service means that it has capacity to complement the region's public transport system by overcoming the 'first and last mile' problem and provide more demand-responsive servicing for the transport-disadvantaged and special requirements segments.

Chapter 7 provides further discussion on shared services, implications, and potential applicability for Bay of Plenty.

4.6 Connective and Autonomous Vehicle technologies

Autonomous Vehicles (AVs) are poised to be the next transformative change on current patterns of mobility and land use (IHS Automotive 2014: *Autonomous Cars – Not If, But When*. The U.S. leads the way in the pursuit of autonomous vehicles with three states (Nevada, Florida, and California. Michigan) having passed laws in 2012/2013 to allow driverless cars to be tested on public roads. In Britain, the government is supporting the implementation of driverless cars with its Meridian Shuttle trial. Similar trials are also being conducted in Sweden, Japan, and Singapore[9].

Automated systems are more ideally suited to supplementing mass public transport systems with both collective and personal on-demand and shuttle services when demand is low or pick-up points are far apart. These new fleets could supplement what is currently on offer in the form of readily-available car-sharing services, driverless taxis, or personalised means of public transport.

While we are optimistic about the potential benefits of autonomous vehicles, particularly for public transport applications, we are somewhat sceptical about their uptake in the short to medium term. The relatively slow rate of turnover in the vehicle fleet means that it would take at least a decade to achieve a high-level of adoption, even if competitively-priced autonomous vehicles became available today.[10] Rather than provide a detailed discussion on connective and autonomous vehicle technologies here, we encourage Council to access MRCagney's research report on autonomous vehicles cited about which we have very recently published, specifically with reference to the New Zealand market.

We recommend the following tangible ways BOPRC can prepare effectively for connective and autonomous vehicle technologies:

- **Updating regulatory frameworks in response to the unique features of autonomous vehicles.**
- **Reforming parking policies and management practices to ensure sufficient parking is available in the right place, and at the right price.**
- **Ensuring that investment in public transport infrastructure, networks, and services considers the availability of autonomous vehicle technology over the longer term. For example, the demand for park-and-ride facilities is likely to reduce, while kiss-and-ride (drop-off) facilities may become relatively more important.**

[9] http://press.ihs.com/press-release/automotive/self-driving-cars-moving-industrys-drivers-seat

[10] MRCagney Dec 2017) Autonomous Vehicles Research Report accessible at http://mrcagney.com/uploads/case-studies/MRCAutonomousVehicles.pdf

4.7 New Management and Delivery Models

Today's consumers are more 'connected' than ever – before, during, and after their journeys. The whole concept of the 'customer relationship' has changed, from delivering transport to managing mobility.

Service providers and authorities are now taking advantage of the significantly wider availability of 'big data' (often in real time), to deliver more responsive and customised transport services to the individual, as well as optimise operational performance.

Mobility as a Service (MaaS) represents a new approach to delivering transport which is currently receiving significant attention across the world. In the literature the concept may be referred to as Future Mobility, Total Mobility, Mobility Management etc. although several agencies are using the term somewhat incorrectly as a 'catch all' for account-based ticketing systems and inter-operability initiatives. **This approach moves beyond providing a single transportation service to a 'family of services' philosophy that can offer a 'one stop shop' offering a wide range of services.** It moves beyond an aggregated transport app for payment and journey planning information.

In the MaaS model, a mobility manager aggregates (increasingly disaggregated) infrastructure, transport services, technology, data, payment facilities, and information on the one platform to meet the travel and lifestyle needs of the individual. It brings together transport operators and third parties, allowing a seamless provision of service, information, booking, payment and customer relationship management services between transport modes. Other lifestyle services can be added to a mobility management account, providing the possibility to influence travel demand through incentives and loyalty schemes linked to the values and lifestyle needs of the varied customer segments. This opens up the double win of new revenue streams from value-added services, and patronage growth through the incentive.

The region's transport network may need to recognise, respond to, and capitalise on the opportunities arising from these changes in the longer term. In particular, technological advances facilitate delivery partnerships between public transport agencies and the private sector.

Further exploration of mobility apps is provided in Chapter 7. Mobility as a Service is discussed in Chapter 9.

4.8 Implications of Trends for Bay of Plenty Transport

There has been a noticeable shift in approach from managing 'transport' to managing 'mobility' – this approach moves beyond planning and delivering a single transport service to adopting a more retail-based model comprising a 'family of services' philosophy.

Five key global megatrends are manifesting this necessary shift in approach:

- **Integration and convergence**: Many different forms of transport are now an integral part of transport networks Modal choices are expanding and the distinctions in what is 'public transport' become blurred with new services such as Uber.

- **User experience**: Transport is redefining itself as "mobility" and focuses on the customer rather than as a product to the customer. This is a profound shift arising from a significant increase in the ability to share information in real time and new business models becoming possible via

technological advances. Expectations and requirements have changed with a greater emphasis on flexibility, personalisation, and on-demand services.

- **Access over ownership**: Providing access to mobility rather than owning (and long-term commitment to) the means of mobility is revolutionising the transportation sector and facilitating new entrants to markets. The collaborative (or sharing) economy is a recognised global phenomenon that has led to more means of connecting people to share opportunities such as lift sharing, car share, bike hire and so on.

- **Technology:** New technologies are significantly changing the established transport sector. It is now possible to integrate journey planning across several modes and to provide real time, accurate information, connected communication, and response.

- **Big Data:** The whole approach to a journey, facilitated by open- source data platforms and aggregation applications, is the underlying driver to these changes. People are now looking at transport as a whole network and understanding the full range of seamless opportunities available.

These trends are already affecting transport systems globally, including how they are operated, maintained, and upgraded, and both governments and service providers are responding.

These key trends all point to a future mobility sector comprising:

- More modal choice and flexibility;
- Greater modal integration and connectivity;
- Greater enabling of transportation ride sharing;
- Greater open data access;
- Data Mixing (web + vehicles + infrastructure + apps, etc.);
- New players in the mobility sector - auto manufacturers + apps + government + technology/web + private equity + logistics;
- Less manual transactions - greater app functionality; and
- Connected vehicles/infrastructure/services/people.

We consider it a high priority for Council to identify opportunities (independently and potentially jointly) to improve urban mobility for all users through collaboration and public-private partnerships, including greater integration of (multi-modal) services, information and payment methods enabled by emerging technologies.

5 SWOT Assessment

The preceding chapters have provided the basis for an environmental scan, both internally and external. A Workshop held on 14 February 2018 provided a forum to discuss the outcomes of the environmental scan and identify key strengths, opportunities, and challenges currently facing the Bay of Plenty Regional Council and its stakeholders.

We summarise the implications for the Bay of Plenty Regional Council in the form of a strengths, weaknesses, opportunities, and threats (SWOT) assessment:

- Strengths and Weaknesses - **INTERNAL FOCUS** - the organisation's resources, capabilities, plans, and strategic direction/priorities

- Threats and Opportunities - **EXTERNAL FOCUS** – political, economic, social, technological, legal, environmental.

5.1.1 Strengths

- Strong alignment with the Bay of Plenty Regional Council's strategic objectives outlined in its Regional Land Transport Plan and Public Transport Plan.
- Strong fit with Council's willingness and commitment to trial new technologies to enhance the customer experience.
- Bus operators report a willingness to trial new technologies and service offerings.
- High customer satisfaction, despite recent patronage declines
- Council's commitment to New Network service enhancements.
- Established collaborations with regional councils, territorial agencies, public transport operators and NZ Transport Agency.
- NZ Transport Agency's national program and preferred supplier panel arrangements for systems integration.
- Excellent site for pilot schemes and evaluation of learnings for the region/wider NZ.
- Aligns well with the preferences and behaviours of the millennial Generation Z.
- Several technology applications now on the market, which Council is clearly demonstrating via trial schemes.

5.1.2 Weaknesses

- Budgetary constraints.
- Competing priorities across portfolio areas – for example, technology investments to enhance general road user safety, build environmental resilience and response to natural climatic events etc. vis a vis investment in technology enhancements for a public transport system which, comparatively, carries a low mode share of the travelling community (may also be considered a threat).
- Some recent technology initiatives place Council in a position of "systems integrator" and wears all the risk, particularly when procuring with less established start-up ventures.

- Limited existing public transport infrastructure means new transit technologies may not have a suitable foundation to be effectively deployed.
- Limited parking management in the City Centre and increasing road congestion affect the demand for and reliability of the base public transport network – benefits of new technology systems may not be realised.

5.1.3 Opportunities

- Significant opportunity to increase the community's total mobility requirements.
- Ageing population – significant opportunities to provide more personalised, flexible, demand-responsive, and on-demand passenger transport services.
- Opportunity to re-capture the tertiary market, due to generational change and responsiveness to technology etc.
- The continued trend of teenagers delaying car ownership or not getting a driver's license at all is an opportunity to target the youth market and retain the cohort as it ages.
- The new Tauranga City Centre campus for the University of Waikato provides an ideal test bed for emerging technologies and new services/applications.
- New communications and outreach methods.
- New service delivery models/alternative and supplementary transport modes to traditionally scheduled public transport services for all customers.
- Open source, cloud sourced, and crowd sourced data for dynamic network planning, response in real time, and event/disruption alerts/response.
- Uber has recently launched in the region and has demonstrated strong willingness to 'serve' not only the general market, but also specialist markets and provide discount and value-add incentives. It is investing significantly in new cutting-edge initiatives.
- CityHop and Mevo ride share providers are slowly expanding their services across New Zealand – there may be an opportunity for Council to facilitate take up, or even consider as a model for corporate fleet provision and management.
- Opportunities for the transit card to be transformed/incorporated into a mobility card in the longer term.
- New public transport operating model and future contracting requirements enabling the Bay of Plenty Regional Council to seek enhanced fleet/service technology solutions from the market rather than directly investing in technology software and hardware.
- Living lab opportunities to research, development, and trial demand responsive or on demand services and pilot programs.

5.1.4 Threats

- The Unknown – the practical application of new concepts that may be in their infancy, especially in the New Zealand market.
- Socio-demographic profile of the region – high proportion of aged people, and this trend will continue. These customers traditionally access information requirements by more traditional, non-digital means, and require more personalised service (which new technologies enable, however we need to be mindful of the older generation's reluctance to/fear of 'change').
- Potential delays in the rollout of the new INIT ticketing system.
- Potential delays in the rollout of the proposed national, longer term integrated ticketing system by the NZ Transport Agency.

- Technology advancing so rapidly that 'solutions' may become outdated/superseded – future proofing of interventions is a key risk.
- Willingness of traditional public transport/passenger transport providers to participate – open data is a requirement for the model to work. There is a nervousness about one company controlling all the data and hence a number of models are being discussed about how to ensure privacy, security and trust for people and business users and the companies.
- The key challenges include the availability of adequate funding and revenue streams, the policy and regulatory environment, overall policies towards open data and data sharing, and organisational and governance structures.
    - Funding means funding the hardware and software which collects and manages mobility information as well as the operations and services that are built on top of these assets.
- Confusion to customers/communities in making too many changes/adopting new systems etc etc.

Threats will need to be monitored and managed closely, and they reinforce the importance of a technology road map being a dynamic document, constantly being adjusted and adapted to reflect the rapidity of change in a world of digital disruption and ensure today's policy and investment decisions are future-proofed.

Together, the SWOT assessment has provided guidance to our suggested prioritising of technology interventions to maximise benefits and minimise (negative) risks.

- **What external changes will bring us opportunities – industry and consumer trends?**
- **Is there a product, a client/contractor relationship, a governance collaboration, or a market presence that we can better leverage?**
- **Is there something we would pursue if we had more resources (people, dollars, time, etc.)?**
- **Is there something we are investing in currently that has 'redundancy' risks, or really is taking our eye (and resources) away from the main game?**
- **What is the market missing, from a 'customer first' perspective – i.e. what will drive positive PT patronage growth most of all?**

MRCagney has used the SWOT to guide strategic recommendations in terms of public transport technology priorities for the Bay of Plenty Regional Council over the short (1-2 years), medium (3-5 years), and longer-term timeframes.

The following chapters review key available technologies and options that are available today and emerging which are of highest strategic relevance and interest to Bay of Plenty Regional Council.

The key strategic recommendations have been summarised in Chapter 8 (short-medium term) and Chapter 10 (longer-term).

6 Review of Intelligent Transport Systems for Buses

The following is a high-level literature review of intelligent transportation systems (ITS) technologies for buses and the relevant elements applicable to the Bay of Plenty Regional Council including benefits assessment/case studies and costs.

Communications technology is the core technology that enables transit ITS on buses. Communications have two main categories: deferred data; and live (real-time) data[11].

Deferred data refers to data stored on a computer on the bus and is downloaded once the bus is within the depot or at a scheduled time. Some examples of deferred data include: video surveillance footage; route, announcement, and scheduling information; and passenger count data.

Deferred data is usually used to minimise heavy data transfers. Transmitting large files over a mobile data network uses up a lot of that network's bandwidth, which could be costly. Data of this nature is usually transmitted using Wi-Fi or is physically downloaded from the device that collected the information such as a computer.

Live or real-time data refers to data being sent back and forth when the bus has left the depot and is in normal operations. GPS coordinates (automatic vehicle location), voice to and from the driver, and live video streams are some examples of live data.

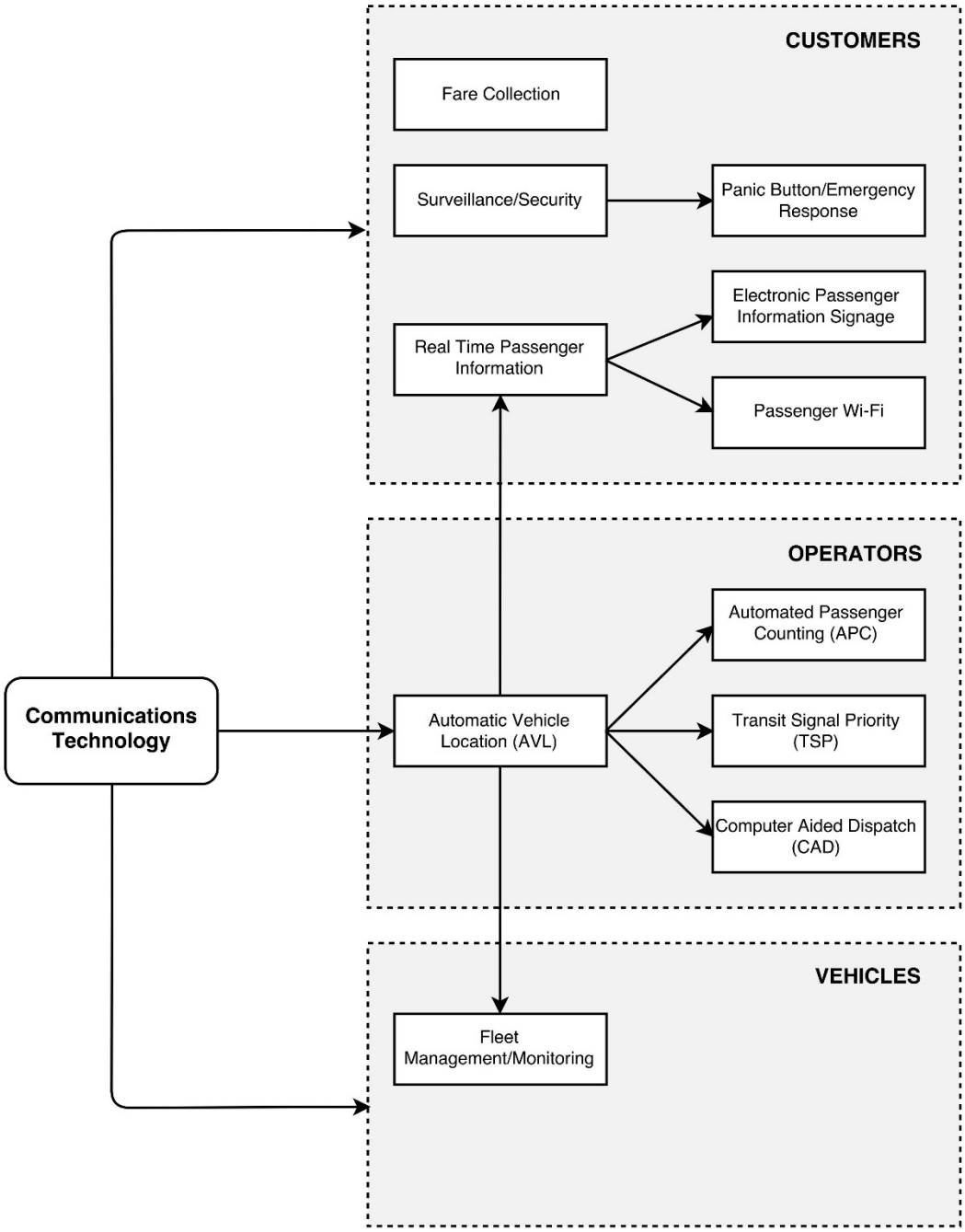
Common methods for transmitting live data include mobile data communications and long-range radio systems.

Previously, voice and data were processed separately through analogue (radio) and digital (data) networks. However, voice and data can now all be transmitted via data networks. In the past, transmitting data via mobile networks was expensive but with the build out of 4G mobile data communications and decreasing costs, more and more live data is being transmitted via mobile data networks as opposed to long-range radio systems.

The relevant systems for this project are shown in the following diagram and are grouped in terms of their application: for customers; for operators; and for vehicles.

[11] Source: Adapted from Implementing BRT Intelligent Transportation Systems (APTA BTS-BRT-RP-005-10), American Public Transportation Association, 2010.

Figure 6-1: Relationship of relevant transit ITS systems



Source: Adapted from Implementing BRT Intelligent Transportation Systems (APTA BTS-BRT-RP-005-10), American Public Transportation Association, 2010.

The Council listed in its brief for this project technologies that it is most interested in exploring. These technologies are all grouped with their relevant system as per Table 6.1 below.

Table 6-1: Technologies that Bay of Plenty Regional Council seeks to implement

Transit ITS System	Technologies Council wants to implement initially
Electronic Passenger Information Signage, Real Time Passenger Information	• A real-time passenger information system • A mobile device application indicated when to expect buses • On-bus display of next stop information (visual and audio) • Digital signage at key bus stops (limited) indicating when to expect buses • Real-time data output that interfaces with Council's bus information website and is accessible to the public, particularly application developers
Passenger Wi-Fi	• On-bus Wi-Fi
Automatic Vehicle Location, Automatic Passenger Counters, Fleet Management/Monitoring	• Real-time data capture for contract monitoring

The key system that links all of the proposed technologies is the Automatic Vehicle Location (AVL) system.

The following sections of this Chapter will examine the benefits and costs of implementing the systems listed below. Case studies have been provided to underline the effectiveness of each system and the lessons learned are summarised.

- Automated Vehicle Location (AVL) system
- Real Time Passenger Information (RTPI)
- Automated Passenger Counters (APC)
- Electronic Passenger Information Signage
- Passenger Wi-Fi
- Transit Signal Priority
- Business Intelligence for Operational and Fleet Management/Monitoring.

6.1 Automated Vehicle Location System

The automated vehicle location (AVL) system is a core piece of software used by dispatchers to manage operations. The system periodically updates the location of fleet vehicles using real-time data. Most AVL systems currently have computers on board the buses which have an integrated GPS receiver and are capable of transmitting mobile data via a mobile communications network.

The AVL system is relied upon by other ITS applications such as the display of real-time passenger information on dynamic information signs at stops. Other examples include on-board next stop announcements, and voice communications to passengers.

6.1.1 Benefits

In addition to enabling other transit ITS applications, AVL systems also provide the following key benefits for passengers and operators alike:

- **Better fleet management and monitoring**
  - With improved situational awareness and additional voice communications management capabilities, dispatchers can handle larger fleets more effectively.
  - Text messaging capabilities help distribute information to operators, resulting in more efficient dispatch.
  - Background alarm monitoring allows operators to quickly inform dispatch about onboard emergencies and for the dispatcher to know the vehicle location immediately, so they can send assistance.
  - Comprehensive data collection and incident reporting allows for more effective and detailed analysis.

- **Better bus operations**
  - The transmission and collection of real-live data gives operators, dispatchers, and supervisors the ability to monitor the level of schedule adherence. This allows them to apply the feedback to maximise the reliability and punctuality of the fleet.
  - One single login for all onboard equipment which minimises the potential for inaccurate log ins by drivers and thus maximises the accuracy of fare data collected.

- **Better customer information**
  - Automated next stop announcements keep passengers informed at all times. This can especially aid passengers with disabilities while reducing operator workload so that they can focus on safe driving.
  - Real-time bus arrival predictions on electronic signs at bus stops may help increase patronage (via improving 'perceived reliability' and 'responsiveness') and reduce customer anxiety.

6.1.2 Case Studies

Nowadays, AVL systems are being used extensively in cities to improve efficiency, effectiveness, and quality of road transit services. The location and the communication technology pillars of these systems support real-time functions (i.e., fleet management and operations, transit priority and information to passengers) and other functions such as performance measurement and service operations planning. AVL-based improvements to planning and control are becoming increasingly mature. The high availability of reliable data reporting the vehicle operations in real time pushes up this trend.[12]

As an example, London Buses mandates the use of a shared AVL system: the iBus system is installed on every bus and allows both the operator and authority access to real-time information. The system was initially implemented by Siemens and is now managed by Trapeze. This technology has enabled the shift of service performance monitoring from data collected through customer surveys to data collected from operational systems. The technology assists in monitoring multiple operators and has simplified the KPI's measures of contract management systems.

INIT utilises a 'multi stage' enhanced GPS positioning technique for its automatic vehicle locating. This includes using raw coordinates from GPS, applying dead reckoning by logical location monitoring, and comparing the current calculated position with nominal streets. This leads to a final GPS coordinate based on logical positioning corrected GPS coordinates

A number of small and mid-sized cities in the US have reported an increase in efficiency of operations as a result of the implementation of AVL systems.

In Chattanooga, Tennessee (population of 177,571 in 2016[13]), the regional transit authority previously relied on a manual run-cutting method. Drivers were manually assigned to buses, which can be a very tedious process. The authority found that by switching from manual run-cutting to the scheduling software from the AVL system, they could generate multiple run-cutting scenarios and pick the most suitable one. In doing this, they were able to save almost two-week's worth of labour for each of their semi-annual service revisions. The software was also capable of generating new passenger information materials such as schedule leaflets which saved additional labour[14].

In Portland, Oregon (population of 639,863 in 2016[15]), the regional transit authority found that the availability of real-time information resulted in better dispatch management, which in turn could reduce running times by an average of 1.45min/trip and passenger waiting times at stops by 0.11 minutes.

In Columbus, Ohio (population of 860,090 in 2016[16]), the Central Ohio Transit Authority found that changes in the workflow for dispatchers saved nearly 3 hours in the time required for daily work. It was also observed that the existing numbers of dispatchers could handle a fleet size increase of 10% without adding any new staff.

[12] https://www.researchgate.net/profile/Luis_Moreira-Matias/publication/276245114_Improving_Mass_Transit_Operations_by_Using_AVL-Based_Systems_A_Survey/links/5559bfcd08ae980ca6108df9.pdf
[13] United States Census Bureau
[14] ITS Benefits, Costs and Lessons Learned: 2014 Update Report – Final, U.S. Department of Transportation Intelligent Transportation System Joint Program Office
[15] United States Census Bureau
[16] United States Census Bureau

6.1.3 Lessons Learned

Some of the overall lessons learned from our research review include the following:

- There are minimal barriers for implementation of operational and fleet management systems, including dynamic scheduling opportunities, however, **AVL systems are a prerequisite**.
- **The integrated nature of the AVL system makes it advantageous to use a single procurement with multiple deployment stages**. The multiple rollout stages allow the transit agency to initially bring into operation the core functionality system that staff are used to using before additional subsystems are added.
- There is a considerable **advantage of purchasing from a system integrator to manage**:
  - Onboard equipment, workstations and server hardware and software;
  - Mobile data communications system enhancements;
  - Installation;
  - Integration, training, and documentation;
  - Project management, design review and acceptance testing; and
  - Warranty and an initial supply of spare components.
- Advancements in bus / transport technologies increasingly enable the leveraging of significant amounts of transport data in order to improve transport systems. It is now possible to assess boardings and alightings by individual stop, payments, journey times and traffic monitoring to enhance scheduling and vehicle management and overall reliability of the overall transport network, using data streaming in from an array of sources such as bus schedules, traffic detectors, AVL, CCTV, mobile phones, and electronic ticketing systems.[17]
  - Transport authorities will need to ensure an adequate level of data literacy for understanding and analysing new streams of data. A potential risk is that there is potential for a poor return on investment if the data is not properly understood or utilised.
  - An increasing amount of data pertaining to road safety, traffic management, and travel behaviour is held by the private sector. Innovative data-sharing partnerships between the public and private sectors may need to go beyond today's simple supplier-client relationship
  - Privacy protection issues may result in a backlash against the collection and processing of location data.
- **Do not neglect the issue of ownership of data** when developing contracts for the procurement of ITS technologies.
- **Ensure in-house resources are trained** to effectively use the collected ITS data.

[17] https://www.itf-oecd.org/sites/default/files/docs/15cpb_bigdata_0.pdf

6.2 Real Time Passenger Information - Review of Radiola 'Temporary' Solution

The Bay of Plenty Regional Council has arranged to procure a temporary real-time information system from Radiola Smart Transit for the Tauranga and Western Bay bus services and this system is expected to run for 9 months from March 2018 to December 2018 on a CAPEX free basis. The reasoning for procuring the temporary solution was to address reliability issues on the network enabling real time information, enhance the level of communication to customers, and help turn around moribund patronage trends.

This contract does not provide for electronic passenger information signs to be installed at bus stops. Electronic passenger information signs would need to be purchased separately and integrated with the Radiola system.

BOPRC has indicated that it is up to the City Councils to make the decision for the purchase and installation of electronic signs at bus stops in their local areas. At this point in time, we understand that the City Councils have not made any firm decisions regarding the purchase and installation of electronic signs.

In this temporary solution, Radiola acts as the system integrator while utilising relatively new US-based start-up companies to provide the scheduling software (Trillium GTFS Manager) and real-time predictions (Swiftly).

The study team has identified potential issues with the temporary solution.

6.2.1 Issues with relying on GTFS for scheduling

The scheduling software that Radiola relies on, Trillium GTFS Manager, relies on GTFS for scheduling.

There are some issues with this. GTFS as a standard has loose specifications. Some data is optional in the GTFS format such as information with regards to non-revenue (deadhead) trips and if this information is not provided as part of the GTFS feeds, this information becomes less useful for managing bus operations.

6.2.2 Importance of dispatching for predicting real-time passenger information

The ability to do dispatching is also critical for providing real-time passenger information. For example, for a real-time passenger information that relies on just the GTFS timetabling information for predicting the next-bus arrivals, if a bus is taken out of service due to some reason, the predicted next-bus information will just remain there until it disappears as the following next-bus information is predicted. With a dispatching functionality, if a bus is taken out of service, the real-time passenger information showing the predicted next-bus information immediately reflects this current situation so that passengers will not be waiting for a 'ghost' bus that never arrives.

It is the understanding of the study team that the Radiola solution does not provide for dispatching capabilities in its real-time predications and that the real-time passenger information in the system specified by Radiola only relies on GTFS timetabling information.

6.2.3 Issues with the accuracy of locational information by relying on GPS data only

The Radiola solution relies on a standalone GPS unit to provide locational information to do predications for real-time passenger information and standalone GPS data is usually not accurate enough to provide for good real-time information. For the predication of real-time passenger information, it is usually recommended to utilise dedicated 3G/4G enabled automated vehicle location (AVL) devices which blend data from different sources such as map data, etc. with GPS data to provide the most accurate locational information of bus vehicles.

6.2.4 Future proof capabilities

There are risks associated with this temporary solution with regards to the future proofing of capabilities. Compared to more established transit technology vendors with a long track record of deployments, these start-ups may only offer limited capabilities and may not offer future-proofed capabilities that the Bay of Plenty Regional Council may not have had the opportunity to consider as yet but may require in the future.

As a result, if the Regional Council suddenly discovers some capability/functionality which is not offered by the start-ups, it may either have to wait for the start-up to implement that capability which is dependent on that start-up's technology roadmap or procure another system to work in parallel with the existing one. This is a very real threat and can cause system integration problems.

6.2.5 Duplication in hardware with the already purchased electronic ticketing equipment

The Bay of Plenty Regional Council is also part of a consortium of New Zealand's smaller regional councils that has produced a new electronic ticketing system which is to be supplied by INIT. This electronic ticketing system is scheduled to be implemented across the Regional Council's network by the end of June 2018.

The electronic ticketing (smart card) system to be supplied by INIT will include an automatic vehicle location (AVL) system which sends and receives GPS data for the touch-on, touch-off smart card system to work. All that is needed to enable real-time passenger information on the INIT system is a software update to the AVL systems installed on the vehicles.

The Radiola temporary solution utilises a separate GPS tracker device which enables the real-time predication system. However, with the AVL system to be supplied by INIT, there will indeed be duplicate GPS devices in each vehicle.

In addition, Radiola reports that if an AVL system is available, they can remove the GPS device and they will supply and utilise the AVL system installed on the vehicle. However, there are risks with system integration of components from different vendors and suppliers. If Radiola cannot integrate its system with the AVL system from INIT, every vehicle will essentially have two GPS devices. In addition to leading to an inefficient use of scarce funding resources, there will be serious problems in blending the data from the two GPS devices for reporting and analysis.

6.2.6 Additional costs versus shared costs

By utilising the INIT system, maintenance costs are shared among the nine regional councils that are part of the consortium that is procuring the INIT system. If the Bay of Plenty Regional Council opts for a separate supplier, it is most likely that it would need dedicated personnel to assume responsibility for managing, maintaining, operating, and auditing this separate real-time passenger information component.

6.2.7 System integration risks with the individual purchase of electronic signs

Some City Councils have received a quote from Radiola with regards to the purchase of electronic information signs while others have expressed interest in other products from other suppliers. There are system integration risks by purchasing electronic signs from a vendor different from the one supplying the real-time passenger information system because it then places the responsibility on the Regional Council or City Council to manage the integration of the electronic signs with the real-time passenger information system vendor. If electronic signs are supplied by the same real-time passenger information system vendor, these integration risks are generally mitigated.

Therefore, **we recommend that after the INIT electronic ticketing system is in place, the Bay of Plenty Regional Council seek to utilise the real-time passenger information system provided by INIT and decline to extend the contract for the temporary solution from Radiola.**

6.3 Automated Passenger Counters

There are a number of advantages in considering the incorporation of automated passenger counters on buses:

- Optimise vehicle allocation/rostering - know when you need extra vehicles on the road and when you have occupancy availability.
- Enable revenue validation and reconciliation - compare with ticketing data records.

Automated passenger counters (APC) are devices typically installed at doorways of buses to record boardings and alightings at each stop and to keep a running total of passengers on board a bus. There are mainly three counting methods: 1) infrared-based method; 2) pressure sensing-based methods; and more recently 3) computer vision (depth cameras/Time of Flight 3D imaging).

APC devices typically include sensors and cameras to monitor passengers that get on and off a vehicle. APC units can easily be integrated with automated vehicle location (AVL) systems and transit priority systems (TSP). If the APC devices are integrated with AVL and TSP systems, conditional intersection signal priority can also be given based on the number of passengers on board a bus. This would give buses shorter "reds" and longer "greens" which could improve the reliability of journeys (schedule adherence).

APC devices may be implemented with a GPS separate from the AVL system (because the APC devices were in place before the AVL system or because the APC devices were deployed with a different vendor). However, we consider that this is not ideal as it produces mismatched data and incurs higher maintenance costs. These arise as a result of the post-processing of data in order to match APC with AVL data.

Rather than passenger counting systems working independently, we recommend they be integrated with existing on-board AVL technology systems to provide an all-encompassing transport solution.

While this is not an immediate priority, **in the longer term we recommend BOPRC, together with other members of the Regional Consortia discuss with the new electronic ticketing systems supplier to provide a commercial pathway proposal towards incorporating APC functionality**. For the region's requirements a basic active sensor system, with a specified margin of total occupancy (passenger) error (5%) would suffice. More advanced systems would be of value for complex metropolitan networks and mass transit systems.

6.4 Electronic Passenger Information Signage

6.4.1 Overview

Electronic passenger information signage at bus stops is the most widespread medium for the distribution of real-time passenger information.

With smart phones becoming increasingly the 'norm' and mobile data networks becoming cheaper and faster, transit agencies are increasingly looking towards providing real-time information via smart phones as they require much less resources to implement than physical electronic passenger information signage. However, transit agencies have also recognised that not all passengers carry smartphones. Therefore, it is more convenient to view and obtain real-time passenger information via fixed electronic passenger information signage[18].

37 transit agencies were surveyed by the Transportation Research Board in 2013 and survey results from this study are referred to throughout this chapter. From this survey, it was found that the major reason for deploying electronic signage was to increase customer satisfaction, followed by trying to improve the perception of the transit system, and to supplement other methods for disseminating information.

Table 6-2: Reasons for deploying electronic signage from surveyed transit agencies

REASONS FOR DEPLOYING ELECTRONIC SIGNAGE

Motivation for Deploying Electronic Signage	Response Percent
Increase customer satisfaction	97.3
Improve perception of transit system	70.3
To supplement other methods of disseminating information	70.3
Because we are a progressive agency	59.5
We want to keep up with current technology	51.4
Increase ridership	48.6
Received funding to deploy signage	32.4
Customers requested the signs	18.9
Part of a subway, light rail/streetcar, or BRT project	16.2
Influenced by other agencies' deployment of signage	5.4

Other:
- Part of an overall ITS communication strategy.
- To take advantage of real-time open data across several transit modes.
- We wanted to change the customer's perception of the waiting time.
- Part of larger ITS procurement.

Source: TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.

6.4.1.1 Underlying Technology

Real time passenger information is most commonly transmitted to electronic signage through bus AVL systems. AVL systems use schedule adherence and location data from GPS to develop real-time predictions for bus arrival times at stops. These predictions are dependent upon the polling rate of the bus' AVL system. The polling rate is the number of times the bus sends information per given period of time.

[18] TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.

Previously, buses AVLs were only polled once every 2-3 minutes due to mobile communication costs resulting in inaccurate predictions. With significantly lower costs, many AVL systems can now poll vehicles at higher frequencies (e.g. once every 30 seconds) leading to more accurate real-time arrival information.

Among the 37 transit agencies were surveyed in 2013, the most common underlying technology was AVL systems with a response rate of 83.3%.

Table 6-3: Underlying technologies of electronic passenger information signage from surveyed transit agencies

UNDERLYING TECHNOLOGY

Underlying Technology	Response Percent*
Vehicle tracking: Computer-aided dispatch (CAD)/ automatic vehicle location (AVL)	83.3
Vehicle tracking: Global positioning system (GPS)	80.6
Vehicle tracking: Rail signal system	25.0
Sign communication: Hard-wired communication (e.g., Ethernet)	61.1
Sign communication: Cellular radio network	52.8
Sign communication: Wireless area network (e.g., wireless Ethernet)	27.8
Sign communication: Agency radio network	25.0
Real-time prediction software: Purchased as part of a CAD/AVL or related system	52.8
Real-time prediction software: Developed in-house	27.8
Real-time prediction software: Licensed (software-as-a-service)	16.7
Real-time prediction software: Purchased independently	13.9
Real-time prediction software: Open source	8.3

*Not all survey respondents answered every survey question, so the response percent represents the number of respondents that answered this particular question out of all respondents that answered this question.

Source: TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.

6.4.1.2 Sign Technology

Technology for electronic passenger information displays traditionally included light emitting diode (LED) matrix and liquid crystal display (LCD) signs. LED matrix signs can typically only display a couple lines of text in one of multiple colours while LCD signs can display text and graphics. Both types of displays typically require a dedicated source of power from the grid.

Figure 6-2: Example of LED and LCD signs

LED Matrix sign in Washington DC	LCD Monitor style sign in Denver, Colorado
	
Source: TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.	

Recently, electronic ink (e-ink) displays such as those that are based on the technology of portable electronic book readers have started to appear in the marketplace on a more widespread scale. E-ink displays have the advantage that they are extremely energy efficient and can be run independently from the power grid.

In addition, the paper-like, high contrast display offers high readability for passengers and can be updated with real-time information from a central location. These e-ink displays have the advantage of having low operations and maintenance costs. However, due to the "newness" of the technology, they are still not widely used by transit agencies yet.

In 2012 Visionect and Mercury Innovation started installing E Ink based traffic signs in Sydney, Australia. The two companies report that there have been no hardware failure reports since installation.

Commencing 2016, Transport for London is trialling the deployment of e-ink electronic signs at select bus stops. We note however that the e-Ink bus signs have not been rolled out more widely, and remain only available in four locations, near Waterloo Bridge, although the plan is to introduce a further three in Parliament Square, Piccadilly Circus, and Sloane Square.

In November 2017, Vienna Airport installed outdoor E Ink signage to show real-time passenger information to guide travellers to the airport. The project includes signage for all the shuttle bus stations (over 25).

Figure 6-3: Example of an e-ink electronic passenger information sign deployment in London

Source: http://smartcitydisplays.co.uk/

It is to be noted that proprietary is only attached to dot matrix style signage. We **recommend that for BOPRC's future signage investment decisions proceed on the basis of LCD monitor style (or E-Ink style) for passenger information signs.**

Figure 6-4: Example of an e-ink electronic passenger information sign deployment in Vienna

Source: https://www.e-ink-info.com/viennas-airport-line-install-e-ink-signage-all-its-shuttle-bus-stations

6.4.2 Benefits

There is a variety of research that identifies the benefits that come from the deployment of electronic passenger information signage. The main benefit is that real-time information provided to passengers through electronic passenger information signage often reduces passengers' perceived waiting times at stops and stations.

A study evaluating the return on investment of real-time bus arrival information systems[19] found that although electric signage at stops does not directly reduce wait times, it reduced anxiety and security risks. By knowing next-arrival information, passengers may be able to make better use of their time, find alternate modes of transportation (e.g. if the wait time is too long) or adjust their strategies (e.g. letting a crowded bus go by if the display showed that another would be arriving shortly).

Another research study[20] found that electronic passenger information signage could improve public transport patronage due to the predominantly 'psychological' or perceived benefits. Real-time transit information has often been reported in transit literature to have a positive effect on commuters' attitudes. Commuters expressed intentions to increase transit use if such a system is provided.

6.4.2.1 Case Studies

Effects of real-time information displays have been reported in several cities in Europe[21].

In Stockholm, a study found that without real-time information displays, passengers overestimated their wait time by 24% to 30%. With real-time information displays, passengers only overestimated their wait time by 9% to 13%.

In London, the provision of real-time information at stops was found to reduce perceived wait time by 26%.

In The Hague in the Netherlands, the introduction of electronic passenger information displays reduced perceived wait time by 20%.

In New York City[22], a survey of subway customers found that stations with countdown clocks increased customer satisfaction. These provided information such as time until the next train arrived, whether there were any unscheduled delays and provided clarity for announcements. As customers could easily determine the frequency and reliability of the service, the perceived performance of the service was improved.

6.4.3 Costs

In terms of capital costs of LED and LCD signs price varies widely depending on whether signs are installed indoors or outdoors. LCD signs tend to be cheaper for both indoor and outdoor applications. This may be because LCD signs are just generic computer monitors whereas LED signs are proprietary products offered by single vendors.

[19] Real-time Bus Arrival Information Systems Return-on-Investment Study, Federal Transit Administration, 2006.
[20] Tang, L. and P. Thakuriah, "Will the Psychological Effects of Real-time Transit Information Systems Lead to Ridership Gain?" 90th Annual Meeting of the Transportation Research Board, Washington, DC, Jan. 23-26, 2011.
[21] Caulfield, B. and M. O'Mahony, "A Stated Preference Analysis of Real-Time Public Transit Stop Information," Journal of Public Transportation, Vol. 12, No. 3, 2009. p. 3.
[22] 2011 MTA Customer Satisfaction Research Results, New York City Transit Subway.

For outdoor applications, such as deploying an electronic sign at a bus stop, costs of LED signs can range from US$1,500 to US$17,000 while costs of LCD signs can range from US$1,500 to US$10,000.

Table 6-4: Capital costs of electronic signs from surveyed transit agencies

CAPITAL COSTS

Sign Type	Number of Respondents	Cost Range (per sign)
Indoor LED	5	$200 to $12,500
Outdoor LED	18	$1,500 to $17,000
Indoor LCD	6	$500 to $5,000
Outdoor LCD	4	$1,500 to $10,000

Source: TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.

A limited number of transit agencies have reported the per-unit annual operating and maintenance costs for each type of sign. Overall it seems that LCD signs for both indoor and outdoor applications have lower operating and maintenance costs.

Table 6-5: Per-unit annual operating and maintenance costs of signs from surveyed transit agencies

Sign Type	Number of Respondents	Cost Range (per-unit)
Indoor LED	2	$40 and $1,000
Outdoor LED	11	$0 to $1,000
Indoor LCD	3	$30 to $300
Outdoor LCD	2	$50 and $300
Source: TCRP Synthesis 104: Use of Electronic Passenger Information Signage in Transit. Transportation Research Board, 2013.		

6.4.4 Way Forward – Electronic Signage

We recommend the following principles for BOPRC's future investment in, and deployment, of passenger information electronic:

- **Minimise capital and ongoing costs related to electronic signs**:
  - Use only one size sign.
  - **Invest in generic signs that can interface with real-time information systems rather than proprietary signs that lock you in**.
  - Infrastructure costs such as connecting to the power grid can often be more than expected.
  - Expenses related with the procurement of signs, installation and maintenance can add up, so we **recommend it is better to concentrate on key locations and rely increasingly on the use of electronic personal devices rather than widespread physical display rollout**.
- Ensure the accuracy and validity of the underlying data and have the capability to assess the 'health' of the sign by collecting diagnostics in real time and being able to view what is displayed at any time.

In addition, we recommend:

- Ensure that there is proper testing after installation.
- LED technology is reported to be more reliable in hot, humid climates.
- Keep the messages displayed on the signs as simple as possible.
- Do not try to serve multiple purposes with the signage (e.g., wayfinding and advertising).
- Have the message satisfy everyone's needs (keep it simple, keep it generic).
- Note that civil works affect the signage location and infrastructure requirements for power and communications are the biggest challenge.
- There are currently a low number of practical solar-powered options for traditional LED and LCD signs.

6.5 Passenger Wi-Fi

We understand BOPRC is currently running a Wi-Fi trial with 12 units in operation -six in Tauranga and six in Rotorua. The units are leased for three months (Dec – Feb) at a cost of $700 per unit (for the three months). The units are through Icomera and the data is through Vodafone. These are proving to be popular so far, with a total of 727 people using the service 973 times since the service went live.

Below are some insights from a review of experiences across other transit agencies.

Within the last decade, providing free passenger Wi-Fi on-board buses and trains has been one of the passenger amenities that transit agencies have been considering/enabling to make transit more attractive and to promote greater usage of transit.

However, reported experiences from transit agencies, particular from North America, over the past decade suggest that for urban transit with short trip lengths, free passenger Wi-Fi has a negligible impact in making transit more attractive and in attracting new users to transit.

In 2016, Singapore included USB charging ports on its 10 double decker buses and is now rolling these out progressively with new bus fleet. Brisbane City Council recently announced that all new buses in Council's fleet will now each be fitted with 16 USB charging sockets.[23] New buses will have stronger 2.5amp outlets installed – rather than the 1amp which was trialled in its pilot program during 2016. We consider this functionality is not a priority investment. We consider this feature to have more applicability for long-distance coach services.

6.5.1 Lessons Learned

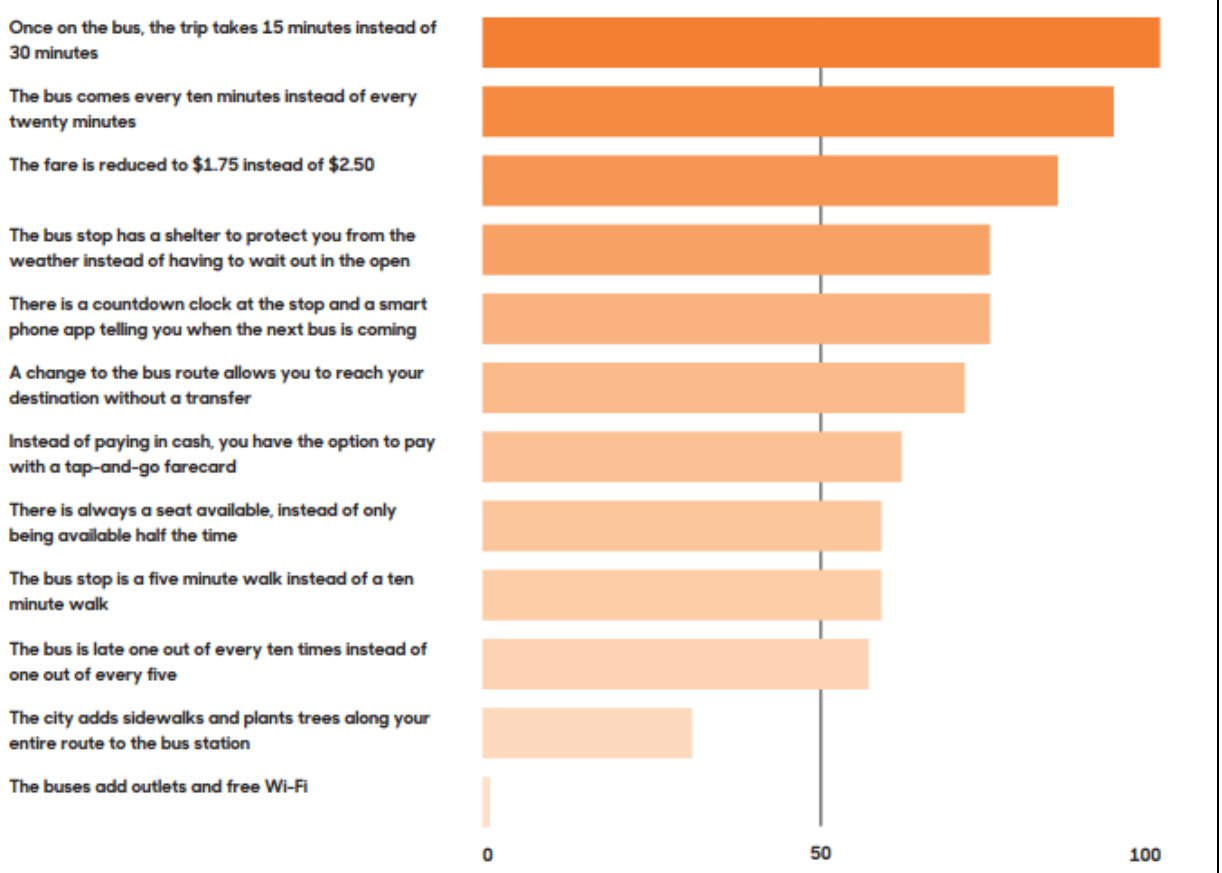
The City and County of San Francisco and Cisco conducted 'The Connected Bus: Connected and Sustainable Mobility Pilot'. The year-long pilot equipped a bus with high speed wireless internet along with real-time travel information via onboard touch screens and a calculator that provided information about the environmental impact of the bus as it travelled throughout the city.

During the evaluation of the pilot, it was found that 64% of surveyed users had used the real-time travel information and 68% of surveyed respondents said that passenger information was very important and could likely increase how frequently they would use the service. In contrast, only 24% of survey respondents said that they had used the onboard Wi-Fi and only 32% of respondents considered Wi-Fi very important. It is interesting to note that even in 2008 when mobile data communications were expensive and slower, passengers did not consider onboard Wi-Fi to be important in their decision to choose public transport.

In 2016, around 3,000 public transport users from 17 regions in the United States were surveyed by the non-profit foundation, TransitCenter, to find out what works and what doesn't in public transport. It was found that the most important service improvements to public transport related to the reduction of travel times, frequency of service and cost of the fares. The least important improvements were found to be the provision of onboard free Wi-Fi for buses and USB charging outlets.

[23] https://www.brisbanetimes.com.au/national/queensland/new-brisbane-city-council-buses-to-have-a-phone-charging-port-20170615-gwrj6u.html

Figure 6-5: Service improvements that transit users valued



Source: Who's On Board 2016: What Today's Riders Teach Us About Transit That Works, TransitCenter, 2016.

From these studies, it can be observed that the provision of technology to improve onboard amenities, such as Wi-Fi and USB charging outlets, are not so important to public transport users and that reduction of travel times and increasing frequency of service are most important.

We have been unable to access reports on the outcomes on recent trials across Australia or New Zealand. We can however report that the NSW government's trialling of Wi-Fi on its buses has resulted in significant outcry by privacy activists and the NSW Greens due to the data collected to register to the service.

Not only do many Wi-Fi owners gather data from their users for advertising or statistical purposes, which may concern the general public, the use of public Wi-Fi also increases the opportunity for hacking activity.

Recent reviews by Harvard Business Review and Norton also recently reported [24] using free public Wi-Fi networks, for example, comes with any number of serious security risks:

24 Using free public Wi-Fi networks, for example, comes with any number of serious security risks and https://us.norton.com/internetsecurity-mobile-why-public-wifi-could-be-a-disaster.html

> *"The more you take your chances with a free network connection, the greater the likelihood that you will suffer some type of security breach"*

Similar public backlash has ensued in other areas with claims that "it is a frill that's not needed and the money — even though it is a small amount — would be better spent to improve existing transit service."[25]

A recent media article[26] reported:

> *"With wireless carriers offering more affordable data plans, consumers don't need to log on to a wi-fi network to avoid costly overage charges anymore. That's a critical change that threatens to render wi-fi obsolete. And with new competitive technologies crowding in, the future looks even dimmer. Customers are rational. When pricing incentives favour Wi-Fi, customers use more Wi-Fi. When pricing incentives shift, so does behaviour."*

Wi-Fi may also potentially be over-taken by new and emerging technologies such as LTE or LTE-U, using a combination of new small-cell towers and home wireless routers. Consumers don't have to type in passwords and sign in to every network like they do for public Wi-Fi hot spots. They can seamlessly move between their carriers' cellular network and LTE-U.[27]

Another technology that risks making Wi-Fi outmoded is something called CBRS, short for Citizens Broadband Radio Service. By using CBRS, wireless carriers can deploy 5G faster and easier, using the shared airwaves instead of trying to acquire spectrum licenses at auction or through deals.[28]

It is for these key reasons that we **recommend Council reconsider its plans for wider rollout of the current Wi-Fi initiative and potentially limit this investment and deployment to longer distance commuter services**. Whilst not considered a priority, we **recommend BOPRC consider that future contracts with bus operators include broader specifications for future fleet to be equipped with add-on features such as provision for charging mobile devices.**

25 https://www.wired.com/2016/07/public-transit-riders-want-better-service-not-free-wifi/
26 https://www.bloomberg.com/news/articles/2017-03-09/a-world-without-wi-fi-looks-possible-as-unlimited-plans-catch-on
27 http://www.smh.com.au/business/innovation/world-without-wifi-looms-as-unlimited-plans-rise-20170312-guwfua.html
28 https://www.networkworld.com/article/3180615/mobile-wireless/faq-what-in-the-wireless-world-is-cbrs.html

6.6 Transit Signal Priority

Transit Signal Priority (TSP) systems is a transit ITS technology that gives buses extra green time or less red time at signalised intersections to reduce the time they are slowed down by traffic signals. It is commonly used in Europe and has proven to be a cost-effective method for improving bus travel times and reliability.

TSP systems can either be implemented as a stand-alone system which requires the installation of additional physical infrastructure to detect when buses approach a signalised intersection, or it can utilise existing AVL systems to detect when buses approach an intersection thus saving costs in installing additional hardware on buses or streets.

TSP systems can be used to improve both service reliability and improve travel time. In the case of improving service reliability, the TSP system would only grant priority to buses conditionally based on the buses' adherence to the vehicle schedule or headway interval. This helps to assist buses that are running late to improve reliability of services. In order to grant conditional priority to buses, either an AVL system is required or a separate system feeding into traffic control systems.

On the other hand, alternative detection systems (such as loops and ID tags) can grant priority to each bus that arrived at an intersection within certain parameters. In this case an AVL system is not required and is simpler to implement.

6.6.1 Case Study of Benefits

Research conducted in North America on the impacts of TSP systems for Bus Rapid Transit systems found that although benefits of TSP systems varied depending on the type and degree of application, there was generally a positive impact on reducing the running time, increasing travel speed, and reducing intersection delay.

Many operators consider TSP to be a positive element of their bus network, delivering a range of benefits. Brussels noted that TSP delivers benefits in the range of a 10% increase in commercial speed and regularity. In Seattle, it has been reported that TSP reduced journey time by up to five minutes as well as a reduction in total intersection delay of up to 1.5 minutes for a corridor with bus priority measures. In Barcelona, the implementation of a green wave is reported to have improved punctuality by up to 10%. London Buses identified that on average each bus travelling through a TSP equipped junction saves at least 2 seconds, thereby providing significant time savings over the entire bus route.[29]

[29] http://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/centre-for-transport-studies/rtsc/The-Identification-and-Management-of-Bus-Priority-Schemes---RTSC-April-2017_ISBN-978-1-5262-0693-0.pdf

Table 6-6: Reported benefits to buses from traffic signal priority

Location	% Running Time Saved	% Increase in Speeds	% Reduced Intersection Delay
Anne Arundel County, MD	13-18	-	-
Bremerton, WA	10	-	-
Chicago: Cermak Road	15-18	-	-
Hamburg, Germany	-	25-40	-
Los Angeles: Wilshire-Whittier Metro Rapid	8-10	-	-
Pierce County, WA	6	-	-
Portland, OR	5-12	-	-
Seattle: Rainier Avenue	8	-	13
Toronto	2-4	-	-
Source: Transit Cooperative Research Program (TCRP) Report 118: Bus Rapid Transit Practitioner's Guide			

In 2013, New York City's Department of Transport (NYC DOT) and Metropolitan Transportation Authority (MTA) updated the Transit Signal Priority (TSP) on three road corridors to reduce the travel time of buses by extending and advancing green lights whilst shortening red lights.

The new TSP system involved installing GPS trackers on buses that relayed GPS signals to a traffic management centre, which then controlled the traffic lights, superseding the need to rely on 'line of sight' devices such as optical emitters. The equipment cost approximately USD $4,219 per bus for the newer TSP system and approximately $1-2m to roll out the TSP system per bus route. Evaluations of the M15 route suggest that bus travel times were cut by around 11-17%. Some constraints have been reported including coordination issues and impacts on other corridor traffic and pedestrians. [30]

We note that disadvantages have also been reported. TSP impacts on general traffic (London), including lower speeds for general traffic (Istanbul, London, Singapore, Vancouver), impacts on non-priority approaches and possibly neighbouring intersections (Lisbon).

Another key disadvantage of TSP mentioned is that the technology does not work well in slow-moving traffic or congestion where there is no dedicated bus lane (Barcelona, New York, Sydney).[31] Sydney Buses has experienced similar issues and reported that TSP cannot be used during peak hours when there are too many requests for priority for too many intersections. The system cannot manage which request gets priority over the other.

Emerging cooperative and automated vehicle technologies (CAVI) and connective vehicle-infrastructure technologies, discussed briefly in Chapter 4.6, are now transforming opportunities to provide priority to modes, in real time.

[30] L.E.K. research; NYC Department of Transport; Metropolitan Transportation Authority; Streetsblog NYC; Transport Simulation Systems; Greenman-Pede

[31] http://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/centre-for-transport-studies/rtsc/The-Identification-and-Management-of-Bus-Priority-Schemes---RTSC-April-2017_ISBN-978-1-5262-0693-0.pdf

For these reasons, we **recommend that Council does not invest in a stand-alone signal priority system, rather review longer term opportunities.**

In the interim, more cost-effective interventions such as bus only turn lanes, priority lanes in peak hours/areas of high bus demand, and appropriate enforcement of these lanes is suggested. Further, it is recommended BOPRC review longer term opportunities enabled by emerging Cooperative Intelligent Transport Systems.[32]

[32] https://ec.europa.eu/transport/themes/its/c-its_en

6.7 Business Intelligence for Fleet Management and Planning

6.7.1 Overview

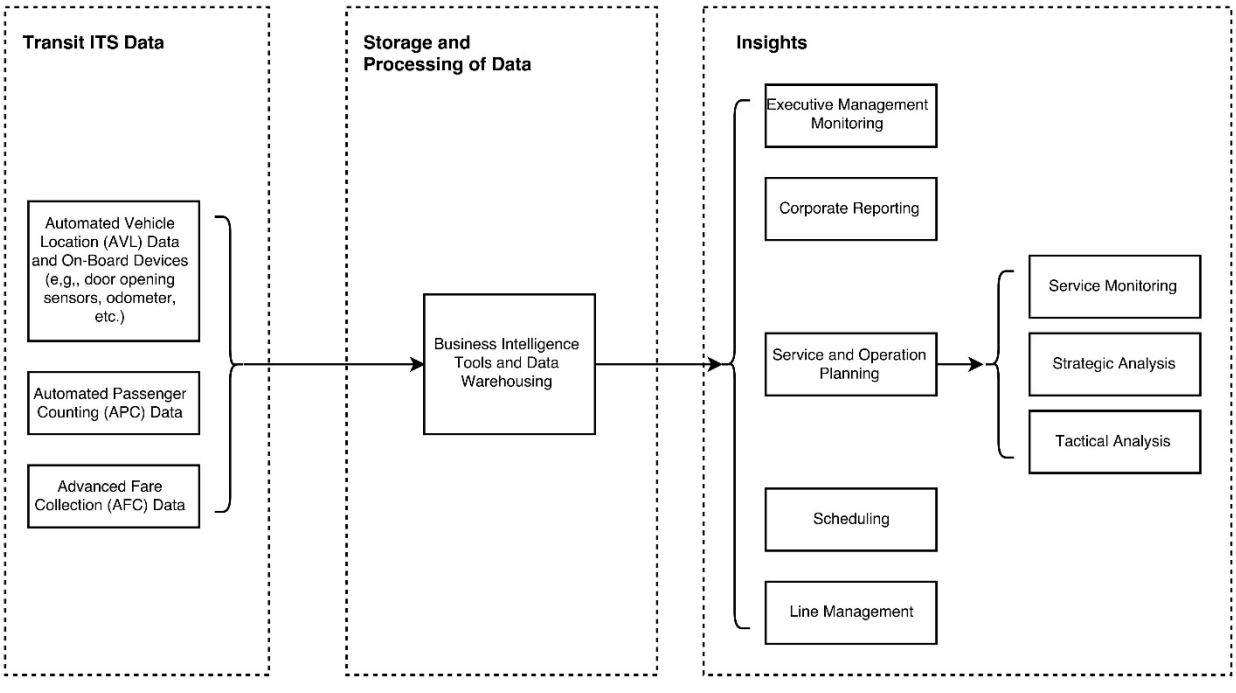
There are surprisingly very few studies detailing the state of practice of utilising transit ITS for fleet management and planning since automated vehicle location (AVL) and automated passenger counting (APC) systems were first deployed in the 1980s-1990s.

One of the most recent studies is a discussion paper from 2015[33] published by the Intelligent Transportation Society of America (ITS America) and this section heavily references material from that paper.

All of the transit ITS systems such as AVL systems, APC systems, and advanced fare collection (AFC) systems generate a wealth of data. This data can be used to provide information that will help enhance fleet management and planning and support business processes and decision making. Such information is collected using software tools and services known as "business intelligence". They access and analyse data sets and produce analytical findings in the form of reports, summaries, dashboards, graphs, and charts.

The process from data collection to the generation of insights to guide transit decision making is shown in the following figure.

Figure 6-6: Process of generating insights for decision making from transit ITS data



Source: Adapted from The Use of Transit ITS Data for Planning and Management and Its Challenges; a Discussion Paper, July 2015. ITS America.

[33] The Use of Transit ITS Data for Planning and Management and Its Challenges; a Discussion Paper, July 2015. ITS America.

In addition to the key data sets of scheduling / planning, ticketing, and vehicle location (including real-time), a BI system can also process and report on data from ERP (financials, assets, HR/payroll, maintenance, fuelling, inventory, payables, receivables), CRM (complaints, call centre, web enquiries), incidents/accidents, surveys, revenue protection, and driver cash deposits.

The data sets directly available from the public transport industry can be even further "enriched" by fusing external data sets such as weather, demographics, and traffic.

6.7.2 Sources of Data

The primary sources of transit ITS data for planning and management come from AVL systems, APC systems and AFC systems.

As stated previously, the AVL system is at the core of transit ITS system and links all other systems together. It continuously tracks all buses in real-time and this allows for efficient and effective operational control, management of incidents, response to security issues and restoration of services. The AVL system gathers a wealth of data from on-board devices (e.g., GPS device, door opening sensors, odometer, automated passenger counter, etc.) that is geo-coded and/or time stamped to describe what the transit vehicles are doing. This data can then be transformed into information to get more insights on schedule adherence, on-time performance, running times, dwell times, delays, vehicle speeds and others.

Data from APC systems can be used to obtain detailed profiles of passenger activity by stop and time of day as well as provide accurate estimates of passenger loads. This information can be used to gain insights on passenger demand for the transit service and to adjust schedules accordingly.

Traditionally, data collected from legacy fare collection systems was of limited value due to the aggregated nature of the data. However, with modern AFC systems that utilise smart cards, information can be obtained with regards to passenger behaviour such as each passenger's trip origins and destinations and the data can also be analysed to understand travel times and general system performance.

6.7.3 Benefits

The transit ITS data that is processed through business intelligence can provide a large variety of insights for different purposes. Some of the most important uses of transit ITS data are summarised below.

6.7.3.1 Executive Management Monitoring

Executive management can be provided with processed data to monitor corporate performance on a daily, weekly, monthly, seasonal, and/or annual basis. The data provided can be structured to create colour-coded dashboard alerts that highlight critical indicators such as the previous day's missed runs, etc. so that executive management can make enquiries to the appropriate contracted operators.

6.7.3.2 Corporate Reporting

Business intelligence can provide an automated way to process the transit ITS data to generate key performance indicators for the general public, for contract management and monitoring purposes, and/or for reporting to council stakeholders and other levels of government.

6.7.3.3 Service and Operational Planning

Transit ITS data can be used via business intelligence to help in the following ways:

Service Monitoring

For service monitoring, business intelligence typically produces standardised reports based on transit ITS data on a regular basis (e.g., daily, weekly, etc.). Typically, reports are produced for the following purposes:

- Measuring on-time performance of buses to improve service reliability for passengers
- Analyse passenger load versus vehicle capacity and overloading and pass-ups of vehicles
- Build patronage profiles by bus stop to identify key markets to transfer locations for route network design
- Identify recurring incidents of missed runs, overloads, early departures, etc.

Strategic Analysis

After a continuous service monitoring process is set up, the data can be used in various other ways. Service monitoring can act as the base for strategic analysis of network redesigns, corridor priority treatment and improvement of transit connectivity.

Tactical Analysis

Additionally, transit ITS data could be used for tactical analysis. Examples include, using the data to determine appropriate locations to invest in for bus shelters, to identify passenger transfer movements to improve schedule coordination and amenities and for projects to consolidate bus stops. Similarly, the data can be used to examine the delays caused by intersections to select where transit signal priority would be the most useful.

6.7.3.4 Scheduling

Transit ITS data can be invaluable in improving the design of schedules. The distribution of actual running times can be determined from data. These times also include deadhead run times by time of day, day of month. When a bus is operating without accepting or carrying passengers, it is said to be dead running. This can usually occur when buses go out of or back into a garage. By knowing the location and time associated with maximum loads, scheduling can be improved.

By having better knowledge of the variability of running times, schedulers can better adjust running times to reduce recovery time which saves operator hours and can help to provide operational cost savings.

6.7.3.5 Line Management

Transit ITS data can also be used to monitor individual operator performance on specific lines/routes. This is especially helpful if it is known that buses are not arriving and leaving on time as a result of external events or as a result of a poorly designed schedule. This information can be helpful in identifying operators who need assistance, supervision, or discipline.

6.7.4 Lessons Learned

Experience from practitioners in the field, consultants, suppliers, and researchers suggest that ownership of data and management of data and better understanding of the uses of transit ITS data from decision makers are key learning points.

When ITS technologies are designed and procured, transit agencies need to be aware that ownership of data does not only include access to data aggregated reports but access to the raw data and that legal contracts should clearly say this.

There were numerous cases where transit agencies did not make it clear in their legal contracts that all data generated by the system belonged entirely to the transit agency. As a result, suppliers asserted through their contracts, that the data and its use were proprietary. This in turn allowed the suppliers to charge licence fees for data usage in addition to the costs for developing the interfaces.

Data management is also critical in making full use of transit ITS data in service planning. It is essential that IT departments are not under-resourced and possess the capabilities and expertise to effectively use transit ITS data.

IT departments in transit agencies can ensure they are fully resourced and possess the expertise to fully utilise transit ITS data. By gaining a better understanding of the usage and potential benefits of transit ITS data, they can provide important resources for IT.

Best practices and perceived benefits of using transit ITS data are powerful catalysts for building support and understanding among senior management with regard to transit ITS data. Some of the benefits include key applications, return on investment, visualisation technologies and demonstration of data utilisation via dashboard visualisations.

6.7.5 Way Forward – BI Systems

A business intelligence system is crucial to processing and analysing the data coming from the different transit ITS systems and devices. When the INIT electronic ticketing system is being implemented, a business intelligence system ideally should be implemented at the same time. Although the electronic ticketing system by INIT will provide some reporting capabilities, we consider that this will not provide enough broader information/feeds to interrogate the system performance of the transit and transport networks.

Some transit agencies try building their own business intelligence systems in-house while others procure a 3rd party solution. From our experience, building a custom in-house business intelligence system requires considerable expertise not only in IT but also in the operations of transit as well as system development costs.

It is usually less risky to utilise a business intelligence solution from a proven vendor with several years of proven operating experience. We note that NZTA has recently secured panel arrangements with preferred suppliers which Councils may then seek and enter in to procurement arrangements directly.

Service monitoring from business intelligence is also invaluable for managing performance specifications with private bus operators. With automated systems to monitor key performance indicators, not only are costs reduced, but private bus operators can be held more accountable to realistic performance specifications which provide good services to the customers as well as providing the right incentives to the private operators.

We stress that implementing electronic ticketing systems without a corresponding business intelligence system is unlikely to maximise the benefits from that considerable investment. If a business intelligence system is not procured, then the data gathered from the electronic ticketing system may not be easily and fully utilised for planning and operational improvement purposes.

For this reason, we recommend that BOPRC **procure a system which does all the integration for the agency, is a comprehensive, mature, cloud-based data warehouse, data analytics, business intelligence solutions which is tailored specifically to the public transport industry across *all* transport modes and provides easy report generation** (but also the granularity of data enabling more detailed data mining).

Further **ensure a BI systems specialist provide an integrated service, incorporating:**

- **automated ETL, data warehousing, business intelligence and workflow;**
- **report generation;**
- **automated data matching across scheduling, real time vehicle movements and ticketing systems;**
- **automated data quality and data cleansing (e.g., wrong trip boarding, invalid trip starts, etc);**
- **automated fault detection, classification, and identification;**
- **full support, data analysis and officer training services;**
- **data enhancement suggestions for improved analysis;**
- **contract reporting analysis and report enhancements; and**
- **ongoing research and development.**

We understand, under the NZTA's new AFC Panel, that transport agencies (and any participating Regional Councils or Unitary Authorities) do not need to openly advertise each new individual contract opportunity. They can directly purchase from the panel or develop their own secondary procurement process to select a supplier or suppliers from the New AFC Panel (based on their own internal process, best-fit for purpose and value for money analysis). The initial term of contract with NZTA is 5 years with an expiry date of 30 November 2022, with an optional 2-year extension.

We further understand that NZTA's AFC Panel provides eligible regions, including BOPRC, with the opportunity to access suppliers with the understanding that a formal pre-selection process has already been undertaken, which will facilitate the procurement process and ensure agencies procure a proven, 'fit for purpose' system, which aligns with national strategic specifications and investment decisions.

We recommend Council's next key technology priority is to further investigate a BI solution, availing of the intel and assistance provided by NZTA's AFC Panel arrangements.

We further recommend that BOPRC reviews its current and future contracts to ensure that all data created belongs in entirety to BOPRC and that suppliers do not assert proprietary rights, which then enables suppliers to charge licence fees for data use in addition to development charges to build interfaces.

We further recommend, especially given the importance over the medium term to consider more on-demand and demand responsive solutions (refer Chapter 7), that BOPRC invests in systems which offer an integrated Demand Responsive Travel technology solution to facilitate demand responsive travel as a natural extension of the public transport network:

- provide customers with a full-service mobile application and web site to register travel preferences, plan their journey, book demand responsive trips, pay fares, manage their account, track vehicles, and receive arrival time predictions. The service may provide alerts, targeted information about service disruptions/irregularities, and allow the customer to respond to surveys, rate their travel experiences, and provide direct feedback to operators and transit authorities.
- provide navigation directions to drivers to follow the most efficient routes to pick up and drop off customers who have booked demand responsive services.
- provide a data analytics platform to deliver tailored information directly to network planners/schedulers, operations staff, and contract administrators so they can make optimal, fully-informed strategic and operational decisions. To get the best network integration, efficiency, and customer experience.

7 Other Short-Medium Term Technology Interventions

Council's brief for this project was to focus specifically on leveraging off the significant investment in the new electronic ticketing system, and especially recommendations for the provision of real time passenger information and other on-bus and at-stop enhancements to:

- Improve real-time information for customers;
- Improve monitoring, in real time, of contractor service delivery;
- Enhance customer experience; and
- Deliver value for money.

In this chapter we offer some broader insights regarding other short to medium term technology applications that may assist in achieving Council's objectives.

We believe the **key opportunities arise through Council's ongoing tendering and contracting for urban and rural bus services. Council's key role here is to be an enabler and a specifier of desired outcomes, rather than being a procurer/asset owner/risk owner of costly technology hardware and software**.

The following 'other' short to medium interventions discussed in this chapter include:

- New fleet technologies
- On Bus passenger enhancements
- CCTV surveillance
- Bus Stop/shelter enhancements
- New Bus Service Delivery Models
- Personalised Passenger Transport/Shared Services Opportunities
- Transport and broader Mobility Mobile Apps.

7.1 New Fleet Technologies

The Bay of Plenty Regional Council will need to be cognisant of emerging trends in motor vehicle technology and travel behaviour, as these may provide opportunities for Council to be an 'early adopter', or at least a 'rapid follower'. While future-proofing existing or even soon-to-be-built infrastructure may not currently be practical for broad-scale application, initial provisions (i.e. pilot programs) may be considered to better understand the potential demand, feasibility, and operational requirements.

Examples of emerging motor vehicle technology include:

- **Electric vehicles**: While hybrid (typically electric and petrol/diesel power) vehicle technology is common, full electric vehicles are currently a relatively new technology. Provision for electric vehicle charging stations within significant parking structures/areas (particularly linked to solar power collection) would cater for these types of vehicles; and
- **Autonomous vehicles**: While a technology currently in its infancy, there are currently several companies well advanced in the development of autonomous/driverless/self-driving vehicles. These vehicles do not require direct driver input while travelling between destinations, relying instead on monitoring cameras and intelligent processing to control the vehicle. As the time frame for this public transport technology strategy is over the next five years, we consider that the deployment of autonomous vehicles be a 'watching brief' for Council. Notwithstanding, the University of Waikato may provide an ideal testing ground with an intra-campus trial on its new campus in Tauranga.

At the time of this report, several different models of these vehicles have been placed into field trials where they operate on public roads, mixing with traffic. It is expected that field testing will continue to provide further data (and improvements) before acceptance of this technology by road authorities.

Currently on the market, alternatives to modern diesel buses include fully electric and hybrid vehicles.

A summary of the advantages and disadvantages are shown in the following table.

Table 7-1: Overview of the alternatives to diesel buses

	Modern Diesel	**Diesel/Electric Hybrid**	**Fully Electric**
Single Vehicle Cost	Low ($300,000 - $450,000)	Medium ($600,000)	High ($900,000 - $1.1 million plug battery replacement)
New Infrastructure Cost	None	Minimal	Extensive (charging stations/or induction pads)
Maintenance Cost	Baseline condition	Slightly higher than diesel	Lower than diesel due to fewer moving parts
Emissions	As per Euro ratings	Up to 25% less than diesel	Zero **local** emissions
Flexibility	Complete flexibility with the existing road network	Complete flexibility with the existing road network	Range limited to battery charging requirements
Reliability	High	Unproven in the long term	Unproven
Maturity of Technology	Mature	Maturing	Immature

Advantages	Lowest capital cost	Lower emissions Improved fuel efficiency No supporting infrastructure required (charging stations)	Lowest noise and emissions Lower energy costs Lower maintenance costs
Disadvantages	Highest emissions Loud when accelerating	Poorer performance at higher speeds/over longer distances	Reliability unproven High infrastructure costs

We provide a brief summary of key insights for Council's consideration over the next one to year years. In summary:

- Modern diesel engines have been improved to burn more "cleanly", vehicle costs are low, and most transport agencies have access to diesel fuel.
- Hybrids cost about 30% more than pure diesel, however they achieve improved fuel economy and reduced emissions.
- Recent hybrid technology has matured and become more reliable:
    - Parallel hybrid system: electric motor works at lower speeds, while combustion engine works at higher speeds. Both the electric motor and combustion engine work during acceleration. Battery is charged during regenerative braking. Generally, they perform better at higher speeds.
    - Series hybrid system: only the electric motor is connected to the transmission. Combustion engine powers the electric generator, which powers the motor and recharges the battery. Regenerative braking is also available. Generally, they perform better at lower speeds. Regenerative braking works well in a hilly environment. International experience would show that likely the worst place to deploy hybrids would be a busway or motorway-based route.
- Full electric vehicles are still evolving. They achieve "zero" local emissions, however one must consider the means of electricity production as well. They also would require investment in extensive charging infrastructure. Benefits considered include lower greenhouse gas emissions, better air quality in bus corridors, and lower bus noise in the city centre. There is over the long run, the potential for lower maintenance costs because there are fewer moving parts. China (Shenzhen), Amsterdam, Los Angeles are trialling fully electric buses. There are two options.
    - Full day battery: fully-charged overnight, no charging required en-route. Limited to range provided by a single charge. Increased flexibility due to less infrastructure, potentially reduced passenger capacity due to larger, heavier batteries
    - Induction charging: bus charges at stopping points (bus stops) along the route. Can carry a smaller, lighter battery. Associated with a much higher infrastructure cost, and limits flexibility to routes with induction charging stops, and charging needs may cause delays
    - Could also combine these options, for maximised range capacity.
- Some, but not all the increased costs of hybrids/EVs over diesel buses should be recovered from fuel savings.
- BOPRC also needs to consider reliability (including cost and frequency of maintenance requirements) and the current maturity of technology. Electric buses are not likely to be market-ready for over a decade.

7.1.1 International Experience

- Vancouver has been trialling diesel, "clean" diesel, CNG, diesel-electric hybrid and biofuel

- Top performer for fuel economy/cost and emissions was the hybrid, which performed best in fuel economy, fuel costs and emissions, but had higher maintenance costs
- CNG (compressed natural gas): performed well in terms of fuel costs and particulate matter emissions, but poorly in terms of greenhouse gases, and had the highest maintenance costs. CNG vehicles performed poorly in terms of reliability and availability
- Biodiesel and "clean diesels" were most available.

- Diesel-electric hybrids have also been tested in Reading, United Kingdom; Rotterdam, The Netherlands; and Bremen, Munich and Leipzig, Germany. Rotterdam test results were acceptable other than concerns about vehicle availability for services. Other results were not as favourable, with concerns that fuel savings would not match the additional capital investment
- Fully-electric and hydrogen cell vehicles have had much less testing. Trials will be important in BOP, especially because of humid climate and steep hills

Figure 7-1 Breakdown of whole-of-life fleet costs under alternative fleet upgrade scenarios

Fleet scenario	Bus purchase costs (incl. fixed costs)	Fuel costs	Bus maintenance and renewal costs	Driver costs	Total
Do-Minimum	$278.3m	$377.1m	$546.6m	$745.4m	$1947.4m
Better diesel buses	$304.8m	$367.7m	$547.5m	$745.4m	$1965.5m
Hybrid bus introduction	$408.4m	$321.8m	$545.4m	$745.4m	$2021.0m
Diesel then electric	$495.3m	$314.7m	$563.3m	$745.4m	$2118.7m
Hybrid then electric	$539.7m	$296.2m	$563.0m	$745.4m	$2144.4m
Accelerated electric	$540.2m	$302.7m	$567.6m	$745.4m	$2155.9m

In the medium term (under new urban service contracts), there exists the opportunity to introduce either diesel/electric hybrids. In the long term, fully electric vehicles are expected be a fully matured technology. Technological advances in battery technology could also improve the operating range of the vehicles and reduce the time required for charging.

It is recommended that future bus operator contracts do not lock in a current fleet standard, but ensure the operators incorporate new fleet and technologies as they become viable.

7.1.2 Concept Demonstrations

7.1.2.1 Brisbane Airport Electric Bus Shuttles

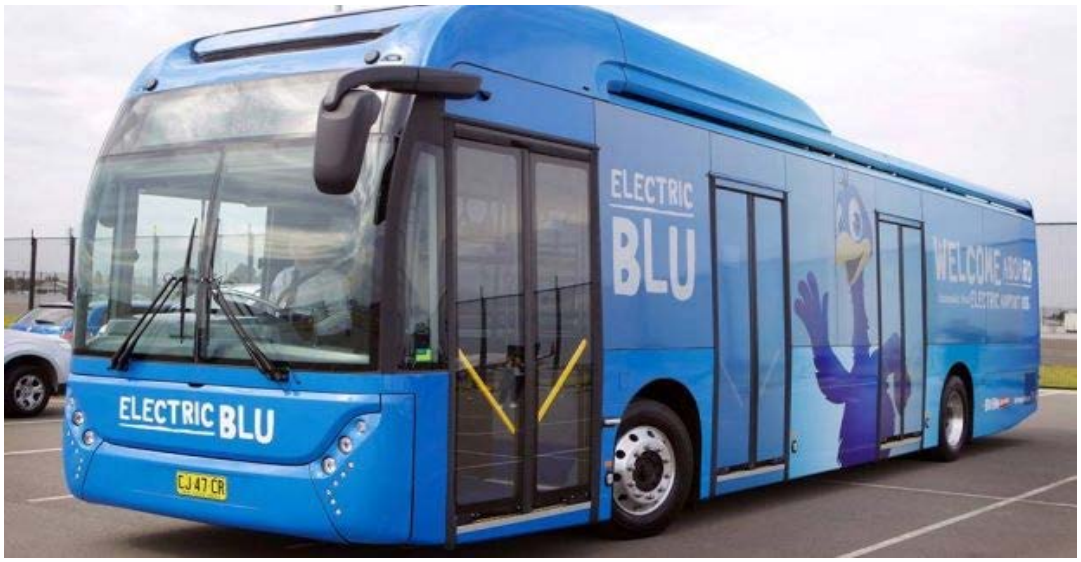
Brisbane Airport is the first Australian airport to roll out a fleet of 11 electric buses[34]. Carbridge has been awarded contract to build, operate and maintain all aspects of the Brisbane Airport bus fleet. The Toro electric

34 http://newsroom.bne.com.au/new-electric-buses-at-brisbane-airport-a-winwin-for-travellers-and-the-environment/

buses created by Carbridge are powered by BYD battery technology and are reported to have a driving range of 600 km.

The five-year contract commenced on 1 July 2017 with the new electric bus fleet coming into full operation in February 2018. The vehicles include GPS next stop announcements, driver monitoring and real-time tracking data.

Figure 7-2: Example of the Brisbane Airport electric shuttle



7.1.2.2 Hydrogen Bus – Ohio State University

In March 2017 Ohio State University commenced trials of a new hydrogen fuel cell bus as part of the Campus fleet and is on loan from the Stark Area Regional Transit Authority for one year. It intends to procure 13 hydrogen fuel cell-powered buses over the next two years[35].

The first buses have been funded under a National Fuel Cell Bus Program, in partnership with Calstart of Pasadena, Calif., which requires a 50% in-kind contribution. Additionally, the partners for building the bus, El Dorado, Ballard Power Systems, and BAE, have also contributed to the in-kind match.

Additional buses are now funded under the US Federal Transit Agency's No and Low Emission program.

35 https://www.sartaonline.com/hydrogen-fueled-bus-makes-its-debut-on-osu-s-campus

Figure 7-3: Example of a hydrogen bus at Ohio State University

7.1.3 Autonomous Vehicles

A study by the Boston Consulting Group has noted that self-driving technology has the potential to be more disruptive to traditional car ownership. The report said that the deployment of large numbers of autonomous vehicles "will change the game, erasing the distinction between car sharing and ride sharing and offering users a significant edge in the total cost of ownership."[36] Uber has already joined with Ford Fusion to trial driverless vehicles in Pittsburgh[37].

7.1.3.1 Concept Demonstrations

The Mercedes-Benz Future Bus

In 2016, Mercedes-Benz unveiled a 12 metre futuristic self-driving bus[38]. The semi-autonomous Future Bus uses cameras and radar to navigate the roadways while giving the human driver a bit of a break. Its predictive driving style also lowers fuel consumption, which helps cut greenhouse gas emissions.

The Future Bus has driven on a test track in the Netherlands covering 20 km, linking Amsterdam's Schiphol airport with the town of Haarlem. The CityPilot can recognise traffic lights, communicate with them, and safely negotiate junctions controlled by them. It can also recognise obstacles, especially pedestrians on the road, and brake autonomously. It approaches bus stops automatically, where it opens and closes its doors. It has a top speed of 70 km/hr and can drive through tunnels.

36 http://www.cthreereport.com/study-car-sharing-isnt-a-threat-to-car-ownership-but-autonomous-vehicles-are/
37 https://www.wired.com/tag/autonomous-vehicles/
38 https://www.dezeen.com/2016/07/19/mercedes-benz-self-driving-future-bus-autonomous-vehicle/

Figure 7-4: Example of the Mercedes-Benz Future Bus

Washington DC's Olli

IBM has partnered with U.S. start up Local Motors to design and road test a self-driving electric vehicle, called Olli. The vehicle has a capacity of 12 passengers and is currently being trialled in Washington DC. Passengers speak their destination to Olli and request an expected arrival time.[39]

The company is also planning a pilot in Denmark and Berlin. In the future, the company envisages producing and assembling the minibus components by 3D printing in 10 hours.

Olli is one of the three main autonomous minibus vehicles being trialled in various sites around the world. Others are provided by Easymile and Navya.

Figure 7-5: Example of the Olli in Washington DC

39 https://coolblindtech.com/introducing-olli-the-worlds-most-accessible-self-driving-vehicle/

Seoul

Seoul National University has been testing the driverless taxi to transport handicapped students around campus.[40] The vehicle, called Snuber, had been navigating the 4,109 square metre campus for 6 months in 2015-2016 without any accidents. It worked in conjunction with a hailing app.

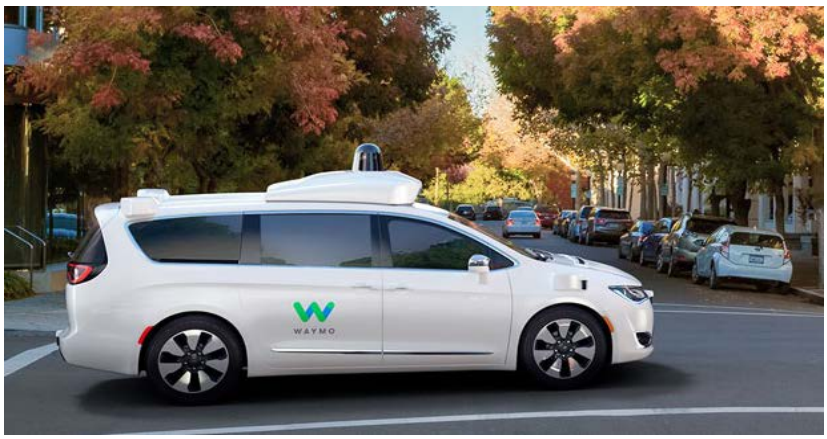
Figure 7-6: Example of a driverless taxi in Seoul

Waymo's Level 4 Autonomy Autonomous Vehicle Trial in Arizona

Alphabet Inc's (parent company of Google) self-driving business unit Waymo introduced trials of autonomous vehicles in Chandler, Arizona in a wide test area operating at Level 4 autonomy at the beginning of November 2017. The autonomous vehicles can go anywhere within this defined space[41].

Level 4 autonomy means that the autonomous vehicles share public roads with human-driven cars and pedestrians and no one is at the wheel to take over if there are problems. Trial operations at Level 4 autonomy is considered a huge milestone in the autonomous vehicle industry.

Figure 7-7: Example of Waymo's Level 4 autonomous vehicle trial in Arizona



40 http://www.stuff.co.nz/motoring/news/75656813/Driverless-taxi-on-Seoul-campus-offers-glimpse-of-future
41 https://techcrunch.com/2017/11/07/waymo-now-testing-its-self-driving-cars-on-public-roads-with-no-one-at-the-wheel/

nuTonomy's Driverless Taxi Trials in Singapore

nuTonomy is a software provider for self-driving vehicles and was founded by two Massachusetts Institute of Technology researchers. In October 2017, global auto parts supplier Delphi Automotive acquired the company.

Since August 2016, nuTonomy has been conducting limited public trials of its technology with driverless taxis in Singapore. nuTonomy partnered with Grab, a local ride-sharing company, and invited a select group of people to download its app and ride for free in its driverless taxis in a western Singapore business district[42]. The trial rides utilise a standard Mitsubishi i-MiEv electric vehicle with an engineer sitting behind the wheel to monitor the system and to take control if necessary. The company plans to launch the full driverless taxi service in Singapore in 2018[43].

Figure 7-8: Example of the nuTonomy driverless taxi trial in Singapore

EasyMile's EZ10

Now being trialled in Darwin, Australia the EZ10 electronic driverless shuttle bus can carry up to 12 passengers at a time and has a capability of running for up to 12 hours per charge. It is guided by GPS and multi-sensor localisation technologies. It's also fully air-conditioned.[44] EasyMile was founded in 2014, and headquarters are in Toulouse (France). In the near term, BOPRC may consider a trial in an area of high tourist activity, or for application on a university campus.

Figure 7-9: Example of EasyMile's EZ10

42 https://spectrum.ieee.org/transportation/self-driving/after-mastering-singapores-streets-nutonomys-robotaxis-are-poised-to-take-on-new-cities
43 https://www.reuters.com/article/us-autos-selfdriving-singapore/first-driverless-taxi-hits-the-streets-of-singapore-idUSKCN1100ZG
44 http://easymile.com/

7.2 On Bus Passenger Enhancements

A number of suppliers provide a comprehensive solution for on-board passengers:

- Audio Announcement Systems
- Interior LED Signs
- Multimedia Screens.

The technology is there, but the hardware/maintenance costs are likely to be not a priority investment. Besides, on traditional bus services especially in less dense metropolitan area, until autonomous systems are in play, the driver/operator is the 'moment of truth' and can provide a personal customer service function via announcing stops and answering questions (when safe so to do), at a fraction of the cost of installing audio/visual route/stop signage and announcements.

7.2.1 Concept Demonstrations

In central London, electric buses currently run on routes:

- 507 - Waterloo station to Victoria bus station
- 521 - Waterloo station to London Bridge station
- 360 - Elephant & Castle to Prince Consort Road

All electric buses on these routes have live information boards that report to customers how long it is to the next stop as well as live status updates across other parts of the network. There are also USB ports for charging phones.

Figure 7-10: Example of live information boards on buses in London

In Paris, France, SIEL indicator systems (abbreviated from Système d'information en ligne) are installed on 250 bus routes on the RATP bus system as well as the Metro.

In Brisbane, Australia passenger information stop arrival signs are in place in the high frequency central city, on board the CityGlider bus services.

PTV Victoria, Australia also is currently testing new passenger information on board buses. New digital passenger information is being tested on board five buses on routes 477, 478, 479, 482, 484 and 543. It will measure the accuracy and consistency of the information and identify whether additional development needs to be undertaken before a future roll out is considered. For the purpose of the test, on board screens will display a map with the bus location and the next three stops. It will also include audio providing next stop information.

In Singapore, the Central Fleet Management System (CFMS) is the new Automatic Vehicle Location and Control system that is being installed on all buses. It allows the Service Controllers of all bus operators to actively see all buses on a route.

The Singapore Land Transport Authority (LTA) uses this system to provide bus stop information to passengers. In December 2016, the LTA also trialled Passenger Information Display systems on one bus service. The Passenger Information Designation Screens (PIDS) tap on information from the Central Fleet Management System (CFMS) and was developed by ST Electronics and the Trapeze Switzerland GMBH Consortium. ST Electronics (Info-Comms Systems) has implemented various transport systems in Singapore, including CCTV surveillance at traffic junctions. Trapeze Switzerland GMBH Consortium specialised in implementing transport control systems for public transport, including Transport for London's buses.

The new LCD screens on the Singapore trial buses, installed near the exit door, displayed information such as the bus service number, current and upcoming bus stops, and the end destination. A later software update included estimated travel time to upcoming bus stops and the route terminus. In April 2017, the system was upgraded to feature connecting bus/train information and audio announcements. However, it is to be noted, after gathering public feedback, the ***trial was ended and the PIDS was removed from the bus in mid-April 2017***.

Figure 7-11: Example of the live information board trial in Singapore

Whilst the technology is available and may be supplied/managed via a variation to the new Electronic Ticketing systems procurement arrangements, we recommend that it does not provide significant benefit to warrant the investment. Notwithstanding, it may be considered for a small pilot on a bus

service targeting the visitor market (for example, in Rotorua), or as a component of a universal access scheme

7.3 CCTV Surveillance

We understand that Council is considering rolling out its CCTV coverage by now installing into its Rotorua fleet, as current contracts run until 2025. CCTV is a part of the new units in Tauranga and these will be in place from December 2018.

The primary purpose of installing CCTV on buses is usually to provide drivers with better personal security, deter property damage, criminal actions, and other anti-social behaviour. The key benefit is the potential deterrent value of a CCTV system, that would-be criminal or other unacceptable/unsafe behaviours are minimised by the presence of CCTV.

Therefore, we recommend that **CCTV systems are non-covert and public information should be displayed about the presence of CCTV**.

In providing CCTV, it is recommended that Council requests that suppliers:

- **comply with privacy protocols including restricted access to software and hardware used to download images to prevent the unauthorised recovery of images;**
- **advise relevant stakeholders of any material change to a prescribed or minimum function or feature of the CCTV or software;**
- **provide clear written instructions on the operation of their CCTV for operators; and**
- **ensure that there is an emergency '24 hour 7 days a week' download facility available to recover images from buses fitted with the CCTV.**

Notwithstanding, we note that of the most important service dimensions reported by Bay of Plenty bus non-users (what would make you consider using public transport), safety/security is only mentioned by around 1% of non-users. Bus customer surveys also do not suggest that increased surveillance is a pressing issue which may be influencing a shift away from transit use.

There is no denying the fact that surveillance systems are effective tools in increasing the safety and security of both the driver and the passengers of public buses. However, we suggest to Council that **it is not Council's most critical investment requirement**, at least from the wider community's perspective.

We recommend safety/security outcome specifications be addressed as part of bus contracting to supplement a corporately prepared and publicly published public transport safety and security policy which operators and the general public must comply with.

7.4 Bus Stop/Shelter Enhancements

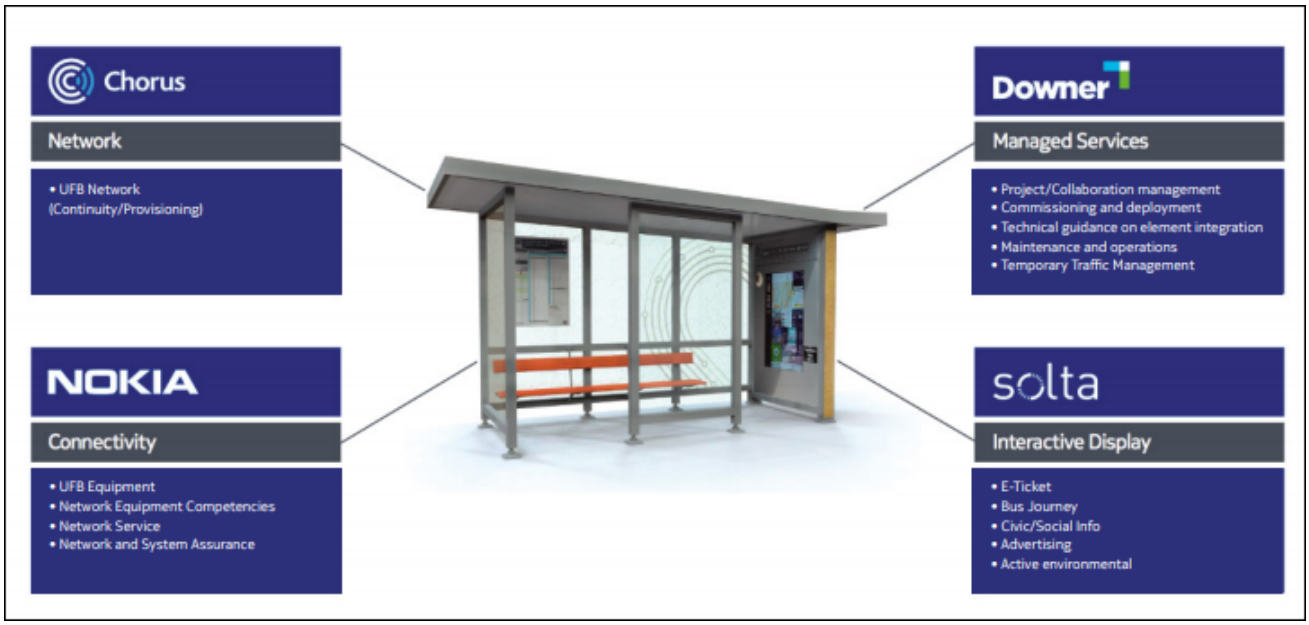
Bus stops around the world are getting more 'high-tech' with services like free Wi-Fi and charging ports while waiting. A number of transit agencies provide USB and electric bicycle charging facilities at solar powered bus shelters.

7.4.1 Concept Demonstration – Auckland

We note a recent market trial of new, modern shelters with ultra-broadband connections was performed in Auckland, New Zealand by an Auckland consortium of companies, including: Chorus, Downer, Nokia and Solta. During the trial, a survey was conducted to get a perspective from users about the features offered and to test reactions to potential future capabilities.

A user survey was carried out by the Auckland University of Technology: 91% of users found the interactive display useful. 26% viewed bus routes / maps, 18% viewed weather, and around 13% viewed local information. When asked about future additions, around 85% of users suggested Wi Fi, CCTV, and ability to transfer information from the interactive display to their mobiles.

Figure 7-12: Smart Shelter – Auckland



7.4.2 Concept Demonstration - Singapore

Inclusion of technology has taken one bus stop in Singapore to 'best practice' levels. Developed by DP Architects, a local firm, in collaboration with various Singaporean government agencies, the bus stop in Jurong, in west of Singapore features rooftop solar panels and garden, bookshelves, swing, kiosk, phone charging ports, free Wi-Fi, interactive screen and ample seating.

The installed solar panels generate enough power to meet the bus stop's power needs and interactive digital screens broadcast bus timings, weather, and news highlights. The digital screens are also connected to the National Library allowing passengers to download e-books by scanning a QR code with their phones.[45]

Figure 7-13: Example of bus stop enhancements in Singapore

[45] https://www.citylab.com/transportation/2017/03/singapore-may-have-designed-the-worlds-best-bus-stop/518226/

The above examples demonstrate that the traditional bus shelter design can be challenged. However, moving forward the key considerations for the region's principal bus stops/interchanges should be:

- Improved comfort and increased safety and security;
- Improved access and integration with other modes, including walking/cycling;
- Improved design (including iconic branding) that signifies not only a legible, high quality bus network but a sense of 'purpose' and 'place'; and
- Improved functionality - supported by frequent, connected services. A 'signature' stop which is not supported by 'signature' services will draw criticism from the general public.

Electronic signage for displaying the real-time passenger information at bus stops is expensive. The cost for an electronic ink real time information sign as quoted by Radiola Smart Transit is NZ$5,900 per stop and solar unit and an additional NZ$890 annually for maintenance and support.

If local city councils want to install real time passenger information signage at stops to show to the public that they are making efforts to improve public transport, they should purchase and install as few as possible. This is because technology in transit is rapidly evolving towards the provision of personalised information to be delivered to passengers via their smartphones or personal devices. Local city councils may be advised to avoid installing large numbers of expensive physical electronic signs which may be obsolete in the not so distant future.

However, the installation of real-time information displays can still provide value by increasing customer satisfaction by reducing the perceived wait time and improving the perceived performance of service if they are installed at the right locations such as bus stops with high patronage or at bus stations with many transferring passengers, or on services and in areas with a very high proportion of visitors.

We therefore recommend that **Council consider small enhancement treatments at one or two central, key interchange stop/stations, also aligning these priority 'select' locations with RTPI signage.**

Stops/services which cater for a high proportion of visitors, rather than the informed frequent user would also be of benefit.

We recommend that **treatments not necessarily incorporate high-tech solutions but strive to demonstrate Council's commitment to a quality service and to enhancing the customer experience**.

7.5 New Service Delivery Models

In transport, disruption and megatrends are already changing how services are and can be delivered. As discussed in preceding Chapters, this certainly provides opportunities for BOPRC to deliver more demand-responsive, flexible, and personalised public transport services. There are cost-effective alternatives to achieving coverage/connectivity objectives where demand is low, or there are greater proportions of transport-disadvantaged customers.

The whole approach to a journey, facilitated by open-source data platforms and aggregation applications, is transforming the way transport is delivered.

A few examples, available right now are discussed briefly below. More examples of alternative delivery models are provided in the Shared Services section below and within the Mobility as a Service (MaaS) discussion in Chapter 9.

7.5.1 On Demand Bus Services

BRIDJ is an intelligent public transport service powered by a demand responsive technology platform[46]. Essentially, BRIDJ works like Uber, but for buses: tap an app, reserve a seat, say on a 14-passenger shuttle bus operating at fixed times, then get taken to your destination.

BRIDJ bridges the gap between bus transit and passenger transit provided by the rideshare/ride-sourcing apps such as Uber. It is not a door-to-door application – rather, a demand responsive point to point application based on a sequence of stops, some fixed and some candidate or 'virtual' stops.

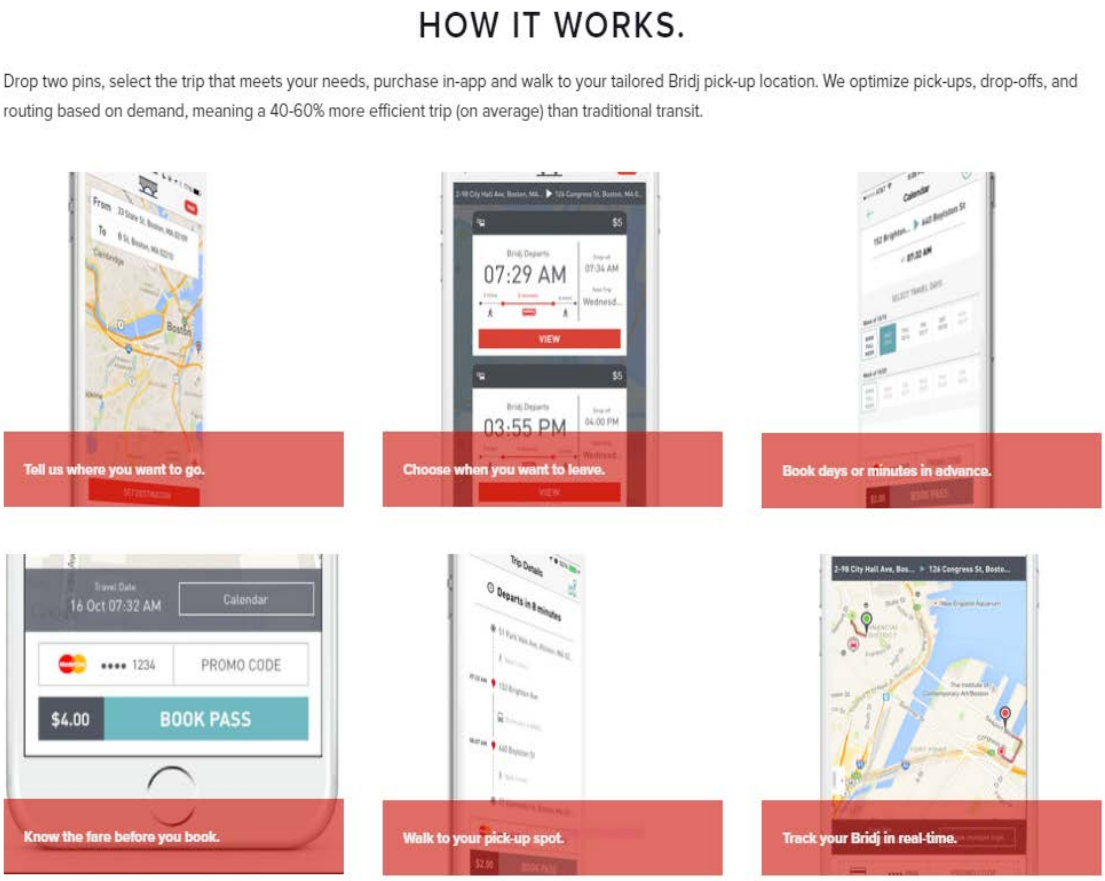
Initially launched in Boston, BRIDJ was designed originally for commuter bus services taking passengers from an origin roam zone to a destination zone. It provides a platform which enables public transport services to be dynamically routed – to optimise travel times and network efficiency.

A similar commuting service, **Chariot**, is running in San Francisco and Austin and works by crowdsourcing routes.

Transit Systems and BRIDJ launched Demand Responsive bus services in Western Sydney on 4 December 2017.

46 https://www.transitsystems.com.au/our-businesses/demand-responsive-transport/Bridj

Figure 7-14: Example of how BRIDJ works



BRIDJ delivers Demand Responsive bus services by analysing the travel demands and scheduling bus services that service that demand (for example, adapt routes, frequencies and even size of buses). The technology platform groups nearby passengers with similar travel requirements (passenger clusters) and provides walking directions to their closest pick up location. The technology then dynamically routes based on real time traffic conditions.

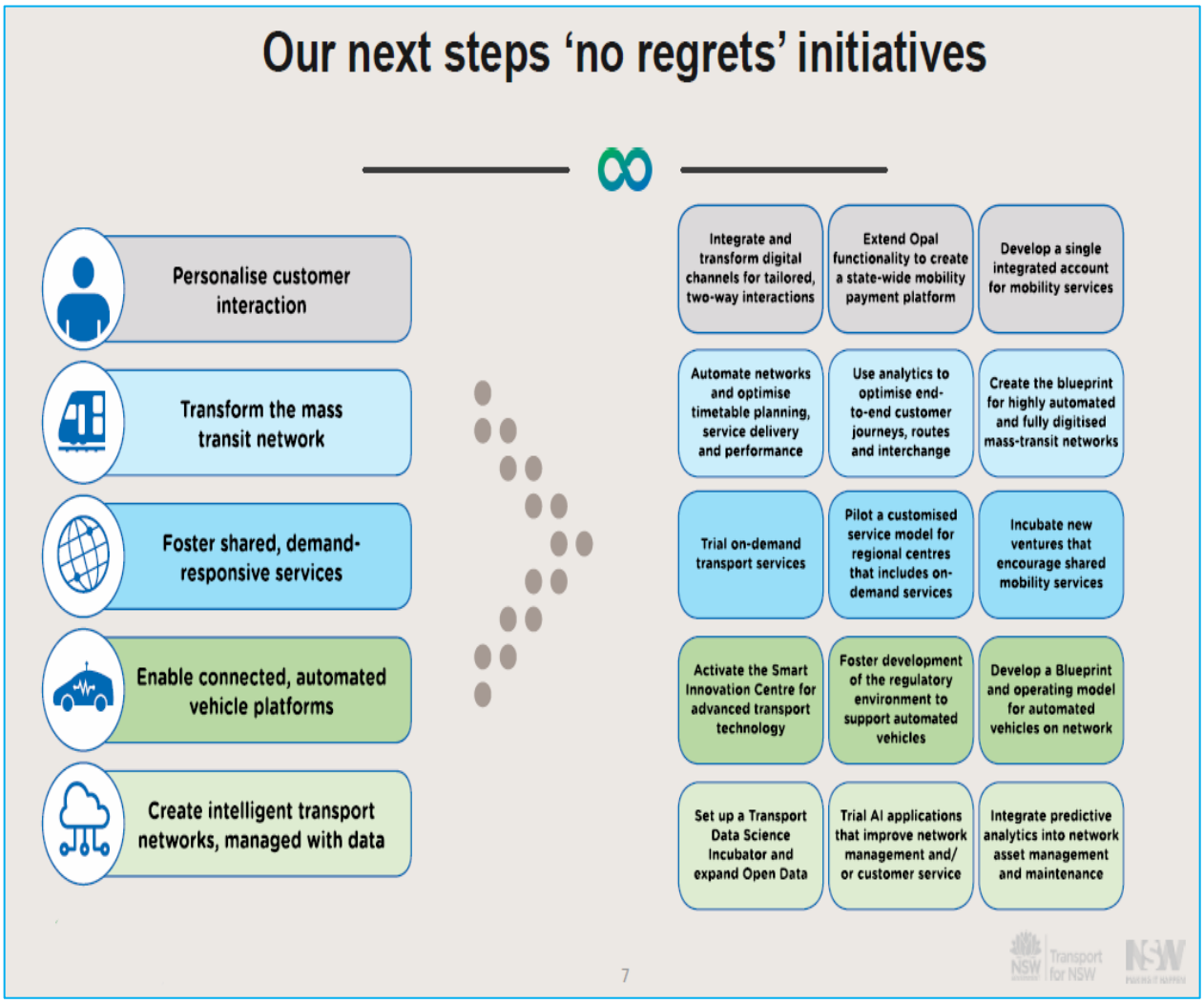
> *"They're able to track their vehicle's arrival at the pick-up location and their onward journey in real time, while behind the scenes the BRIDJ technology optimises the route and drop off location to minimise each customer's walking distance and total travel time. BRIDJ will help remove large empty buses from our suburban streets, replaced instead with 'right-sized' services that enhance value for money while delivering better travel outcomes for everyone in the catchment."* [47]

Transport for New South Wales (TfNSW) is currently trialling and tendering for on-demand services to supplement its public transport services:

> *"We want to provide a new model of transport for rural and regional NSW that satisfies the individual and unique needs of local towns and rural cities."*

47 https://www.transitsystems.com.au/all-latest-news/item/demand-responsive-bus-services-to-be-launched

Figure 7-15: TfNSW On Demand Transport overview



On demand bus services (Dynamic Routing or Scheduling) is very closely related to ride sharing and matching. The service requires in-vehicle devices to guide the driver and links to the control centre where the ride sharing calculations and matching are performed.

Since schedules are re-calculated in real time - only summary and approximate advance information can be conveyed to waiting passengers. For instance, times may be shown as a 'time window' in which the vehicle will arrive, rather than a detailed timing.

7.5.1.1 Way Forward for Future Bus Operating Contract Specifications

Moving forward, instead of aiming at detailed input/output specifications for new scheduled bus services, BOPRC should aim to specify performance-based standards to see what innovative solutions the market can provide.

It is recommended in future bus contract tendering, that BOPRC clearly articulates that it is seeking to be at the forefront in demonstrating innovation by embracing new and emerging technologies and service delivery models to deliver better transport, mobility, and customer outcomes for its customers. This includes:

- Providing frequent, accessible, highly legible passenger transport services;
- Improving 'first mile last mile' access to scheduled public transport services;
- Embracing emerging technologies;
- Highly visible branding and positioning of BOPRC's commitment to innovation and sustainability objectives (via fleet enhancements etc);
- Real time passenger information and response; and
- Safe and environmentally sustainable fleet and services.

With regards to the terms of the contact, **it is recommended offerors are provided at minimum a 7 year plus extension options contracts to incentivise the offeror to invest in fleet, systems, and technology** and to provide extension rights based on satisfactory performance.

It is recommended that Council **consider incentivising operators to raise the service quality and provide demonstrated support for Council's sustainability objectives via use of modern environmentally sustainable fleet, the use of dynamic information and guidance systems, and other demonstrations of 'premium' service**.

7.6 Shared Services Opportunities

Traditional public transport systems operate predominantly on fixed routes with set schedules and stops. Personalised Passenger Transport (PPT) refers to systems which utilise a more flexible network of vehicles/drivers at various locations for users when they desire them, allowing those users to take any route/vehicle that serves their needs. PPT services may supplement public transport systems by providing flexible, cost-efficient 'first mile/ last mile' public transport options. The 'first mile/last mile' problem refers to the difficulty (or inconvenience) in starting and ending a commute by public transport, and therefore resulting in some people resorting to driving the entire way to reach their destination.

These services also provide the potential to reach out to those private vehicle users who will not currently consider public transport options because of perceived 'convenience and comfort' factors, which traditionally do not compare with the private vehicle.

In addition to taxis - bus shuttles, van-pools, car-share and ride-share, bicycle sharing schemes may all be considered as examples of personalised passenger transport.

The sections below briefly summarise recent trends and emerging services/products with a view to demonstrating key opportunities for BOPRC to further enhance accessibility, perceived safety, reduce an over-reliance on private vehicle access, and more efficiently cater for the provision of transport services without requiring significant investment in assets.

7.6.1 The Sharing Economy

'Shared Services', with respect to the transport industry, is a term capturing taxis, ride-share, ride-source, and even bike-share modes. The key guiding principle is 'access over ownership' of transport assets, management, and service provision.

BOPRC can embrace innovations enabled by the rapidly growing phenomena of the sharing economy to supplement traditional scheduled public transport offerings for 'first mile/last mile' connectivity, and provide more flexible, personalised, on-demand, and demand responsive passenger transport services.

Transport is a natural market for the 'sharing economy'. Taxis, rideshare and car-share services connect people with drivers and vehicles when and where they need it. There is less need to own a car/bike when people can either share resources or get a ride with others. Ride-share and car-share technologies enable everyone to access the convenience and comfort benefits of a personal vehicle, while avoiding the need for individual ownership. These services essentially deliver 'mobility on demand'.

There is an almost universal view among academic, market and technology commentators that the sharing economy, and the associated demand for ride sharing services, will continue to grow.[48]

The key insights for BOPRC are:

- Members of Generations' Y and Z currently use, and are projected to continue to use, public transport at a higher rate than their older counterparts.

48 Deloitte Access Economics (2015) The sharing economy and the Competition and Consumer Act (Australian Competition and Consumer Commission)

  - Transport planning will need to consider a shifting generational view of public and passenger transport and greater take up of shared transport options.
  - Even without direct travel demand management interventions by Council, public transport/active transport will require a greater 'urban footprint' than in the past.
- A shift to 'access over ownership' and 'flexible personalised trip options' represent opportunities to re-think passenger transport requirements, and passenger transport funding and delivery models.
- Physical transport/land use planning must consider the likely greater take up of shared services in the future.

Shared modes will continue to grow in significance. It is recommended that BOPRC identify opportunities (independently and potentially jointly) to improve accessibility and connectivity for all users through collaboration and public-private partnerships, including greater integration of multi-modal services, information, and payment methods.

The following sections briefly describe a range of options available to Council to utilise 'shared services' to:

- Improve 'first mile/last mile' access to scheduled public transport services;
- Persuade committed private vehicle users to reduce their single-occupancy vehicle trips and 'share' their ride; and
- Persuade committed private vehicle users to source an alternative means of transport which is as convenient, cost-effective, and personalised.

The take up of more ride-sharing and ride-sourcing may also be facilitated by Council via:

- Adjustments to parking management, including the allocation of dedicated, priority parking spaces or parking price discounts for users of 'green transport' options;
- Provision of space for ride-sourced waiting area, pick up and drop off points;
- Potential joint venture with a car-share provider for corporate service fleet requirements and shuttle services; and
- Potential joint ventures/contracts with a ride-source provider.

There may also be alternatives to the current corporate pool fleet arrangements, new ways for the provision of specialist services currently provided for those who are mobility impaired, and transport services provided for the safety of the community when regular scheduled services are not available or viable.

Successful ride-sharing take-up will require a range of measures including:

- Genuine incentives to ride-sharers;
- A ride-sharing system that is perceived to be easy to use, available, trustworthy and value for money by ride-sharers;
- High visibility and endorsement as a legitimate travel mode;
- Ride-sharing software suitable for smart phones that not only provides matching services but also ultimately enables "on the fly" route planning for car-sharing pickups and drop-offs; and
- Ride-sharing programs that have post-match-up capabilities to manage on-going ride-sharing arrangements with the flexibility to respond to changes to ride-sharers travel plans.

7.6.2 Reported Benefits of Car and Ride-Sharing

Car share services provide a range of benefits which align with the strategic directions of Council's transport plans. Key benefits reported recently by RPS include:[49]

- Car ownership reduction – each car share car replaces 10 cars;
- Reduces parking pressures / frees kerb space – 100 car share cars free 5.8km of kerb space or 30,000m2 floor area in buildings;
- Members reduce overall car use / vehicle kilometre travel by over 50%;
- Members increase public and active transport use;
- Active transport facilitates health benefits; and
- In addition to the transport benefits, the cost savings available from car share provide a direct means to assist the goal of 'affordable living' – particularly where car ownership is reduced and the cost of purchasing or renting a car park avoided. Car parking costs between $AUS30,000 - $50,000 per space to construct and approximately $50 per week to rent, whilst the average costs to own and operate a modern car exceed $10,000 per year.

7.6.3 Car Sharing Schemes

It is considered that more flexible taxi style services or car sharing schemes may be of greater applicability for BOPRC.

As discussed briefly in the strategic context chapter, CityHop operates out of Auckland and Wellington and is planning to expand across further areas of New Zealand[50]. Mevo, a new Wellington start-up, is another car share providing using hybrid electric vehicles. Its fleet is made up of premium brand Audi A3 e-tron vehicles. The company plans to expand across New Zealand, but for now it has two 'pods' in Wellington city. BOPRC should consider opportunities to discuss potential applicability, at least in the medium term, for the Bay of Plenty region.

7.6.3.1 Tertiary Concept Demonstration - GoGet Car Share

We provide a concept demonstration for the University market. This is particularly relevant given the opening of a new University of Waikato campus in heart of Tauranga in 2019.

The University of New South Wales, University of Melbourne, La Trobe University, Optus Macquarie Park, and University of Queensland (UQ) have recently partnered with Australia's largest car sharing scheme, GoGet. A key objective is to reduce the use of motor vehicles to access the campuses.

The UQ car sharing service is the second-largest university deployment in Australia; second to La Trobe University's fleet of GoGet cars deployed in 2016. GoGet cars at the UQ St Lucia Campus are available for staff, students, and the public to book, by the hour or by the day via online or the GoGet app. The GoGet cars are available for bookings in the following locations:

- Three cars are available in University Drive, St Lucia Campus
- Two cars are available in Services Road (Seddon West Bldg), St Lucia Campus

49 http://www.rpsgroup.com/Australia-Asia-Pacific/News/2016/SEQ-Urban-Transport-Futures-Time-to-Look-Ahead.aspx
50 https://www.newsroom.co.nz/2017/05/28/30812/here-in-my-car

- Four cars are available in Mansfield Place (Goddard Building), St Lucia Campus
- Two cars are available in the Oral Health Centre carpark, Herston Campus.

The GoGet student rate is currently $AUD6.55 per hour + $0.40 per km (petrol & insurance included) or $74 per Day including 150 km free + $0.25 per extra km (petrol & insurance included).

Figure 7-16: Example of the GoGet car-sharing scheme

La Trobe has also provided GoGet cars on campus and also liquidated its depreciating car fleet assets and replaced most of its campus corporate pool fleet with on-campus GoGet cars. These cars can be used not just by staff, but students and the local community as well. GoGet technology has also been installed in La Trobe's own special vehicles and regional campus fleets, so they appear on the booking system alongside GoGet cars for La Trobe staff.

It is noted that La Trobe's Melbourne Campus also has allocated 40 dedicated carpooling spaces.

In 2011, UNSW became the first university in Australia to have car sharing facilities on campus. Four vehicles (including a van) from the car share company GoGet are available for hire. In 2015, approximately 110 students and staff used the service. There were over 2,600 bookings across the year with an average booking length of 4.3 hours per booking[51].

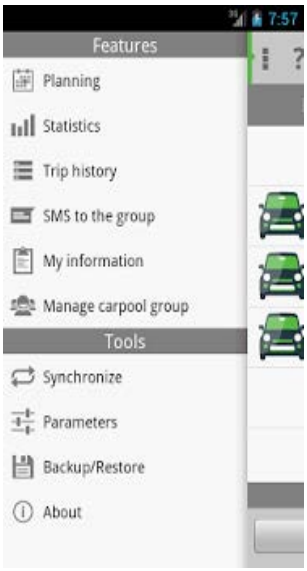
In 2014, GoGet teamed up with the University of New South Wales (UNSW)on a research project on driverless cars and now has a self-driving Yaris research vehicle in its fleet, being tested on the campus.

51 http://sustainabilityreport.unsw.edu.au/environment/transport

Figure 7-17: Example of a car-sharing driverless car project at the University of New South Wales

UNSW also promotes the MyCarpools app which works by matching locations, time of departure and personal preferences with other UNSW MyCarpools members. MyCarpools allows people to register as a driver, passenger, or both, and people can change their travel details or preferences at any time. People can also set up a username to message and confirm carpools with other members.

Figure 7-18: Example of the MyCarpools app at UNSW



It is recommended that the University of Waikato be encouraged to consider shared services and facilitate the provision of an on-campus or near-campus car share scheme for staff/student/general community use. Given the recent decline in patronage by the tertiary market, an innovative passenger transport delivery model may shift students away from single-occupant private vehicle use.

7.6.4 Ride-Sourcing Schemes

The regulatory regime in New Zealand now allows ride sourcing drivers to operate legally. The new model also focuses on customer and driver safety. The new regulations should also encourage further innovative services to better meet the needs of individual customers.

It is to be noted that ride sourcing and ride sharing are both used interchangeably to refer to rides via 'shared' resources.

There are several schemes available and in operation currently. Undoubtedly, Uber (discussed below) is currently the dominant player.

7.6.4.1 'Business to Peer' Ride Sourcing

Uber

There are a range of products now offered by Uber to meet specific market segments or specific locations. Some of the products include: UberXL larger vehicles to transport up to 6 people; uberASSIST designed to provide additional assistance for members of the community with special accessibility needs; and Scheduled Rides (30 minutes to 30 days in advance). The Uber website provides further information and rates for its range of services. However, as discussed below, Uber has also partnered with various government agencies, employers, and educational institutions to provide a tailored product to meet specific needs.

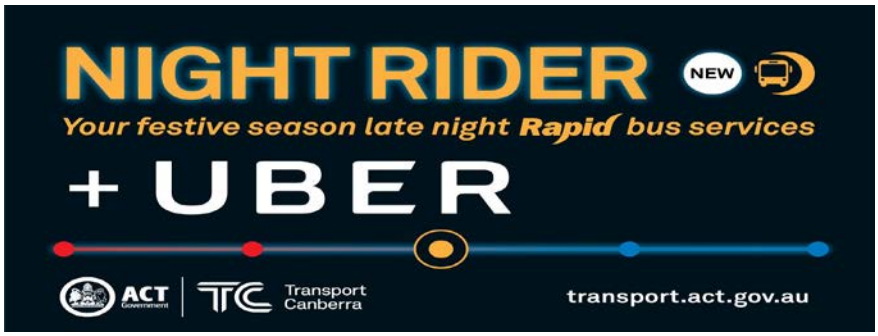
Uber is now partnering with TripGo to help complement and extend the reach of public transport networks across seven Australian cities - Brisbane, Gold Coast, Melbourne, Newcastle, Perth, Sunshine Coast, and Sydney[52]. TripGo users are given access to real time ridesharing and public transport data to allow people to request and synchronise Uber rides with public transport connections, bridging the first/last mile gap.

We note that ride-sharing services are currently most frequently used for social trips between 10pm and 4am, times when public transit runs infrequently or is not available. It is reported that shared modes substitute more for automobile trips than public transit trips.[53]

Transport Canberra has already recognised the opportunity of extending the reach and attractiveness of public transit by integrating with ride-share. It recently implemented a deal with Uber which saw Night Rider bus users get $10 trip discounts for their 'last leg home' from the city last Christmas period[54].

52 https://newsroom.uber.com/australia/uber-and-tripgo-to-help-more-aussies-access-public-transport/
53 American Public Transportation Association (March 2016) Shared Mobility and the Transformation of Public Transit.
54 http://www.canberratimes.com.au/act-news/uber-discount-for-night-rider-bus-users-this-festive-season-20161125-gsxccx.html

Figure 7-19: Example of Uber providing last leg home services



RideFlag

RideFlag provides trips that are on-demand, so while users can plan commutes weeks in advance, many can use it for when they need a ride in that moment.

- With one tap, users can switch between being a driver or a passenger.
- App users can set up groups – referred to as "Circles"[55] – of people with similar routes or, for example, teachers who live in the same neighbourhoods and teach at the same schools. Trust builds as users take increasingly more trips and driver ratings, much like in the Uber and Lyft apps, are also compiled.
- Drivers set their own prices, which could even be nothing. Pricing is typically set at about 40 cents per mile, and the passenger pays the driver that amount digitally through the app.

RideFlag's business model is to work through transport agency partnerships. RideFlag's first beta version was released in 2015 in Montreal, working in consultation with the region's transportation department. The app is currently launching in parts of southern Florida – taking advantage of HOV lanes in the region. Starting in late May 2017, the Florida Department of Transportation tested specific local carpooling initiatives with RideFlag by providing a US$100 cash incentive for those willing to use the RideFlag app.

7.6.5 'Peer to Peer' Ride Sharing

A number of peer to peer ride sourcing applications now present themselves for consideration (as discussed below). However, BOPRC will not achieve the consistency of message, the completeness of a 'packaged solution', nor the high visibility of 'demonstrated' commitment to alternative sustainable modes of transport if it simply leaves it to the 'peer to peer' market to make it happen.

Interestingly, the larger players in the business to peer sector are actively developing variants to manage and facilitate peer to peer interactions – for these key reasons.

In the ridesharing sector, both Uber (UberPOOL) and Lyft (Lyft Line) are now developing services to dynamically match different riders to create 'routes' on the fly which transport people at a reduced price compared to the regular ridesharing services[56].

55 http://mobilitylab.org/2016/05/11/on-demand-carpooling-rideflag/
56 http://recode.net/2015/06/03/uber-ceo-half-of-all-rides-in-sf-are-for-its-carpool-service/

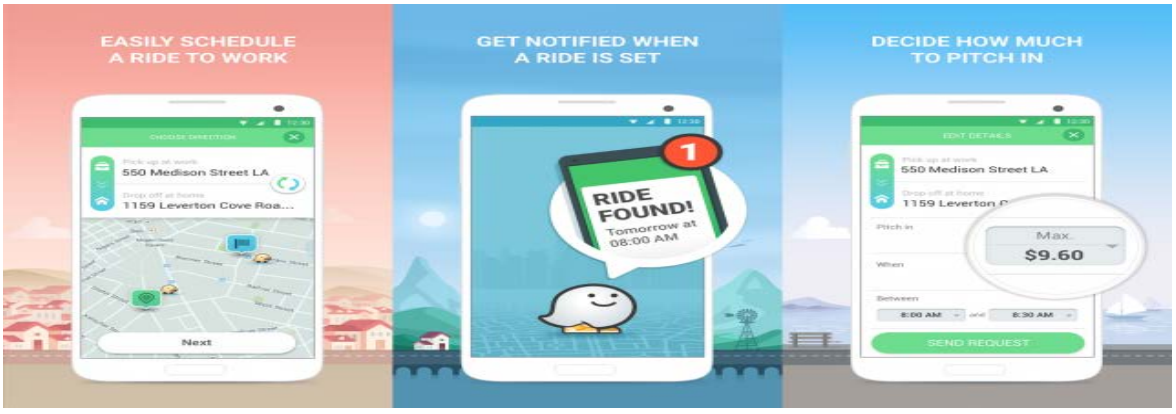
In San Francisco, where Uber has its headquarters, 40 per cent of Uber trips are now pooled. (UberPOOL). UberCOMMUTE is also now available. The feature lets drivers find people who want to secure a shared ride on their commute to and from work. It's pitched either at part-time Uber drivers or people who just want to be an Uber driver on their commute, with the income from picking up a passenger to helping to cover their commuting costs.

There are also Uber vehicles unique to parts of the world. In Istanbul for example, people can catch an UberBOAT, in Shanghai people can get an UberCHOPPER, in India there are UberGO hatchbacks and in Bangkok people have the option to catch a ride on the back of a UberMOTO motor bike.

Figure 7-20: Example of other Uber services, such as a boat in Istanbul

Google is now launching a ride-sharing service[57] that also manages carpools. It is expanding the service to its Waze navigation app in a number of cities across the United States and in Latin America over the next few months. The move makes Google a new large competitor for Uber.

Figure 7-21: Example of Google's new ride-sharing service



With Waze Carpool. riders will select the closest driver who is planning a drive on their route. Drivers will receive the ride requests and can choose to accept or decline them.

There are some issues currently which may favour the promotion/coordination of a business to peer ride sourcing scheme. For example, there are current concerns regarding the safety and vehicle standards, quality of service, the difficulties of verifying people in person, liability risks and insurance issues associated with

57 http://fortune.com/2017/02/22/google-entering-ride-hailing-uber-lyft/

individuals sharing their private vehicles. For these reasons**, it is recommended that BOPRC pursue the business to peer ride sourcing models at this stage.**

7.6.6 Way Forward for Shared Services

The technology is there, the market is there, and the product is there. Government's role may simply require funding resources as an enabler, facilitator, promoter, and incentiviser. It can bring to the table the allocation of 'dedicated' space, preferred/sole supplier benefits, and branding signage throughout the region in return for exclusive rights etc.

Council should at least strive to be an early adopter or preferably, a rapid follower, and future proof today's decisions.

The following is a list of shorter term implications for Council's consideration:

- **Do not 'lock in' or provide long term (10 plus years) extensions to current contractual arrangements for the continued provision of traditional bus transport services.**
- **Be cautious with any direct purchase of corporate pool vehicles in the short to medium term.**
- **Consider partnering with a commercial car-share/ride share provider to provide pool fleet requirements and to assist with supplementary services** – especially in areas where there are transport disadvantage communities, or where traditional public transport servicing is costly to provide (such as in more remote, low density settlement areas).
- **Facilitate the take up of more ride-sharing and ride-sourcing via:**
  - **adjustments to parking management, including the allocation of parking spaces or parking price discounts for users of 'green transport' options;**
  - **provision of space for ride-sourced waiting area, pick up and drop off points; and**
  - **provision of dedicated RideShare carpooling bays, preferably in prioritised locations, with highly visible branding and signage. Ensure these spaces are enforced.**
- Given the readily available options, **avail of the opportunity to partner with a business to peer ride sourcing operator:**
  - By collaborating with a commercial provider, the offering will achieve more 'reach' and 'frequency' in the marketplace by joint marketing, advertising, and promotions.
  - A suite of 'green transport' options can also be provided under the over-arching sustainable transport/better transport choices banner.
  - Incentives to reward the community for sustainable transport choices should be added to the package.

7.7 Transport Mobile Apps

The presence of and rapid evolution of smartphone and computer applications ('apps') will also continue to transform the way in which they reach and influence *customer behaviour*.

Access to GPS data, open data from publicly funded transit agencies, and crowd-sourced data, along with a more refined understanding of how these data can be applied to transportation, has led to the rapid development of transport applications.

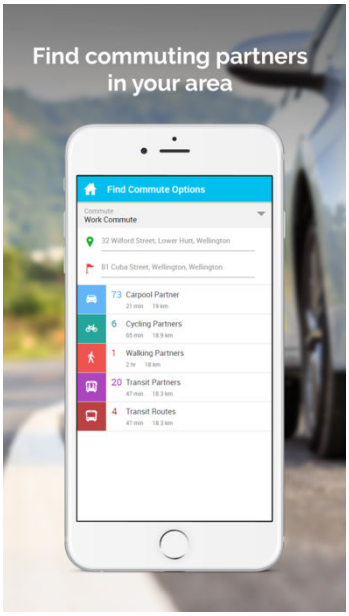
The following sub-sections highlight the array of apps available – in the longer term (as discussed further in Chapter 9) we recommend apps are developed/transitioned under an integrated Mobility as a Service platform:

7.7.1 Smart Travel NZ

Bay of Plenty Regional Council supports Smart Travel which is an online platform and app that helps people find other local commuters and people to share rides with and plan your journey. Smart Travel supersedes the old Let's Carpool website, developed in 2008 to offer an alternative transport option in areas not well-supported by public transport.

The Smart Travel platform was developed by RideShark - commuter management web developer based in Ottawa, Canada. RideShark's platform is used throughout North America and in parts of Australia.

Figure 7-22: The Smart Travel NZ app



As well as carpooling, Smart Travel encourages the use of public transport, walking and cycling and is the first multi-modal transport platform in New Zealand.

The Incentives aspect of the scheme has not been widely used. Since going live (May 2017) nationwide there are 2,300 registered, mainly in Auckland and Wellington. In the Bay there are currently 76 registered users.

Council reports that it is about to undertake a radio and digital promotion concentrating on the carpooling aspect and raising awareness.

The other workstream includes working with workplaces and encouraging them to use the App and online tool as part of workplace travel plans to incentivise multi-modal commutes. Currently Tauranga City Council is piloting this.

We recommend that BOPRC, in collaboration with participating agencies, review the Smart NZ App and online tool and seek to obtain feedback from registered users, and local councils/employers who may be utilising the tool for workplace travel behaviour programs.

The feedback will be most useful in the longer- term development of a more comprehensive Mobility App incorporating other modes (including ride share), lifestyle services, journey alerts in real time and incentives for those who take up sustainable travel choices.

7.7.2 Best Practice – Concept Demonstrations

My Urban Pulse

Transdev's Urban Pulse is a smart phone application recently launched in Paris which integrates lifestyles and public transport. The developers' vision is to 'enable people to get out more, and to better benefit from all there is to do'. It can tell you everything that is 'pulsating' around you – things to do, special promotions, location of nearby friends – as well as offering multimodal trip planning and directions. Trip capture and management is also enabled, providing a valuable source of data for ongoing network and service planning and whereby demand ultimately can be managed in real time to smooth travel peaks and respond to planned and unplanned service disruptions.

Google started the initiative by incorporating fixed-route transit data into its Google Maps program. Any transit agency wishing to post its data to Google Maps had to translate that data into General Transit Feed Specification (GTFS; originally known as Google Transit Feed Specification). Apps developed by using these technologies allowed the creation of data streams that revealed the exact location at any given time of the bus/train and the passenger as well as lines not operating or experiencing delays. Thus, an app could locate a user's current position, find the closest local fixed-route transit stop, and show the user in real-time when the next bus or train would arrive at that stop. This type of data enabled and facilitated the creation of maps, routes, schedules, and interactive sites for trip planning and, ultimately, specific transit apps.

RideScout/Ride2Go

RideScout's app (purchased by Moovel in 2014) aggregates multiple ground transportation ride options, allowing users to compare the travel time and costs in real time. The app integrates transit information, car sharing and bike sharing options, taxis, and peer-to-peer ride sharing, and allows users to search for and book rides. Travellers who prefer to walk can use Apple Maps (formerly HopStop) or Google Maps which, in addition to providing information about transit, cycling, or taxis, provides point-to-point walking directions. The app also links to restaurants, shopping, and other nearby destinations.

7.7.3 Smart Parking Apps

Parking has been undergoing the same type of changes as mobility with the emergence of smart parking systems. There are many smart parking projects around the world using sensors in the road and back office systems of payment. These will continue to develop and will be an important element of mobility management. In the future there will be more back-office parking accounts with payment by mobile enabling people to pay on line in real time, to extend parking times, and to be informed as to where the available spaces are. There will need to be little, if any, equipment 'on street'. This is happening at present in North America, Europe, and Australasia.

Smart parking can help reduce congestion and pollution by taking customers straight to parking spaces saving time, vehicle miles, pollution, and energy. However, it is even more powerful that all of that. Once a Mobility Manager incorporates a smart parking system then it can also shape parking (and driving) behaviours.

Opportunities that come from Smart Parking include:

- Flexible parking rates by time and place
- Priority parking for high use (member) participants
- Parking space trading
- Premium for wider, safer, more convenient spaces
- Options for discounting/incentives as a direct offer from retailers
- Opportunity to expand the business model to encompass all potential customers – public transport users, visitors, etc.
- Time based incentives
- Promote public transport – e.g. park and ride at certain times
- Promote walking by incentivising use of more remote parking
- Integration with complementary transport offerings
- Potential to link with existing loyalty card offers.

Examples of Smart Parking Systems in practice include:

- Toulouse Smart Parking System
- San Francisco Smart Parking System
- Smart Parking in Tallinn
- Parramatta Smart Parking

7.7.4 Digital Wayfinding via Mobile Apps

Today people have maps instantly at their fingertips in a variety of smart phone applications – providing directions, access to high-resolution satellite imagery, street-level photographs, and even full 3D modelled environments – accessed through an array of interactions including voice, touch and gesture-based interfaces, and augmented reality (AR) devices. AR wayfinding applications overlay visual data onto a live view of whichever direction the device's camera is pointed. A 'Tunnel Vision' app developed by Bill Meier in 2014, for example, displays live train locations and other information when users point their devices at maps in New York's subway system[58].

[58] http://www.tunnelvisionapp.com/

Advances in digital and mobile wayfinding have been brought about through a combination of location-aware technologies - GPS (global positioning system), RFID (radio-frequency identification), Wi-Fi and Bluetooth LE (low energy) beacons - which can determine the geographical position of people or objects, in combination with enterprise wayfinding software, which provides powerful mapping and third-party integration capabilities[59].

Digital wayfinding has a key advantage over traditional wayfinding signage - data can be updated in real-time through the underlying wayfinding platform. Administrators can manage wayfinding data and content directly, and to configure business rules that will automatically trigger changes based on special events.

7.7.5 Incentivising Behaviour via Mobile Apps

A key sustainable development objective is not just to operate effective mobility services and to manage the transport infrastructure effectively via enabling technologies and applications, but more strategically it is to undertake more efficient and sustainable urban travel. Hence, a more specific goal is often to reduce the use of private car use and to promote a greater uptake in public transport use and human-powered travel (e.g., walking or cycling, by offering travellers the right kind of incentives).

An effective incentive is one that motivates individual travellers to change their travel behaviour to achieve the overall authorities' goals (e.g., to reduce car use during peak commute times, to protect the environment through reducing air pollution emissions, to promote well-being through using more human-powered mobility during urban travel and to facilitate personal travel safety).

7.7.5.1 Real-Time Information Alerts/Guidance

Users may be provided with real-time information on the conditions of the transport network such as delays, planned or emergency road works, parking availability, and traffic alerts and hazards (e.g., a road accident or a bus service cancellation). Information on these conditions can be coupled with personal habitual travel patterns to deliver information that is personalised to individual users' information, enabling them to make more informed travel choices.

A range of apps offer real-time advice such as an alternative route on a currently congested route, weather etc**.** One example is WAZE, the largest community-based traffic and navigation application in the world:

> *"Waze is a free GPS-based geographical navigation app for smartphones and tablets. It has display screens which provides turn-by-turn information and route details. When you use Waze, you can also actively report information to the other users (a.k.a. "Wazers") about things like traffic conditions, accidents, police traps, blocked roads, weather conditions, potholes and much more. Waze collects this information and immediately analyses it in order to provide other Wazers with the most optimal route to their destination, 24 hours a day"*[60]

[59] http://www.jibestream.com/
[60] http://rockawaytimes.com/index.php/news/621-in-touch-with-tech-by-the-waze

Figure 7-23: Example of the WAZE app

7.7.5.2 Feedback and Self-Monitoring

Travel Feedback Programs provide personalised feedback on individual travel behaviour. These aim to raise people's awareness on impacts caused by the way they travel. The metrics used are often relatively simple, such as cost, time, calories, distance, and carbon footprint.

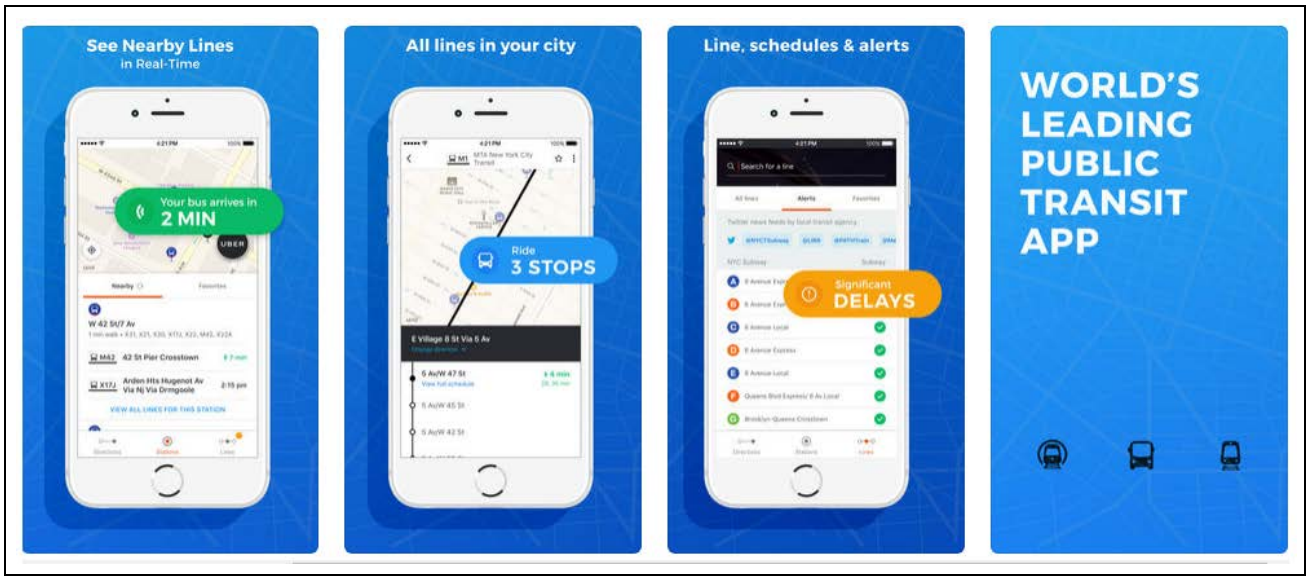
There currently exists a range of 'apps' such as Strava (and supporting devices such as FitBit and Smart Watches) that assist with users setting their own targets for travel, such as CO_2 reduction and weight lost and that help users achieve them through tips and monitoring. These applications and devices also effect 'persuasion', further incentivising people to strive to even more sustainable and healthy travel choices by encouragement, and competition amongst peers.

7.7.5.3 Social Networks

The key incentive of social networks for travel is to provide users with a means to communicate, and to share their travel experience and information with each other. This promotes collaboration among users and facilitates the take up and perceived security of ride sharing.

Crowdsourcing also offers information on estate assets and services. FixMyStreet (UK) and Nextdoor (USA) allows users to report local problems such as the condition of the road, among other things. Apps that allow customers to rate their transit commute include Moovit and Tiramisu (New York and Pennsylvania). Tiramisu also offers crowdsourced real-time information.

Figure 7-24: Example of the Moovit app



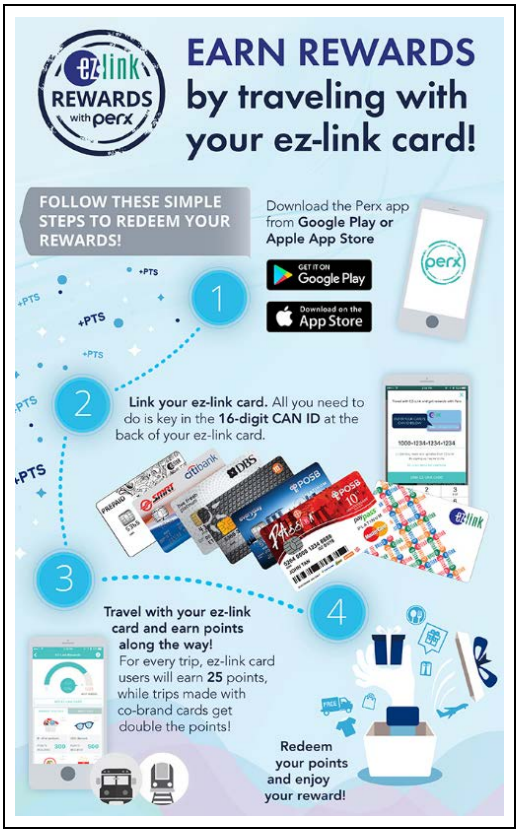
7.7.5.4 Rewards and Points

There are many computer and smartphone games that use a points' based system to motivate players to stay 'online'. Travel can also be gamified using a points' based system. Linking bonus points to different rewards may be a necessary step to provide the extra 'push' required to get travellers to change their behaviour. Mobility Management incorporates the establishment of a basic personal mobility measurement engine on which stakeholders can couple and integrate services, Apps, and campaigns to incentivise travellers. Technological advances facilitate this information exchange and incentive distribution between third parties, city authorities, transport suppliers, employers, and end-users.

As an example, in Singapore, commuters who use the EZ-Link card earn rewards points every time they take the train. They earn 1 point for every kilometre travelled on the train during the week, from Monday to Friday. To encourage people to travel off peak, passengers earn more points (up to 6 times the number of points) if they tap the EZ-Link card between the hours of 6.15am to 7.15am or 8.45am to 9.45am. People can either redeem their incentive points in cash ($1 per 1000 points) or play a 'Spin to Win' game to win random prizes, from 50 points to SG$200[61].

[61] http://home.ezlink.com.sg/perx

Figure 7-25: Example of the EZ Link card rewards programme in Singapore



7.7.6 Future Mobile App Specifications

The following key objectives for specifications are recommended to make future transport apps more comprehensive, integrated, serve holistic functions (beyond just customer information). These are provided for Council's consideration should it wish to further progress current apps from a journey planner function to a mobility manager platform.

Smarter

Personal mobility companion that provides travel information in real time, journey planning assistance, and re-scheduling advice based on events and incidences, will lead to better management of travel demands and reduce the footprint of private vehicles on the campus.

- Dynamic campus traffic control and guidance
- Accurate bus arrival/departure times
- Public transport priority
- Dynamic last mile delivery (shared services)
- Fleet tracking
- Mobile pedestrian/cyclist app synced with signals
- Pedestrian counts/cycling counts and tracking
- Smart parking guidance
- Smart parking availability

- Crowd-sourced visualisation and data mining.

Safer

- Surveillance
- Dynamic speed alerts
- Pedestrian management
- Incident management
- Pavement sensors.

More Accessible

- Real time Passenger Transport Information
- Pre-trip information
- On-trip information by VMS and portable devices
- Parking booking
- Integrated public transport ticketing
- Public transport/shared services/parking payments
- Alternative services (e.g., electric vehicles charging) payments
- Specialist services for disadvantaged people
    - For example: for blind users as well as people unfamiliar with the campus, the Michigan State University Guide App works in tandem with a text reader, and it offers a wand feature, which allows people to point their phones in all directions to learn what's around them. For those with physical challenges, the app provides accessible entrance information for buildings so people can determine whether doors have handles, whether ramps are available or whether there are stairs.

More Sustainable

- Incentives for active transport, public transport, and shared services - more sustainable choices
    - Motivational apps to encourage healthier active transport choices. For example, the app Zombies, Run!, Nike Training, Club (iOS), Sworkit, Moves, Fitbit (iOS), JeFit, RunKeeper, Strava, 7 Minute Workout and MapMyFitness.
    - Nudge is another app that collates all the apps' fitness data and stores it in one place. This means users can keep track of nutrition, exercise, hydration, and sleep, without checking the progress reports from each app.
- Feedback on energy consumption - earn green points which may be redeemed.
    - For example: MoveUS Genoa and MoveUS Tampere.

8 Summary of Short to Medium Term Recommendations (1-5 years)

8.1 Minimise BOPRC's risks and future-proof investment decisions by procuring a packaged ITS solution from an experienced AVL system integrator

- Discontinue arrangements where BOPRC is taking the role (and risk) of acting as systems integrator by procuring an ITS solution requiring separable contracts with different parties.

- Procure from an experienced AVL system integrator, with multiple deployment stages. The multiple rollout stages will allow BPROC/operators to initially bring into operation the core functionality system before additional subsystems are added.

8.2 In the procurement of ITS technologies, ensure BPROC retains issue of ownership of data

- Review all current and future contracts to ensure that all data created belongs in entirety to BOPRC and that suppliers do not assert proprietary rights, which then enables suppliers to charge licence fees for data use in addition to development charges to build interfaces.

8.3 As a priority, procure a Business Intelligence system, potentially via the NZTA AFC supplier panel arrangements

- Procure a system which: does all the integration for the agency; is a comprehensive, mature, cloud-based data warehouse, data analytics, business intelligence solution tailored specifically to the public transport industry but applicable across *all* passenger transport modes and provides easy report generation (but also provides granularity of data for more detailed network planning/scheduling purposes).

- Further ensure a BI systems specialist provide an integrated service, incorporating:
  - automated ETL, data warehousing, business intelligence and workflow;
  - report generation;
  - automated data matching across scheduling, real time vehicle movements and ticketing systems;
  - automated data quality and data cleansing (e.g., wrong trip boarding, invalid trip starts, etc);
  - automated fault detection, classification, and identification;
  - full support, data analysis and officer training services;
  - data enhancement suggestions for improved analysis;
  - contract reporting analysis and report enhancements; and

  - ongoing research and development.
- Ensure in-house resources are trained to effectively use the collected ITS data.

8.4 Identify opportunities for improvement in the Transit Network from the Business Intelligence data to grow patronage

- Once the business intelligence system is in place along with the new electronic ticketing system, undertake a detailed analysis of the existing transit network by investigating, for example:
  - Hypothetical 'what if analysis' to test different timetables, network design, fares, etc. to compare and contrast operational metrics such as in-service km, headways, non-revenue runs (dead-running) etc.;
  - Bus routes which may be operating with low/over-loaded levels of occupancy; and
  - Bus routes which are consistently not able to adhere to timetabled schedules therefore requiring necessary adjustments to timetable/driver rosters.

- With this detailed data available on a daily basis, compared to aggregate data being compiled at the end of each reporting period, service planners can make timelier and better informed decisions on improving the transit service, demonstrating rationale for proposed changes to the system, and impacts on operating kms/hours and associated costs.

8.5 Invest in ITS systems which offer an integrated Demand Responsive Travel technology solution to facilitate demand responsive travel as a natural extension of the public transport network

- provide customers with a full-service mobile application and web site to register travel preferences, plan their journey, book demand responsive trips, pay fares, manage their account, track vehicles, and receive arrival time predictions. The service may provide alerts, targeted information about service disruptions/irregularities, and allow the customer to respond to surveys, rate their travel experiences, and provide direct feedback to operators and transit authorities.

- provide navigation directions to drivers to follow the most efficient routes to pick up and drop off customers who have booked demand responsive services.

- provide a data analytics platform to deliver tailored information directly to network planners/schedulers, operations staff, and contract administrators so they can make optimal, fully-informed strategic and operational decisions – to deliver the best network integration, efficiency, and customer experience.

8.6 Consistent with recommendation 8.1 consider procuring Real Time Passenger Information (RTPI) functionality as an extension to the procurement of future ticketing system solutions

- Decline to extend the contract for the temporary RTPI solution Radiola.
- The RTPI system solution should not be procured as a standalone package but aligned with the new electronic ticketing system solution.

8.7 Consistent with recommendation 8.1 consider procuring an Automatic Passenger Counting (APC) as an extension to the procurement of future ticketing system solutions

- Together with other members of the Regional Consortia, negotiate with the new electronic ticketing systems supplier to provide a commercial pathway proposal to incorporate APC functionality in the integrated AVL system in the medium term.

8.8 Do not lock in proprietary-based Electronic Signage solutions and invest in generic solutions that interface with RTPI systems

- Minimise capital and ongoing costs related to electronic signs by investing in generic signage solutions that can interface with real-time information systems rather than proprietary signs that lock Council in.

- Proceed on the basis of LCD monitor style (or E-Ink style) for passenger information signs.

- Concentrate on key locations, such as high-volume interchange locations or services/stops catering for the visitor market and rely increasingly on the use of electronic personal devices rather than widespread physical display rollout.

8.9 Re-consider expansion of Wi-Fi initiative

- Reconsider plans for wider rollout of the current Wi-Fi initiative and limit Council's ongoing investment and deployment to longer distance commuter services.

- Consider including in future bus operating/fleet procurement contracts broader specifications for future fleet to be equipped with add-on features such as provision for charging mobile devices.

8.10 For Transit Signal Priority focus on cost-effective interventions such as bus only turn lanes, priority lanes in peak hours/areas of high bus demand, and appropriate enforcement of these lanes

- In the longer term, consider opportunities to integrate Transit Signal Priority as part of Automatic Vehicle Location (AVL) Systems and emerging connective vehicle and infrastructure technologies

- Do not invest in a stand-alone signal priority system.
  - The electronic ticketing system that is being procured can be interfaced with a TSP system and other than the costs of installing the necessary hardware at selected intersections, the cost for adding the TSP system capability to bus vehicles already equipped the automatic vehicle location (AVL) devices maybe minimal.

8.11 Limit Council's direct investment in on-bus audio/visual displays unless there is a compelling business case to do so (such as additional revenue generation via granting of advertising rights etc.)

- Whilst the technology is available and may be supplied/managed via a variation to the new Electronic Ticketing systems procurement arrangements, we recommend that it does not provide significant benefit to warrant the investment.

- Notwithstanding, it may be considered for a small pilot on a bus service targeting the visitor market (for example, in Rotorua).

8.12 Consider rolling out CCTV surveillance on major routes/special late-night services *if* customer/community surveys trigger a requirement

- CCTV systems should be non-covert and public information should be displayed about the presence of CCTV.

- In providing CCTV, it is recommended that Council requests that suppliers:
  - comply with privacy protocols including restricted access to software and hardware used to download images to prevent the unauthorised recovery of images;
  - advise relevant stakeholders of any material change to a prescribed or minimum function or feature of the CCTV or software;
  - provide clear written instructions on the operation of their CCTV for operators; and
  - ensure that there is an emergency '24 hour 7 days a week' download facility available to recover images from buses fitted with the CCTV.

- Of the most important service dimensions reported by Bay of Plenty bus non-users, safety/security is only mentioned by around 1% of non-users. Bus customer surveys also do not suggest that increased surveillance is a pressing issue which may be influencing a shift away from transit use. It is not Council's most critical investment requirement, at least from the wider community's perspective.

- As CCTV systems provide added security/safety to drivers, we recommend safety/security outcome specifications be addressed as part of bus contractor obligations, to supplement a corporately prepared and publicly published public transport safety and security policy which operators and the general public must comply with.

8.13 Limit bus Stop/shelter technology enhancements to one or two key locations only, and focus on fundamental design principles to enhance accessibility/system legibility

- Consider small enhancement treatments at one or two central, key interchange stop/stations, also aligning these priority 'select' locations with RTPI signage. These should be at stops which cater for a high proportion of visitors.

- Treatments do not necessarily need to incorporate high-tech solutions but should strive to demonstrate Council's commitment to a quality service and to enhancing the customer experience.

8.14 Ensure future Bus Operating Contracts specify and incentivise operators to deliver innovative solutions and incorporate new technologies as they become more readily available

- New operating contracts provide the opportunity for Bay of Plenty to consider new service delivery models and specifications/incentives to encourage provision of new/alternative fleet (electric/hybrid/hydrogen vehicles) as part of the contract. We recommend the evaluation criteria for selection include the following:
  - Proposed transport network and services integration;
  - Potential of solutions to either improve customer services and grow patronage;
  - Improved 'first mile, last mile' access to scheduled public transport services;
  - Desirable sustainability features/practices; and
  - Innovation (embracing emerging technologies) and value-added initiatives.

- With regards to the terms of the contact, it is recommended offerors are provided at minimum a 7 year plus extension options contracts to incentivise the offeror to invest in fleet, systems, and technology and to provide extension rights based on satisfactory performance.

- Consider incentivising operators to raise the service quality and provide demonstrated support for Council's sustainability objectives via use of modern environmentally sustainable fleet, the use of dynamic information and guidance systems, and other demonstrations of 'premium' service.

8.15 Prepare effectively now for the future world of fleet and connective and autonomous vehicle technologies and develop a council position on how to respond effectively

- In the medium term (under new urban service contracts), there exists the opportunity to introduce either diesel/electric hybrids. In the long term, fully electric vehicles are expected be a fully matured technology. Technological advances in battery technology could also improve the operating range of the vehicles and reduce the time required for charging.

- Ensure future bus operator contracts do not lock in a current fleet standard, but rather specify that operators incorporate new fleet and technologies as they become viable.

- Ensure environment standards and the requirement of operators to consider/progress/implement new fleet technologies be greater components of new operator contract specifications and performance standards. Facilitating the deployment of new fuel and fleet technologies is a highly tangible demonstration of Council's sustainable transport objectives.

- Update regulatory frameworks in response to the unique features of autonomous vehicles.

- Reform parking policies and management practices to ensure sufficient parking is available in the right place, and at the right price.

- Ensure that investment in public transport infrastructure, networks, and services considers the availability of autonomous vehicle technology over the longer term. For example, the demand for park-and-ride facilities is likely to reduce, while kiss-and-ride (drop-off) facilities may become relatively more important.

8.16 Explore new Service Delivery Models

- As part of future service planning and procurement activities, undertake a market sounding/tendering process to deliver on-demand/demand responsive services to transport disadvantaged segments and supplement scheduled public transport service offerings.

- Undertake an active role as an enable and influencer for the greater take up of shared services – via policy settings, potential partnerships with shared service providers, parking management practices, and urban design.

- Encourage the University of Waikato to consider shared services and facilitate the provision of an on-campus or near-campus car share scheme for staff/student/general community use. Given the

recent decline in patronage by the tertiary market, an innovative passenger transport delivery model may shift students away from single-occupant private vehicle use.

- Pursue a business to peer ride sourcing model at this stage to ensure Council has greater control over desired outcomes and maximises its demonstration as an enabler and facilitator
  - Be cautious with any direct purchase of corporate pool vehicles in the short to medium term.
  - Consider partnering with a commercial car-share/ride share provider to provide pool fleet requirements and to assist with supplementary services – especially in areas where there are transport disadvantage communities, or where traditional public transport servicing is costly to provide (such as in more remote, low density settlement areas):
    - By collaborating with a commercial provider, the offering will achieve more 'reach' and 'frequency' in the marketplace by joint marketing, advertising, and promotions.
    - A suite of 'green transport' options can also be provided under the over-arching sustainable transport/better transport choices banner.
    - Incentives to reward the community for sustainable transport choices should be added to the package.

- Facilitate the take up of more ride-sharing and ride-sourcing in the Region via:
  - adjustments to parking management, including the allocation of parking spaces or parking price discounts for users of 'green transport' options;
  - provision of space for ride-sourced waiting area, pick up and drop off points; and
  - provision of dedicated RideShare carpooling bays, preferably in prioritised locations, with highly visible branding and signage. Ensure these spaces are enforced.

8.17 Progress Transport Mobile Apps and incorporate broader mobility/lifestyle functionality

- Review, in collaboration with participating agencies, review the Smart NZ App and online tool and seek to obtain feedback from registered users, and local councils/employers who may be utilising the tool for workplace travel behaviour programs.

- The following key objectives for specifications are recommended to progress future transport apps which are more comprehensive, integrated, and serve holistic functions (beyond just customer information).
  - Smarter
    - Dynamic campus traffic control and guidance
    - Accurate bus arrival/departure times
    - Public transport priority
    - Dynamic last mile delivery (shared services)
    - Fleet tracking
    - Mobile pedestrian/cyclist app synced with signals
    - Pedestrian counts/cycling counts and tracking
    - Smart parking guidance

- Smart parking availability
- Crowd-sourced visualisation and data mining.

- Safer
  - Surveillance
  - Dynamic speed alerts
  - Pedestrian management
  - Incident management
  - Pavement sensors.
- More Accessible
  - Real time Passenger Transport Information
  - Pre-trip information
  - On-trip information by VMS and portable devices
  - Parking booking
  - Integrated public transport ticketing
  - Public transport/shared services/parking payments
  - Alternative services (e.g., electric vehicles charging) payments
  - Specialist services for disadvantaged people
- More Sustainable
  - Motivational apps to encourage healthier active transport choices. Feedback on energy consumption - earn green points which may be redeemed.

9 Longer Term Opportunities

The brief to MRCagney was to provide advice to assist with Council's development of a Public Transport Technology Strategy over the next five years – with a primary focus on Real Time Passenger Information and an enhanced customer experience.

Given the rapidity of change it is most important to understand the latest emerging trends in order to future proof today's decisions for tomorrow's world and to ensure Council does not invest in interventions that may become redundant, or indeed less relevant, moving forward.

For this reason, we provide a high-level overview of some key changes already taking place in the transport industry and in transit systems operations, enabled by technological advances. Whilst these changes may be in their infancy and not sufficiently mature for consideration by Council in the short to medium term, it must be noted that these changes are happening across the world right now. The way passenger transport is managed and delivered is fundamentally changing. Council may wish to consider longer term opportunities and implications arising from these emerging trends to start preparing now for tomorrow's world.

This chapter focuses on the fundamental shift from managing transport to delivering aggregated, mode-neutral, personalised Mobility as a Service (MaaS). To note, the terms' Mobility as a Service and Mobility Management are used interchangeably throughout this chapter.

9.1 Mobility as a Service (MaaS)

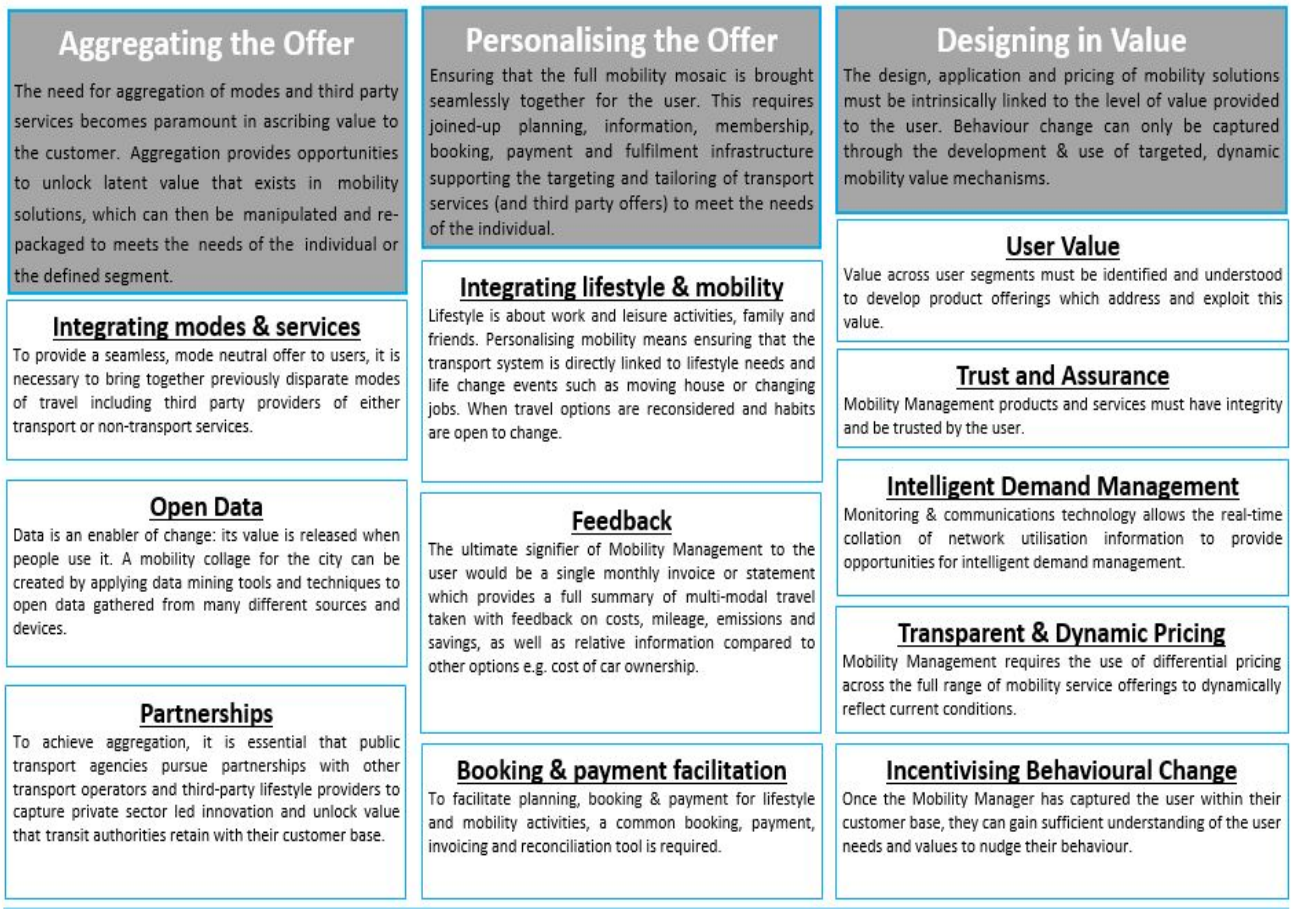
Today, mobility has a wider meaning. It is an enabler that provides the means to multiple ends. For users, the focus is no longer on the transport mode, but rather on mobility. Mobility is more an information service with products that physically transport people, rather than a transport product with additional services. It is not just about meeting the demand for getting from A to B; it is about understanding and meeting the full lifestyle needs that surround the origin, destination, activity, and journey experience.

A Mobility as a Service framework aggregates infrastructure, services, technology, and information to suit the travel and lifestyle needs of the individual. It brings together transport operators and third parties, allowing a seamless provision of service, information, booking, payment and customer relationship management services between transport modes.

This framework provides a pathway towards strategic management. Through innovation and multi-agency activity, resources can be coordinated more efficiently, customers can make better decisions, customer service and satisfaction are enhanced, and better travel demand management is achieved.

Key Elements of delivering Mobility as a Service are shown in Figure 9-1.

Figure 9-1: Key Elements of Mobility as a Service



9.1.1 Key Benefits of MaaS

Among its benefits, Mobility as a Service:

- Coordinates multimodal options (such as public transport, bike share, car share, and paratransit);
- Improves the effectiveness of the whole transport system. Benefits include being able to allocate resources efficiently (based on a user's real needs), improving the management of traffic incidents and travel demands, and having a more reliable transport system through advanced data;
- Promotes a business strategy that addresses consumer needs by forming alliances among public and private organisations to support and contribute to the financing of the total mobility offer;
- Personalises the mobility offer to align with user behaviours, preferences, and lifestyle needs; and
- Identifies and leverages value for the customer and thereby encouraging more sustainable travel behaviours.

Potential outcomes for the Bay of Plenty Regional Council and the wider community include:

- New markets and profits;
- New funding streams from value added products and services;
- Attract and retain students, residents, businesses, and visitors;

- Efficiency savings;
- Lead the shaping and balancing of the mobility system;
- Other strategic objectives like health, environmental sustainability, equity, and accessibility, and demonstrating leadership in innovation; and
- Better supply and demand management.

9.1.2 The Basis of MaaS - Connective Technologies

Connected vehicle technology enables vehicles (private and public) to wirelessly communicate with each other, with roadside infrastructure, and between personal mobile devices, sharing valuable information that could save lives, reduce congestion, and lessen the impact of transport on the environment. The technology has arrived much faster than previously anticipated – aspects expected to be delivered by 2020 are already in production and in use. Japan has already deployed vehicles with V2I (Vehicle-to-Infrastructure) and I2V (Infrastructure-to-Vehicle) cooperative systems capabilities.

For the passenger transportation industry, connective technologies facilitate the provision of dynamic transit services with the following implications:

- Dynamic scheduling, dispatching, and routing of a vehicle by matching compatible trips;
- Interoperability among service providers;
- Ability to coordinate various modal options, including demand responsive service, fixed-route service, and private service, such as taxi and ride share;
- Considers and responds to real-time traffic conditions and vehicle capacity;
- Monitors the situation and provides connection protection status to travellers; and
- Most likely will replace some late night or mid-day fixed route services with more efficient and flexible accessibility and connectivity options.

In short, connective technologies enables coordination. Ubiquitous connectivity among mobility service clients, transit vehicles, service providers and mobility managers mean the delivery of a higher quality of service. Customers can better manage their own travel requirements and make more informed travel choices with respect to when and how to travel.

With open data, mobility managers can also make more informed decisions to match demands with supply based on real-time information.

For funding agencies, this will result in a lower program cost through greater 'whole of system' productivity and efficiency, and greater accountability and transparency through an automated management and billing process.

9.1.3 Examples of Mobility Managers

Examples of mobility management systems in practice are briefly outlined below.

9.1.3.1 Sweden's UbiGo

Since 2015, households have been subscribing to a fully integrated mobility service called UbiGo with positive results. The service combines public transport, car sharing, rental car service, taxi, and a bicycle system – all in one app, all on one invoice and with 24/7 support and bonus points for sustainable choices.

The UbiGo service has been developed and tested in Gothenburg by partners such as Volvo, Chalmers University, City of Gothenburg, Viktoria institute, Västtrafik and Lindholmen Science Park. The project involves the cooperation between transport providers - Vasttrafik public transport operator, Sunfleet car sharing, Hertz car rental, TaxiKurir taxi and JCDecaux bike sharing. The ICT, payment and ticketing are combined on the one application – even rental cars are opened and accessed via the app. Households subscribe for prepaid tailored monthly packages and then customise their package based on their needs as a household. UbiGo subscribers receive bonus points for sustainable travel choices.

9.1.3.2 moovel Group GmbH

moovel Group was founded in Germany by Daimler[62]. The technology provided by moovel aggregates transportation information and booking/payment options into one connected experience for transportation providers, app companies, and consumers through two products:

- moovel transit:
  - The moovel transit platform is a suite of mobile ticketing and payment solutions for public transit authorities. moovel transit also helps public transit apps integrate with the rest of the urban transportation ecosystem, including first/last mile options like bike share and on-demand car services.
- RideTap: A Software Development Kit (SDK) that allows any app to leverage a network of transportation partners.
  - Transit apps can use RideTap to solve common first/last mile issues, or a messaging or restaurant review app can integrate RideTap to help their users get to their final destination. Through the RideTap network and the RideTap SDK, both transportation and non-transportation apps can provide a seamless, real-time, and multimodal experience to their users.

> *"moovel is working to create a future for urban mobility. We want all forms of transportation, from public transit to rideshare to on-demand ride apps, to break out of their silos and become organized into one well-connected experience, with public transit as the foundational core."*[63]

[62] https://moovel-group.com/en
[63] http://www.businesswire.com/news/home/20160414005312/en/RideScout-GlobeSherpa-Merge-moovel-North-America

9.1.3.3 Netherland's Mobility Mixx

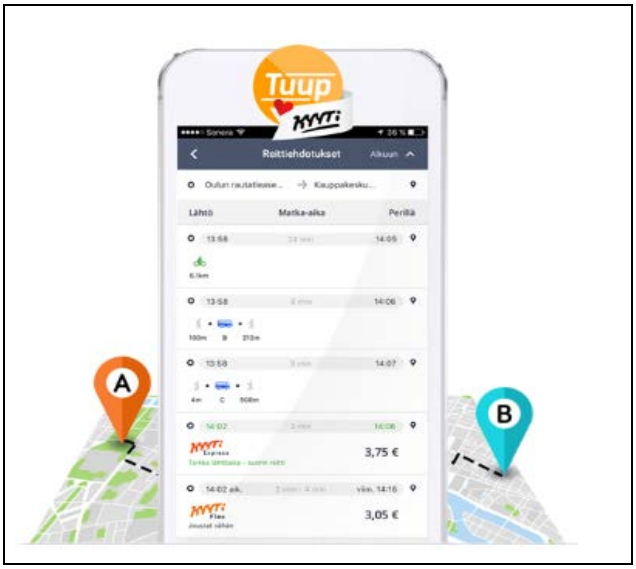
Netherland's Mobility Mixx is targeted to companies, offering employers a complete mobility service. With the Mobility Card, employees make use of train, OV-fiets (public transport and cycling) carpooling and park and ride facilities. Employees receive a monthly review of all mobility costs. Each employee receives a 'mobility budget' that they can use as they see fit. If an employee chooses to travel by train instead of the car, they gain money from an allocated mobility budget. Employees therefore save on a set mobility budget if they use 'cheaper, sustainable transport options.

Figure 9-2: Example of Netherland's Mobility Mixx

9.1.3.4 Tuup – Finland

Tuup is an integrated multi-modal mobility application that allows customers to plan a route, compare the various mobility services that are available, and book their journeys. It covers services such as intercity buses and trains, car rentals and sharing, and city bikes. The application also has the ability to pinpoint available city bikes and car sharing stations in Helsinki.

Figure 9-3: Example of Tuup from Finland



Tuup also offers a flexible taxi-pooling service called Kyyti, which allows customers to carpool with others to their destination of choice. Customers choose a destination, pick-up location, and time of pick up/drop off. The trip is paid in advance. The service rewards customers who are flexible in their travel and waiting times with lower charges. Tuup also offers the Kyyti Express service which picks up the customer at a scheduled time and schedules, in real time, the most direct route to their destination in exchange for a higher fee.

Tuup is looking to expand its mobility services by adding taxis, long-distance buses and trains, Helsinki region public transport tickets, additional car rentals and the PiggyBaggy trade carpooling service which offers its users the ability to coordinate and share courier deliveries[64] [65].

9.1.3.5 MyCicero - Italy

MyCicero is an account based, integrated parking and transport application which commenced in 2015 and is now available in many of the main cities in Italy such as Rome and Milan.

The service provides connections between urban, extra-urban and national public transport lines for the train, bus, and metro as well as real time information on arrivals and departures. The service allows customers to pre-purchase tickets and store them on their account. MyCicero also provides its customers with an e-wallet which they can top up and use on the go. [66]

An innovative parking booking system allows users to book parking in their area of choice via free phone call, SMS or IVR (interactive voice response). Parking inspectors verify bookings by checking the number plate on the MyCicero app.

Figure 9-4: Example of MyCicero from Italy

With the prominent existence of congested charging zones (CCZ) in the main tourist cities, MyCicero enables people to purchase a CCZ pass very easily. Users simply locate the area of interest and pay through the app.

[64] http://www.tuup.fi/en/
[65] http://piggybaggy.com/en/#intro
[66] http://www.mycicero.eu/trasporto/index.html

Congested charging zones exist in Italy to minimise traffic through highly populous areas by charging drivers a fee. [67]

The city of Senigallia is currently the sole user of MyCicero's Municipal Services platform which establishes a direct point of contact between its user and their municipality. The service provides notices of expiry and lets users pay their administrative penalties through the app. Users can also report breakdowns or disruptions on the roads and can send alerts and pictures directly to the appropriate office of authority[68].

9.1.3.6 MoveUS

The MoveUS project is an ICT cloud-based platform and mobility service, funded from the European Union's Seventh Framework Programme for research, technological development, and demonstration. It is developing and trialling:

- A cloud-based mobility management platform, which collects input data from distributed sources and processes these data to infer valuable information of the traffic status and users' mobility patterns;
- An application programming interface (API) toolkit offered as a platform extension, to provide developers and third parties access to these data;
- A set of innovative services supported by an incentive-based model, aimed at influencing users' mobility choice, and fostering behavioral changes towards sustainable transport modes;
- A fully integrated smart mobility application (MoveUS App), running either on users' smartphones or control centres owned by Local Authorities or Transport Operators; and
- Energy efficiency assessment tools to measure users' carbon footprint[69].

Cities piloting the MoveUS initiative include Madrid – a large capital city starting to position itself in the smart cities landscape, Genoa – a medium-sized Mediterranean city and the largest seaport in Italy, and Tampere – a small inland city.

Figure 9-5: Example of smart city pilots using MoveUS in the EU

Each pilot city in MoveUs has established its own Living Lab, where experts from relevant disciplines, stakeholders from the public transport and mobility areas, and end-users meet to contribute in all the phases

[67] http://www.mycicero.eu/sosta/index.html
[68] http://www.mycicero.eu/serviziComunali/index.html
69 http://www.moveus-project.eu/content/concept

to the development of the MoveUs platform. The MoveUs mobile App is now being trialled and evaluated by real users.

MoveUS Madrid

- Smart Crossing
  - A controlled traffic light crossing is equipped with cameras to detect crossing pedestrians; LED lamps to reinforce the lighting at the crosswalk; Bluetooth and 3G communications beacons for pedestrian interaction (via Smartphones) and real-time information of the crossing status. The system allows the traffic light regulator to extend green pedestrian time, to provide lighting and to activate a green-light request via cell phones' Bluetooth. This system is integrated with the MoveUs app and activates a vibrating alert as a signal that the green phase is active. It has been deployed in Madrid within a controlled traffic light crossing with the support of the City Council.
- Multimodal Journey Planner
  - The multimodal journey planner is the 'standard' function giving people directions as to how to go from an origin to a destination according to different modes of transport (public transport, car, walking). The service also provides results on time of travel, cost, energy consumption, carbon footprint, incentives, etc.
- Smart Bus Priority
  - The aim is to give traffic light priority to buses who have been delayed on their schedule. The bus, through its on-board system, knows its status and location and when it detects its proximity to traffic regulators sends the request to the MoveUs platform which in turn connects to the control systems to assess and respond to the bus, accepting or rejecting the request. If the application is accepted, it is communicated to the driver via the on-board console.

MoveUS Genoa

- Crowd-sourced traffic data collection
  - MoveUS is trialling a traffic data collection service built over the integration of crowd sourced (sensor data) provided by users through mobile devices.
- Incentive-based mobility services

  MoveUs has designed and developed a complete system where incentives can be gained for users choosing shared vehicles, bicycle, and public transportation.

MoveUS Tampere

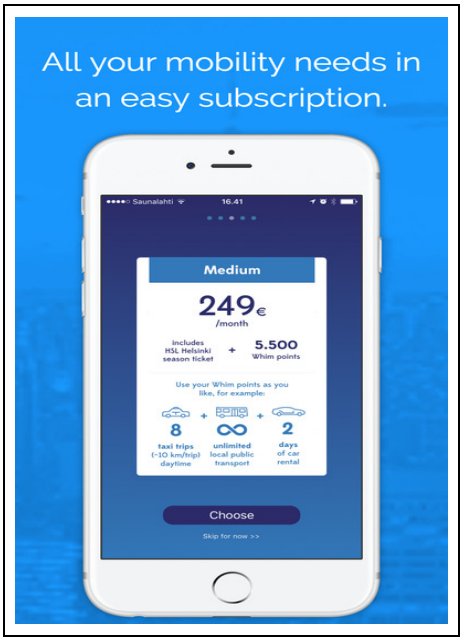
The Tampere pilot has developed a multimodal journey planner application. The journey planner integrates walking, cycling, public transport and car route information and shows available parking spots for cars. The journey planner shows the CO_2-emissions for the chosen mobility modes. The user gets points according to the mobility choices which can be then exchanged for different rewards.

9.1.3.7 Whim - Helsinki

The Whim app[70] was released in the Helsinki region by MaaS Global at the end of 2016. The subscriber chooses a monthly mobility package to get the best value or people may buy each journey separately.

The core of the MaaS concept is that a single service covers all your daily mobility needs. Whim manages everything from travel planning and routes to bookings, tickets, and payments. The service is currently available in the Helsinki region, with access to HSL public transport (buses, commuter trains, trams, metro and the Suomenlinna ferry), taxis and Sixt rental cars. Soon, it will be adding new services, like city bikes, long-distance travel, and car sharing services.

Figure 9-6: Example of Whim in Helsinki



9.1.3.8 Bremen, Germany - Mobility Hubs

Bremen provides a good example of the implementation of a mobility hub, which brings together all the available modes of transport in a single location, giving the user a seamlessly integrated experience that combines car sharing, taxi, cycling and public transport[71].

The effective management of this system is enabled by an umbrella association which brings together all transport operators and one information system for all transport modes, and provides one integrated smart card for transit, car-sharing, parking, and payment needs.

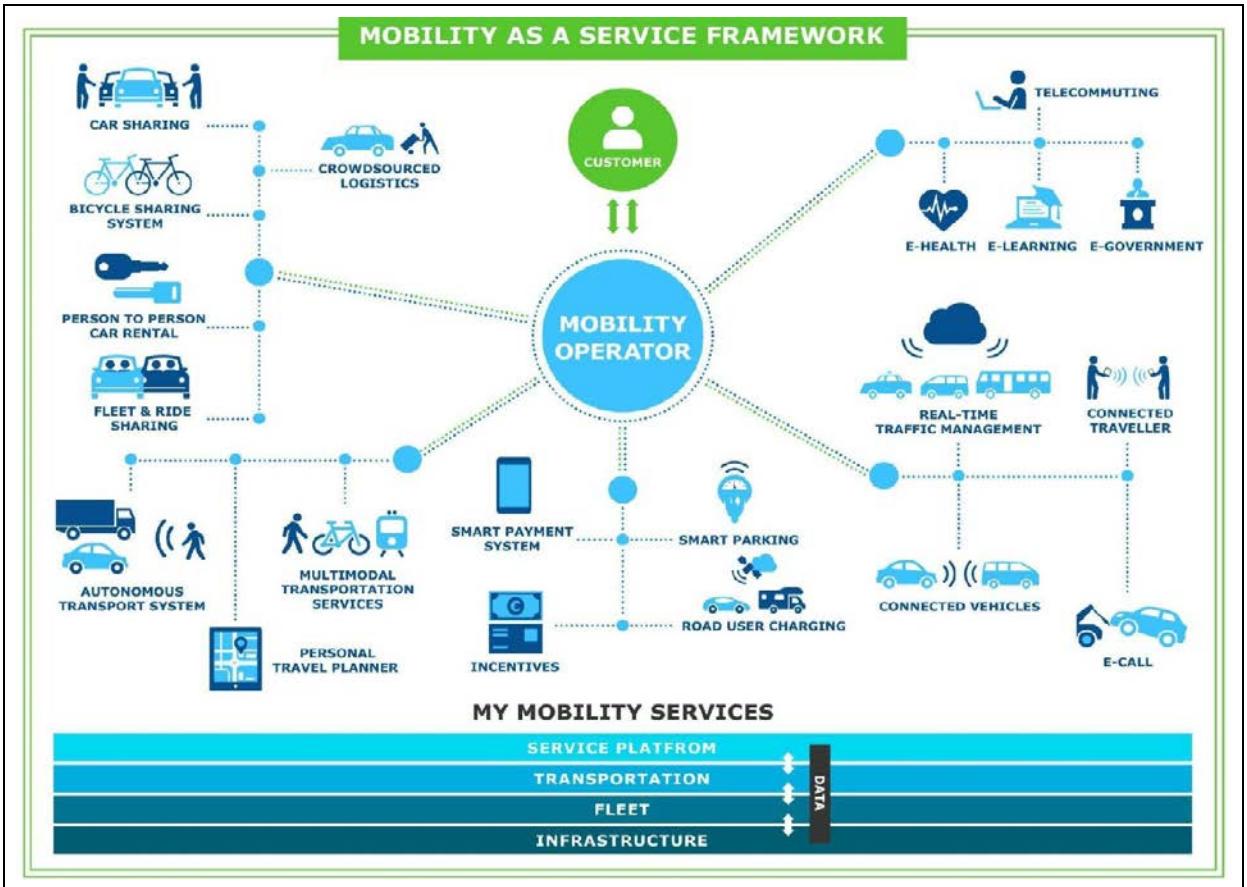
Toronto has followed the lead of Bremen and is establishing similar mobility hubs throughout its network[72].

[70] http://whimapp.com/fi-en/
71 http://www.eliptic-project.eu/eliptic-use-cases/bremen
72 http://www.tcat.ca/knowledge-centre/metrolinx-mobility-hub-guidelines-for-the-greater-toronto-and-hamilton-area/

9.1.4 MaaS Funding and Delivery Options

The Mobility as a Service architecture/framework is illustrated below. The key fundamental premise is one of shifting the primary customer transactional interface from the mobility (transport) operator to the MaaS provider. MaaS is being developed across the world. The main centres currently are in Europe, in Finland, Sweden, Germany, and Scotland and through the Ertico European MaaS Alliance, in North America in Michigan and Ohio, and now also in Australia[73].

Figure 9-7: The Mobility as a Service framework



Source: Telematics Wire.Net.
Accessed at https://transportfutures.co/customer-service-standards-in-a-maas-future-2a2f90d41a0b

A number of funding and delivery models are starting to emerge. These are described briefly below for longer term considerations. The 'not for profit' public entity has merit, given it has the benefit of private sector involvement whilst addressing governments' equity/social justice and data privacy/personal consumer security concerns associated with open data access.

[73] http://maasaustralia.com/

9.1.4.1 New Private Company: MaaS Global

MaaS Global, has been formed in Finland. MaaS Global provides the app, the customer account and interface, an incentivisation/loyalty system, and a pricing system. It will partner with a technology integrator who will partner with suppliers.

The main company shareholder is Transdev with 20%, a major transport operator in France. Karsan Otomotiv Sanayii and Ticaret AS a leading car-industry company from Turkey are the other main investors. The initial finance was used to establish a cloud based interoperability platform.

MaaS Global is targeting the global MaaS market as a private company who can deliver MaaS ecosystems designed for the local situation. It is wholly private sector owned and will sell its MaaS capability to clients in the public and private sectors. All they need are access to the APIs of existing transport suppliers, to integrate them into one, personalised API for the customer.

MaaS Global believes it can provide mobility packages that are seamless and door-to door, profiled to each user, rather like mobile packages, for this level of spend and less, offering greater value and a better, more efficient service. The users design their package for their lifestyle and budget.

At the end of 2017, MaaS Global has launched their Whim app (discussed above) and MaaS service in Helsinki, Finland, West Midlands in the UK and Amsterdam and Antwerp in the Netherlands.

9.1.4.2 Public Entities: Travel Spirit and UbiGo

Other countries think that MaaS should be led by the public sector. The main reasons for this are to ensure security and independence of data and the inclusion of social and environmental targets. This is the view in Sweden, London and with some groups in Finland.

Travel Spirit has been launched in Manchester in partnership with the UK Department for Transport and private companies. It is set up as a 'Not for Profit Association' and an 'Open Sourced Licensed Community'. It is based on the concept of public software - so all code is open source, all development is open, and all governance is public. It is guided by public sector benefits and goals and objectives. Travel Spirit co-ordinates and integrates the digital technology sector and the data supply chain with mobility suppliers and then communities, cities, and national governments.

Ubigo, in Gothenburg, is another example of a public entity model. It was formed as a company owned by the public sector to deliver MaaS and they conducted a pilot study with 20/30 households which offered a seamless, multi-modal MaaS-type service. It was well received and worked well.

9.1.4.3 Public-Private Partnerships

Another view of a possible MaaS business model is a partnership between the public and private sector. This seems a sensible option although there is no commercial model for this at present. One of the first questions regarding this model is - who has the control?

As an example, Scottish Future Trust (SFT) is interested in developing a Social Enterprise Partnership around this model[74].

[74] Advice to MRCagney from Professor George Hazel

9.1.5 Steps to Facilitate a MaaS Future

The key challenges in establishing and implementing a Mobility Management framework include the availability of adequate funding and revenue streams, overall policies towards open data and data sharing, and organisational and governance structures.

We consider that a MaaS project would require a collaborative effort by the regional consortia of Councils, NZ Transport Agency, and the private sector.

We recommend that BOPRC's role in creating a MaaS future concentrate on being an influencer, enabler, and partner rather than a provider.

A technology solution to the problem is certainly achievable, however creative new business models are needed to encourage public and private collaboration among transportation service providers and build in incentives to influence appropriate travel behaviours.

Project champions are key to providing leadership.

Keys steps to facilitate a MaaS framework in the longer term are outlined below:

- **Adopt a cloud-based business intelligence system and mobility management platform integrating different transport and traffic management components** which are able to collect heterogeneous data and process to provide valuable information on the transport network's status (holistically) and users' personal mobility patterns to better manage travel demands.

- **Share and expand opportunities across agencies**. - start an agreement process on standardised interfaces between NZ Transport Agency, regional and local authorities, service providers, and other stakeholders to assure a minimum degree of interoperability.

- **Specifications should be 'technology neutral' (outcomes/outputs rather than input specifications) so that implementation (current and future) can be achieved on different platforms and via different solutions.**

- Effective intelligent transportation systems (ITS) deployment requires **collaboration between government agencies and private service providers**, exploring:
  - Integration of different types of information (like locations of service users, deliveries, fleet management and route planning, traffic information)
  - Funding for development and supporting infrastructure, if necessary
  - Commitment for support of projects for test and demonstration of new technologies within real world conditions
  - Data security and privacy.

- **Explore target areas where partnerships can potentially yield value and assist in the funding of an all-encompassing mobility management system in New Zealand and the Bay of Plenty Regional Council:**
  - NZ Transport Agency, regional and local government authorities – and beyond transport to include health, community services, and education portfolios.

- Complementary transport providers – bus operators, ferry operators, taxis, Uber, Cityhop, SmartTransport pooling etc.
- Retail sector: e.g. street wear clothing, green living, coffee, and entertainment offers etc.
- Banking sector: aside from possessing a wide market capture, banks around the world are readily exploring direct partnerships with passenger transport authorities to capture greater market share through collaborative smartcard/bank card systems.
- Lifestyle service providers: health and wellbeing providers (fitness, complementary therapies, gymnasiums) and sporting and community clubs.
- Technology providers.

9.2 Next Generation Ticketing

Whilst a review of electronic ticketing and payment systems is beyond the scope of this project, a brief discussion of next generation ticketing is provided below. Account based ticketing systems are a key enabler of inter-operability and an aggregated mobility management platform.

9.2.1 Account Based Ticketing

The new INIT electronic ticketing system operates on a prepaid basis and uses smartcards as stored value cards, where ticketing data (including the card's account balance) is stored on the card's chip.

Because the computational processes of ticketing transactions occur within the devices installed inside buses or on station platforms, there is a limitation to how complex these processes can be. It is virtually impossible to operate different fare structures (and different modes) under the same system.

Smartcards are part of what is known as a closed-loop system, where only a specific transit card is accepted as a permit to travel.

Next generation ticketing systems are moving away from this approach, towards 'account based systems', taking passenger and ticket information from a smartcard to the cloud, or 'account'. The main difference is how and where the data is stored. Passenger data and rights to travel are not stored on individual physical items like smartcards, removing the need to carry a transport-specific card to access certain services. Its overarching aim is to allow passengers to travel across various modes of transport (and pay for other services) based on the individual's account.

An account-based system processes ticketing transaction through a back-office network managed by a service provider and facilitates payment for transport fares by a variety of methods. Passengers with accounts can tag on and off by a number of means, each of which simply acts as an identifier for that person and their account, potentially including:

- Credit/debit cards;
- Mobile phones and smart watches, using near-field communication (NFC); or
- Even Biometrics, including facial or retinal recognition (the application of this technology for ticketing is in development).

Because the processing happens in the back-office, the computational power exists to process far more complex fare rules, and to develop new ticketing products and administer them in a more dynamic and agile manner. As an example, it would be possible to link a person's purchase of a special event ticket to the ticketing back-office, allowing that person free travel to and from that event.

Account-based ticketing systems are: more scalable, flexible, and reliable; result in faster product development; more able to respond to extreme events, e.g. mass fare adjustment and unlimited auto-load; and enable the addition of more incentives (i.e. loyalty schemes, discounts etc.) and value adding services/products to the transport offer.

This type of system is already in operation in London – one third of journeys are now made not via the Oyster smartcard but with bank cards enabled with technology such as Visa pay Wave. 4.5% of contactless journeys are now with smartphones. The customer loads his/her bank card to a phone via Apple Pay or Android Pay.

A similar trial is also underway in Singapore. Also, in the Netherlands, Trans Link Systems has worked with Accenture on a cloud-based programme to upgrade its OV-chipkaart smartcard to allow passengers to travel now and pay later.

It is not 'if' but 'when' that agencies will progress to this next generation of ticketing, significantly removing barriers to interoperability and indeed, harmonised fares, discount and loyalty incentives and concessionary policies. It is the key enabler/supporting technology to provide a mode neutral integrated booking and payments platform and the provision of a Mobility as a Service (MaaS) framework in the long term (discussed in more detail in ensuing sections of this chapter).

9.2.2 Ticketing Interoperability

For the passenger transport sector, many international ticketing organisations are working on interoperable solutions. Leading ticketing organisations in this field are ITSO from the UK, AFIMB from France, VDV-KA from Germany as well as the Calypso Network Association.

In fact, interoperable systems are not a 'new' consideration. Back in 2007, the UITP (International Association of Public Transport) published a Focus Paper 'Everybody Local Everywhere' which strongly recommended striving for some degree of interoperability among electronic ticketing systems.

One leading initiative to be noted is the European Interoperable Fare Management Project (EU-IFM). The aim was to develop standards to progress towards cross-border interoperability. The project developed specific guidelines on Privacy and Trust Schemes and Back Office data needs. The difficulty of absolute interoperability lies in the fact that interoperability is often interpreted as agreeing on identical commercial structures.

However, public transport pricing and ticketing systems are naturally reflective of economic, socio-demographic, and geographic/land use circumstances at the local/regional level. For this reason, the EU-IFM Project did not seek to deliver standardisation in the sense of developing a 'one e-ticketing system' for Europe, but rather focused on ensuring systems 'compatibility' across Europe.

Compatibility respects the independence of commercial policies of different authorities and operators but facilitates cooperation. The aim is that customers are enabled to download an application onto their preferred (and compatible) media (smart card or mobile phone), which can be recognised in all participating regions. The fare media knows the status of its owner (e.g., if he/she is older than 60 years, if he/she is a student or disabled). If special prices are available for this user group on this service, then the account holder would be able to benefit from these concessions/discounts automatically. In that sense, interoperability of public transport implies removing the obstacles for the customer in switching transport modes.

9.2.3 Beyond Next Generation Ticketing

We provide this information just for general interest. However, it reinforces the message that the 'future' is happening today.

The use of biometrics for security purposes and by governments in personal identification is becoming quite common. However, implementation in the transit sector is only in the developmental phase and mostly, to date, in the security and fraud identification areas.

Sao Paulo and Rio de Janeiro already have live implementations of biometrics in transit. The Dallas Area Rapid Transit (DART) in North Texas also became one of the early adopters in 2016. The system is used to alert police to know if a wanted person is on board.

In 2016, facial recognition technology was implemented in Beijing Train Station ahead of the Lunar New Year holidays to improve the process of ticketing and passenger management efficiency. Refer to the article at (http://usa.chinadaily.com.cn/china/2016-11/30/content_27529029.htm) for further information.

In India, train stations in certain cities are planning to make use of biometric data to manage behaviours. Refer to the article at (http://www.iritech.com/blog/biometric-transportation-0217/) for further information.

As an initiative of the Australian Federal Police, facial recognition technology is also set to be deployed on some parts of the public transport network and buses at the Gold Coast Commonwealth Games next year, to identify potential terror suspects.[75]

To replace pin numbers and reduce fraudulent card use, Mastercard is now currently trialling biometric payments card in supermarkets in South Africa with further trials in Europe and Asia Pacific in the coming months. It launched a new biometric card in April 2017 combining chip technology with fingerprints.

> *"A new card builds on fingerprint scanning technology used for mobile payments today and can be used at EMV terminals worldwide. A cardholder enrols their card by simply registering with their financial institution".*[76]

Figure 9-8: Example of a Biometric Payments Card

The use of biometrics is evolving more broadly for application in the retail sector. In Seoul, Lotte Card in conjunction with the convenience store chain 7-Eleven, installed a new payment system for customers using a

[75] http://www.skynews.com.au/news/national/qld/2017/06/09/facial-id-to-rollout-at-gold-coast-games.html
[76] https://newsroom.mastercard.com/press-releases/thumbs-up-mastercard-unveils-next-generation-biometric-card/

biometric palm vein recognition device at the Lotte World Tower shopping complex as well as at other 7-Eleven stores.

The HandPay system, in which individuals are recognized by their veins, was chosen over other types of BioPay -- such as iris or fingerprint recognition.

A similar system is now available in Sweden. Vein-scanning terminals have been installed in a number of shops and restaurants.[77]

Figure 9-9: Example of the HandPay system in Seoul

The following is a list of companies which are putting into use biometric recognition technology:

- Hitachi's biometric security solutions provide finger vein authentication technology that is used in logical access applications, applications for physical access through finger vein authentication systems, vein pattern applications for ATM & banking, and embedded applications.
- M2SYS provides a suite of products for multiple industries spanning from mobile biometrics, biometric readers on fingerprint, finger vein, voice recognition, face recognition, palm vein, iris, and smart cards.
- Palmsure offers a palm vein device that captures an individual's palm image with near-infrared rays. Contactless device is promised to have high accuracy of a false rejection rate of 0.01% and a false acceptance rate of less than 0.00008%.
- Biometrics Tech designs, develops, integrates fingerprint, face, iris, voice, and signature recognition. These technologies can be used separately or together in one package to meet entire authentication and identification needs.
- Fujitsu provides a highly reliable biometric authentication system based on palm vein pattern recognition technology. PalmSecure is claimed to feature industry-leading authentication accuracy with extremely low false rates, and the non-intrusive and contactless reader device provides ease of use with virtually no physiological restriction for all users. Devices can be applied for physical access control, time and attendance track, user authentication for PCs or servers, government/commercial identity management systems and more.

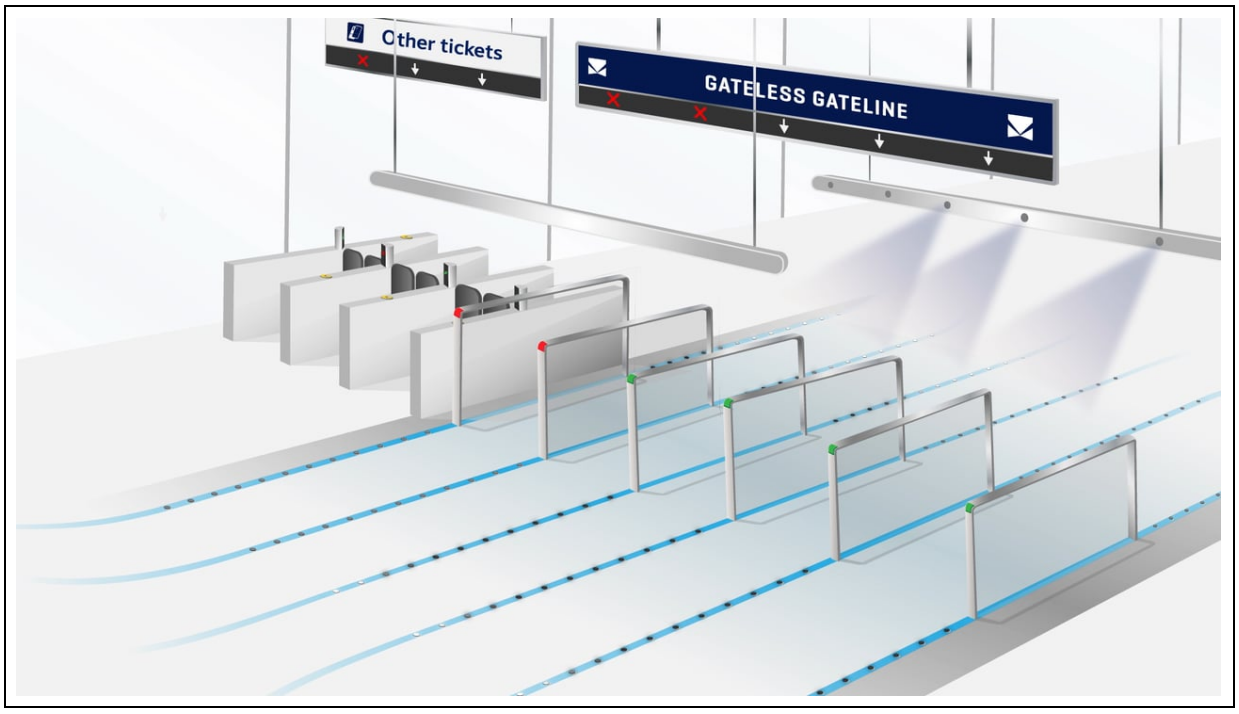
[77] http://www.dailymail.co.uk/sciencetech/article-2605947/Pay-swipe-HAND-Contactless-payment-scans-VEINS-shoppers-palm-trialled-Sweden.html

- NEC provides IT and network technologies, along with a suite of biometric identification systems that work on facial recognition, fingerprint identification, palm scan, etc.

Most recently the Rail Delivery Group (RDG) stated in its digital blueprint for Britain's railways that biometrics will be pursued as an option to purchase tickets for trains in the UK in the future to enhance the customer experience. Further information is provided in the article accessed at: (https://www.raildeliverygroup.com/media-centre/press-releases/2017/469771892-2017-02-07.html).

Cubic's Gateless Gateline is a prototype system that integrates future ticketing technologies including biometrics to support a doubled rate of passenger throughput. The firm's 'FasTrak Gateless Gateline' proposal was submitted to the Railway Standards and Safety Board's (RSSB) Future Ticketing Detection competition last year and won Government funding for prototype development. The system is designed to meet a projected doubling in the number of passenger rail journeys over the next 30 years. According to Cubic its system can double the 'throughput' of an entrance – from 25 people crossing a gate's threshold per minute to about 50 people.

Figure 9-10: Cubic's Gateless Gateline prototype system



The program is being developed at the Cubic Innovation Centre in London, partially funded by a grant from the UK's Railway Standards and Safety Board. Cubic's partners include the Maynard Group and Bristol Robotics Laboratory. The UITP Global Public Transport Summit 2017 was the first public showing of the prototype technology and system. Cubic expects at least one London tube station to deploy the technology within the coming year, and another station along one of the UK's regional train systems.

Further articles and concept demonstrations may be sourced at:

- http://techseen.com/2016/09/14/travelers-ticketing-cubic-gateless/
- https://www.citylab.com/transportation/2017/05/to-ride-the-subway-of-the-future-all-you-need-is-your-face/526917/

10 Longer Term Recommendations

10.1 Explore Connective Vehicle/Infrastructure Technologies

- Facilitate the provision of dynamic transit services via connective technologies, including:
    - Progress dynamic scheduling, dispatching, and routing of vehicle;
    - Progress dynamic transit and pedestrian signal priority via cooperative intelligence technologies; and
    - Work with NZTA and partners to progress national interoperability among transport service providers.
- Review opportunities to incorporate connected vehicles and infrastructure across the wider transport network, for example:
    - Road Weather Warnings- issues alerts and advisories to travellers about deteriorating road and weather conditions on specific roadway segments.
    - Incident Zone Warning.
    - Connection Protection- if multiple people on a delayed bus will miss their next connection, transportation providers can adjust bus departures in live time to enable the passengers to make their next connection.
    - Mobile Accessible Pedestrian Signal System- sends an 'automated pedestrian call' from the smart phone of a pedestrian with disabilities to the traffic controller, holding the walk signal until the pedestrian has cleared the crosswalk. Also, it alerts drivers of the presence of a pedestrian with disabilities at the crosswalk.

10.2 Advance Way Finding incorporating digital and dynamic Way Finding technologies

- Avail of opportunities provided by GPS (global positioning system), RFID (radio-frequency identification), Wi-Fi and Bluetooth LE (low energy) beacons - which can determine the geographical position of people or objects, in combination with enterprise wayfinding software, to provide more powerful mapping and third-party integration capabilities, including digital and dynamic way finding.[78].
- Over the longer term, progressively incorporate dynamic mobile and beacon assisted way finding, directional signage and information/communications into existing wayfinding provisions, in coordination with the development of an interactive wayfinding application.
- Step-by-step instructions with animated journeys, supported by 2D/3D route mapping should be provided on Mobility (Smart Travel) Apps to assist users in visualising their journey. Interactive

[78] http://www.jibestream.com/

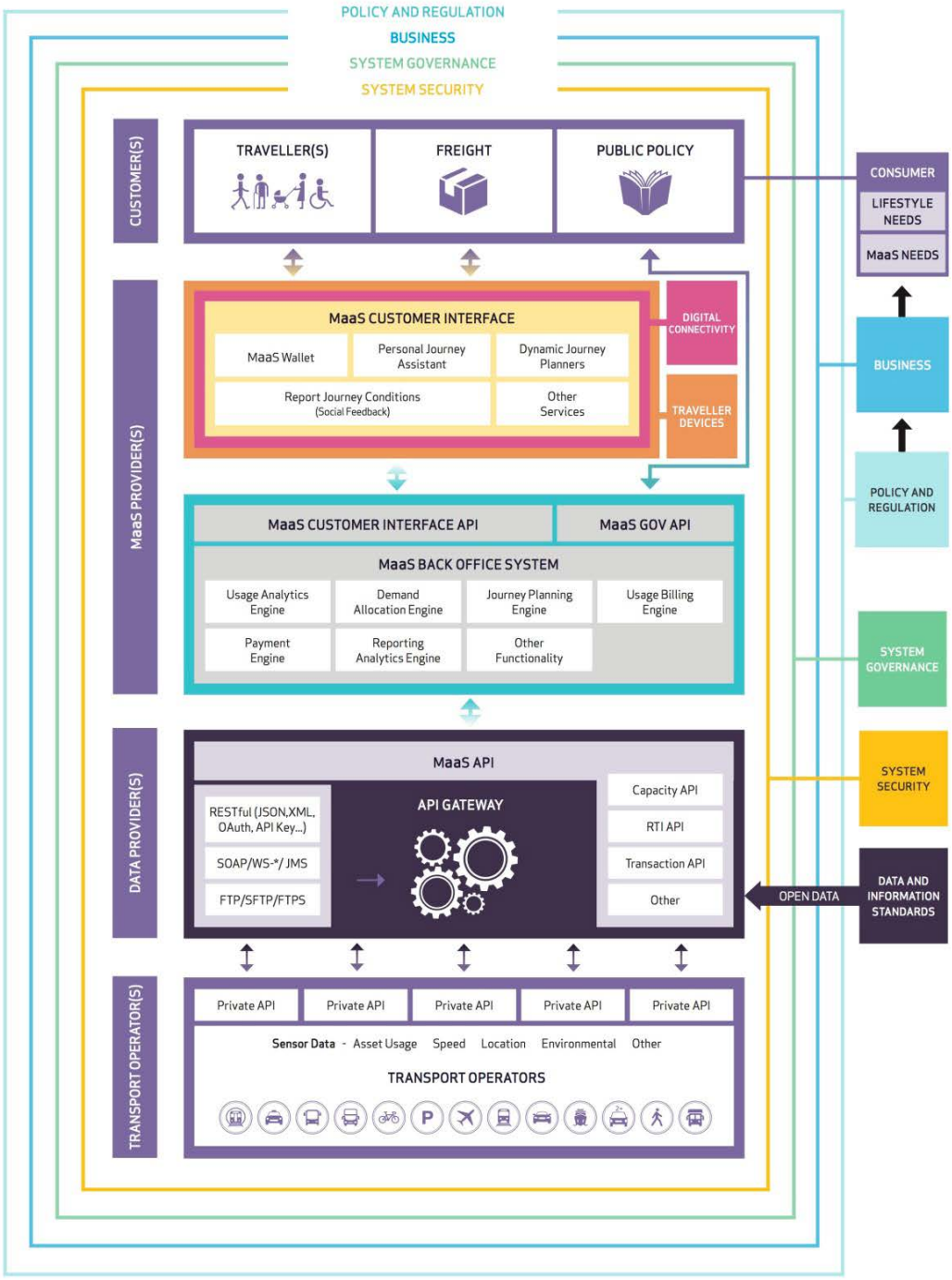
wayfinding infrastructure should interact with future MaaS applications or interactive wayfinding applications to provide personalised information.

10.3 Enable and prepare for a new Mobility as a Service framework

- Establish BOPRC as a regional project champion to advocate and progress a Mobility as a Service framework, adopting the following guiding principles:
    - Future mobility is mode neutral.
    - The offer is aggregated:
    - Open Data
    - Integrating Modes and Services
    - Partnering for Delivery.
    - Simple and integrated booking and payment is facilitated.
    - The offer is personalised to meet individual requirements.
    - Value is designed in to the offer (and incentivises sustainable travel choices)
    - Lifestyle and Mobility are integrated.
    - Two-way feedback is enabled, in real time, to continuously improve the mobility offer.
- Develop and articulate a genuine 'total mobility' policy:
    - Integrate 'mobility management' as opposed to 'transport modal management' thinking into transport planning, design, and provision of transport infrastructure and services.
    - Critically examine (and future proof) physical planning, design, infrastructure, and services through the lens of future mobility.
- Continue to progress and integrate a suite of options on a more integrated Mobility App to assist and influence sustainable travel choices.
    - Undertake a continuous review of new app products for incorporation.
    - Incentivise sustainable travel choices by incorporating value-adding products and services, and dynamic feedback and reinforcement mechanisms on the mobility app.
    - Incorporate Smart Parking in the mobility management framework.
    - Enact regulation to enable MaaS.
    -
- Review MaaS Scotland model and activities – MaaS Scotland is a partnership between Technology Scotland and ScotlandIS – and it is actively forming a global network of MaaS clusters. Membership on the network brings:
    - Access to EU MaaS networks, latest news, and key industry reports.
    - Access to new markets and projects.

- Links to key stakeholders: including local councils, central government, regional transport partnerships, Innovate UK, the Transport Catapult, KTN and others.
- The Mobility as a Service (MaaS) Alliance (Finland) is a public-private partnership to facilitate a single, open market and full deployment of MaaS services.
- Review concept demonstrations in key cities for learnings.

Figure 10-1: MaaS Architecture



11 Conclusions

Given the nature of anticipated change, the future holds both opportunities and risks for public transport agencies. The pace of evolution in the transport sector is subject to a high degree of uncertainty. This creates difficulties for agencies that invest in projects with lifespans across several years. However, ceasing investment is not a viable an option for authorities. Therefore, it is important to create a coherent vision of what public transport should do for its customers, regardless of technology and other changes, and work toward that vision with all investments.

Public transport providers can leverage disruptive change and megatrends to create a transport system that is more efficient and reliable, integrated, safe and more personalised. Doing so will be vital to the future of public transport in the Bay of Plenty.

Alternative services and delivery models are available now that can complement/supplement and indeed potentially replace some current scheduled public bus services as they become available. Currently, there are a number of low patronage, low frequency routes funded by BOPRC that provide essential affordable links for people to access opportunities and essential services. These services also link people into the wider public transport network for travel across the region. The nature of these services could change in the future by being replaced with demand-responsive (door to door), on-demand (dynamic scheduling and routing) bus services, car-share, and ride-share/source delivery models.

The area of transport ticketing is likely to see significant change with continued moves towards 'Mobility as a Service'. Mobility as a Service requires BOPRC to work with its neighbouring regional partners, the NZTA, and emerging transport utility providers to sell transport access on a wholesale market. Integrating services across a number of providers, both public and private, will be important as public transport represents just one component of a larger system. Therefore, ensuring ticketing, real time location and reliability data is available to be used as part of other platforms would be beneficial for BOPRC. Council should also strive to advocate for and participate in national efforts for systems integration and interoperability across New Zealand.

The emergence of new technologies is also likely to challenge traditional contracting arrangements, with new players offering new services emerging quickly. Rather than contracting directly with new mobility providers BOPRC may negotiate with these providers for complementary service provision, provide trade-offs such as access to pick-up and drop-off zones in priority locations and integration with other BOPRC services. Also, rather than contracting operators to provide services along fixed routes at a fixed timetable, the contracting measures may relate more to customer focused measures such as percentage of people picked up within specified timeframes. Contract specifications should shift from outputs to outcome specifications.

Regardless of how the transport system responds to disruptive change in both the near- and long-term there are both opportunities and risks for public transport. These opportunities and risks present themselves in both capital and operational (including policies, internal capabilities, and resourcing) facets of BOPRC. However, if leveraged and approached with care, substantial benefits can be realised in terms of service delivery, operational efficiencies, and customer satisfaction.

More than ever, there is considerable uncertainty and change in the public transport industry. These are:

- **Uncertainty around technological development and disruption - strategic response**:
    - Strategic investment planning must identify where technology offers benefits and potential threats to the current public transport network's capability to meet and respond broader accessibility goals.
    - Planning should ensure that the adoption of new technology is appropriately managed to lock in the benefits and safeguard against potentially investment in short term initiatives that may become obsolete. It should be noted that too many short term 'changes' may also cause customer confusion and impact on demands.
    - Wherever possible, maximise current investments by leveraging off and integrating current ET systems with supporting technology solution suppliers. Consolidate websites/journey planning apps to centralise and standardise information and services,
    - Avoid taking on the 'systems integrator' role and significant associated risks.
    - Partner with regional and local authorities to derive greater economies of scale, and system legibility/ease of use for customers, in future 'technology' investments.
    - Ensure next rounds of operating contracts encourage/incentivise the incorporation of new fleet/fuel technologies, are less prescriptive in output specifications and articulate outcome specifications to encourage new and more responsive service delivery solutions.
    - Avail of NZTA's panel of preferred suppliers with proven experience and capabilities to facilitate procurement activities and align with regional and national interoperability objectives.

- **Uncertainty around travel demands - strategic response**:
    - These are affected by factors both internal and external to transport policy and investment decisions - some are beyond BOPRC's direct control, and BOPRC will need to respond. We note Council is already actively engaging with the community and customers to enhance the public transport experience, and projects such as the PT Technology Strategy highlight it is not prepared to sit back but rather position itself to be able to respond to changing customer expectations and global megatrends.
    - Relative investment in 'mode neutral' integrated mobility solutions, enabled by new and emerging technologies will position BOPRC best to respond, facilitate, and realise a greater take up of sustainable travel.

11.1 Recommended Way Forward

- Minimise BOPRC's risks and future-proof investment decisions by procuring a packaged ITS solution from an experienced AVL system integrator.

- Focus investment on technology applications which enhance business intelligence to improve the areas which most influence the decision to use public transport – i.e. better service reliability, frequency, convenience, and accessibility.

- Adopt a business intelligence system and ultimately a mobility management platform integrating different transport and traffic management components which are able to collect heterogeneous data and process to provide valuable information on the transport network's status (holistically) and users' personal mobility patterns to better manage and personalised individuals' travel demands.

- Share and expand opportunities across agencies rather than investing/procuring alone.

- Start an agreement process on standardised interfaces between NZ Transport Agency, regional and local authorities, service providers, and other stakeholders to assure a minimum degree of inter-operability.

- Future proof contract specifications and provide 'technology neutral' (outcomes) specifications, so that implementation (current and future) can be achieved on different platforms and via different solutions.

- Collaborate with government agencies and the private sector to explore:
  - Integration of different types of information and service delivery models;
  - New funding streams for research and development, services, and supporting infrastructure, if required;
  - New/revised policy and regulatory settings to ensure appropriate operator/driver accreditations, compliance with minimum service standards; environmental and safety/security standards are met, whilst enabling innovation in passenger transport delivery;
  - Opportunities to test and demonstrate applicability of new technologies within real world conditions; and
  - Data security and privacy requirements to enable a future Mobility as a Service framework for serving the regional community and its visitors.

11.2 Summary of Recommendations

The intent of this Stage 1 of BOPRC's PT Technology Strategy was to provide strategic advice to inform the development of a technology road map which supports the pending rollout of the new, interim Electronic Ticketing system across the Bay of Plenty and neighbouring regions.

A summary of our key short, medium, and longer-term recommendations is provided in the Table below. Council's strategic objectives (discussed and agreed at the Stakeholder Workshop) provide a useful set of guiding principles for prioritisation of interventions.

It is not intended to be a technical nor prescriptive PT Technology Plan, but rather a summary of recommended key areas of focus, and potential investment.

Table 11-1 - Summary of recommendations

	Report Reference	Recommendation	When to action/consider			Bay of Plenty Regional Council Strategic Goals						
			Short-term (1-2 years)	Medium-term (3-5 years)	Long-term (6+ years)	Improved real-time information for customers	Improved monitoring, in real time, of contractor service delivery	Enhanced customer experience	Value for money	Patronage growth	Environmental sustainability	Demand responsive transport
1	8.1	Minimise BOPRC's risks and future-proof investment decisions by procuring a packaged ITS solution from an experienced AVL system integrator.	▬			✓	✓	✓	✓			
2	8.2	In the procurement of ITS technologies, ensure BPROC retains issue of ownership of data.	▬	▬	▬		✓		✓			
3	8.3	As a priority, procure a Business Intelligence system, potentially via the NZTA AFC supplier panel arrangements.	▬			✓	✓		✓	✓		✓
4	8.4	Identify opportunities for improvement in the Transit Network from the Business Intelligence data to grow patronage.	▬	▬	▬		✓	✓	✓	✓		✓
5	8.5	Invest in ITS systems which offer an integrated Demand Responsive Travel technology solution to facilitate demand responsive travel as a natural extension of the public transport network.		▬				✓	✓	✓	✓	✓
6	8.5	Provide customers with a full-service mobile application and website to register travel preferences etc.		▬		✓		✓		✓		✓
7	8.6	Consistent with recommendation 8.1 consider procuring Real Time Passenger Information (RTPI) functionality as an extension to the procurement of future ticketing system solutions.	▬			✓	✓	✓	✓	✓		✓
8	8.6	Decline to extend the contract for the temporary RTPI solution Radiola.	▬				✓		✓			
9	8.7	Consistent with recommendation 8.1 consider procuring an Automatic Passenger Counting (APC) as an extension to the procurement of future ticketing system solutions.		▬			✓			✓		✓
10	8.8	Do not lock in proprietary-based Electronic Signage solutions and invest in generic solutions that interface with RTPI systems.	▬	▬			✓		✓			
11	8.8	Proceed on the basis of LCD monitor style (or E-Ink style) for passenger information signs.	▬	▬		✓	✓	✓	✓	✓		
12	8.9	Re-consider expansion on Wi-Fi initiative.	▬						✓			
13	8.9	Consider including in future bus operating/fleet procurement contracts, broaded specifications for future fleet to be equipped and add-on features such as provision for charging mobile devices.		▬	▬			✓		✓		
14	8.10	For Transit Signal Priority focus on cost-effective interventions such as bus only turn lanes, priority lanes in peak hours/areas of high bus demand, and appropriate enforcement of these lanes.		▬			✓	✓		✓		✓
15	8.10	Do not invest in a stand-alone signal priority system.		▬			✓		✓			
16	8.11	Limit Council's direct investment in on-bus audio/visual displays unless there is a compelling business case to do so (such as additional revenue generation via granting of advertising rights).		▬				✓	✓	✓	✓	
17	8.11	Consider a small pilot for on-bus audio/visual displays on a bus service targeting the visitor market (for example, in Rotorua).		▬				✓	✓	✓	✓	
18	8.12	Consider rolling out CCTV surveillance on major routes/special late-night services if customer/community surveys trigger a requirement.			▬		✓	✓				
19	8.13	Limit bus Stop/shelter technology enhancements to one or two key locations only, and focus on fundamental design principles to enhance accessibility/system legibility.		▬		✓		✓	✓	✓	✓	
20	8.14	Ensure future Bus Operationg Contracts specify and incentivise operators to deliver innovative solutions and incorporate new technologies as they become more readily available.	▬	▬	▬		✓		✓	✓	✓	✓
21	8.15	Prepare effectively now for the future world of connective and autonomous vehicle technologies and develop a council position on how to respond effectively.		▬				✓		✓	✓	✓
22	8.15	Ensure environment standards and the requirement of operators to consider/progress/implement new fleet technologies be greater components of new operator contract specifications and performance standards.		▬			✓	✓	✓	✓	✓	

	Report Reference	Recommendation	When to action/consider			Bay of Plenty Regional Council Strategic Goals						
			Short-term (1-2 years)	Medium-term (3-5 years)	Long-term (6+ years)	Improved real-time information for customers	Improved monitoring, in real time, of contractor service delivery	Enhanced customer experience	Value for money	Patronage growth	Environmental sustainability	Demand responsive transport
23	8.15	Ensure that investment in public transport infrastructure, networks and service providers considers the availability of autonomous vehicle technology over the longer term.							✓		✓	✓
24	8.16	Undertake a market sounding/tendering process to trial on-demand/demand responsive services to transport disadvantaged segments.					✓	✓	✓	✓		✓
25	8.16	Encourage University of Waikato to consider shared services and facilitate the provision of an on-capsu or near-campus car share scheme for staff/student/general community use.						✓	✓	✓	✓	✓
26	8.16	Consider a business to peer ride sourcing model for pool fleet/supplementary passenger transport services at this stage to ensure Council has greater control over desired outcomes and maximises its demonstration as an enabler and facilitator.						✓	✓	✓	✓	✓
27	8.16	Facilitate the take up of more ride-sharing and ride-sourcing in the Region via adjustments to parking management, provision of space for ride-sourced waiting areas and provision of dedicated carpooling bays.						✓	✓	✓	✓	✓
28	8.17	Progress Transport Mobile Apps and incorporate broader mobility/lifestyle functionality .						✓	✓	✓	✓	✓
29	8.17	Review, in collaboration with participating agencies, the Smart NZ App and online tool and seek to obtain feedback from registered users, and local councils/employers who may be utilising the tool for workplace travel behaviour programs.				✓	✓	✓		✓		✓
30	9.1	Investigate partnerships with government and private sector, and formulate a business model to facilitate MaaS.				✓		✓	✓	✓	✓	✓
31	9.1	Adopt a cloud-based business intelligence system and mobility management platform integrating different transport and traffic management components.					✓	✓	✓	✓		✓
32	9.1	Explore target areas where partnerships can potentially yield value and assist in the funding of an all-encompassing mobility management system in New Zealand and the Bay of Plenty Regional Council.							✓			
33	9.2	Consider opportunities to incorporate an account based ticketing system to encourage multi-modal transportation.						✓	✓	✓		
34	10.1	Explore connective vehicle/infrastructure technologies.				✓		✓	✓	✓	✓	✓
35	10.1	Facilitate the provision of dynamic transit services via connective technologies.						✓		✓		✓
36	10.1	Work with NZTA and partners to progress national interoperability among transport service providers.					✓	✓	✓	✓		✓
37	10.1	Review opportunities to incorporate connected vehicles and infrastructure across the wider transport network.						✓				✓
38	10.2	Advance wayfinding incorporating digital and dynamic wayfinding technologies.						✓		✓	✓	
39	10.2	Incorporate dynamic mobile and beacon assisted way finding, directional signage, and information/communications into existing wayfinding provisions, in coordination with the development of an interactive wayfinding application.				✓	✓	✓		✓		
40	10.3	Enable and prepare for a new mobility as a service framework.				✓	✓	✓		✓	✓	✓
41	10.3	Critically examine (and future proof) physical planning, design, infrastructure, and services through the lens of future mobility.						✓	✓		✓	✓
42	10.3	Incentivise sustainable travel choices by incorporating value-adding products and services, and dynamic feedback and reinforcement mechanisms on a potential mobility app.						✓	✓	✓	✓	✓
43	10.3	Incorporate Smart Parking in the mobility management framework.				✓		✓		✓		✓
44	10.3	Enact regulation to enable MaaS.				✓	✓	✓	✓	✓	✓	✓