Frictionless Ticketing for Public Transport – Summary

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Introduction

Transport for New South Wales (Transport) has partnered with iMOVE and La Trobe's Centre for Technology Infusion (CTI) to evaluate emerging technology options that can deliver Frictionless Ticketing. This project has the primary goal of exploring which of these technologies can reduce friction for People with Disability (PWD).

Project approach

Several technologies have the potential to deliver a frictionless ticketing experience, whereby the end-user can simply walk through gates that automatically open or walk onto platforms and be issued with a ticket automatically, without the need to tap on and off. This project evaluates which technologies should be prioritised.

To do that, we followed a mixed method approach that set out to:

1. Assess the significance of Frictionless Ticketing
2. Develop a technology evaluation framework through stakeholder engagement
3. Review the current state of Frictionless Ticketing: a global literature and industry scan
4. Prioritise technology options by means of a gap analysis
5. Identify legal and regulatory barriers
6. Develop a test/trial plan for the selected technologies

Project activities

Stakeholder engagement was a key focus of the project. Assisted by the Physical Disability Council of NSW (PDCN) and the Australian Federation of Disability Organisations (AFDO), Centre for Technology Infusion held a series of online information sessions and focus groups with people with lived disabilities. CEOs of Disabled People Organisations and selected experts in the public transport field with a lived disability were also consulted. To understand the views and requirements of operators, six workshops were held covering various modes of public transport. We also conducted an extensive regulatory review, and we reviewed transport operator websites from around the world as well as many academic publications.

Summary of findings and recommendations

1. Frictionless Ticketing impacts a significant segment and is the key to service improvements

A significant segment is having difficulties with public transport ticketing. 16,000 concession cards were issued in 2021, mainly for severely vision impaired people; 60,0000 people applied for a concession card. While no doubt that number is inflated by the appeal of free travel, for People with Disability that do not meet the concession criteria, tapping on and off can still pose a significant challenge. For instance, for people with a mental or physical disability, using public transport can be a stressful experience and concerns about having the right ticket ready and finding access to the platform adds to this stress.

The absence of Frictionless Ticketing requires mitigation for gate management for which there are no efficient options. Because People with Disability can't open platform gates using concession cards, gates are required to be manned, closely monitored, or left open.

Not having to tap on and off also causes a data blind spot. Transport and its operators have no visibility on the patronage and travel patterns of People with Disability with concession cards as tapping on/off is not required. This creates a risk in case of emergencies as these passengers could be left unaccounted for.

Frictionless Ticketing provides an opportunity to deliver on Transport's vision 'to not just move people but enhance their lives' (Transport for NSW, 2022). Frictionless Ticketing can enable a more customised journey experience by capturing specific data, for instance, simply being aware of the arrival and location of a People with Disability can smoothen assistance operations.

Lastly, Frictionless Ticketing is also significant as a steppingstone towards Mobility as a Service (MaaS): Easy and smart payment across various modalities will be key to a MaaS model for public transport, but that is outside the scope of this project.

2. Global technology review: It's an emerging territory

Frictionless ticketing is an emerging area of interest. We found limited academic support and few case studies on transport operators' websites about true frictionless ticketing. Older articles and case studies are available but deal with clearly outdated concepts, such as 'SMS your bus' (where passengers can book and pay for their bus by SMS).

We did find a limited number of case studies using smartphones, facial recognition, 5G and Ultra-Wide Band (UWB). In Asian countries such as China, Korea and Japan, facial and voice recognition are being trialled for gated solutions. In Europe, the focus is more on Bluetooth solutions that are trialled for buses. In Japan, 5G walk-through gates are being trialled. Metropolitan Transit Authority (MTA) New York is adopting UWB for ultra-precise vehicle positioning.

None of these trials address all the Transport's requirements. We have not yet been able to identify an operator that has deployed frictionless ticketing across all modalities, gated and non-gated solutions, indoors and outdoors.

3. Evaluation framework: One solution doesn't fit all, the challenge is accurate and fast positioning

From a technology point of view, the key challenge is to deliver reliable and accurate positioning indoors and outdoors, so that, for instance, the gate only opens for the first person in line, not for the second. This needs to be executed with sufficient speed so that no delays are created. For non-gated platforms, the key challenge is the ability to process large numbers of passengers simultaneously.

People with Disability want frictionless ticketing to be reliable and easy, which isn't a given as there are, for example, still plenty of 4G black spots. A (human) fall-back option is therefore a high priority for People with Disability. When talking about 'ease of use' it is not only about being handsfree, low physical effort, but also about low mental effort in the use of the technology.

The operators welcome frictionless ticketing, as it enables them to become truly inclusive, potentially increase patronage and provide better service. Besides being reliable and very low maintenance, easy sign up

for one-off or new customers and the management of fare evasion are other priorities. One solution doesn't fit all. The type of disability determines which solution is most suitable, and not one solution suits all types of disabilities.

A wearable set-and-forget token seems to cater to the largest variety of disability requirements. This token can take many forms: a tag attached to a watch or a guide dogs' harness, a necklace, or in a 'credit card' form.

A smartphone solution, however, is preferred by People with Disability that depend on their phone for many aspects in their life. The advantage of a smartphone solution is that it can be scaled beyond People with Disability to all passengers.

Biometric recognition can serve as an option for people who cannot use a token or a phone. Some People with Disability, for instance with an intellectual disability, would be served best by this solution.

Some People with Disability use wayfinding apps. Integrating ticketing functionality into these apps could be a simple solution for them.

Frictionless ticketing is only as 'frictionless' as the weakest link in the end-to-end process. In other words, unless all aspects of the ticketing process are addressed, it is not really frictionless. We identified and listed several issues for Transport to address in the end-to-end ticketing experience (Table 1).

Table 1. Factors to be considered for People with Disability when developing a frictionless ticketing system

Factors end-to-end user experience	People with Disability requirements
Registration	Ability to choose a registration option to suit needs (online, in person, via phone)
	Online via previously registered services (Service NSW, Google, Apple, MyGov)

	In person – Post Office, Telstra shop, local council office, Service NSW centre
	Phone assistance
	Previous recognition of 100 points ID
	Ability to include disability specific requirements (e.g., to automate assistance on any journey)
Education	Education of any new system and piloting to test functionality
Assistance	Help function when needed (button or intercom)
	Link to human assistance
Automation	Automatically registers need for assistance (ramp for boarding)
	No physical interaction needed during journey
Notification	Provide notice of changes to trip
	Advise when on wrong journey/mode
	Confirmation of payment (vibration/light/sound)
Payment	Online account to track payment
	Ability to split payments between personal and work use
	Accessible top up stations
	Option suitable for those with limited funds/financial management
Integration	With transport apps
	With assistive technologies
Frictionless Ticketing Technology	Inclusive solution preferred: works for all, not just PWD
	No ‘lag’
	Easy ability to cancel (card/token) when lost
	Elimination of physical ‘gates’
	Fail safes when one technology doesn’t work
Flexibility/Choice	Provide personal choice
	Used by those with and without disability

The operators welcome frictionless ticketing, as it enables them to become truly inclusive, potentially increase patronage and provide better, more efficient service. Besides being reliable and very low maintenance, easy sign up for one-off or new customers and the

management of fare evasion are other priorities.

One solution doesn't fit all. The type of disability determines which solution is most suitable, and not one solution suits all types of disabilities. The key options are summarised.

Smart phone: An app on your smart phone or smart watch.

Preferred by People with Disability that depend on their phone for many aspects in their life. The advantage of a smartphone solution is that it can be scaled beyond People with Disability to all passengers; A small device, like a key chain or wristband (the token can take many forms).

Wearable token

A wearable set-and-forget token seems to cater to the largest variety of disability requirements; A device on the train station or bus stop that can read a biometric characteristic (face, fingerprint, voice, etc.)

Biometrics

Biometrics can serve as an option for people who cannot use a token or a phone. Some People with Disability, for instance with an intellectual disability, would be served best by this solution; A body camera or a phone app for people with disability that 'looks out' for you and guides you.

Integration with assistive technologies

Some People with Disability use wayfinding apps. Integrating ticketing functionality into these apps could be a simple solution for them.

4. Gap analysis: Ultrawide Wide Band and 5G are the most promising (but don't disregard biometrics and wayfinding integration)

The most promising technology for a token is UWB. Due to its inherent features, UWB is the best fit-for-purpose technology for a token. UWB uses 500 MHz with a very wide frequency band (for high throughput), short pulses (for minimal interference), and has very low power consumption over short distances. UWB provides precise indoor tracking up to centimetre-level accuracy using Time of Flight (ToF) rather than Received Signal Strength Indicator (RSSI), which is the traditional technique for indoor positioning for RFID tokens but is less reliable as

the signal can be easily blocked. Thus, the broad frequency and small pulses of UWB deliver more reliable position information than RSSI.

5G promises to enable a smartphone frictionless ticketing experience. 5G uses new technologies to provide faster and more accurate positioning than 3G/4G (3GPP) for compatible devices, even for crowded indoor spaces. 5G releases 16 and 17 use enhanced Return Travel Time (RTT) for distance measurement and advanced Beam Forming (e.g., Massive- Multiple-Input Multiple-Output (MIMO)) for precise Angle of Arrival (AoA) and Angle of Departure (AoD) measurements.

Facial recognition for gated solutions is a mature technology, for non-gated solutions, the question is that of capacity. At the moment facial recognition is a sensitive option with regards to privacy.

Simultaneous Location and Mapping (SLAM) is rapidly evolving from robotics into real-life wayfinding solutions. This can be an alternative to biometric recognition.

The roadmaps for the technologies differ. The use of 5G will depend on new releases and their supporting infrastructure, which is expected to be deployed within the next 2-3 years. The rate of penetration of 5G enabled phones will further influence the rate of adoption.

UWB can be developed now. The technology is ready, and prototypes of tags and wearables have already being developed. The size and cost are likely to come down rapidly in the coming years.

5. Regulations need an update

NSW regulation of public transport ticketing, could be argued, is outdated. NSW relevant legislation and regulations require amendment to ensure technological neutrality in transport regulation for the future. For example, the concept of ‘authority to travel’ (Cl 69 of the Passenger Transport (General) Regulation 2017 (NSW)) is linked to the notion of a ticket as a physical item, despite later amendments providing for the use

of Opal cards and debit or credit cards. This does not easily fit with an authority to travel conferred by the use of biometrics. This is not a major barrier to a pilot project, as an exemption may be made or, for the purposes of a pilot, a covering ticket or other device might be issued. Amendment of the 2014 and 2017 Regulations to incorporate biometrics for ticketing is also possible but this may involve significant political considerations. Exemptions in relation to the ticketing provisions could, however, shift legal liability from the operator to Transport. Depending on the scope of any pilot project, these challenges need to be navigated. In addition to the regulatory context, 7 other attention areas have been identified, none of them represent barriers to a pilot project, provided due attention to current laws and regulations is paid (see section 2.5).

The Department of Infrastructure, Transport, Regional Development and Communication (DITRDC) is currently (since 15 March 2022) soliciting feedback on fare systems. In March 2022 DITRDC released ‘Reforms of the Disability Standards for Accessible Public Transport 2002, Stage 2 Consultation Regulation Impact Statement’ (Department of Infrastructure, Transport, Regional Development and Communications, 2022), where fare systems are listed twice.

6. Staged test plan required

Launching frictionless ticketing in the near future would require a staged testing and development approach.

Stage 1

Lab testing: Technical tests to inform the most reliable configuration given a variety of expected situations.

Co-creation - Proof of concept development: User-centric design, product development, testing (a technical test plan has been delivered to the project team). For usability design, questions involving end-user interaction of the system would need to be asked, for example, “does the token need to vibrate to confirm a ticket has been issued?”

Quantitative end-user testing: Refinement of the design priorities and quantified segments. After successful lab trials and prototype

development, a field trial can be organized, of which the goals would be to verify end-user satisfaction, test ticket control/fare evasion methods and acquire insights with regards to the effective deployment across multiple modalities in real-world, indoor and outdoor environment.

Stage 2

After successful lab trials and prototype development, a field trial can be organized, of which the goals would be to verify end-user satisfaction, test ticket control/fare evasion methods and acquire insights with regards to the effective deployment across multiple modalities in real-world, indoor and outdoor environments.

Other programs of work would need to be initiated in parallel to enable functionality adjacent to the core functionality of frictionless ticketing, such as:

1. Regulatory and policy approvals.

2. Preparation of added value services that can be delivered by the introduction of frictionless ticketing. Examples include ramp requirement notification, lift operation, hidden disability acknowledgement, and location in case of an emergency.

3. Frictionless ticketing and fare evasion: Conduct behavioural research/analysis: Will frictionless ticketing reduce or increase fare evasion?

4. Prepare data analysis capabilities: Leverage frictionless ticketing data and turn this into planning improvements. What improvements can likely be delivered first?

5. Prepare the capability to extend ticketing functionality to 3rd parties and payment of 3rd party providers (e.g., parking)

List of acronyms and abbreviations

AFDO	Australian Federation of Disability Organisations
AoA	Angle-of-Arrival
AoD	Angle of Departure
API	Application programming interface
CTI	Centre for Technology Infusion
DITRDC	Department of Infrastructure, Transport, Regional Development and Communication
MaaS	Mobility as a Service
MIMO	Multiple-Input Multiple-Output
MVP	Minimum Viable Product
PDCN	Physical Disability Council of NSW
PWD	People with Disability
RFID	Radio-frequency identification
RTT(1)	Return Travel Time
RTT(2)	Round-Trip-Timing
SLAM	Simultaneous Location and Mapping
ToF	Time-of-Flight
UWB	Ultra-wide band