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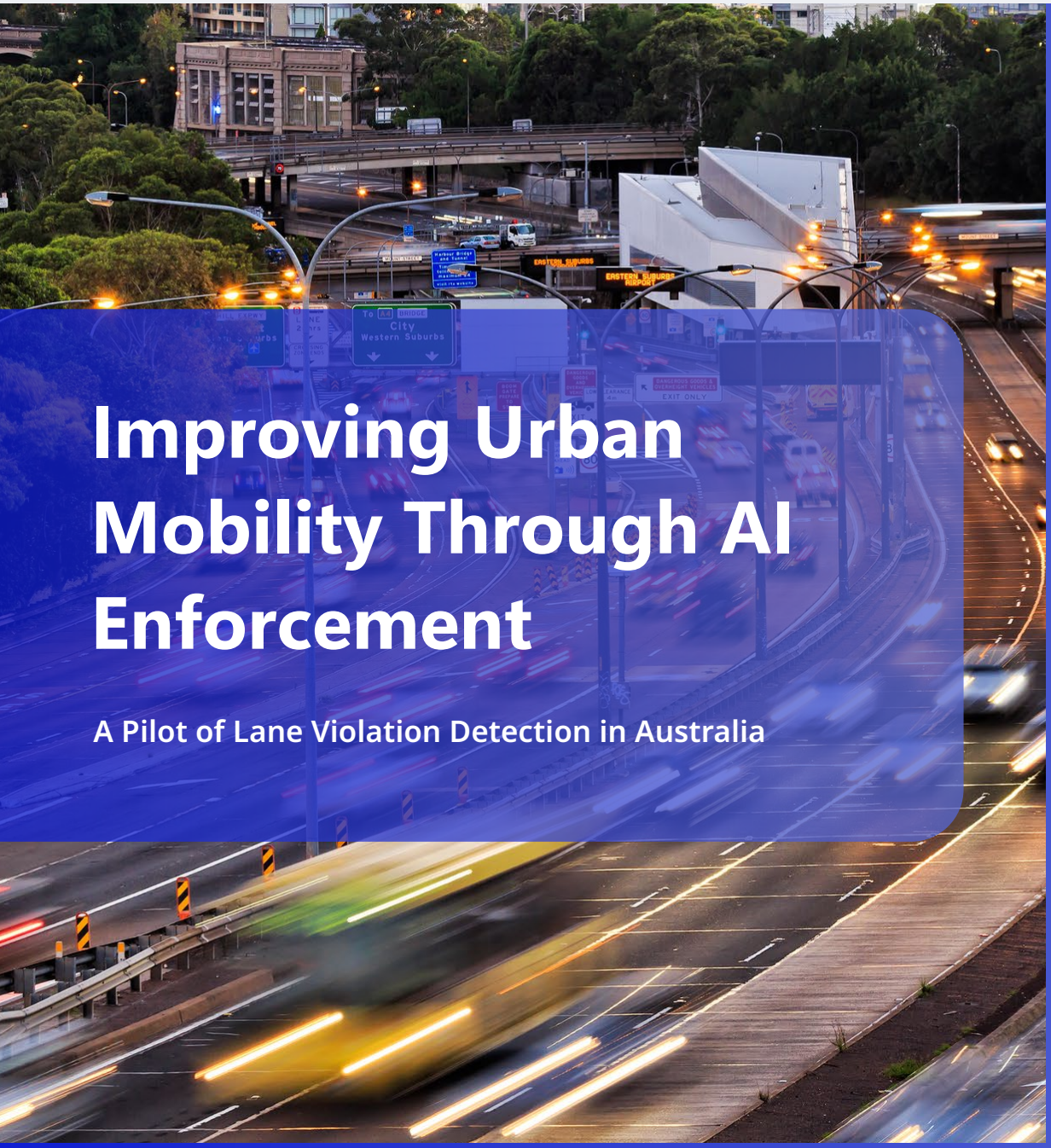

Improving Urban Mobility Through AI Enforcement

A Pilot of Lane Violation Detection in Australia

Authors: Renaldo Catanzariti - Specialist BDM
Mike Jones - Senior Project Manager

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Introduction

As Australia's cities grow, our streets are becoming more congested and our public transport systems increasingly burdened. In this context, making buses safer, more reliable, and more efficient is critical to maintaining and growing public confidence in the network.

One of the biggest barriers to reliable and safe bus operations is the unauthorised use of dedicated bus lanes and stops. When these lanes are blocked—whether by drivers seeking shortcuts or vehicles parked illegally—the consequences are more than just delays. They're dangerous.

Illegally parked vehicles at bus stops force passengers, including those with disabilities or mobility aids, to board or alight into live traffic lanes.

Likewise, when buses are forced to weave in and out of traffic due to blocked transit lanes, the risk of collisions rises significantly. In New York City, for example, the Metropolitan Transportation Authority (MTA) reported a 20% reduction in collisions on routes equipped with bus-mounted enforcement cameras.[1]

Recognising this challenge, NEC Australia partnered with Hayden AI and Transport for NSW to pilot an AI-powered mobile enforcement system that actively detects and documents transit lane violations. This white paper outlines the approach, findings, and opportunities that emerged from this first-of-its-kind trial in Australia.

The Problem

Lane violations are undermining safety, accessibility, and service reliability.

Unauthorised vehicles driving or parking in bus lanes and at bus stops create serious challenges for public transport operations—far beyond mere delays. These violations compromise safety, impede accessibility, and degrade the overall passenger experience.

Safety Risks – When buses are forced to change lanes or merge into general traffic because a dedicated lane is obstructed, the risk of side-swipe collisions and sudden braking increases for both the bus and surrounding vehicles. International data supports this concern: the New York MTA reports a 20% reduction in collisions on routes where bus-mounted enforcement cameras are used. Each violation is not just an inconvenience—it's a hazard.

Accessibility Impacts – Illegally parked vehicles at bus stops block kerbside access, preventing buses from aligning properly with the curb. This creates dangerous boarding conditions and, in many cases, makes it impossible for passengers who rely on level boarding—such as people using mobility devices, parents with prams, or people with vision impairments—to safely get on or off the bus. It undermines network-wide efforts to make transport inclusive and compliant with accessibility standards.

Reliability and Efficiency – Bus lanes are designed to prioritise high-occupancy, sustainable transport. When they're misused, journey times increase, timetable adherence declines, and service reliability suffers. This not only inconveniences passengers but also erodes public trust in the system and discourages mode shift away from private cars—ultimately working against broader sustainability and congestion reduction goals.

Limited Enforcement Tools – Traditional methods of enforcement—such as manual patrols or static-mounted cameras—are limited in their scope. Static cameras only monitor specific fixed locations, leaving entire stretches of road unprotected. Manual enforcement is resource-intensive and cannot provide real-time or route-wide coverage.

In short, lane violations present a systemic issue. Without scalable, efficient monitoring and enforcement, the safety, accessibility, and reliability of public transport are all at risk.

Pilot Overview

To address the widespread issue of bus lane and stop violations, NEC Australia partnered with Hayden AI and Transport for NSW to conduct a proof-of-concept pilot. The aim was to test the effectiveness of mobile, AI-powered enforcement technology in a real-world Australian context—evaluating its potential to enhance public transport safety, accessibility, and service performance.

The pilot focused on three primary goals:

1) Validate Accuracy and Reliability

Assess the ability of AI-powered, vehicle-mounted cameras to detect and record lane and stop violations with high accuracy, across varying conditions.

2) Understand Operational Impact

Measure how improved enforcement could contribute to reduced congestion, better bus journey times, and overall operational efficiency.

3) Test Scalability

Determine the feasibility of rolling out the solution across multiple routes and modes, with minimal infrastructure investment.

Location & Duration

The pilot was carried out over four days during peak traffic hours on a selected high-traffic corridor in Sydney, known for persistent bus lane violations. The trial route was chosen due to its heavy ridership and documented issues with unauthorised vehicle use in bus lanes and stops.

Technology & Development Context

Hayden AI's transit zone enforcement system—already deployed by major U.S. agencies such as the New York MTA—was integrated into a test vehicle fitted with high-resolution, AI-enabled cameras. These cameras were mounted externally on a mobile enforcement SUV for the pilot, although the system is designed to be installed behind the windshields of transit buses during full-scale deployments.

The platform combines real-time computer vision detection with automatic number plate recognition (ANPR), GPS geolocation accurate to within 10 cm, and secure cloud-based data management. Violations are captured and logged dynamically as the vehicle moves along its route, offering continuous coverage that static cameras cannot provide. Vehicles were cross-checked in real time against a whitelist of permitted vehicles.

By piloting the solution in live traffic, the project not only tested its technical capability but also captured insights about user behaviour, the frequency and types of violations, and the practicalities of enforcement integration into a transport authority's broader strategy.

Key Results

The pilot produced strong evidence that mobile, AI-powered enforcement can deliver significant improvements in transport network performance, passenger safety, and operational efficiency. The results reflect both the accuracy of the system and the scale of the opportunity for broader application..

High Detection Volumes – Over just four days of operation, the system detected 89 potential lane and stop violations. By monitoring the full length of a route—rather than just isolated intersections—the mobile enforcement platform was able to identify more offenses than traditional static-mounted cameras typically detect. This suggests that lane and stop misuse is significantly underreported and underenforced using current methods.

Accessibility and Safety Validation – Crucially, the trial confirmed that many of the detected violations involved vehicles blocking bus stops—obstructing access for passengers requiring level boarding. These are not just traffic infringements; they are direct barriers to safe and equitable transport access, particularly for people with disabilities or mobility limitations.

Precision and Accuracy – Using advanced GPS and AI-based object recognition, the system was able to pinpoint violation locations with an accuracy of up to 10 cm. This geolocation precision is essential for issuing enforceable citations and for validating when and where each violation occurred.

Image and Data Quality – The cameras successfully captured high-resolution images and video clips of offending vehicles in all lighting conditions, including low light during early morning and late evening peaks.

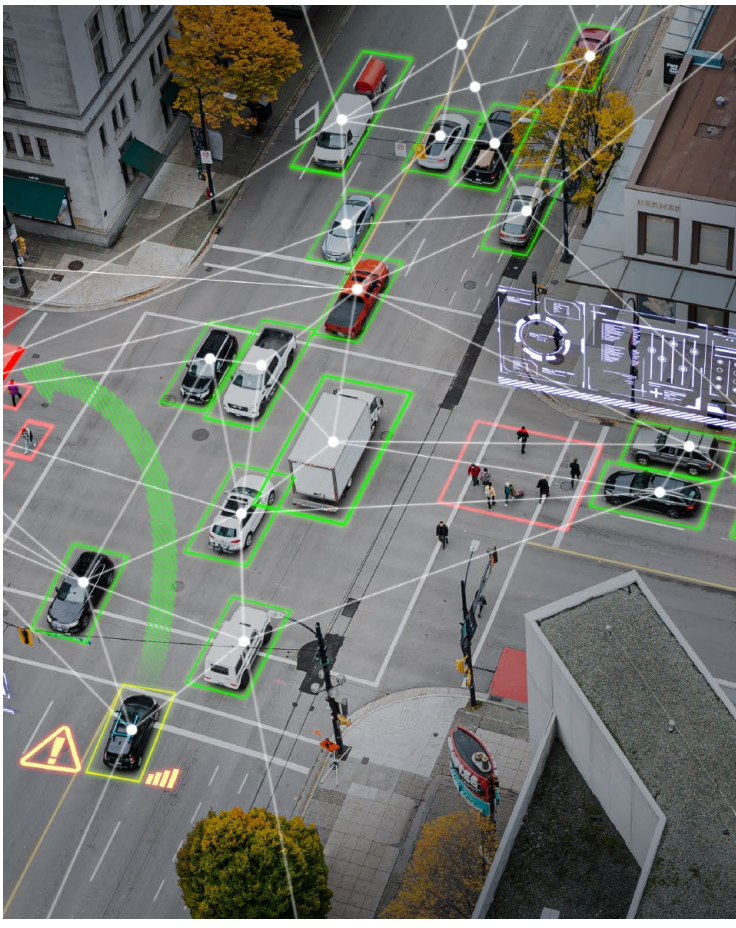
Number plates were clearly readable, and the automatic number plate recognition (ANPR) performed at a level equivalent to existing fixed enforcement systems.

Exclusion of Permitted Vehicles – The system's ability to cross-check against a whitelist of permitted vehicles (e.g., emergency services, maintenance crews) was demonstrated successfully. No false violations were recorded for authorised vehicles, illustrating the platform's ability to differentiate between legal and illegal use in real time.

Operational Efficiency and ROI – The pilot revealed a high return on investment potential. Mobile enforcement not only detects a higher number of infringements, but it does so without the need for costly roadworks, fixed infrastructure, or additional human patrol resources. This makes the technology an attractive, scalable option for cities facing resource constraints.

Challenges & Mitigations

While the pilot demonstrated strong performance, it also surfaced several important implementation challenges—each of which presents manageable, known mitigations.



Privacy and Data Protection – Capturing vehicle data requires a privacy-first approach. The solution was designed with privacy by design principles—though continuously recording, only capturing and storing short video clips of potential violations and retaining registration data solely for non-compliant vehicles. All data handling adhered to Australian privacy regulations, with cloud storage secured and access strictly limited.

False Positives and Model Tuning – Early in the trial, some misclassifications occurred, particularly with closely spaced vehicles or complex traffic movements. These were addressed through iterative model tuning and improved whitelist logic, ensuring high accuracy in distinguishing authorised from unauthorised vehicles.

Connectivity and Power Needs – Reliable 4G connectivity and consistent power are essential. For production deployment, internal bus-mounted installation offers improved durability and stability compared to temporary external test rigs.

Together, these lessons provide a clear pathway for optimising future deployments and scaling confidently across complex urban environments.

Real-World Impact

Strengthening Safety, Accessibility and Service Reliability in ANZ

The results of this pilot are more than a proof of concept—they signal a powerful real-world solution for improving urban mobility across Australia and New Zealand.

Tackling a Known Problem at Scale – Unauthorised use of bus lanes and stops is a persistent issue in many Australian and New Zealand cities. As urban centres densify and demand for public transport grows, the pressure on road space increases. Static enforcement cameras—limited to fixed intersections—miss violations that occur across large sections of bus corridors. This mobile solution fills that gap, enabling complete route visibility and dynamic enforcement.

Enhancing Safety for All Road Users – In both countries, buses frequently operate in mixed traffic environments. When these environments are compromised by illegal lane use, bus drivers are forced to swerve into traffic or skip stops—raising the risk of collisions. With enforcement-enabled deterrence, this technology can help reduce preventable crashes, improving safety for drivers, passengers, cyclists, and pedestrians alike.

Improving Accessibility and Transport Equity – The importance of level boarding is enshrined in both countries' disability standards. When a bus cannot pull flush to the kerb due to an obstructing vehicle, passengers with mobility needs may be unable to board safely or at all. This creates a direct barrier to inclusive transport. By actively preventing obstruction of bus stops, mobile AI enforcement plays a critical role in ensuring equitable access for all.

Supporting Network Reliability and Mode Shift – In cities like Sydney, Auckland, and Melbourne, reliable journey times are essential to shifting more people from cars to public transport. Faster and more predictable bus journeys help build public confidence. In jurisdictions like New York City, similar enforcement programs have already led to a 5% increase in average bus speeds and a 20% reduction in collisions—tangible improvements that ANZ agencies can replicate.

Reducing Operational Costs and Boosting ROI – For agencies across ANZ working within tight capital budgets, the low infrastructure footprint of this solution is especially valuable. It requires no road construction, integrates into existing bus fleets, and is cost-effective to operate and scale—making it a financially viable alternative to labour-intensive or fixed-location enforcement.

This technology has the potential to shift the baseline for transport safety, accessibility, and service performance across the ANZ region—helping our cities meet the growing demand for inclusive, efficient, and sustainable mobility.

Recommendations

Production Deployment – Integrate the system into frontline transport buses to enable continuous, route-wide enforcement, with direct connection to infringement issuance platforms.

Strategic Rollout – Prioritise deployment along high-frequency, high-violation corridors to maximise impact, reduce risk, and boost service performance.

Public Awareness Campaigns – Educate the public on enforcement zones and the consequences of violations to increase voluntary compliance and community support.

Continuous AI Improvement – Regularly retrain AI models to adapt to evolving traffic patterns, vehicle types, and road conditions, ensuring long-term accuracy.

Policy Integration – Work with government stakeholders to embed mobile enforcement into transport policy frameworks as a core safety and accessibility initiative.

Conclusion

This pilot has demonstrated that AI-powered, vehicle-mounted enforcement represents a transformative opportunity for public transport networks in Australia. By dynamically monitoring bus lanes and stops in real time, the technology successfully identified safety risks, accessibility barriers, and efficiency gaps that often go unnoticed with traditional enforcement methods.

The results confirm that mobile enforcement systems not only enhance compliance but also deliver measurable benefits for all road users—fewer collisions, more reliable bus services, and safer conditions for passengers boarding and alighting. Most critically, the system helps ensure that dedicated bus infrastructure serves its intended purpose: giving priority to high-capacity, accessible public transport.

With proven success in global markets and clear applicability in the Australian context, this technology offers transport agencies a practical and scalable tool to support mode shift, improve safety, and meet accessibility targets.

Source [1]: https://new.mta.info/press-release/mta-announces-bus-lane-camera-enforcement-expanded-include-new-violations

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