7. TRANSPORTATION SYSTEM EFFICIENCY

The City of Toronto will enhance its ability to manage traffic in real-time through driving automation systems for the purpose of increasing the efficiency of moving people and goods.

Driving automation systems, at varying levels of automation, offer quantifiable benefits in terms of improving traffic efficiency. Low levels – including adaptive cruise control, automatic emergency braking, and lane departure warnings – contribute to fewer incidents, which in turn provides a positive effect on overall traffic congestion. Studies have also shown that with a higher adoption rate of these low-level systems, roads can operate at higher vehicle densities and flow rates. [100]

In the long-term, as centralized management of all vehicle movement becomes more feasible with connected vehicle technology and higher adoption rates of AVs – increased capacity and reduced delays from incidents will become much more likely. Advanced sensors in AVs will be able to collect and distribute information at a faster and more accurate rate, contributing to the overall effect of traffic information as an indispensable tool for informing drivers of traffic conditions and incidents along their route.[100]

The City will continue to use tools to manage traffic, which will only be further improved as AVs emerge. Current strategies – deterring the use of low-occupancy private vehicles through regulation, pricing mechanisms, and policies, encouraging transit use, exploring potential partnerships, and keeping drivers informed in real-time through increased amounts of data – will continue to play a vital role in traffic management.

Guiding Policies and Strategies:

Congestion Management Plan (2016-2020):[101]

- Intelligent Transportation Systems - increasing the amount and quality of traffic information for improved planning, prioritizing and performance evaluation;
- Congestion & Engineering Studies - Identifying practical solutions to key expressway congestion and safety concerns, through advanced technologies/ systems or applying current solutions in innovative ways;
- Curbside Management - Using innovative solutions to improve the balance of parking demand with traffic operational requirements;
- Support of All Modes of Transportation
    - Improving the effectiveness and coordination of traffic management activities involving public transit vehicles and active transportation modes; and
    - Exploring the most creative and effective use of typical street design standards and traffic engineering techniques to provide a more balanced use of the road right-of-way

- Traveller Information - Strengthening data sources and networks to ensure information on current traffic conditions, incidents and events is accurate and reliable.

Summary of Goals and Tactics

Goals	Tactics	Key performance indicators
7.1 Increase System Capacity	7.1.1 Transition to AVs - Traffic Flow 7.1.2 Active Traffic Management & Coordination 7.1.3 Designated Loading Areas 7.1.4 Open Data	Annual average daily curbside access events per 100m Number of open datasets on City of Toronto Open Data portal Throughput in persons per hour per unit area of public right-of-way
7.2 Manage System Demand	7.2.1 Curbside Fee 7.2.2 Transit Incentives and Pricing 7.2.3 Manage On-Street Parking Demand 7.2.4 Manage Off-Street Parking Demand 7.2.5 Manage the Peak 7.2.6 Manage Travel Demand	Proportion of daily traffic outside AM/ PM peaks

7.1 Increase System Capacity

In 2050, the City will have harnessed the widespread adoption of AVs to better manage all vehicular traffic in real-time conditions, and to increase the capacity of existing transportation infrastructure.

7.1.1 Transition to AVs – Traffic Flow

Proposed Tactic: Develop and implement a mechanism to improve traffic flow in real-time by managing the mix of non-automated, partially automated, and highly automated vehicles travelling together on city streets and highways.

Managing the flow of traffic can be a challenge for transportation authorities. One solution in use in several neighbourhoods and cities across North America to reduce traffic speeds, encourage safe driving, and improve traffic flow is the Pace Car. Pace Car Programs work like this: residents signing up for the program agree to drive courteously, at or below the speed limit, and follow other traffic laws – essentially acting as a 'mobile speed bump' which models safe driving and results in calmer traffic.[102] Through advanced computer modelling and machine learning, an automated Pace Car could analyze traffic conditions, such as bottlenecks, gridlock, and on-ramp merges, adjusting its speed and position in a way that improves traffic flow for other vehicles on the road.[103]

The City will explore tools and techniques such as Pace Cars to manage the mix of non-automated, partially automated, and highly automated vehicles in real-time. Other options to manage the flow of traffic include traffic calming mechanisms such as traffic circles, choker/chicane/pinch point devices, and speed humps.

Proposed progress to 2022: Identify potential options to manage the mix of varying levels of automation on Toronto's streets. Identify the optimal solution for Toronto based on research.

7.1.2 Active Traffic Management & Coordination

Proposed Tactic: Develop and implement a mechanism for increasing the average annual daily AV traffic per lane kilometre of arterial roads and expressways.

AV and connected infrastructure technologies could help the City move more vehicles through a given segment of road, thereby increasing the efficiency of existing transportation infrastructure.

First, vehicle-to-vehicle (V2V) communications enabled by connected technology allow cars to communicate and coordinate with each other in real-time.

Second, vehicle-to-infrastructure (V2I) technologies, including smart signals can use cameras and sensors to detect how many cars are waiting in each lane and, how much time it takes to clear up this traffic and it can also communicate with other nearby smart signals to connect to the grid as a network of signals that will work in tandem to maximize traffic efficiency. [104]

Finally, vehicle-to-network (V2N) or vehicle-to-everything (V2X) systems, allow connected vehicles to communicate with cellular devices and the cloud so that drivers can take advantage of in-vehicle services that assist with traffic updates. Transmission of connected vehicle data to traffic management centres allows for real-time active traffic management, relaying information that can enhance the level of predictability for AVs, improving overall travel time and increasing vehicle densities and flow rates.[104]

Proposed progress to 2022: Coordinate the development of a mechanism to increase throughput with the development of the 2021-25 Congestion Management Plan.

7.1.3 Designated Loading Areas

Proposed Tactic: Develop and implement a standard for designating automated vehicle loading and unloading areas in high-demand places.

With the increased demand on the curb from the introduction of AVs, designated hubs for pick-up and drop-off zones become vital. Cities need to incorporate structure and incentives around access to the curb to influence its impact on the mobility system, and assist productive use of street place, while ensuring public life and the urban economy flourish.[79]

Aside from designated zones by geography, the City of Toronto can also consider time of day designations that can address peak congestion periods, peak delivery periods, and free-flow timing.

Proposed progress to 2022: Research, identify and assess potential options to designate AV loading and unloading areas in Toronto. Select a preferred solution to be designed in the next phase of this Plan.

7.1.4 Open Data

Proposed Tactic: Coordinate the provision of transportation-related regulatory and traffic data through the City's Open Data Portal.

Four principles of Open Data guide the City of Toronto's information sharing: transparency, participation, accountability and accessibility.[105] The City's Open Data Portal exemplifies these principles, as an easy-to-use tool that allows both technical and non-technical users to interact with and use City data in a visual way. The Portal currently includes the City's entire catalogue of open datasets, as a means of improving service delivery, and supporting public trust in government.[106]

There are currently 64 datasets included in the Transportation Data Catalogue shared via Open Data.[107] The City will coordinate the addition of more transportation-related regulatory and traffic data into the Open Data portal to improve active traffic management with the introduction of AVs.

Proposed progress to 2022: Continue adding transportation-related regulatory and traffic data sets to the City's Open Data Portal.

7.2 Manage System Demand

In 2050, the City will have harnessed the widespread adoption of AVs to ensure less acute demand across the transportation system.

7.2.1 Curbside Fee

Proposed Tactic: Develop and implement a pricing mechanism or permit system to manage curbside demand from AVs.

Whether as storage space for vehicles, space of commerce, or space for people, curbs have increasingly become contested spaces.[108] Pick-up and drop-offs from ride-hailing services are already placing increased demands on limited curbside space – a condition expected to worsen if shared AV fleets become widespread.[109]

Pricing the curb would allow for efficient allocation of limited curbside space, ensuring faster turnover of vehicles, increasing access to delivery zones and pick-up/drop-off areas while minimizing the fight for the curb across modes.[110]

Proposed progress to 2022: Coordinate the development of curb management for AVs with the City's Curbside Management Strategy. Explore variable pricing options to manage demand from AVs (both personally owned and commercial), and isolate a preferred solution based on success from short-term curb management initiatives, and the City's intended focus for the medium-long term.

7.2.2 Transit Incentives and Pricing

Proposed Tactic: Develop and implement a pricing mechanism or value proposition that ensures transit is more attractive to riders than AV alternatives.

In many cities across North America, transit ridership is increasingly challenged by factors beyond the control of transit agencies, including the rise of ride-hailing services and decline in employment.[111] Due to these declines, some municipalities have had to form alternative partnerships with private companies, or cede some of its ridership to competitors.[112]

In 2016, TTC ridership flatlined (a growth rate of -0.1%) – a trend attributed mainly to declining growth in full-time employment (and corresponding growth in part-time and temporary employment), rendering the purchase of an Adult Regular Metropass unviable for many people.[113] In response to this trend, the TTC's Ridership Growth Strategy was developed as an extension of the TTC's Corporate Plan 2018-2022 with three main strategic objectives:[114]

1. *Retain current customers;*
2. *Increase transit rides per current customer, and;*
3. *Attract new customers to the system.*

With AVs presenting a new, and convenient method of transportation at potentially lower prices, the City will need to ensure that there are transit incentives, value propositions, and pricing mechanisms in place that preserve transit as the more attractive choice for riders.

Proposed progress to 2022: Use lessons learned from automated transit shuttle pilot to inform further research into the value proposition of automated transit, and research and identify other options.

7.2.3 Manage On-Street Parking Demand

Proposed Tactic: Develop and implement a pricing mechanism to ensure that the cost of on-street parking to the user of an automated vehicle reflects economic, social, and environmental impacts.

Many people have predicted that, with the onset of AVs, users will no longer have the need to park because these vehicles will be able to – through rideshare format – pick up the next customer, or, if personally owned, these vehicles will be able to return home and park themselves. However, current parking revenue trends and expert predictions indicate that parking will remain an important source of revenue for the City of Toronto well into the future.[115]

Drivers' continuous search for parking spaces creates negative externalities: an IBM survey even recognized that parking searches amongst these spots – taking between 13-32 minutes – account for about 30% of traffic and circling vehicles produce harmful emissions.[116] Additionally, on-street parking occupies a large portion of the right-of-way, cutting into public realm space.

Connected curbside sensors may allow for real-time updates of parking availability to be communicated to AVs. Furthermore, demand-based pricing policies have been shown to increase turnover in parking spaces, allowing more people to access parking where and when they need it.[117]

Proposed progress to 2022: Monitor technological and policy developments in other jurisdictions which could inform the management of on-street parking in Toronto.

7.2.4 Manage Off-Street Parking Demand

Proposed Tactic: Develop and implement a regulatory framework or pricing mechanism to ensure that the cost of off-street parking to the user of an automated vehicle reflects economic, social, and environmental impacts.

Studies have been conducted on the impact AVs will have to parking structure designs in the future. According to a study from the University of Toronto, future parking designed especially for AVs could have multiple rows of vehicles stacked behind each other as opposed to two rows for current parking structures, decreasing the need for parking space by an average of 60 percent to a maximum of 90 percent.[118]

Re-imagining car-park designs is only one of the impacts to off-street parking in an automated future. As commercial parking business models change, the City will need to ensure that there is a policy framework in place to make the most of this newly freed-up space.

Proposed progress to 2022: Research, learn and identify externalized costs associated with off-street parking.

7.2.5 Manage the Peak

Proposed Tactic: Develop and implement a mechanism to improve travel time reliability and system efficiency by maintaining or reducing the number of automated vehicle trips during peak congestion periods.

According to the TomTom Traffic Index, Toronto commuters spent 30% more time travelling during peak congestion periods. This translates to an average daily delay of about 34 minutes, a total of 130 hours per year.[119]

Automated and connected vehicles could reduce these statistics, by improving travel time reliability and system efficiency through synchronization, communication, and ideal speed and signal adjustments.[77] In addition to these measures, The City could encourage the implementation of pricing mechanisms and time-based access restrictions on geofenced areas.

Proposed progress to 2022: Research and identify potential congestion issues during peak hours, arising from AVs.

7.2.6 Manage Travel Demand

Proposed Tactic: Develop and implement a pricing mechanism to ensure that the cost of travel to the user of an automated vehicle reflects economic, social, and environmental impacts.

It is uncertain exactly how AVs will impact travel demand; however, one possibility is that vehicular travel could increase due to several factors: enhanced driver experience, more reliable travel times, improved safety, reduced costs associated with vehicle ownership or car-sharing, zero-occupant vehicle standing and circulating, dispersed land use patterns, and increased mobility for non-drivers.[120]

One New York-focused study found that ride-sharing alone increased the cars on the streets of major cities by 180 percent.[121] This is likely to reoccur with AVs, unless fees such as road tolls are implemented to control usage and balance the impacts.[122]

Proposed progress to 2022: Study potential issues associated with zero-occupant vehicles. Engage stakeholders to identify potential solutions and begin generating options for the City of Toronto to implement if and when zero-occupant vehicles become prevalent.

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