TORONTO REGION BOARD OF TRADE

WORLD TRADE CENTRE® TORONTO

NEXT STOP

Building Universal Transit Access

November 2021

In collaboration with **Deloitte.**

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A STRATEGY FOR A GLOBALLY COMPETITIVE TRANSPORTATION SYSTEM

The Toronto Region Board of Trade has been presenting a comprehensive strategy for building an integrated, globally competitive transit system throughout the Toronto region. Such a strategy is urgently needed as congestion costs our region as much as $6 billion a year in lost productivity and disrupted supply chains—a figure that's set to grow to an annual $15 billion in the next decade.

This is the third in a series of proposals that combine to address these critical mobility challenges. The first two proposals in this series discussed overall administrative structure, fare system, and regional rail infrastructure that can help to meet regional mobility objectives. They build on the Board's call for seamless travel across the Innovation Corridor by 2025 through a fully integrated regional transit system in ***Shaping Our Future***, a playbook of ten critical actions to support the region's economic recovery. This proposal discusses the challenge of providing high-quality, innovative local transit to solve the "first and last mile" issue and enable anywhere-to-anywhere, anytime travel. Without achieving excellence in all these categories, the Toronto region will not be able to achieve its climate, equity, and economic growth goals. This is the fastest-growing urban region in North America, and it needs a network of transportation systems that can catch up to our global peers and keep up with our growing population.

As shown in *Erasing the Invisible Line,* the Toronto region is an integrated social and economic unit, but municipal and transit agency boundaries continue to present serious barriers to travel. Whether they be between Toronto and adjacent municipalities, or between local transit operators and the GO network, these barriers constitute significant impediments to regional mobility with important implications for land use. To fix these problems, we proposed a Transit Federation—a kind of cooperative that brings together all of the region's municipal transit agencies, GO Transit, and potentially other operators to collaborate on three key areas: fare integration and revenue sharing, public information, and route scheduling. We also proposed a fare structure that eliminates double fares at municipal boundaries and integrates the GO network into the local fare structure, while retaining the existing flat fare structure for TTC riders.

However, all of the fare and administrative innovation in the world will not provide a full measure of access if it still takes over an hour to travel from northeast Scarborough to Union Station by transit. The region needs a fast, well-planned and high-capacity network of regional rail routes to facilitate medium and long-distance travel, achieve climate objectives, and support regional economic success. In *Getting on the Right Track*, the Toronto Region Board of Trade made a detailed proposal for implementing a fast and frequent regional rail system on the existing GO network, following proven global best practices. The proposal calls for electrified, frequent, two-way, all-day electrified rail service using the most modern technology and planning frameworks drawn from around the world. This network would serve as a regional transit backbone, providing high capacity for local journeys while enabling speedy travel across the region.

Following the current report, the Toronto Region Board of Trade will conclude the series by examining the critical issue of infrastructure construction. The final report in this series will examine some of the challenges faced and propose measures than can help make it easier to get transit infrastructure built.

SUMMARY OF RECOMMENDATIONS

We have identified four guiding principles for building a universally accessible and globally competitive local mobility system, supported by an examination of success stories and challenges in this region and elsewhere. Making these key recommendations core tenets of regional transportation policy, instead of ad-hoc solutions in some parts of the region, would build the foundation needed to make help residents choose not to own a vehicle or to leave their car at home.

Improve Accessibility

To ensure that all residents of the region have access to jobs, education, and other opportunities, it is essential to provide a level of service that guarantees the ability to travel anytime, without needing to wait too long for a vehicle. This means:

- A clear region-wide 10-minute frequency service standard to enable "turn up and go" travel on all major routes
- Creating the right environment to support partnerships and innovative approaches to providing mobility, like technologically enabled on-demand transit, especially where high-frequency service is not feasible

Improve Integration

The Toronto region is an integrated economic and social unit, but its transit system is fragmented between agencies and between modes. A universal transit service means:

- Fare, schedule, and service coordination, so that transfers are seamless—even across agency and municipal boundaries (as outlined in *Erasing the Invisible Line*)
- Making connections as easy as possible.
- Planning for other mobility choices in the same way that we plan for transit, including modeling micro and on-demand mobility

Improve Infrastructure

Local transit also needs to be reliable and time-competitive, which means infrastructure to prioritize transit wherever possible. This includes:

- A comprehensive plan to identify and prioritize infrastructure improvements by rider-minute saved
- Continued expansion of dedicated transit lanes in busy corridors
- Transit signal priority
- Improvements to make bus stops more attractive and usable

Improve Innovation and Multimodality

Transit can benefit from the digital and green revolution. Taking advantage of new technologies can enable better planning, better integration with other modes, and more innovative ways of transit service. This means:

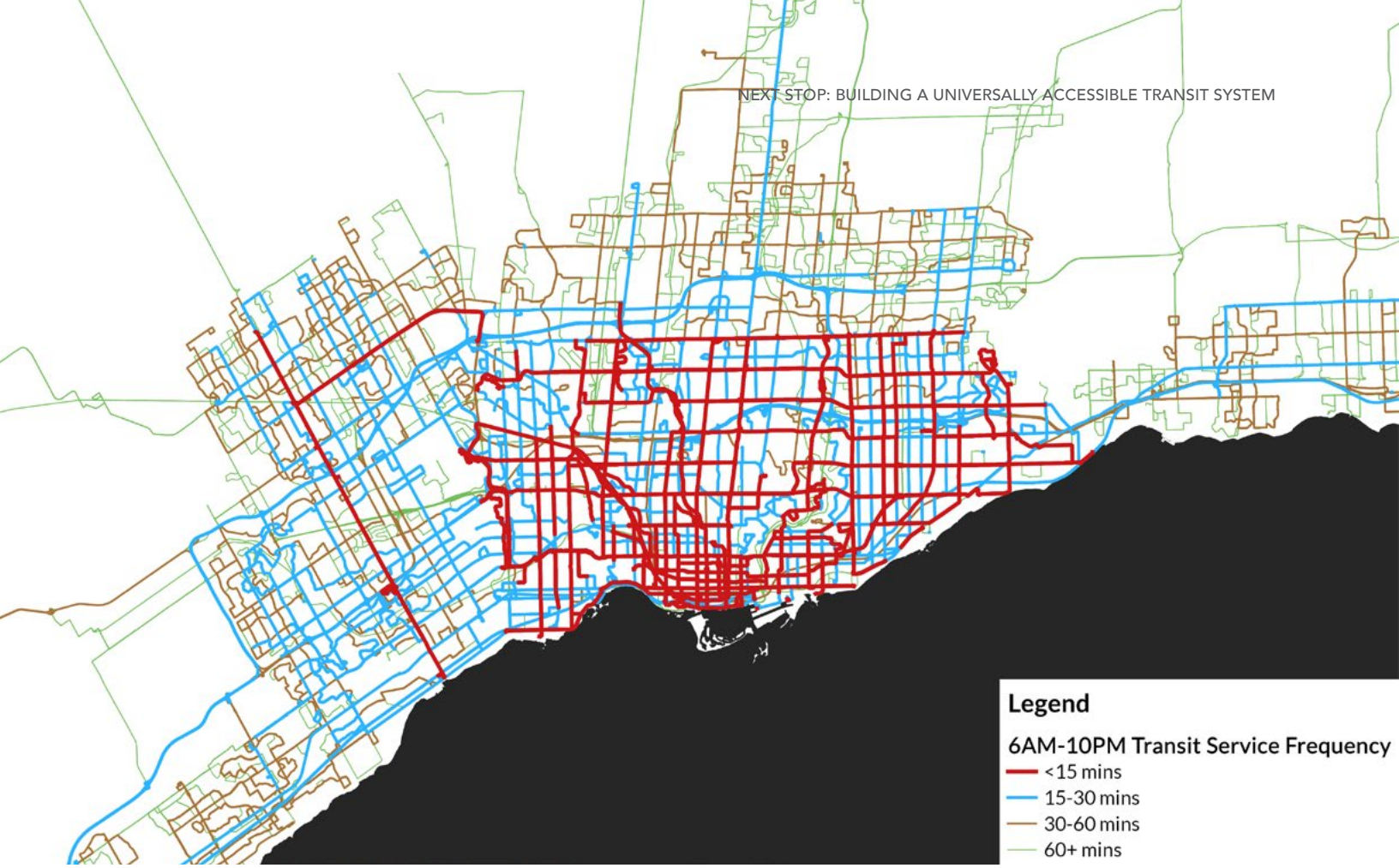
- More dynamic planning and modelling such as using digital twins to model the system and explore innovative ways of providing service
- Data sharing with other providers to facilitate development and adoption of innovative solutions
- Integration between public and private operators to continue to enable micro transit, bike share, and ride sharing
- Implementing infrastructure to support new technologies like automated shuttles
- Activating the business community to incentivize and promote smarter, greener mobility choices

Introduction

A great urban region cannot thrive socially or economically without an efficient, rapid, and reliable mobility system that is accessible to all of its residents. Given its unprecedented growth, the Toronto region must not only catch up with cities that built more infrastructure decades ago—it must also keep up with more than 100,000 new residents that arrive every year. These people simply cannot move on the existing highways and transit infrastructure, nearly all of which are already at capacity. This comes at a severe economic cost: congestion has been estimated to cost the region $6 billion every single year in lost productivity. That figure is expected to grow to $15 billion by 2031.[1] Congestion makes it harder for workers to get to jobs, disrupts supply chains, and impedes essential business deliveries, all of which hampers the competitiveness of the region's businesses. It makes the Toronto region a less appealing place for people to live and for businesses to grow. Inadequate transportation infrastructure is also a major contributor to the inaccessibility of affordable housing—a growing crisis that the Board's *Housing a Generation of Essential Workers* series has shown costs the region an additional $8 billion in lost economic activity.[2]

It would not be possible to expand most of the highways in the region to resolve this crisis, because of the lack of physical space, the environmental impact, and the simple inability of cars to move around and park once they reach dense activity centres. The only viable alternative is to expand mobility options.

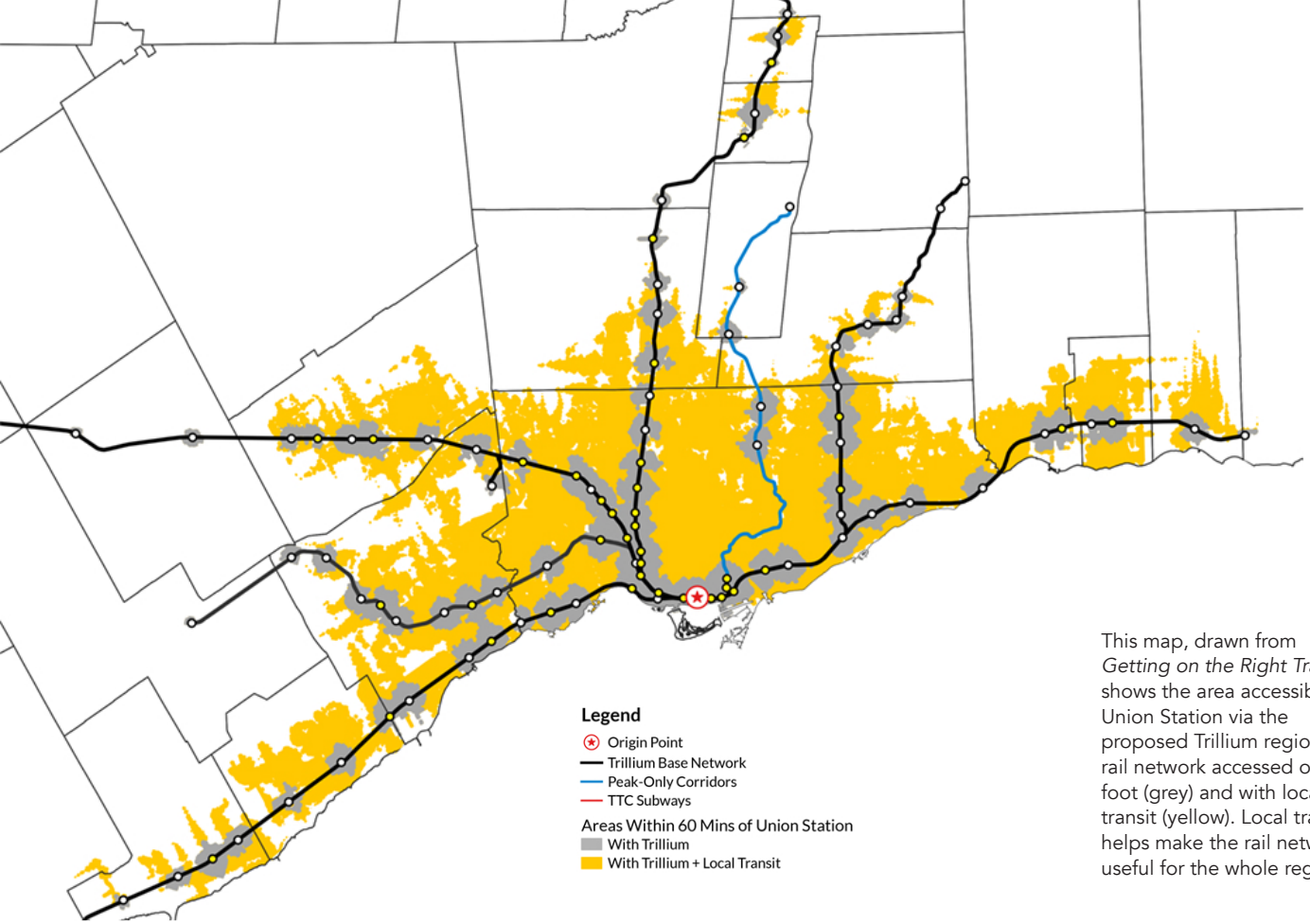
This is also a critical equity question. Access to opportunities and employment is essential for a person to be an equal resident of the region. While 75% of jobs are located in five distinct types of business districts found across the region, most of these districts are not directly served by existing rapid transit routes.[3] There are far too many people who are cut off from opportunities, or who are forced to spend an unreasonable amount of their monthly budget to buy a car, because they lack mobility options. This is an unacceptable situation in a region as prosperous as ours.



This map of the region highlights the level of frequency on transit routes pre-pandemic. While some areas have widespread coverage of routes that come better than every fifteen minutes, every day until 10PM, other areas have far more limited service, including routes that come less than hourly for some parts of the day.

The first two reports in this series have examined the overarching fare and administrative structure and physical infrastructure needed to make travel throughout the region by transit viable. But a fast and efficient regional transit system needs to get you from your doorstep to where you want to go, whether that's to work, to visit a friend, to go out for dinner, or points between. It will never be possible to build a rail transit system that is within walking distance of all—or even most—of a region's residents. Even for those who can walk to a rail line, sometimes their trips aren't going in the direction that the rail line would take them. Consumers value convenience, and anything more than a ten-minute walk from their home to frequent service can deter someone from considering transit as part of their choice of modes. There needs to be a base layer of local service, complemented by other shared mobility options, that can allow them to travel from anywhere, to anywhere in a way that is competitive with personal vehicles. That fundamental network is the subject of this report.

Local transit service is about more than lines on a map. Many cities across North America have very impressive transit maps, with routes that run close to just about every home and business. These comprehensive route maps are a mirage, however, when many routes run infrequently. Many outside the City of Toronto run only once an hour, or are even limited only to rush hours. Fortunately for the Toronto region, those levels of service are rare in comparison with many American cities. Still, there are many parts of the region where relying on transit ties riders to a sparse schedule, limiting their access to opportunities and amenities outside of rush or daytime hours.



This map, drawn from *Getting on the Right Track*, shows the area accessible to Union Station via the proposed Trillium regional rail network accessed on foot (grey) and with local transit (yellow). Local transit helps make the rail network useful for the whole region.

A grid of frequent local transit services, supplemented with other mobility services, can enable trips from anywhere to anywhere, even where rail doesn't run, making universal transit access a reality.

The value of the billions of dollars of transit investment now underway in the Toronto region can only be fully unlocked when everyone in the region can easily access these new rapid transit services. As seen in the map above, even with frequent service on all of the GO lines, the vast majority of region residents will still be beyond walking distance of a rail station. To get them to and from the station, most people will need frequent, all-day local transit service. As we will see, that has been the recipe for success in Toronto. That service needs to be prioritized and integrated with other modes to make journeys as seamless as possible. Where conventional frequent local bus service is not possible, there are many innovative ways to improve access to opportunity, like Durham Region's implementation of technologically enabled on-demand transit. It's not just about getting people to rail stations, either. A grid of frequent local transit services, supplemented with other mobility services, can enable trips from anywhere to anywhere, even where rail doesn't run, making universal transit access a reality.

The design of mobility systems at the local level needs to put the customer at the centre and focus on what they value when they choose to move. This can also enable customers to make green choices and support corporate sustainability objectives. This is an opportunity for our region to use environmentally sustainable transportation options as a key marketing advantage.

This report presents key priority actions that can be implemented and made universal to achieve the globally competitive mobility system that this region needs. They are derived from a series of municipal case studies that highlight the many bold and creative ways that have made transit a successful part of smarter mobility choices in the Toronto region.

The COVID Context and Risk of Inaction

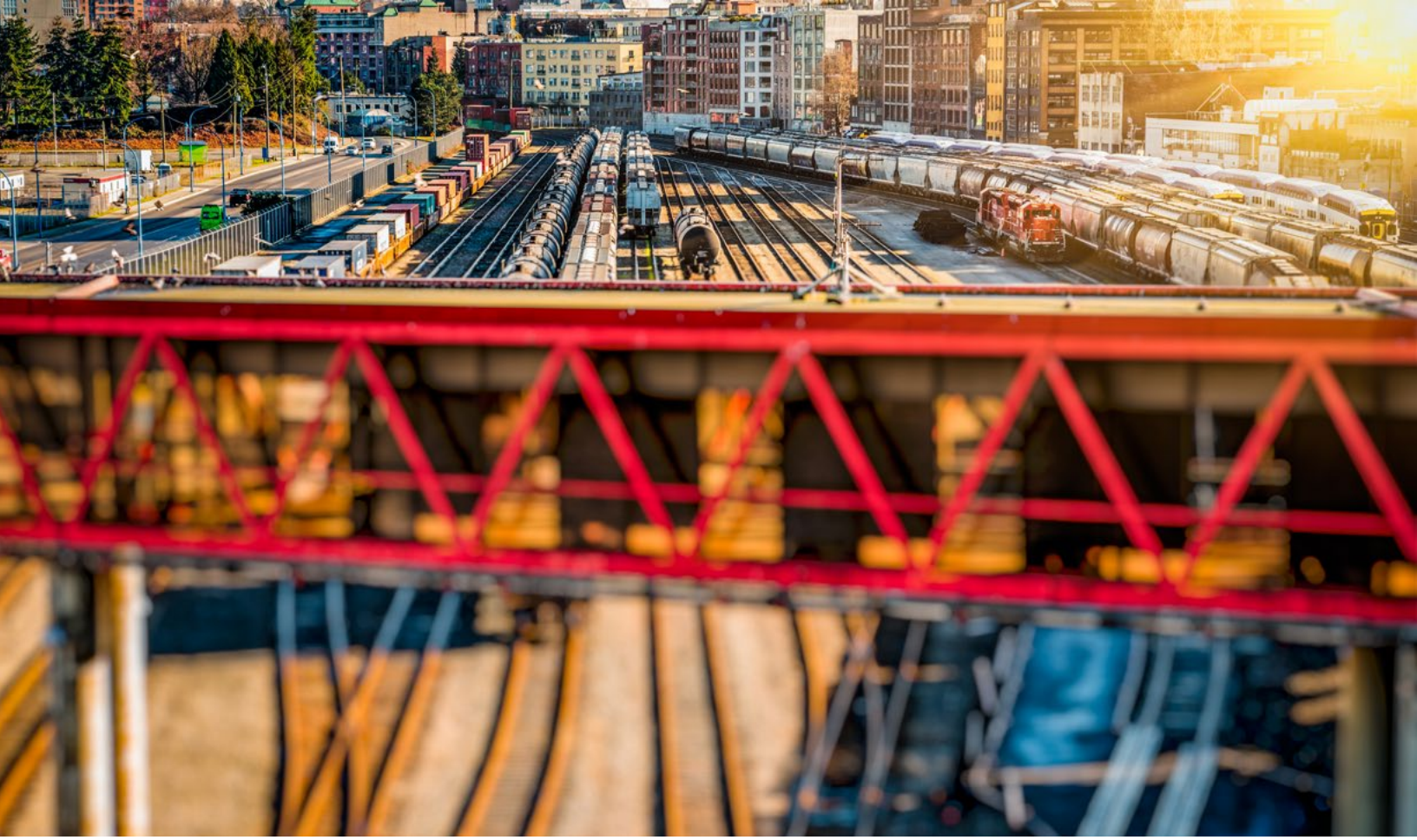
Demand for transit services is not fixed.[4] This means that cuts to transit service can drive riders away, resulting in even lower ridership that prompts further cuts. This creates the kind of vicious cycle that destroyed transit ridership in the United States after the Second World War. It also means that high levels of transit ridership will never materialize until after good transit service is provided. Just as a business needs to open an attractive store before it can start building a clientele, transit needs to provide appealing service before it can attract riders.

Transit in Canada is facing an inflection point that has led many major transit agencies to start thinking about a redefined customer base. In Canada, the Delta variant has negatively affected both reopening plans and growth[5]. Economic recovery is uneven across age, gender, and education[6]. In cities around the world, (such as New York, Australia, Montreal, and Toronto[7]), there is increasing recognition that roads are filling up while transit remains comparatively underused as people make new choices about how they will travel, to work, to school, to shop, and for leisure[8,9]. Beyond transit, ride-sharing firms including Uber and Lyft have also seen significant ridership reductions[10], underlining the breadth of continued public concern around shared transportation modes' safety. As the Economic Blueprint Institute's *Recovery Tracker* has highlighted, ridership declines have been uneven. Ridership on buses in outer parts of the region, particularly employment areas, has held up strongly throughout the pandemic, highlighting the need for investment in anywhere-to-anywhere, all-day local service.

With a quick return to pre-covid ridership less certain, and ridership remaining low (55% of pre-covid levels in Montreal and Vancouver, and 45% in Toronto[11]), while car traffic is already close to its pre-pandemic level, transit agencies are looking to continue to ensure that they are serving their entire customer base, helping people of all demographics to make the decision to walk, ride, cycle – anything but open their car doors when they step out of their homes.

There is a serious risk that many riders simply will never return to transit or other shared mobility options, either because they are nervous about riding or because they are no longer working a conventional schedule that is well-served by transit. In both cases, transit needs to make itself more attractive and flexible if riders are going to return. Transit also needs to consider what partnerships they could deploy to help improve access to their services as well as incentivize their customers to include transit in their mobility choices.

If we fail to meet this challenge, we risk falling into the kind of vicious cycle of ridership declines, revenue loss, and service cuts that devastated American transit in the postwar years—and that the Toronto region successfully avoided. We can meet this challenge and take the opportunity to return stronger with more, better, and more flexible service to tempt riders back. Defeat is not an option—the Toronto region cannot grow or even function with everyone relegated to their own cars. And as we aspire for net-zero carbon emissions, a strong transit system will be key to achieving this goal.



Key Action Items

In order to create universally accessible mobility, regional leaders must advance a number of key action items, which are based on the success stories that are explored below. These success stories all have something in common: providing guaranteed, reliable service that can get people from anywhere to anywhere, whenever they want to travel. Reasonable headways, meaning how long the rider needs to wait for the service, and span, meaning how many hours of the day it is operating, are the foundation of transit service. A transit system needs to be designed around the needs of the customer, enabling trips that might not be typically well-served by transit, and providing mobility alternatives where that is not possible.

Beyond the fundamental need for improved accessibility, there are many more physical, operational, and technological improvements that can be implemented to make transit service even faster, more reliable, and more attractive—as well as more efficient for transit agencies to operate.

- IMPROVE ACCESSIBILITY
- IMPROVE INFRASTRUCTURE
- IMPROVE INTEGRATION
- IMPROVE INNOVATION AND MULTI-MODALITY

On-demand and other flexible services can also help to identify significant travel patterns that aren't being well served by conventional transit service. Innovative approaches facilitate quicker provision of service, as soon as neighbourhoods are built.

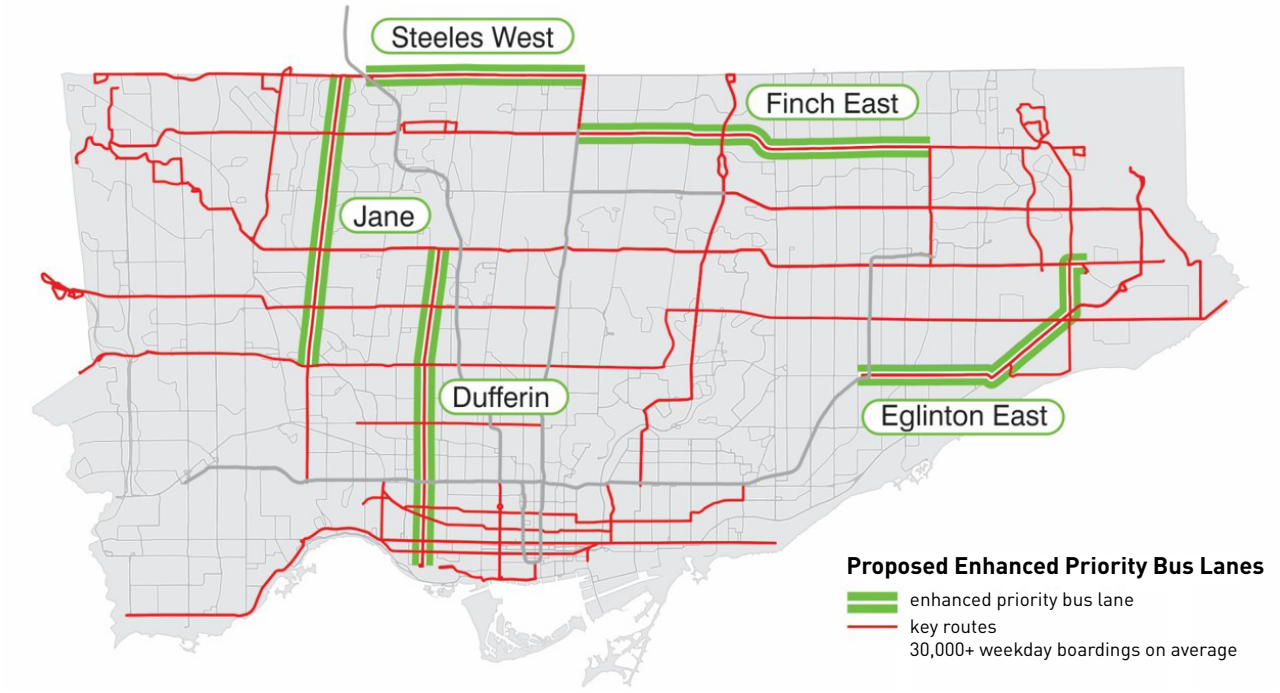
IMPROVE ACCESSIBILITY

Establish a Universal "Turn Up and Go" Service Standard

In order to provide attractive service and facilitate car-free accessibility to the entire region, major transit routes must run frequently enough that riders can "turn up and go." That means that everyone on an arterial transit route in the region should be assured that a vehicle will be along **every ten minutes, from 6 in the morning, all day, seven days a week.** This level of service has been proposed in the Ontario Ministry of Transportation's discussion paper on a Greater Golden Horseshoe transportation plan[12], and the investments and supports should be put in place to make this proposal a reality. Metrics like waiting time, including for connections, could be used to prioritize routes for frequent service. More frequent services also reduce the need for precisely timed schedules, since riders will never have to wait long for the next vehicle. Though higher frequencies will come at an up-front cost, the Brampton case study shows that increased ridership can go a long way to covering the additional expenditure over the medium term. In much of the region, this will require little or no change or added spending. All routes in the City of Toronto already meet the standard, though some like the downtown streetcars could benefit from even more service, and many 905 region main routes would only require a small service increase to meet the standard. Some of the cost of these improvements could be covered, as shown by the Durham Region Transit case, through the shifting of infrequent and lightly used fixed bus routes to different mobility options, like on-demand transit. This is a valuable investment in the region's future that maximizes the value of the billions in infrastructure investment that is now underway.

Introduce On-demand and Other New Approaches

There are some parts of the region where it is simply not feasible to operate a 40-foot bus every ten minutes. For example, there are some neighbourhoods where homes are an unreasonable walk from a major arterial road, in some cases because of road network design. This is the case even in some dense parts of the region. There are also small settlements distant from major urban centres. In these cases, **digitally enabled on-demand service can make transit equally accessible at all times, without unreasonable expense, so that all parts of the region are provided a standard level of mobility.** On-demand vehicles can take riders to and from rail stations or the nearest frequent bus route, and technology can ensure that riders can book seamless journeys, with the on-demand vehicle automatically booked to arrive right on time to pick them up from their bus or train. On-demand and other flexible services can also help to identify significant travel patterns that aren't being well served by conventional transit service. **Innovative approaches facilitate quicker provision of service as soon as neighbourhoods are built.** This is essential because when people move to a new home, they establish their patterns of travel. If they get used to driving for years, it will be very difficult to convince them to start using transit when attractive service is finally provided.



IMPROVE INFRASTRUCTURE

Infrastructure can help to improve the attractiveness, speed, and reliability of transit. Upgraded infrastructure might not be feasible everywhere, but it can be a valuable addition once the fundamentals of universal accessibility have been achieved.

Transit Lanes

Cities across the globe are increasingly turning to dedicated transit lanes as a means of improving the reliability of local transit in congested cities. Studies often find total travel time reductions of 15% or more, and reliability benefits of greater magnitude.[13] This translates into shorter travel times for riders, and lower operating costs for agencies, as equipment cycles faster through the system.

Toronto's King Street transit priority corridor decreased travel times in the afternoon peak period by as much as 20%. The improved reliability and times, coupled with the publicity the project received, led to 16% growth in daily weekday ridership.[14] Metrolinx and other regional agencies have ambitious plans to roll out a comprehensive network of BRT services on major corridors.

There are a variety of different levels of transit priority. One transportation research organization developed a standard classification of bus rapid transit types, ranging between Basic, Bronze, Silver, and Gold. They vary based on a variety of characteristics, including physical infrastructure, service levels, and technology.[15]

In the Toronto region, transit priority can be as simple as painted lanes on the road, sometimes permitting cars to enter the lane to make turns at an intersection or being shared with high-occupancy vehicles. An example would be the longstanding bus lanes on Don Mills Road in Toronto. At the higher end of BRT is the VIVA system implemented in York Region. VIVA corridors have dedicated lanes in the centre of the street, with curbs separating them from general traffic lanes. Stops have substantial shelters and electronic information screens. Mississauga's Transitway has its own corridor, in most locations separated by bridges from cross traffic, and with substantial stations resembling rail transit stations.

As the City of Toronto was hit by the pandemic, Council directed the Toronto Transit Commission to implement a network of bus lanes on some of the city's busiest bus corridors. All of these corridors have in excess of 30,000 riders per day, making them among the busiest surface routes in North America. Furthermore, their ridership held up better than other parts of the system, given the large proportion of essential workers and people who do not have access to a car who depend on them. While only one corridor in Scarborough has been implemented so far, there are studies underway for expanding the network throughout the city. Painting bus lanes is a very quick and simple way to speed and improve reliability of bus services. As was shown with the new corridor in

Scarborough, as well as a variety of pandemic bike lanes, it is possible to create new priority lanes in a matter of weeks.

The TTC operates extraordinarily busy bus routes—busier than many rail transit routes in other cities—and it is very unusual that they receive little or no priority. Likewise, Toronto's downtown streetcar routes are very well-used, but they suffer from slow travel times and poor reliability. Further priority, as well as other measures, could replicate the ridership success on King Street.

Rolling out a strong network of dedicated lanes on key arterials in the region will help improve access and the quality of local transit in the Toronto region rapidly and without the need for major infrastructure construction.

Transit Signal Priority

By allowing buses to 'hold' green lights, transit signal priority, or TSP, helps increase the speed and reliability of surface transit service. Studies have found 10% speed benefits and as much as 50% reliability benefits when TSP treatments are applied at delay-prone intersections.[16] The technology can be especially useful on unreliable services: allowing late buses priority at key intersections can help them recover their schedules and prevent vehicle bunching.

Agencies have made limited implementations of the technology on some routes in the Toronto region, though even many busy routes like the Spadina streetcar do not have even basic signal priority operational. These technologies are also quite rudimentary, simply extending the green light without regard to broader schedule concerns or whether the vehicle will need to make a stop before the light to pick up and drop off passengers, negating the value of the extended green.

New technologies can enable far more sophisticated management of traffic signals. They can monitor traffic levels and congestion points in real time, allowing for adjustments in signal timing and other measures to allow buses or streetcars to move as smoothly and rapidly as possible. Coupling these technologies with small infrastructure improvements, like dedicated turning lanes or queue-jump lanes at intersections, could maximize the benefits while requiring minimal infrastructure.

Bus Stop Improvements

Especially in more car-oriented parts of the region, planners must follow the lead of cities across the globe to improve access to transit through street design. Calming traffic, installing bus shelters, and ensuring maximal pedestrian network connectivity all will be important to the success of local transit improvements.

A key but overlooked contributor to the success of transit in Ontario is the frequent provision of pedestrian and cycle pathways out to the arterial road in areas with a circuitous road network. In a conventional suburb, pedestrians must walk potentially as much as a kilometre to get out of the subdivision and to the bus stop on the main road, even though the direct distance may only be a few metres. The provision of direct paths mean that riders can walk on a straight-line route, making walking distances short, reducing the need for agencies to operate slow and inefficient winding routes through a suburban area, and generally making transit far more competitive in the suburbs.

Many agencies in the Toronto region have put considerable resources into upgrading bus stops on major routes with more attractive and comfortable infrastructure for riders, including public information on the system's status and next trips. These stops also serve as advertisements for the transit service that are highly visible to drivers.

Partnering with adjacent developments could provide for even higher quality waiting areas for riders at busy stops. Developments could provide an indoor waiting area adjacent to the stop, including real-time public information and potentially services like food and retail.

At busy stops, having everyone board and pay their fare at the front of the vehicle can be quite time-consuming, slowing journeys and contributing to unreliability. That's why the TTC has introduced all-door boarding on the streetcar network, as has York Region's VIVA. Since vehicles are already equipped with Presto readers at the rear doors, it would not be difficult to implement all-door boarding on other routes, even if only at the busiest stops.

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Reduce Emissions Through Electrification

Electric bus technology has been advancing rapidly, and a number of Toronto region transit operators have begun testing different models. Electric buses have significant advantages in terms of lower operating costs, and the federal government has been supporting agencies in covering the additional capital cost of acquiring the vehicles. Electric buses, especially with a very low-carbon electricity grid like Ontario's, have dramatically lower emissions, and they're also quieter and more comfortable. This means that they have much lower impact on the communities through which they pass.

Explore New Bus Types

Many major transit operators worldwide, including GO Transit and OC Transpo in Ottawa, use double-decker buses on busy routes. They have significant advantages, notably on the kinds of long and busy routes that are common in the Toronto region. While they offer low floors on the lower level, making them fully accessible, their upper level does not have the same constraints of wheel wells and equipment protruding into the passenger space that limit capacity on low-floor vehicles. Instead, the upper level can have uninterrupted seating, significantly increasing the chance of getting a seat for riders, and providing an improved passenger experience.

IMPROVE INTEGRATION

Better Interchanges

Making things easy for customers starts with good intermodal connections. The TTC long set the international standard for integration between subway and bus service, with most non-downtown subway stations having their own dedicated bus terminal where riders could easily locate their route and wait sheltered from the elements. Passengers can pass seamlessly from bus or streetcar into the subway, without needing to pass through a fare gate. Many suburban GO stations also have a bus terminal, though a lack of fare integration means that riders have to pay a separate fare to make their transfer. In the City of Toronto, however, buses and GO Trains are generally not closely integrated.

York Region, however, has taken this physical integration to the next level at Vaughan Metropolitan Centre station. They have built an attractive arch structure in the middle of Highway 7 that allows buses along that road to pull up to a sheltered platform from which riders can descend directly into the subway station. Buses do not even need to deviate from their route, which saves time for bus riders compared with the traditional off-street terminal model.[17]

The Viva/Subway Interchange at Vaughan Metropolitan Centre Station (Image Source: Google Earth)

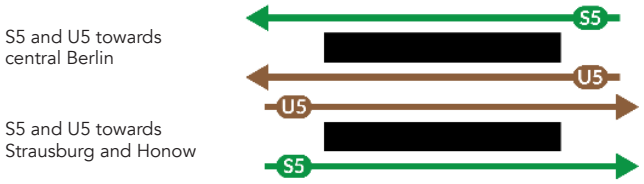
Coordinated Scheduling

Transfers are a serious inconvenience, but they're also the key to anywhere-to-anywhere travel. That's why they should be made as convenient as possible. In most cases, this is best achieved by operating service frequently. Where that is not possible, another way of achieving this is **making sure that vehicles, including those of different agencies, are scheduled to meet each other at the same time,** so riders spend a minimum amount of time waiting.

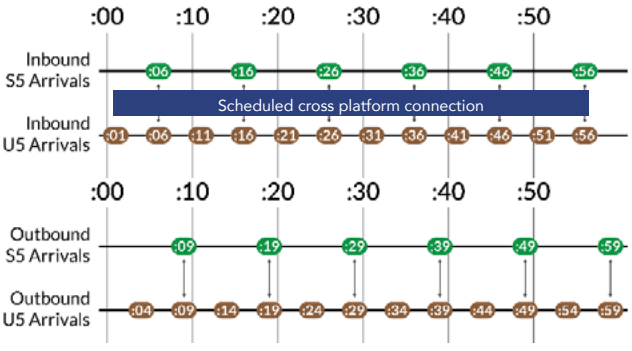
Key to improving the transfer experience is schedule coordination and infrastructure optimization. Rail networks in countries like Germany and Switzerland often offer timed transfers between services: vehicles arrive at key stations at the same time, minimizing waiting times. Stations are also designed to facilitate transfers between vehicles and modes, providing transfers across the platform and easy paths for riders switching services. The TTC has been a North American leader in this variety of infrastructure optimization, but in suburban areas and at agency boundaries, there exist significant opportunities to improve transfer coordination and infrastructure.

These diagrams illustrate coordination between regional rail, subway, and tram services at transfer stations in Berlin. At Wuhletal, the station and timetable are designed to allow riders to make cross-platform connections between fare integrated local and regional services without any wait time. At Fredrichschagen, tram services are scheduled to pulse with trains: inbound services arrive at the station just before inbound regional trains, and outbounds leave just after. This, too, serves to minimize waits, increasing connectivity and making multimodal trips more attractive to riders.

WUHLETAL STATION



To facilitate connections between services, the S5 and U5 timetables are coordinated. Shown below is the midday pattern of arrivals (as of 4/2019), which repeats every hour from 9am to 3pm.



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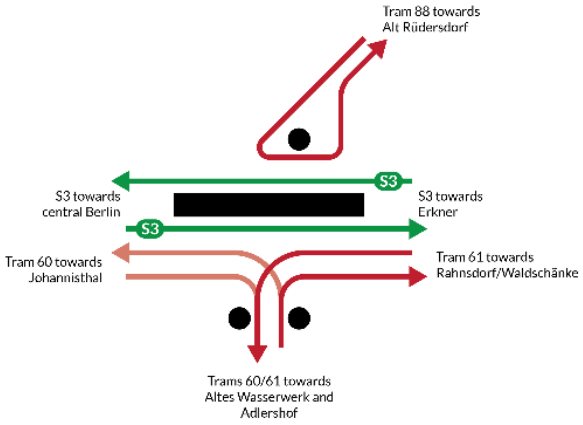
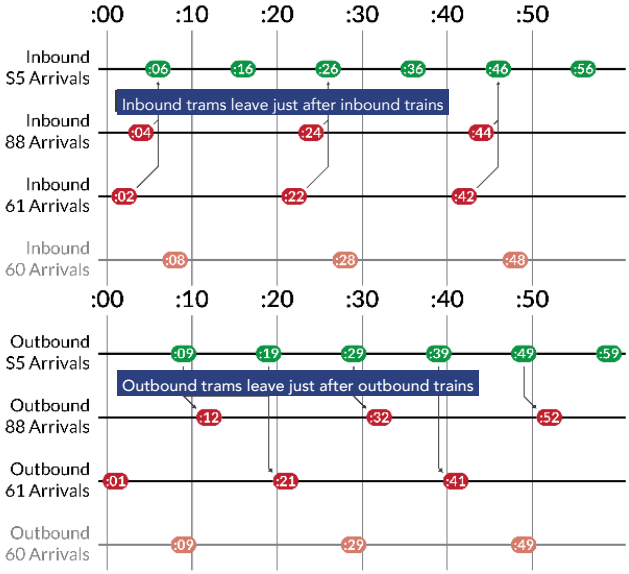
FRIEDRICHSHAGEN STATION



To facilitate connections between services, the S3, 61 and 88 timetables are coordinated. Shown on the right is the midday pattern of arrivals (as of 4/2019)



IMPROVE INNOVATION AND MULTIMODALITY

There are a number of innovative approaches that can facilitate better planning, and, in particular, real-time adaptation of the network and service levels to meet demand and disruptions. At the heart of these innovations is building the technological readiness of transit agencies, by ensuring that they have all the talent they need to operate in a digital environment.

Digital Twins

To respond to changing passenger travel patterns, governments and transit agencies have realized that greater flexibility is required in planning, scheduling, and routing. This has led to the emergence of data-driven decision-making support tools, known as **digital twins**. A digital twin is a digital replica of a physical environment that allows us to predict and control a system or network of systems. By using historic and real-time data, a digital twin can simulate both current and future behaviour by updating itself in response to changes in the physical system.[18] As a mobility solution, these simulation tools can enable multiple scenarios to be defined and explored, and can be used to provide flexible decision making process inputs and dynamic network optimization.

As a data-driven decision making support tool, a digital twin can analyze large volumes of historical data, combined with recent post-pandemic data, to analyze data and make predictions, and use AI models to extract insights, patterns, and identify possible outcomes.[19]

Use Technology to Integrate with Other Modes and Operators

There are also many opportunities to integrate transit with other modes, like bike sharing, micro mobility, and ride sharing. The more that riders are able to seamlessly integrate their travel between modes, the more likely they are to avoid using the car for their whole trip.

Riders should be able to plan and **book seamless journeys on all operators,** implementing the aspiration of mobility-as-a-service. Many users plan their trip with services like Google Maps, enabling riders to get information and schedule journeys on multiple agencies and modes. Apps like *Transit, Triplinx,* and *RocketMan* have additional functionality, allowing a user to book a trip including on-demand service, as well as providing real-time data on vehicle location and even crowding. This could be extended to enable integrated ticketing, as well as to include additional modes, like bike shares,

Vancouver's Translink includes secure and weather protected bike parkades at transit stations.

ride sharing, scooters, and other services. The system should be integrated so that riders can get book a ride share trip to take them to a rail station, take the GO Train, transfer to a bus, and then take a bike share from the bus stop to their final destination in a single transaction. These systems can provide data to track travel demand, and enable decisions based on factors beyond length of journey, such as carbon intensity, and accessibility.

Many transit riders also use ride sharing services, like Uber and Lyft, as part of their journey. There is potential for closer integration between these services and transit, so that people can use the apps to book a mixed transit and ride sharing journey, such as taking a ride share to the rail station and then using rail for the remainder of the journey. Right now, people are generally presented with an either-or option of transit or ride share. By integrating both, transit could become more attractive for ride sharing users who may choose to use transit for part of their journey, facilitating true mobility-as-a-service.

In Berlin, all services, including bus train, scooter, electric mini-scooter, bike sharing, ride sharing, and taxi services, are integrated into a single regional transit app. This makes it significantly easier to switch from one mode to another and can help people get more easily to the station.

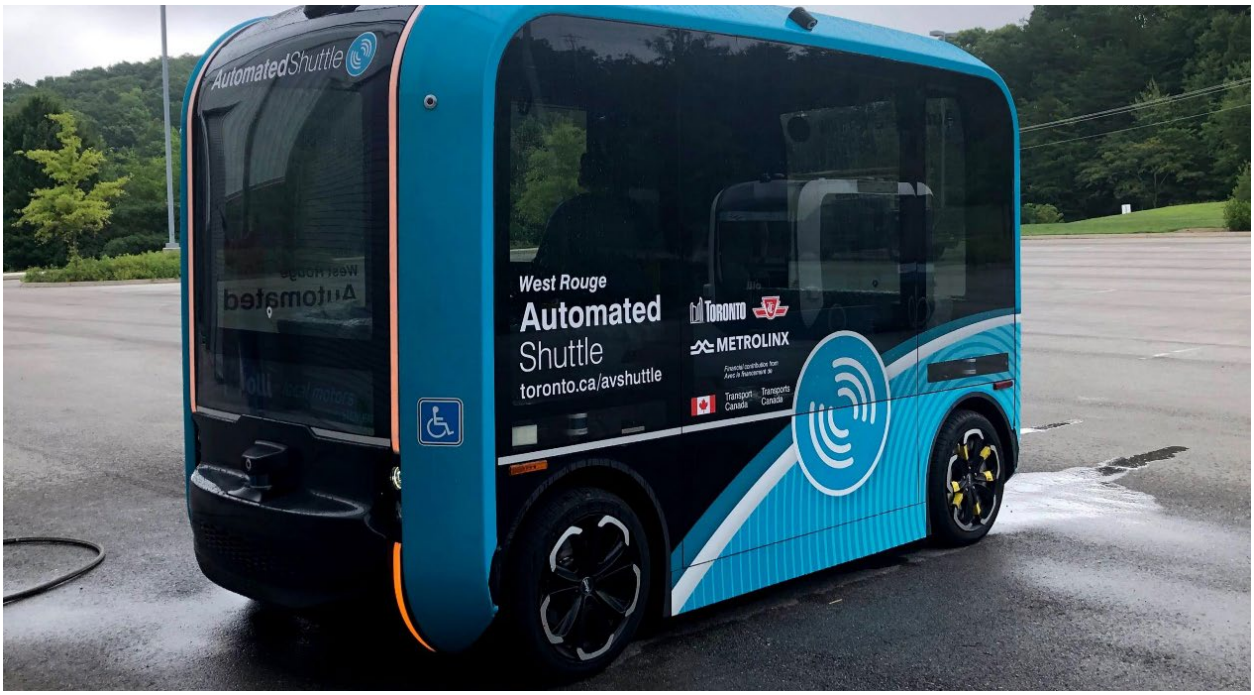
In order to create an environment where partnerships are fully leveraged, sharing data between entities and across public and private sectors must be a priority. In the transit and mobility industry, manual data exchanges continue to be common but limit the immediacy of data use, introduce errors, and unnecessarily curtail the scope of data exchange. Real-time data sharing can enable true integration and adaptation to rapidly changing needs.

Integrate New Modes Into the Transit System

Stations should also be designed to integrate other modes like cycling, ride-sharing, and micro mobility wherever possible. Integrating bike share docks at the station, for example, can significantly encourage use of cycling to access transit. In one British example, improvements to the road layout to facilitate cycling access to stations, as well as providing well-lit bicycle storage and lockers, resulted in a tripling of cycling trips to the station. Mobility interfaces should be designed with the customer in mind, in order to make it as easy and seamless as possible to switch between modes.

Bike sharing is a very effective means of extending the catchment area of transit service. By integrating bikeshare docks with transit stations and even bus stops, it is possible for riders to seamlessly extend their journey without needing to bring a bike with them on the transit vehicle. Bike sharing services are growing in many municipalities across the Toronto region, but there is a lot more opportunity to integrate them closely with transit service. For example, bike share should be able to be paid for with the same fare payment system as transit, and ideally a bike share journey could be included in the transit fare. Real-time information on bike share availability can be integrated into transit trip planning apps.

There is also growing demand for electric powered micro mobility for those who cannot or choose not to ride a bike. Several businesses have been trying to bring electric scooter sharing to the Toronto region, though several municipalities including the City of Toronto have chosen to prohibit their use. While there are challenges, like storage so that they do not become hazards on the street or sidewalk, as well as safety, micro mobility is a potentially effective way of extending transit catchment area and solving



West Rouge Automated Shuttle

last mile issues, particularly for those kinds of locations that are a long walk from the station but too close to viably use a connecting bus.

Micro mobility has typically been planned in an ad-hoc manner, separate from the overall regional transportation system. If we are more purposeful and include micro-mobility in planning and scheduling of the overall regional transportation system, it can become a more integral part of facilitating access for the region's residents.

Both Durham Region and Rouge Hill in Scarborough are the sites of automated vehicle pilot projects. They consist of a van-like shuttle that circulates through the neighbourhood and brings people to a nearby rail station. When vehicles are automated, it is possible to run them at very high frequency even when traffic is relatively low. Both pilot project locations are in environments where walking to the station is challenging, but the road network and population density are not conducive to an efficient conventional transit service. In several Japanese cities, for example, new developments have been built with an automated people mover to take residents to the nearest rail station.

Enhance the Value Proposition for Smarter Mobility Choices

Employers can play a role in driving sustainable mobility. As part of Lisbon's focus on mobility innovation and sustainability as a way to improve the quality of life of its citizens, Lisbon partnered with its stakeholders to implement a Corporate Mobility Pact.[20] The vision is for corporate leaders and cities to collaborate to accelerate the sustainable urban mobility transformation. It is a public grouping of stakeholders with the common ambition to actively improve and transform mobility in Lisbon. The Pact calls for private and public companies based in Lisbon to take ownership of their impact on mobility issues in the city, with an aim to optimizing and decarbonizing corporate operations and fleets, promoting diversification of the modal mix, and promoting growth of multimodal transport.

Signatories agreed to implement two initiatives in two years – an ask paused by the pandemic but quickly regaining steam. Over 85 companies have signed on to date.

Major employers represent significant mobility demand and are well positioned to stimulate these markets through demand-side interventions in collaboration with suppliers. Programs can enable businesses to partner with transit agencies to help get people back on the transit system. Generating deep insights into what drives mobility choices in a region and provide data required to enable employers to make decisions about programs and incentives that can help them achieve their own climate objectives.

Exploring Success Stories

The following sections will explore examples of transit system success in the Toronto region that exemplify the recommendations in this report. These case studies take multiple forms: one examines the history of transit in the City of Toronto to see how it succeeded in attracting riders to transit even in the postwar years as car ownership rose dramatically; one examines a fast-growing Toronto suburb that affordably attracted thousands of new riders to transit by improving service; and one examines an innovative regional transit agency that is using on-demand service to make transit universally accessible where it wouldn't be achievable with fixed-route service.

MUNICIPALITY	ANNUAL VEHICLE HOURS PER CAPITA	ANNUAL RIDERS PER CAPITA
Brampton	1.9	50.2
Burlington	1.0	11.0
Durham Region	0.9	18.3
Guelph	1.4	43.2
Hamilton	1.6	41.1
Mississauga	2.0	52.0
Oakville	1.0	15.0
Toronto	3.9	176.2
Waterloo Region	1.6	43.1
York Region	1.2	20.0

[21]

TORONTO IN THE 1960S: TRANSIT IN THE AUTO-ORIENTED SUBURBS

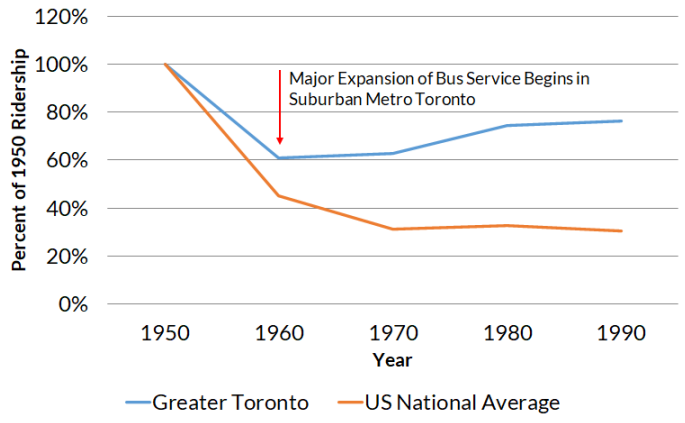
Toronto was once a transit model. In an era when new highways were criss-crossing the city and thousands of new houses with garages spread across what had once been farmland every year, Toronto still managed to keep transit strong: from the Second World War to 1970, Toronto was the only major urban region in North America where transit ridership grew. At the same time, U.S. annual per capita transit ridership plunged by more than two-thirds.

What did Toronto do differently in this period? The differences in highway construction and land use were marginal. The tragedy of white flight and racial segregation that later plagued historic American cities had not yet taken full hold. Where Toronto differed was in the amount of transit service it provided. While most American cities did not meaningfully expand frequent local transit service beyond the area that had already been developed before the war, Toronto began rolling out high quality bus service to new suburbs as soon as they were built.

Toronto Summary

- Toronto added significant service to new suburbs, and the new service unexpectedly attracted major ridership growth, which created a virtuous spiral of further service improvements and ridership gains
- Toronto's approach to service meant that it was the only city in North America that saw transit ridership growth in the postwar years
- Cuts to service in the early 1990s caused a vicious cycle of ridership decline that took many years to recover from

US Comparison Chart



While most American cities did not meaningfully expand frequent local transit service beyond the area that had already been developed before the war, Toronto began rolling out high quality bus service to new suburbs as soon as they were built.

Toronto's transit ridership followed a very similar trajectory to that of American cities in the 1950s, but after radically expanding frequent service to the new suburbs in the 1963, it was able to turn around the decline. After the 1980s, population growth began to occur primarily outside the City of Toronto, in areas where frequent transit service was not provided at the same time as development. That, along with service cuts in Toronto, led to a decline in per capita ridership.

Don Mills (left) was the prototypical Toronto suburb of the postwar years. It would be difficult to distinguish its built form from Levittown, New York, the classic American suburb of the era (right).

Until the early 1960s, Toronto's transit ridership was in a decline similar to that of most American cities (see chart on page 21). That trajectory suddenly turned around in 1963 and was followed by steady growth for decades. What happened? It wasn't a large new subway—the Yonge subway had opened in 1954, while the Bloor-Danforth line was not to open until 1966. Instead, it was the choice to implement a grid of frequent bus routes throughout the new suburbs. The TTC had its service area extended to encompass all of Metropolitan Toronto when the new Metro government was created in 1953. Service beyond the City of Toronto, however, remained limited for another decade.

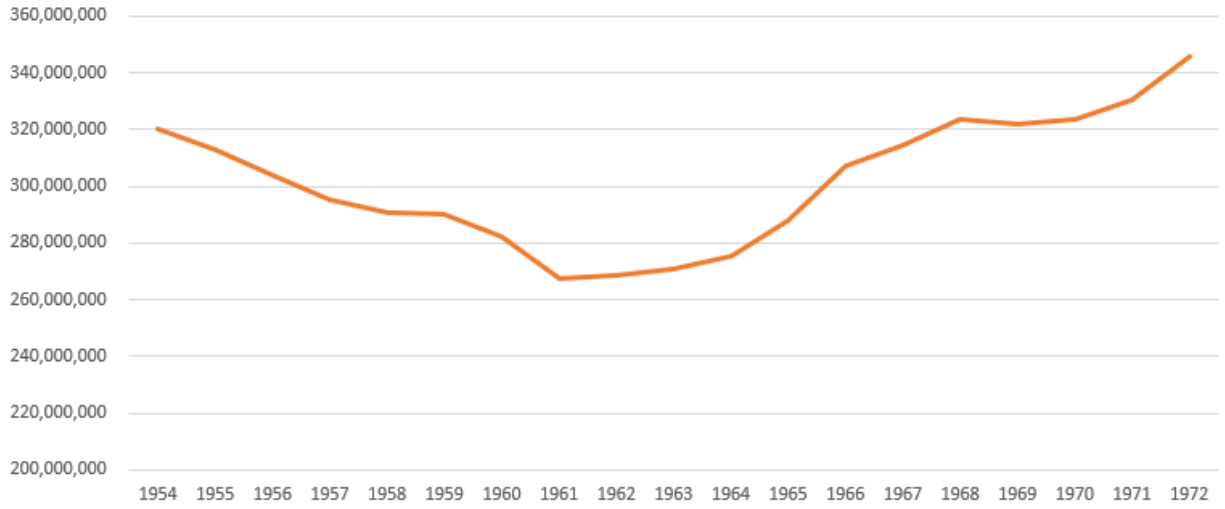
In fact, Metropolitan Toronto wasn't all that much different from American cities in the 1950s and early 1960s. It was building an extensive expressway network, including Highway 401, the Lakeshore (Gardiner) Expressway, and the Don Valley Parkway. Most new homes were built with garages on winding suburban streets. Don Mills—the prototypical Toronto suburb—was largely indistinguishable from American suburbs of the era.

Still, when high-quality service was finally introduced in the new suburbs, their residents shocked everyone by flocking to the new bus services. Ridership was so high that the routes even managed to turn a profit in their first year of operation. Instantly, the steady decline of transit ridership was reversed. The success of the first new services encouraged the development of ever more local transit service, which in turn attracted even more riders, and today, suburban Toronto is one of the most transit accessible regions in the country.

Tellingly, transit's mode share in the old City of Toronto is not exceptional by North American standards at 39.2%—it is not significantly higher than cities like Washington, Boston, and San Francisco. It is in the suburbs like Scarborough, North York, and Etobicoke where Toronto is extraordinary. For work trips, the mode share at 35.5% in those auto-oriented suburbs is barely lower than in the old city. In typical American suburbs, that figure would be in the single digits.

The high level of local transit service also serves to make Toronto's subway North America's busiest per kilometre. A subway system can never be within walking distance of most residents in a city, meaning that there needs to be some other means of access than on foot. In some cities, the emphasis has been on park-and ride. However, a typical suburban Toronto subway station can carry more than 20,000 riders per day. If they all came by car, every single station would need to have a car park the size of Disney World's. Since that is clearly infeasible, as well as environmentally undesirable, a different method is needed to get people to the station: the local bus.

TTC Annual Ridership



It is in the suburbs like Scarborough, North York, and Etobicoke where Toronto is extraordinary. For work trips, the mode share at 35.5% in those auto-oriented suburbs is barely lower than in the old city. In typical American suburbs, that figure would be in the single digits.

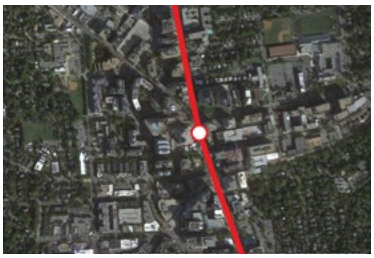
To make connecting between bus and subway attractive, the TTC made the buses come frequently enough that riders do not need to closely adhere to a schedule, and a missed connection, while frustrating, isn't nearly as painful as when a bus comes once an hour. Furthermore, the fares are fully integrated, and at most non-downtown stations' riders don't need to pass through a fare gate—buses and streetcars pull right into an off-street terminal above the subway station. The demand created by trips to the subway helps to justify frequent transit service that makes transit viable on trips that do not involve the subway, such as people transferring from an east-west to a north-south bus route to make a diagonal trip across the suburbs.

Out of this era of success, the TTC developed comprehensive service standards, mandating that everyone in the city be within walking distance of a frequent transit route. They also ensured that 24-hour service was available throughout the city. This model of codified service standards has since been emulated by other successful systems in the region and elsewhere.

In subsequent decades, however, the Toronto region has ceased to be as extraordinary a model. As development spread beyond the boundaries of Metropolitan Toronto in the 1970s, newly developed areas were no longer served by the TTC and did not receive high levels of transit service as they were built. Instead, it has taken decades for service in those regions to match that in similar suburban neighbourhoods on the Toronto side of the boundary, and to this day there are substantial differences in most areas. Unsurprisingly, ridership outside the City of Toronto is considerably lower than within the city, where transit service is generally more frequent.

Finch Avenue is home to one of the busiest bus routes in North America, even though much of its adjoining land use is low-density strip malls and single-family homes. Riders are attracted to transit from their cars through the very frequent service.

El Cerrito del Norte
System: BART
Station area land use: park and ride lot, suburban retail and housing
Weekday ridership (2019): 15,542



Bethesda
System: WMATA
Station area land use: transit-oriented satellite mixed-use district
Weekday ridership (2019): 18,170

York Mills
System: TTC
Station area land use: low-density suburban development and open space
Weekday ridership (2018): 29,660

Cuts to transit service in the 1990s recession, as well as steep fare hikes, reversed the decades-long virtuous cycle and created a vicious cycle of ridership declines and service cuts. It took over a decade for the TTC to recover its 1989 ridership, and some routes have never caught up. Notably, service on the downtown streetcar routes was severely cut, resulting in a major decline in ridership that has never been reversed. Riders travelling short distances are especially sensitive to reduced service.

A firm commitment to supporting transit by both the Metro and Provincial governments meant that the TTC's service was preserved through the early 1980s recession, and transit ridership stayed steady even through that grave economic crisis. The same was not true in the early 1990s, and it produced lasting damage to the system. It is essential that the COVID pandemic does not produce the same vicious spiral of service reductions driving riders away.

BRAMPTON: TRANSIT CAN SUCCEED IN SUBURBIA

We do not have to go back to the 1960s, however, to see a very similar success story in the Toronto region. After expanding its service levels to provide a grid of frequent all-day bus routes on major roads, Brampton Transit experienced ridership growth of 160% from 2009 to 2019-- an amount unprecedented for a major system anywhere on the continent. In fact, these gains came at a time when stagnation of transit ridership was a widespread concern in many North American cities. And they came without a major increase in the percentage of subsidy that transit received.

Brampton is a fairly typical fast-growing suburb. Its population of about 650,000 live predominantly in single-family homes and townhouses with garages; some larger apartment buildings are interspersed. Roads are wide and free parking is ample. It is home to part of the large Pearson airport employment zone, and it hosts a wide variety of industrial and logistics businesses. Though it has some advantages, it is not the kind of environment that would normally be expected to be a transit success story.

Still, the City of Brampton adopted a Transportation and Transit Master Plan in 2004 that aimed to pursue a more balanced transportation policy, in comparison with the previous emphasis on automobile transportation. The plan included shifting the system from a network of relatively infrequent routes that looped through the city's neighbourhoods to a grid of frequent bus routes along the city's arterial roads. Just about everyone in the city would find themselves within walking distance of a well-served route, and, thanks to the grid, they would generally be able to get anywhere in the city with a single transfer.

These service improvements were intended to build ridership for further investment in BRT and, eventually, LRT. This demonstrates a key lesson: BRT and LRT systems will be most successful when ridership has already been built up with frequent conventional service. Furthermore, BRT and LRT ridership will be higher when people with origins or destinations off the corridor can connect to a relatively well-served conventional route.

The critical policy was to bring service to every ten minutes on key routes—frequent enough that people can turn up and go without checking a schedule. Once Brampton Transit introduced these new services, they saw an immediate spike in ridership. These increases in turn justified further service improvements, which resulted in even more ridership growth. It was a virtuous cycle that propelled Brampton to unprecedented transit ridership growth.

Brampton Summary

- Grew ridership by an unprecedented 160% in ten years
- Implemented a high frequency grid network throughout the city
- Built a branded BRT network on key corridors
- Improved public information, including real-time bus arrival information
- Integrated service with adjacent municipalities

The critical policy was to bring service to every ten minutes on key routes—frequent enough that people can turn up and go without checking a schedule. Once Brampton Transit introduced these new services, they saw an immediate spike in ridership.

With the grid of basic service implemented, Brampton moved forward with further plans to make service more attractive. This culminated in the implementation of the Züm BRT network. The busiest bus routes were upgraded into a network that used specially branded buses to raise awareness of the service and to convey a premium image. Attractive shelters made it impossible for passers-by to miss the new investment in transit, and they provided a much more comfortable waiting space for riders.

In addition to the publicity provided by the visibility of the new vehicles and infrastructure, the agency also launched a major marketing campaign to raise awareness of the new services. The improvements were also coupled with investment in new technologies, including online real-time information, so every rider would know exactly when to head to their stop.

Brampton Transit and York Region Transit also partnered on valuable service integration. Since many Brampton residents study at York University or work in Vaughan, the Züm Queen route was extended all the way to York University. Some trips used Highway 407 through York Region, while others used YRT's VIVA BRT infrastructure on Highway 7. These services made it easier for riders to travel between the municipalities, while also providing improved service for York Region residents along Highway 7 in Vaughan. This is an example of the kind of win-win scenario that would be possible with more widespread fare and service integration.

There are further plans to expand the Züm network to additional corridors, and longer-term plans to build full BRT in the median of roads, as is currently in place in York Region. Furthermore, in partnership with Mississauga, Brampton will soon be served by an LRT route along Hurontario and Main Street, connecting a major bus hub to key employment areas in Mississauga. A future extension is planned north to Downtown Brampton, where a connection with GO Transit's Kitchener rail corridor is available.

It is important to remember Brampton's bus routes, some of which have tens of thousands of riders per day, generally serve roads that are lined with industrial buildings, big-box stores, and the backyard fences of single-family homes. If transit can succeed there, it can succeed anywhere.

Sue Connor, who led the agency for much of the period when these improvements took place, has since become head of Burlington Transit. That agency has begun implementing the same model—a frequent service grid—that worked so well in Brampton. In the few months that it was in place prior to the COVID pandemic, they had already achieved a remarkable 14% increase in ridership. This clearly demonstrates that the model is replicable throughout the Toronto region.

DURHAM REGION: NEW APPROACHES ALLOW RELIABLE SERVICE IN A CHALLENGING ENVIRONMENT

Durham Region, east of Toronto, took the crisis of COVID-19 and turned it into an opportunity by establishing strong service standards on key routes and introducing on-demand services everywhere else so that everyone can use transit when they need it.

Durham Region Transit serves the 700,000 residents of its fast-growing region, which includes a string of cities along Lake Ontario in the south, along with a vast rural area stretching north to Lake Simcoe. It is home to many commuters to Toronto, but also a large employment base in its own right, including two of Ontario Power Generation's nuclear power stations, the newly reopened GM assembly plant in Oshawa, and Ontario Tech University. Like Brampton, most Durham Region residents live in single-family homes and most destinations have free parking, making it a challenging environment for transit.

Prior to the pandemic, Durham Region Transit was a leader in providing effective feeder service to the GO Transit network, taking advantage of the relatively high frequency of trains on the Lakeshore East rail corridor through its main cities, including timed connections between bus routes and GO trains. Since the full reopening of Toronto's downtown core remains in the future, ridership connecting to GO remains at only 30% of its 2019 level as of September 2021. Trips to schools and post-secondary institutions, another key market, were hit just as hard.

This collapse in ridership inevitably led to significant reductions in service. The agency, however, chose to get creative so that they could achieve major gains in accessibility with the resources that they still had. They introduced a service standard that all fixed routes will have trips at least every 30 minutes from 5am until midnight, every day. If an area couldn't be served viably with that level of service, meaning that the route carried fewer than 15 riders per hour off peak, they would implement 24/7 on-demand service. When fixed-route service shut down for the night, on-demand would be available in those areas too, making Durham Region one of the few places on the continent with 24/7 transit service everywhere in the urban part of the region.

Durham Region Summary

- Used pandemic as catalyst for restructuring of the system
- Established a minimum service standard of every 30 minutes on all routes
- Where that service level could not be provided, technologically enabled on-demand service was introduced
- As demand increases, fixed routes are reintroduced
- 24/7 service is available throughout the urban area
- Continued implementation of Pulse BRT network on key corridors

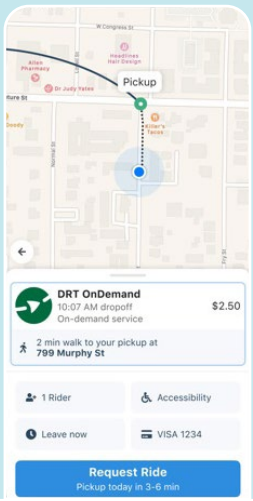
HOW IT WORKS

Download the Transit and DRT On Demand apps
(riders without a smartphone may call to book service).

Select origin and destination points and desired departure time

Transit app will provide the shortest route, and automatically book an on-demand trip timed to link up with connecting transit services

Check app to know when the on-demand bus is approaching.



In every suburban system, there will be some areas that are hard to serve with a 40-foot bus running on a reasonable frequency. Meandering suburban streets can make routes slow and indirect. In Durham Region, they found that these non-core routes combined to account for only 2% of total ridership. While the main grid of arterial roads enjoyed improved service, the remaining routes were replaced with on-demand service. As ridership returns and enough people in certain corridors request on-demand journeys, those fixed routes are being restored.

The service is operated in part by minibuses that had previously been an underused part of the agency's fleet. In areas where demand is lower, like the rural part of the region, it is operated by a contracted taxi company. The physical and technological infrastructure in place for on-demand service can also be used for specialized service for riders with disabilities who are unable to use conventional transit.

On-demand service isn't new. "Dial-a-ride" services have been offered by many agencies for decades. New technology, however, makes the process far more viable. Riders are able to easily book their trip through an app and watch the vehicle's progress to them. That is a major advance from previous practice, where riders would have to book a trip with a telephone dispatcher, from whom they received a wide time window where they would have to wait at the stop. For the agency, the same technology sends the vehicle on the most efficient route possible.

Durham Region is not the only area that has embraced on-demand transit. Beloeil, a close Montreal suburb, reduced bus sizes and replaced all bus routes with a "ride as a service" approach that picks up passengers at their origin and drops them directly at their destination at a standard transit fare.

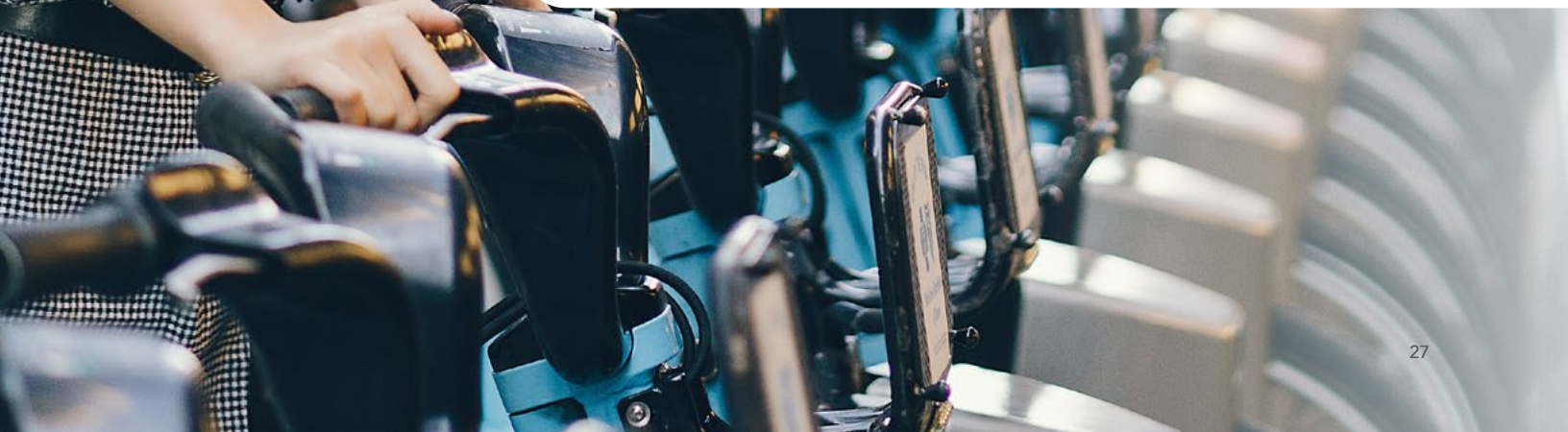
Durham Region has taken advantage of the pandemic crisis to create a quantum leap in transit service. From a system that once offered more limited service in comparison to some other parts of the region, Durham now has the unique distinction of providing 24/7 service throughout its service area. Furthermore, they have established clear service standards that will result in implementation of routes with guaranteed service levels as demand appears, with on-demand providing the service needed to demonstrate that demand. Durham has built a solid foundation for pandemic recovery.

Conclusion

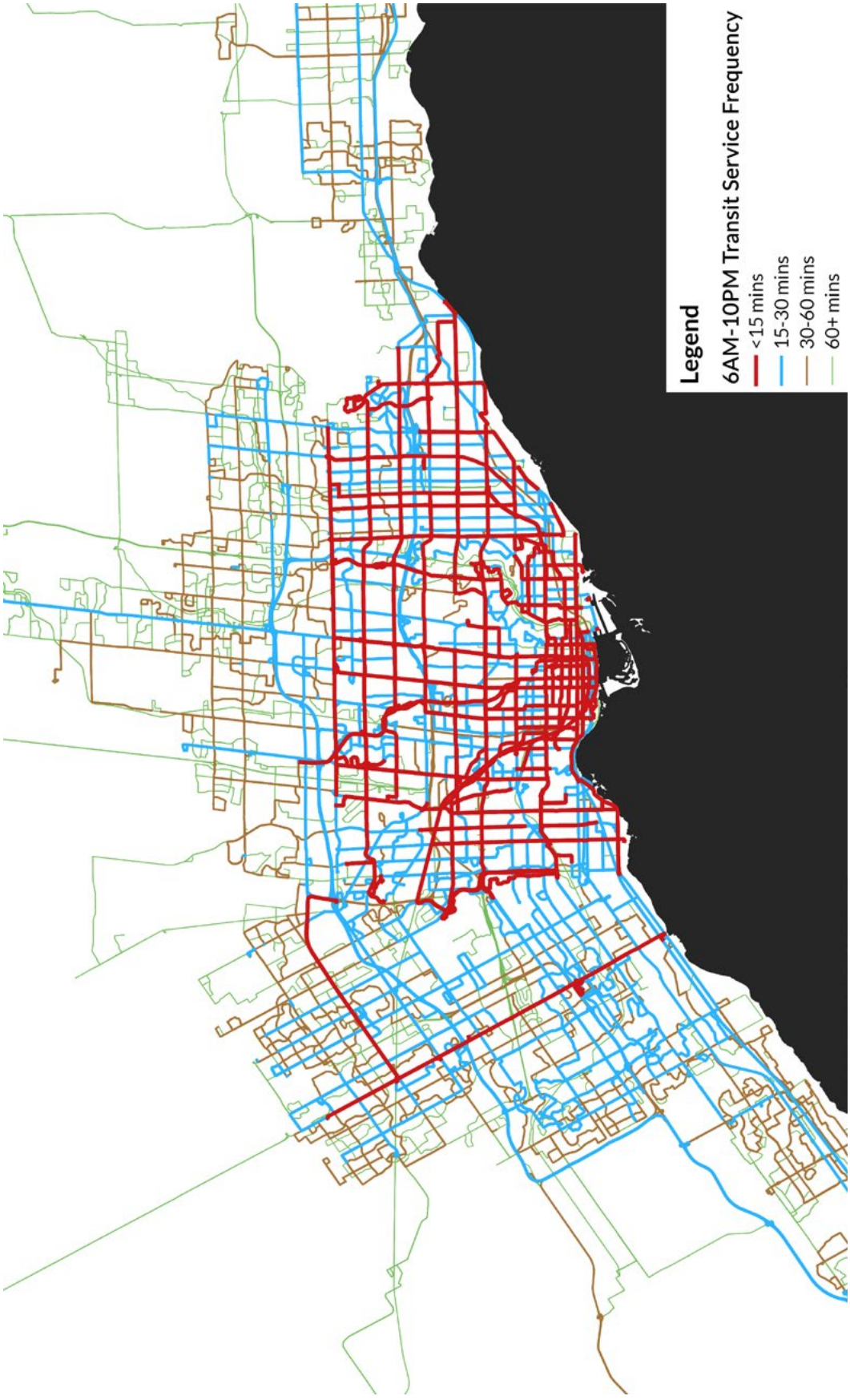
Without efficient travel from and to the front door of a person's origin and destination, even the best regional transit system is ineffective. Most of a region's residents and destinations will never be within walking distance of rail service—that's why it's essential to ensure that local transit and other innovative solutions are in place to ensure people see transit as a viable component of all journeys and that incentives are in place to promote smarter, greener mobility choices. Residents of the Toronto region who can't or who choose not to drive should never be restricted in terms of the employment and other opportunities they can access. That's why a strong local mobility network is essential for an efficient and equitable transportation system.

Building on this research, the Board will be embarking on deep dives examining mobility issues in specific areas, like the Pearson Employment Zone, which is a key example of a major but very widely dispersed employment area. Like many others in the region, these areas need a strong local transit network and other mobility options so that people do not have to rely on their cars.

The Toronto region has a strong legacy of transit successes, and is the site of innovative new approaches to mobility. While big infrastructure projects gain a lot of attention, and are unquestionably important, we must not forget the smaller scale initiatives and projects that are needed to make universal access a reality. The Toronto region needs fare and service integration so that people can travel seamlessly between modes and across jurisdicional boundaries, and we need investment in regional rail to provide a fast and high-capacity regional transit backbone. And to tie it all together, we need a strong local mobility system.



APPENDIX


Legend
6AM-10PM Transit Service Frequency
<15 mins
15-30 mins
30-60 mins
60+ mins

ENDNOTES

1 "A Green Light to Moving The Toronto Region", Toronto Region Board of Trade - https://www.bot.com/PolicyAdvocacy/Campaigns/LetsBreakTheGridlock.aspx

2 "Housing a Generation of Workers", Toronto Region Board of Trade- https://workforcehousing2.trbot.ca/

3 The TRBOT through its Economic Blueprint Institute recently introduced the business district framework, a new tool for integrated economic planning at the metropolitan scale. https://supportbusiness.bot.com/ready-toronto/business-districts/

4 https://www.sciencedirect.com/science/article/pii/S0965856418300296

5 https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/finance/ca-economic-outlook-october-2021-report-en-new.pdf?icid=eo-report-october-2021-aoda-en

6 Charting a path to recovery - Economic outlook (deloitte.com)

7 https://www2.deloitte.com/ca/en/pages/public-sector/articles/the-future-of-urban-mobility.html

8 https://www.afr.com/companies/transport/covid-s-other-nasty-side-effect-traffic-snarls-20211018-p590xh

9 https://www.nytimes.com/2021/10/01/nyregion/new-york-traffic.html

10 https://www2.deloitte.com/ca/en/pages/public-sector/articles/the-future-of-urban-mobility.html

11 https://www.cp24.com/news/ttc-ridership-could-linger-below-pre-pandemic-levels-for-at-least-another-two-years-report-1.5586747?cache=300
https://www.cbc.ca/news/canada/montreal/stm-service-cuts-1.6211998

12 https://www.ontario.ca/page/towards-greater-golden-horseshoe-transportation-plan-discussion-paper

13 https://nacto.org/docs/usdg/shared_use_bus_priority_lanes_on_city_streets_agrawal.pdf; https://uspirg.org/blogs/blog/usp/reimagining-street-how-bus-lanes-speed-morning-commute-and-why-it-matters; https://www.sciencedirect.com/science/article/pii/S0386111214601424; https://archive.curbed.com/2020/1/23/21077583/bus-transit-traffic-congestion-busway-car-free; https://psmag.com/social-justice/designing-a-better-bus-lane

14 https://www.toronto.ca/legdocs/mmis/2019/ex/bgrd/backgroundfile-131188.pdf

15 https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/

16 https://nacto.org/publication/transit-street-design-guide/intersections/signals-operations/active-transit-signal-priority/

17 A similar approach was once used at Bloor Street for transfers between the then-streetcar and the Yonge subway.

18 https://www.optimalreality.com/

19 https://www2.deloitte.com/uk/en/pages/consulting/solutions/motion-simulator.html

20 Lisbon Corporate Mobility Pact, https://www.bcsdportugal.org/wp-content/uploads/2020/02/FINAL-CMP-_-English-and-Portuguese_10.10-1.pdf

21 2018 Fact Book, Canadian Urban Transit Association.

Acknowledgements

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