

# **Public Transit:**

## **GGR424 - Transportation Geography & Planning**

Jeff Allen

University of Toronto

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## What is public transit?

- ▶ Regularly scheduled vehicle trips
- ▶ Open to all paying passengers
- ▶ Can carry multiple passengers
- ▶ Whose trips may have different origins, destinations, and purposes

"transit is about multiple people riding in one vehicle even though they are not intentionally travelling together or even going to the same places"

Walker (2011)



## Public Transit Benefits: Efficiency



[https://www.reddit.com/r/Damnthat'sinteresting/comments/daugu5/public\\_transport\\_vs\\_private\\_transport/](https://www.reddit.com/r/Damnthat'sinteresting/comments/daugu5/public_transport_vs_private_transport/)

**What makes transit useful?** Seven demands of public transit:

1. It takes me *where* I want to go
2. It takes me *when* I want to go
3. It is a good use of my *time*
4. It is a good use of my *money*
5. It *respects* me in the level of safety, comfort, and amenity it provides
6. I can *trust* it
7. It gives me *freedom* to change my plans

Walker (2011)

## Components of a public transit system:

- ▶ **Network** - the combination of all connecting routes and stops
- ▶ **Routes** - connections between stops, usually fixed
- ▶ **Vehicles** - that traverse routes on set schedules
- ▶ **Stops** - where people access and exit the network, or transfer between routes



# Types of transit network layouts: Radial



<https://www.gotransit.com/en/trip-planning/system-and-route-map>

# Types of transit network layouts: Grid

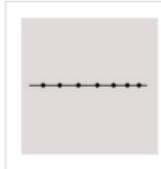


<https://www.ttc.ca/routes-and-schedules/>

# Types of transit network layouts: Circle-Radial



# Types of transit network layouts:



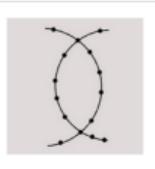
Line, e.g. Algiers, Almaty, Baltimore, Cleveland, Gwangju, Helsinki, Hiroshima, Jakarta, Kazan, Miami, Mumbai, Quito, Sydney, Yekaterinburg, Lima



Cross, e.g. Atlanta, Bangalore, Incheon, Kyoto, Monterrey, Nizhny Novgorod, Panama City, Philadelphia (SEPTA), Rotterdam, Sendai, Warsaw



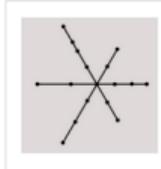
X-shaped, e.g. Amsterdam, Brussels, San Francisco Bay Area, Stockholm, Thessaloniki



Two crossing paths (air bladder), e.g. Cairo, Chennai, Lille, Marseille, Montreal, Nanchang, Nuremberg, Rotterdam, Toronto



Secant, e.g. Athens, Budapest, Busan, Guadalajara, Kharkiv, Hyderabad, Lisbon, Milan, Munich, Philadelphia (including PATCO), Prague, Rome, São Paulo, Tashkent



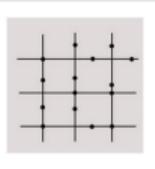
Radial, e.g. Boston, Budapest, Buenos Aires, Chicago, Daegu, Kyiv, Los Angeles, Sapporo, Tehran, Washington



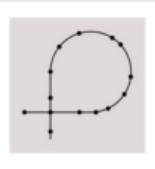
Circle, e.g. Glasgow



Circle-radial, e.g. Bangkok, Beijing, Bucharest, Chengdu, Chongqing, Copenhagen, Delhi, Hamburg, London, Madrid, Moscow, Nagoya, Paris, Seoul, Shanghai, Singapore, Tokyo, Zhengzhou



Complex grid, e.g. Barcelona, Berlin, Guangzhou, Hangzhou, Hong Kong, Mexico City, Milan, Nanjing, New York, Osaka, Shenzhen, Taipei, Tianjin, Wuhan, Vienna



Extended loop, e.g. Sofia, Naples, Newcastle

## Route Characteristics:

- ▶ Technology
- ▶ Level of separation from other transport
- ▶ Capacity
- ▶ Comfort/Safety
- ▶ Frequency
- ▶ Stop Spacing
- ▶ Reliability
- ▶ Network hierarchy



## Routes - Technology



## Routes - Level of separation from other transport

1. Completely separated (can be above, below, or at ground-level)
  - ▶ e.g. TTC Subway Lines
2. Separated from other traffic, but with at-grade crossing
  - ▶ e.g. Spadina Streetcar, Eglinton LRT, Highway 7 BRT
3. Shared with traffic
  - ▶ e.g. Most TTC bus and streetcar routes



## Routes - Level of separation from other transport

1. Completely separated (can be above, below, or at ground-level)
  - ▶ many names, e.g. Rapid Transit, Metro, Underground, Heavy Rail, etc.
  - ▶ Run in exclusive Rights Of Way (ROW)



## Routes - Level of separation from other transport

### 2. Separated from other traffic, but with at-grade crossing

- ▶ LRT (Light Rail Transit)
- ▶ BRT (Bus Rapid Transit)



[https://en.wikipedia.org/wiki/Light\\_rail](https://en.wikipedia.org/wiki/Light_rail)

## Routes - Level of separation from other transport

### 2. Separated from other traffic, but with at-grade crossing

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- ▶ BRT (Bus Rapid Transit)



## Routes - Level of separation from other transport

### 3. Shared with traffic



## Routes - Capacity

Can be measured per vehicle, or per route in a given time (e.g. an hour)



[https://en.wikipedia.org/wiki/Medellin\\_Metro](https://en.wikipedia.org/wiki/Medellin_Metro)



# Routes - Comfort & Safety

Some components can be measured like crowding, but many are subjective

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## Quarter of TTC surface routes regularly exceed crowding standards

TTC numbers show that 43 of roughly 155 bus and streetcar routes exceed the transit agency's crowding standards at some point during the week.

By [Ben Spurr](#) Transportation Reporter  
▲ Fri., Nov. 18, 2016 | 4 min. read

 [READ THE CONVERSATION](#)



## example of a TTC stop schedule (501)

### Routes - Frequency

In transit planning & operations, frequency is often measured by a routes scheduled **headway**, the time between vehicles

"Frequency is freedom" - Walker

5 AM	5:30	5:38	5:46	5:48	5:55	
6 AM	6:03 6:51	6:11 6:59	6:19	6:27	6:35	6:43
7 AM	7:07	7:15	7:26	7:36	7:44	7:52
8 AM	8:01 8:49	8:09 8:57	8:17	8:25	8:33	8:41
9 AM	9:05 9:53	9:13	9:21	9:29	9:37	9:45
10 AM	10:01 10:47	10:09 10:55	10:17	10:25	10:30	10:39
11 AM	11:03 11:51	11:11 11:59	11:19	11:27	11:35	11:43
12 PM	12:07 12:55	12:15	12:23	12:31	12:39	12:47
1 PM	1:03 1:51	1:11 1:59	1:19	1:27	1:35	1:43

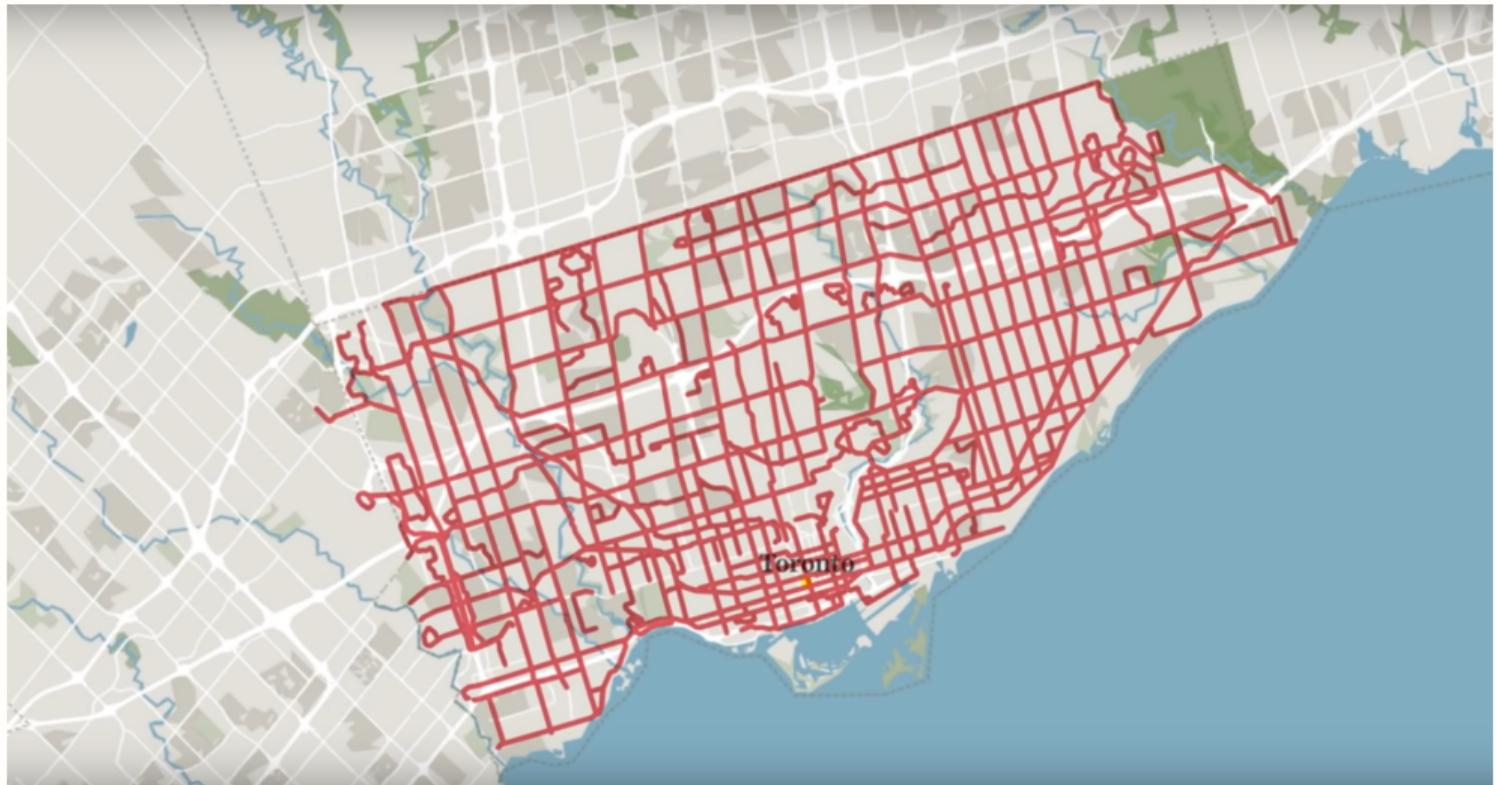
## Routes - Frequency

e.g. bus that comes every 30 minutes, until midnight, 7 days a week:



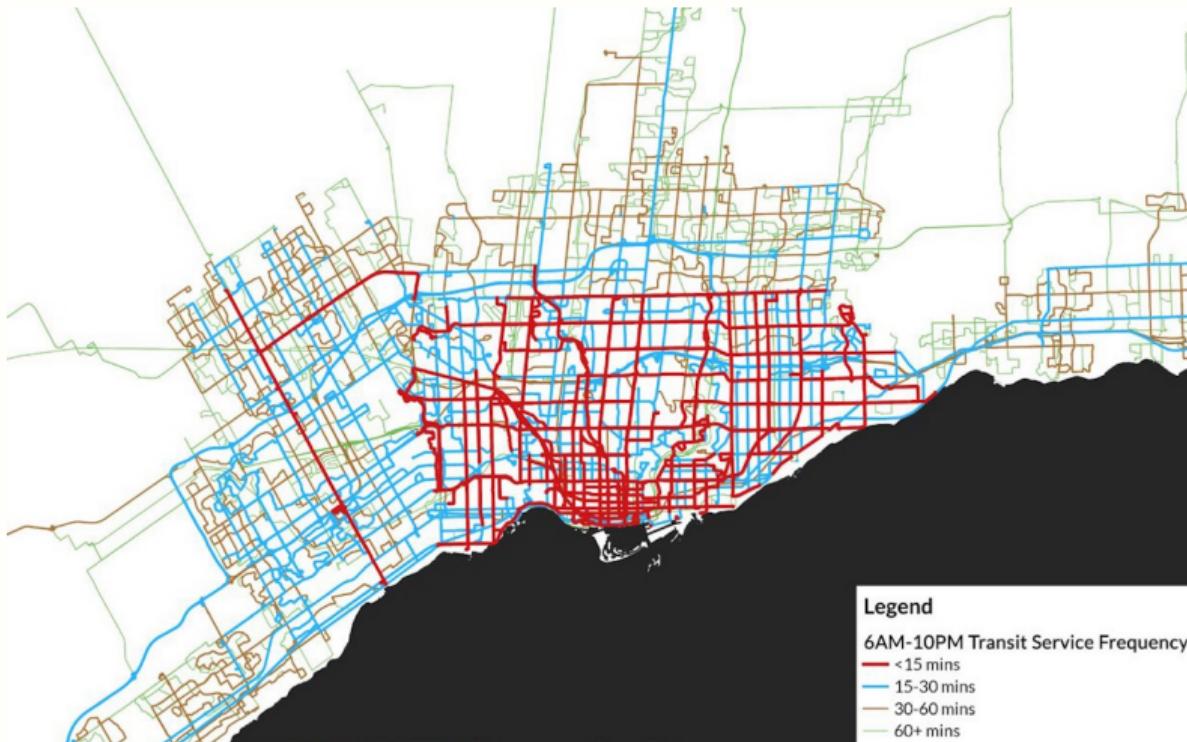
<https://www.youtube.com/watch?v=-ZDZtBRTyeI>

## Routes - Frequency



<https://www.youtube.com/watch?v=-ZDZtBRTyeI>

## Routes - Frequency

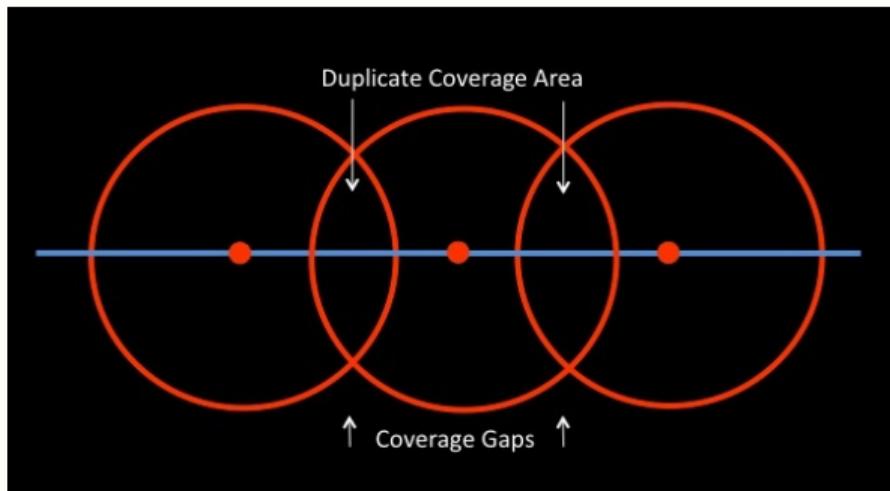


<https://urbantoronto.ca/news/2021/11/board-trade-urges-frequent-transit-service-across-region>

## Routes - Stop Spacing

TTC Bus & Streetcar routes have stops every 100m-300m

More stops means better local access, but reduced speeds and longer travel times because the vehicle needs to make more stops. i.e. a trade-off.



<https://humantransit.org/2010/11/san-francisco-a-rational-stop-spacing-plan.html>

## Routes - Stop Spacing

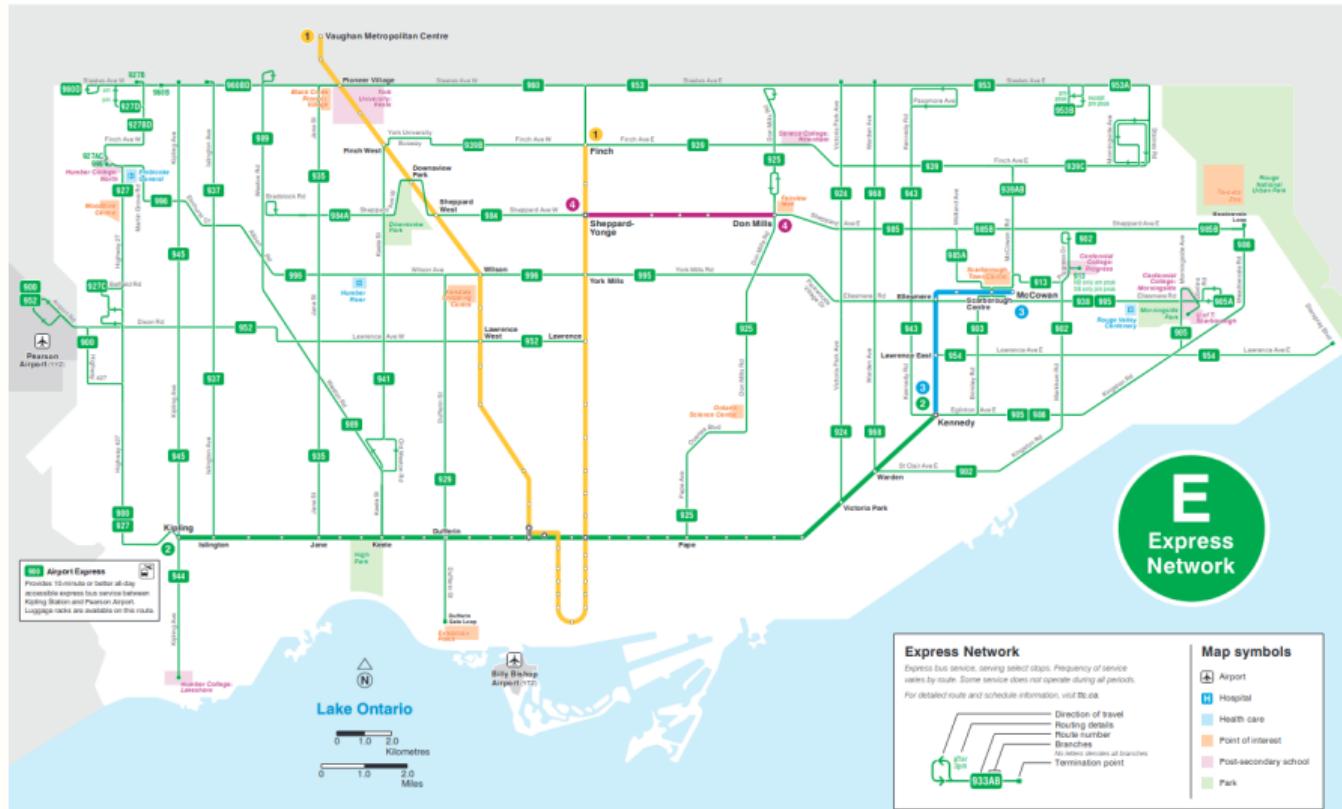
Local access to a stop depends on urban form / street networks (more on this next week)



# Routes - Stop Spacing, e.g. having "express" and "local" buses



Express Network Map



# Routes - Reliability

Does the vehicle arrive on time?

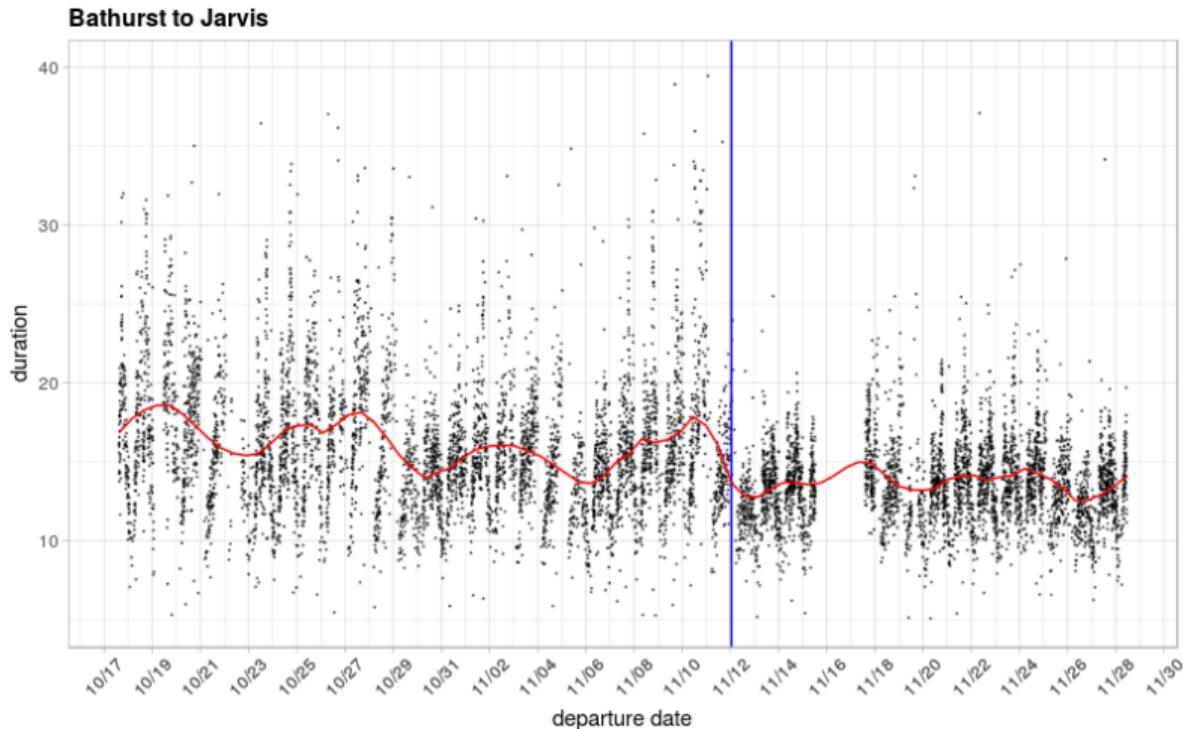


Sort

Sort

## Routes - Reliability

Expected travel times, e.g. along King Street before and after reducing traffic:



## Routes - Reliability

What causes "bus bunching"?



# Routes - Reliability

What causes "bus bunching"?

Why do buses bunch?

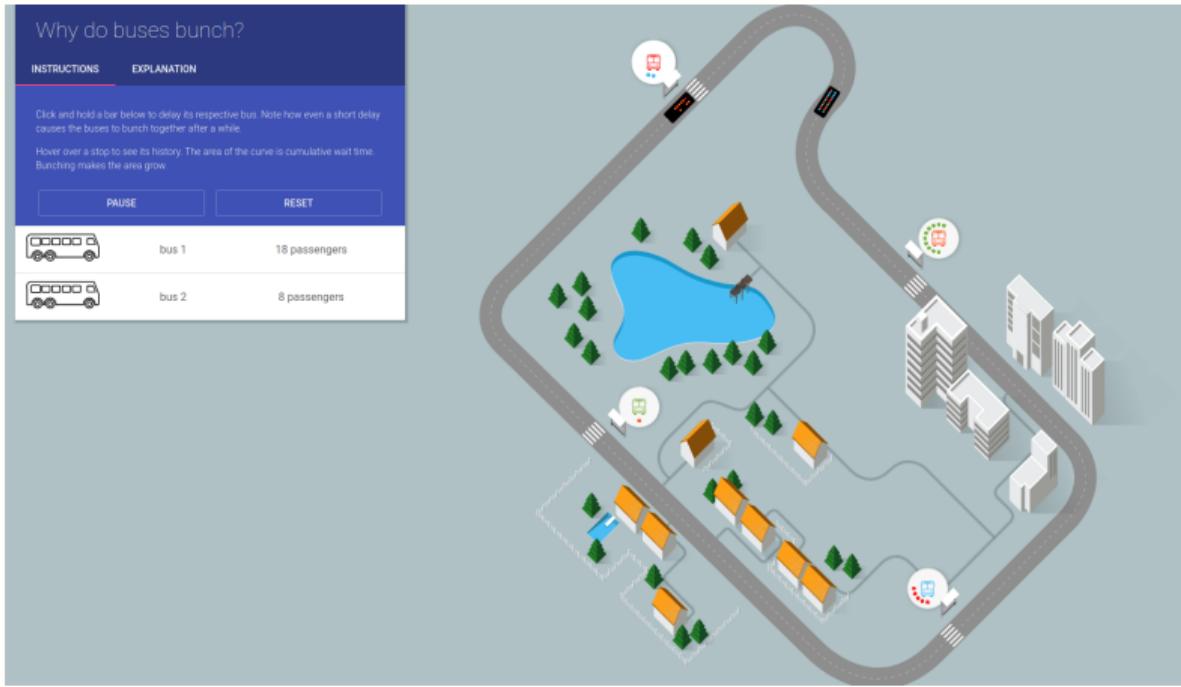
INSTRUCTIONS EXPLANATION

Click and hold a bar below to delay its respective bus. Note how even a short delay causes the buses to bunch together after a while.

Hover over a stop to see its history. The area of the curve is cumulative wait time. Bunching makes the area grow.

PAUSE RESET

 bus 1	18 passengers
 bus 2	8 passengers



The simulation illustrates the concept of bus bunching. Two buses, bus 1 and bus 2, are shown on a route that includes a sharp turn. Bus 1 is delayed at a stop near a lake, causing it to fall behind bus 2. As bus 1 continues, it reaches another stop where it is delayed again, further increasing the gap. This pattern repeats, causing the buses to bunch together at the end of the route. The simulation also shows the cumulative wait time at stops, represented by the area under the curve of the bus's position over time.

<https://setosa.io/bus/>

**Routes** - Unreliability affects wait times:

A simple formula:

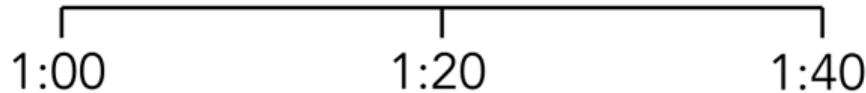
$$T_w = \frac{\sum_i S_i S_i / 2}{\sum_i S_i}$$

$S_i$  = time between arrivals

$S_i / 2$  = average wait time between each vehicle (assuming random departures)

$T_w$  = total average wait time

Average wait time = 10min



Average wait time = 12.5min



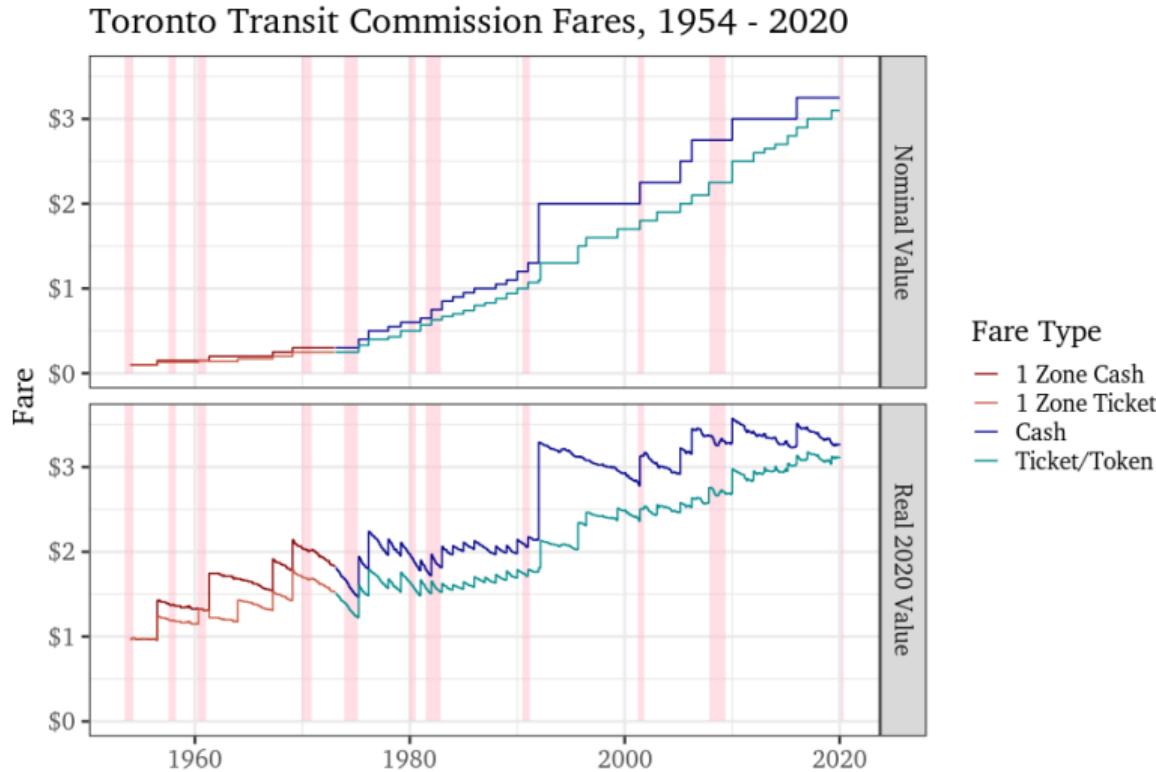
## Fare Types

- ▶ Flat fares (e.g. TTC)
- ▶ By distance (e.g. GO Transit)
- ▶ By zone
- ▶ Daily/weekly/monthly passes
- ▶ Discounts (e.g., child, students, senior, low-income)
- ▶ No fare

## Payment Technology

- ▶ Cash
- ▶ Tokens/Tickets
- ▶ Card (can be tap on only, or tap on and off)

## Fares - e.g. TTC Fares over time



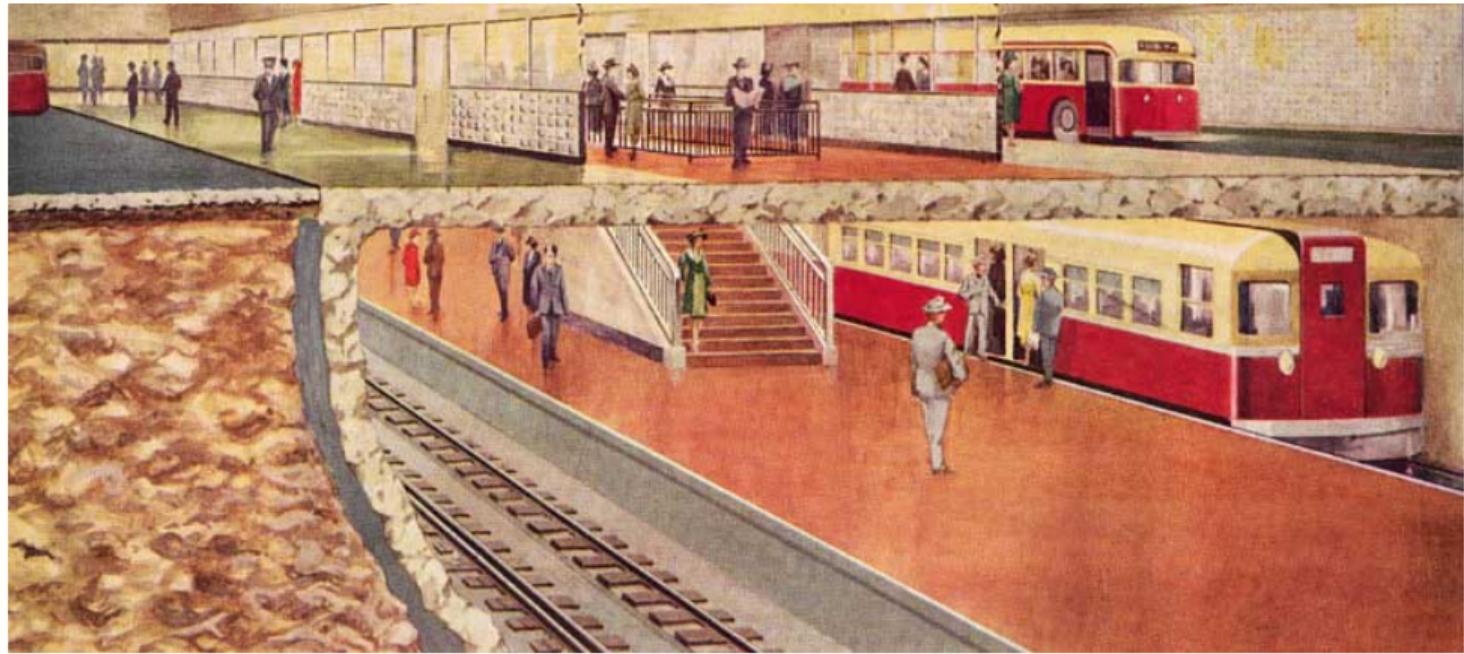
## Stops - Local Stops



## Stops - Transferring

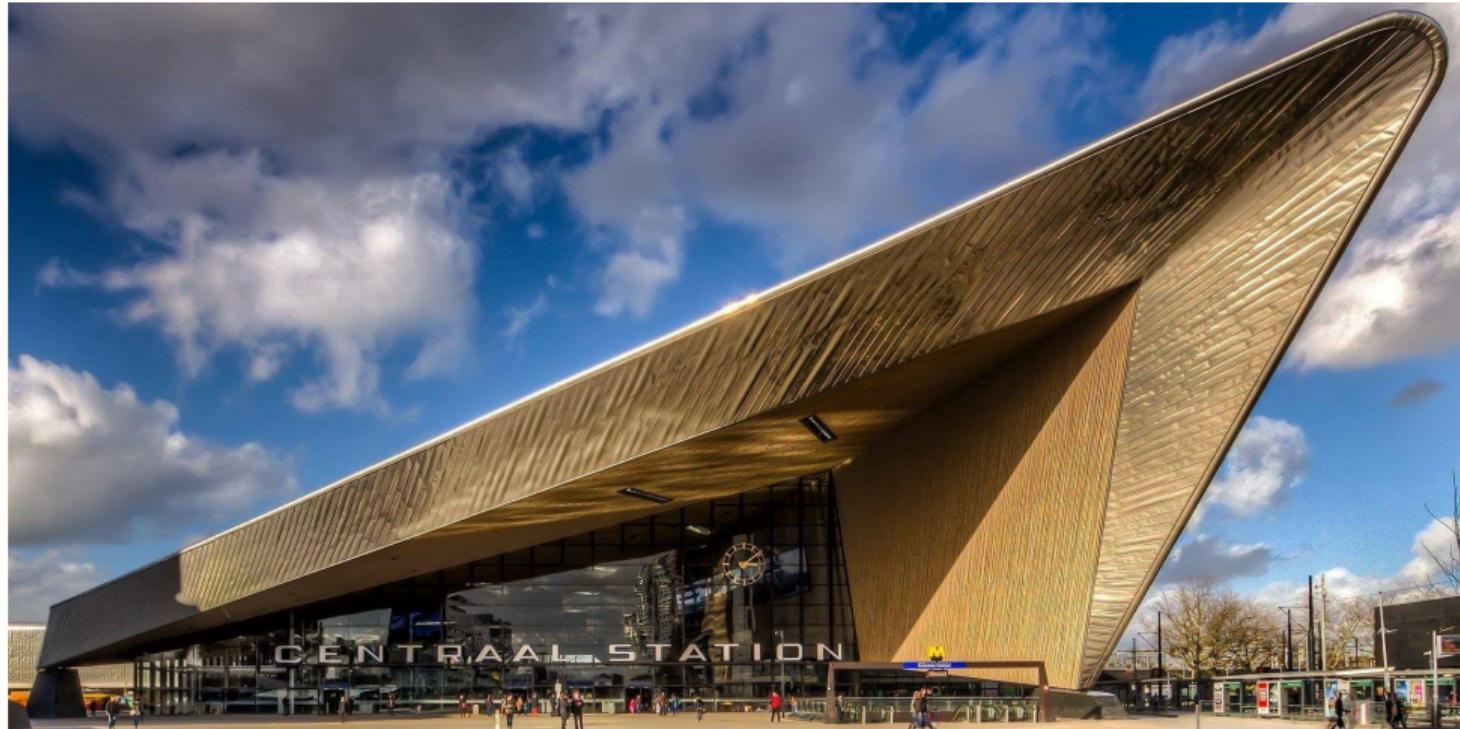


## **Stops - Major stations are key transferring locations**



<https://www.toronto.ca/explore-enjoy/history-art-culture/online-exhibits/web-exhibits/web-exhibits-transportation/canadas-first-subway/canadas-first-subway-why-a-subway/>

**Stops** - Major stations can be iconic public spaces:

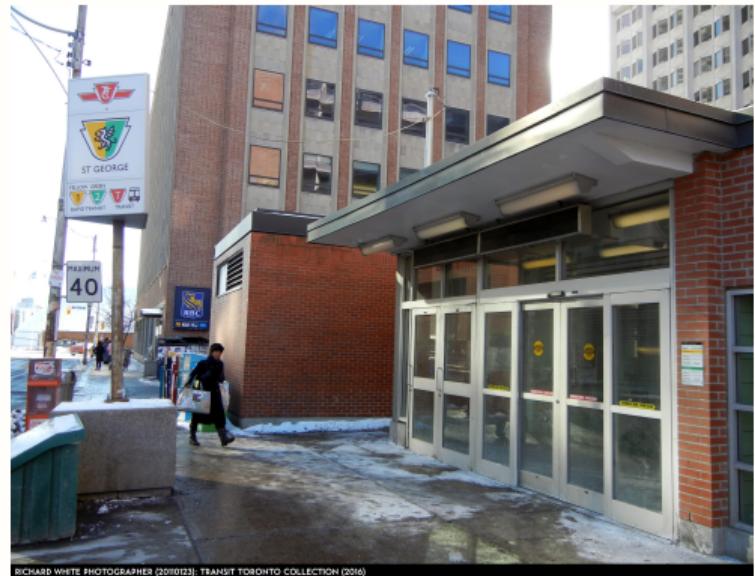


[https://www.reddit.com/r/architecture/comments/20ceny/the\\_new\\_rotterdam\\_central\\_train\\_station\\_opened/](https://www.reddit.com/r/architecture/comments/20ceny/the_new_rotterdam_central_train_station_opened/)

## Stops - Access Mode

e.g. in the GTHA:

- ▶ 91.8% by walking
- ▶ 7.4% by car
- ▶ 0.6% by other mode (mostly bike)



RICHARD WHITE PHOTOGRAPHER (2010123); TRANSIT TORONTO COLLECTION (2016)

## **Stops - Land-Use Around Stops**

Whitby GO Station:



## Transit Oriented Development

- ▶ Focusing urban development near major public transit hubs
- ▶ Often includes a mix of residential, retail, and commercial buildings
- ▶ Goals include increasing transit ridership, local active travel, and reducing sprawl



## Transit Oriented Development

e.g. Marine Drive Station in Vancouver, when built in 2009 and in 2018



<https://www.google.ca/maps/@49.2081409,-123.1191561,497a,35y,50.44h,34.64t/data=!3m1!1e3>  
[https://en.wikipedia.org/wiki/Transit-oriented\\_development](https://en.wikipedia.org/wiki/Transit-oriented_development)

# Transit Oriented Development

Key(s) to Building Transit-Oriented Development?

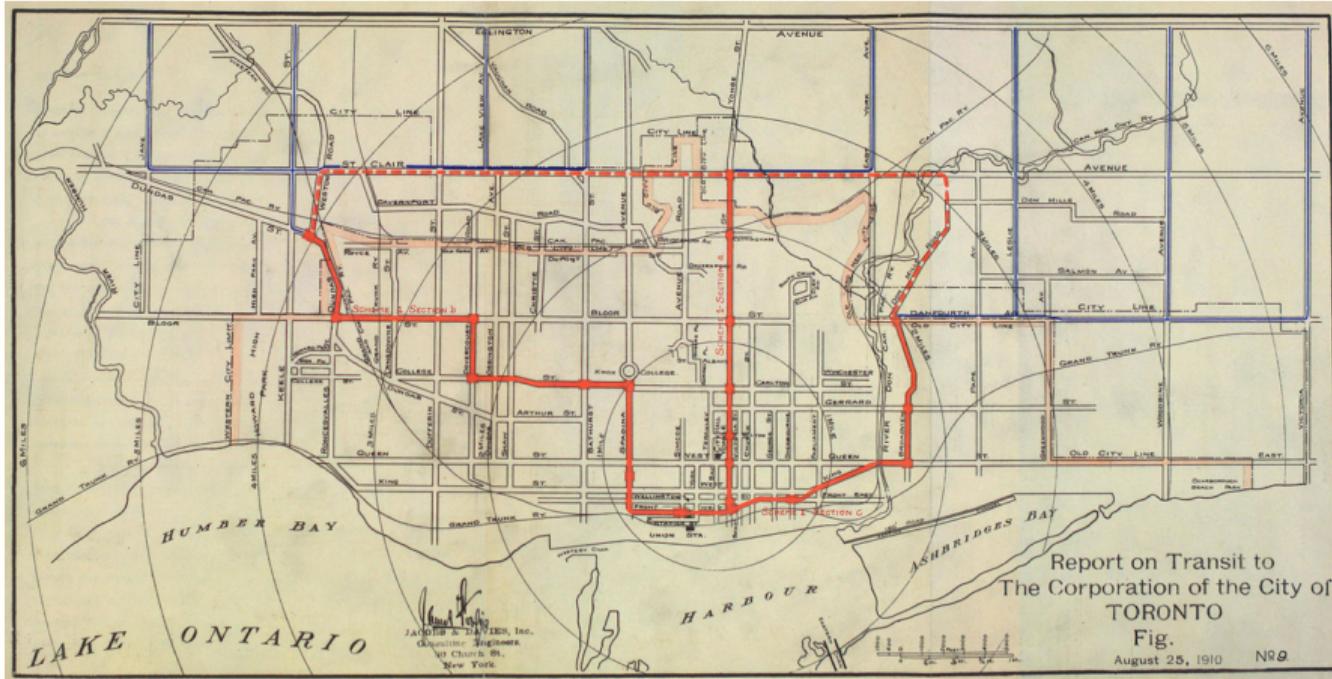


RMTransit Video [https://www.youtube.com/watch?v=5HSI\\_PZBsPc](https://www.youtube.com/watch?v=5HSI_PZBsPc)

More about Humber Bay Shores plan <https://urbantoronto.ca/database/projects/2150-lake-shore>

# Public Transit Planning

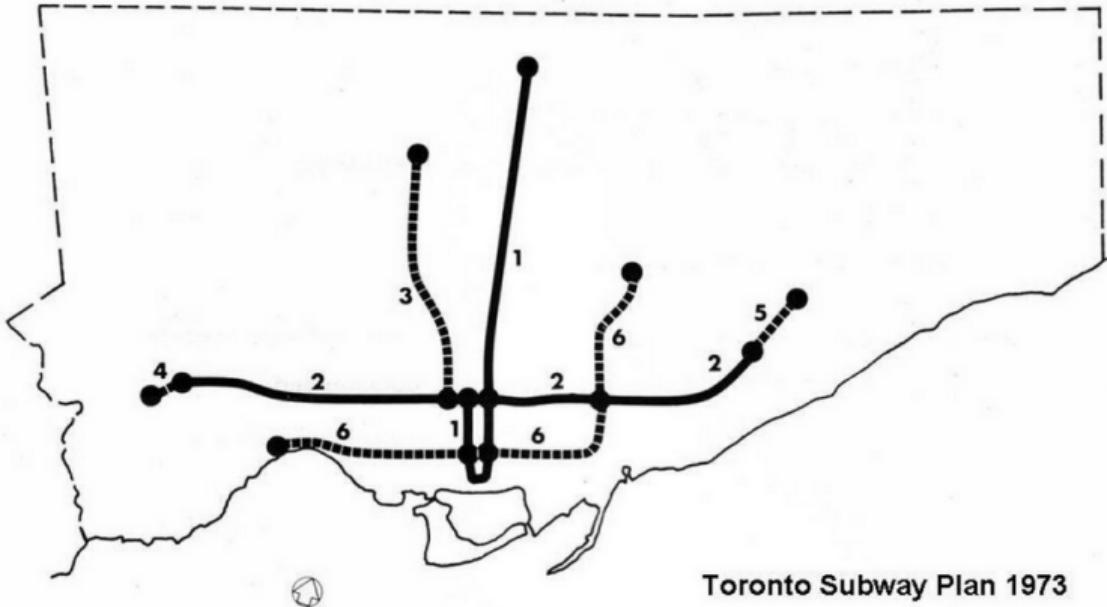
- about improving public transit, with both big and small ideas



# Public Transit Planning



# Public Transit Planning



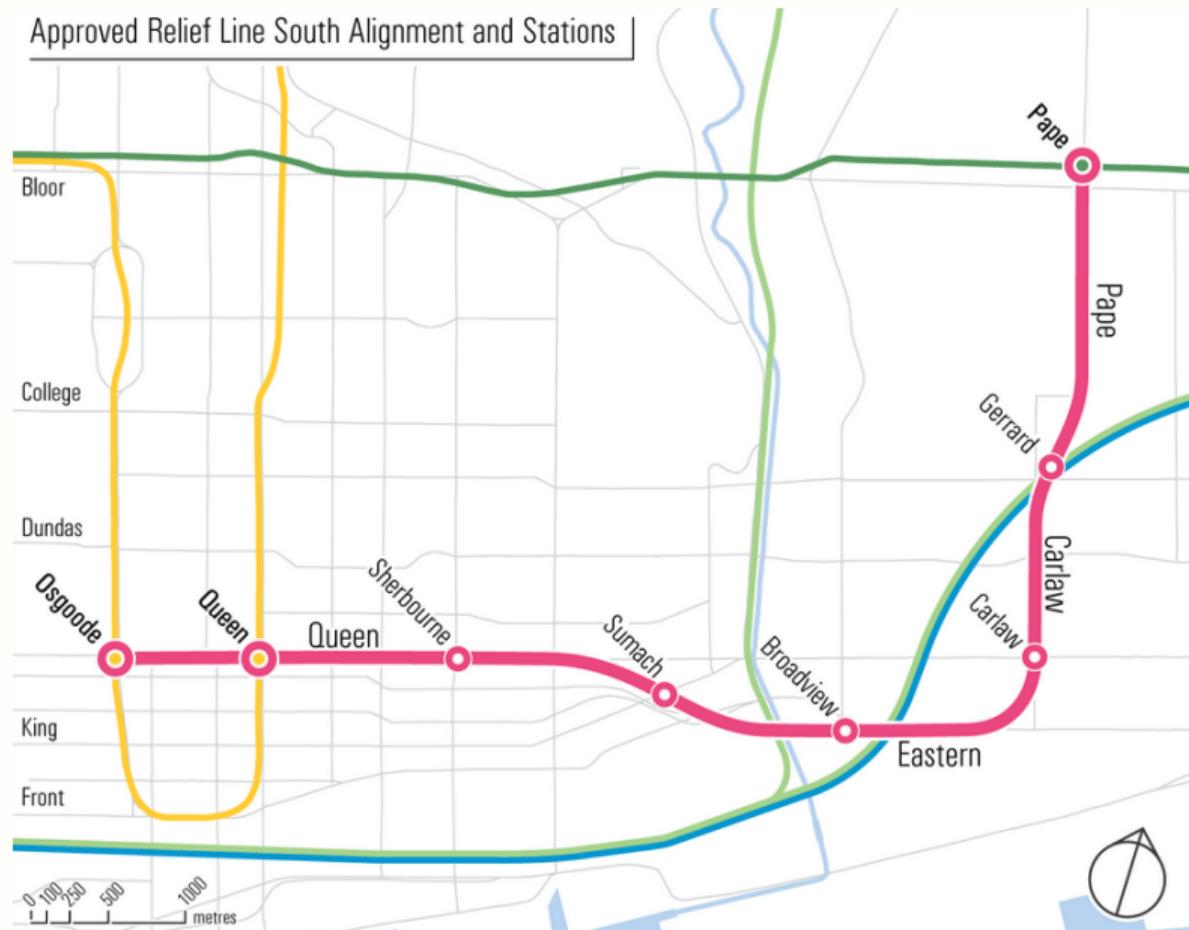
**Toronto Subway Plan 1973**

Present subway lines and TTC proposals  
for future lines in Metropolitan Toronto.

- KEY:
- 1: Existing Yonge-University Line, including northern extension from York Mills to Finch scheduled to open in April 1974
  - 2: Existing Bloor-Danforth Line.
  - 3: Proposed Spadina Line. (Will through work with Yonge-University)
  - 4: Proposed Western extension to Bloor-Danforth. Islington to Kipling
  - 5: Proposed Eastern extension to Bloor-Danforth. Warden to Kennedy
  - 6: Proposed Queen line. Humber to Eglinton and Don Mills.

# Public Transit Planning

Approved Relief Line South Alignment and Stations



# Public Transit Planning



# Public Transit Planning

## How TTC plans to achieve the action and when

Proposed actions	2020	2021	2022	2023	2024
<b>Pillar 1: Enhance the transit network – An expansive network that gets customers to where they want to go, when they want to go</b>					
1.1. Accommodate population and employment growth					
1.2. Implement new services to address travel patterns	Implement overnight network changes & start updating community bus network	Update community bus network, expand Express Bus Network, enhance bus service in Scarborough & add new services		New services to be identified through the annual plan process	
1.3. Open Line 5 – Eglington		Open Line 5 & enhance surrounding bus network			
1.4. Relieve crowding on Line 1			Increase AM peak service		
1.5. Open Line 6 – Finch West				Open Line 6 & enhance surrounding bus network	
1.6. Enhance streetcar network	Deploy new streetcars on 505 Dundas		Enhance streetcar service on 501 Queen & 504 King		Deploy new streetcars on 511 Bathurst
1.7. Apply an equity lens to service planning	Implement new customer consultation process			Pilot new service in Neighborhood Improvement Areas	
<b>Pillar 2: Enhance customer experience at key surface transit stop areas – A pleasant experience that begins before our customers get on a vehicle</b>					
2.1. Expand customer amenities at stops			Install more shelters, heated shelters & benches. Continue with accessible stop & access hub programs		
2.2. Improve wayfinding at stops			Install next vehicle arrival screens & wayfinding maps		
2.3. Improve placemaking at key stop areas			Enhance the walkability, comfort & convenience of key stop areas		
<b>Pillar 3: Improve service reliability – A reliable service that our customers can count on</b>					
3.1. Improve surface transit schedules	Improve remaining weekday & weekend schedules		Improve overnight schedules & ongoing schedule upkeep		
3.2. Mitigate delays & disruptions to service	Add more buses & trains to mitigate delays				
<b>Pillar 4: Prioritize surface transit – A fast service that values our customers' journey time</b>					
4.1. Explore bus transit lanes			Eglinton East, Sheeles West, Jane, Dufferin & Finch East		
4.2. Implement more queue jump lanes		Lake Shore @ Long Branch Loop		Up to 3 locations per year	
4.3. Implement more transit signal priority				Up to 20 locations per year	
<b>Pillar 5: Accelerate integration with regional transit partners and complementary modes of transport – An integrated network that provides our customers with a seamless connection to and from our services</b>					
5.1. Expand service integration	Develop plan & pilot project		Expand service integration with MiWay, Brampton Transit, York Region Transit, Durham Region Transit & GO Transit		
5.2. Integrate microtransit services	Implement Automated Transit Shuttle Trial & integrate private microtransit services		Explore AV shuttle opportunities & expand integration with private microtransit service providers		
5.3. Enhance integration with cycling	Enhance bike parking & repair stations at TTC Stations Collaborate to expand Bike Share into suburban Toronto & increase Bike Share capacity at TTC stations	Establish pedestrian path working group & action plan	Continue to work with the City to monitor, address & support increased cycling demand		
5.4. Enhance pedestrian pathways to TTC		Establish Mobility as a Service (Maas) working group & action plan	Implement pedestrian path program		
5.5. Implement a Mobility as a Service (Maas) strategy		Implement a pilot partnership with another mode of transport		Expand Maas working group & action plan to regional & private partners	

Next week (Feb 7)

- ▶ Transportation and land-use
- ▶ Network analysis & GIS
- ▶ Land-use data
- ▶ Measuring accessibility

Following week (Feb 14)

- ▶ Travel surveys
- ▶ Other transportation-related data
- ▶ Maps for navigation
- ▶ Chat about the assignment