

# Nexus: Sample Use Cases

Workshop on Rail Analytics and Simulation Research

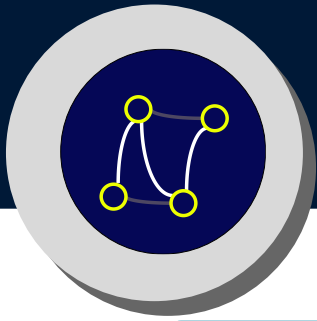
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# Nexus Use Cases

## Capacity analysis and flow management

Capacity analysis of the USRC

Crowding relief benefits of the DRL

Crowding analysis of the B-Y Station

Hub and network flow management

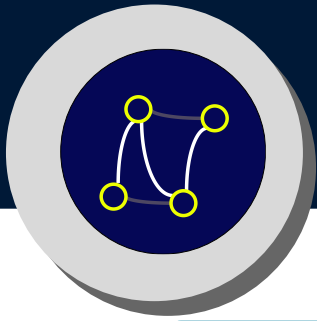
Rail disruption management

## Other

Specialized route operations

Transfer optimization

Integration with activity based demand model



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Crowding analysis of the B-Y Station

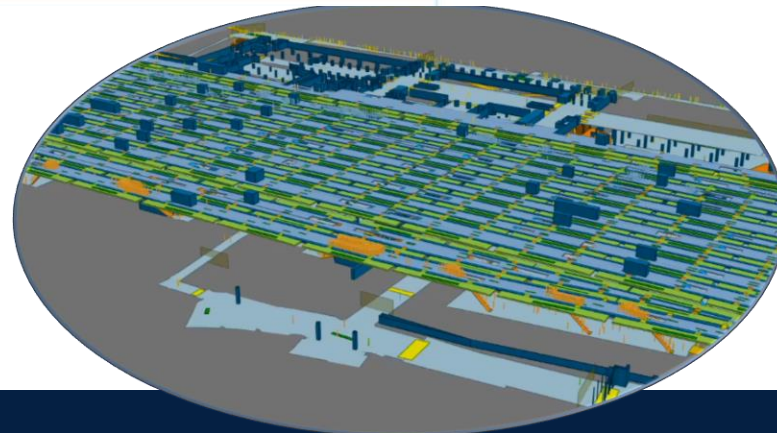
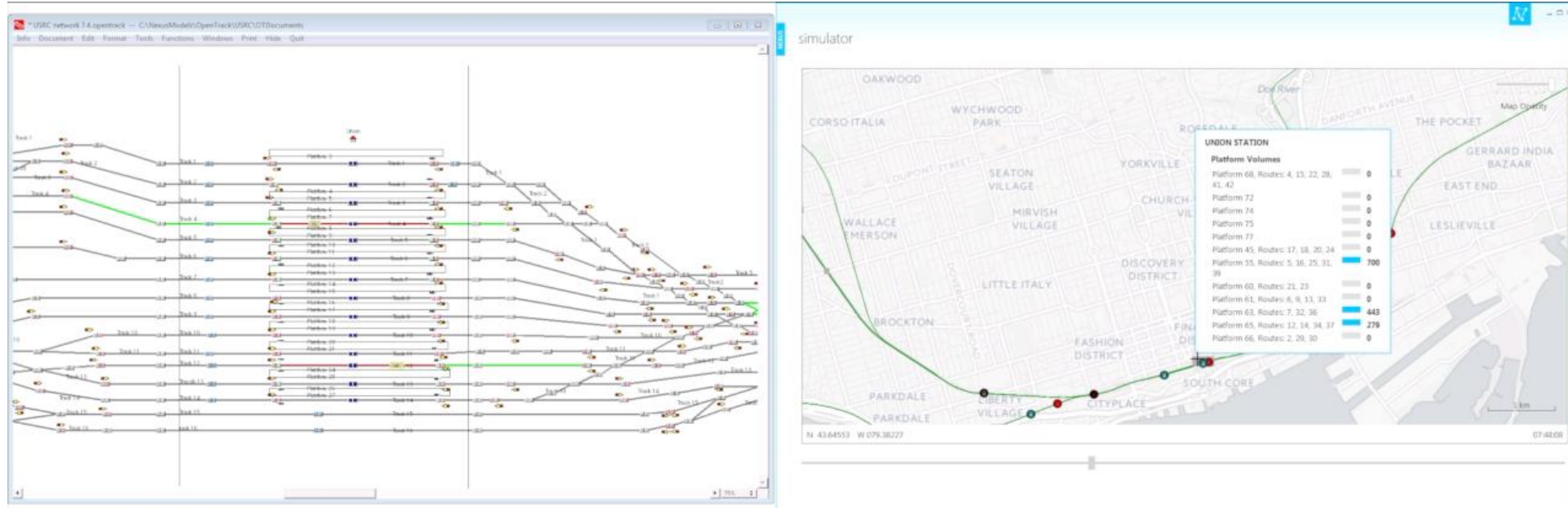
## Other

Specialized route operations

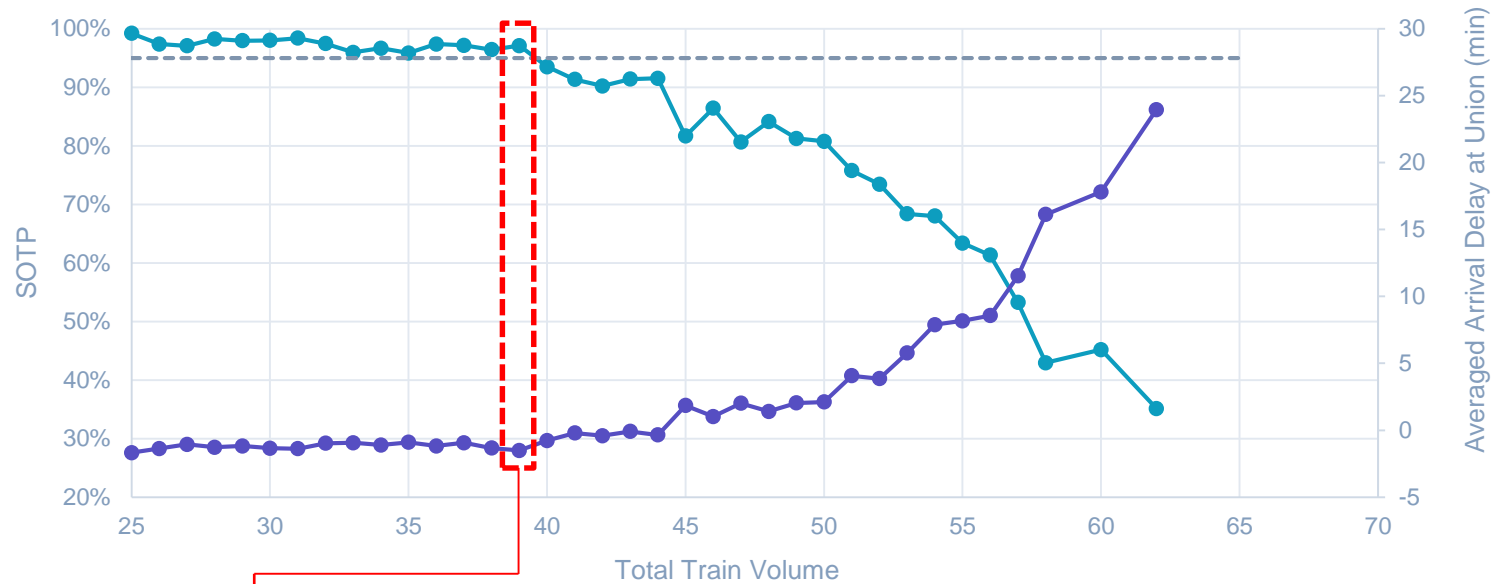
Transfer optimization

Integration with activity based demand model

# Capacity Analysis of the USRC



# Capacity Analysis of the USRC



Method	Total # of Trains	LSW	LSW_E	LSE	LSE_E	KI	MI	BA	RH	ST
OpenTrack	39	4	5	4	4	4	5	4	4	5

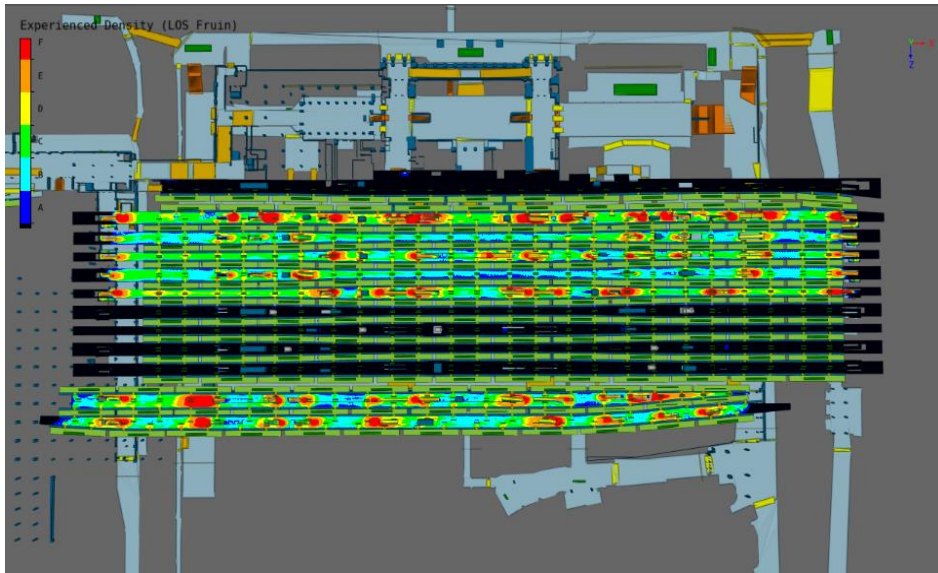
LSW: Lakeshore West Line  
 LSW\_E: Lakeshore West Express  
 LSE: Lakeshore East Line  
 LSE\_E: Lakeshore East Express

KI: Kitchener Line  
 MI: Milton Line  
 BA: Barrie Line  
 RH: Richmond Hill Line  
 ST: Stouffville Line

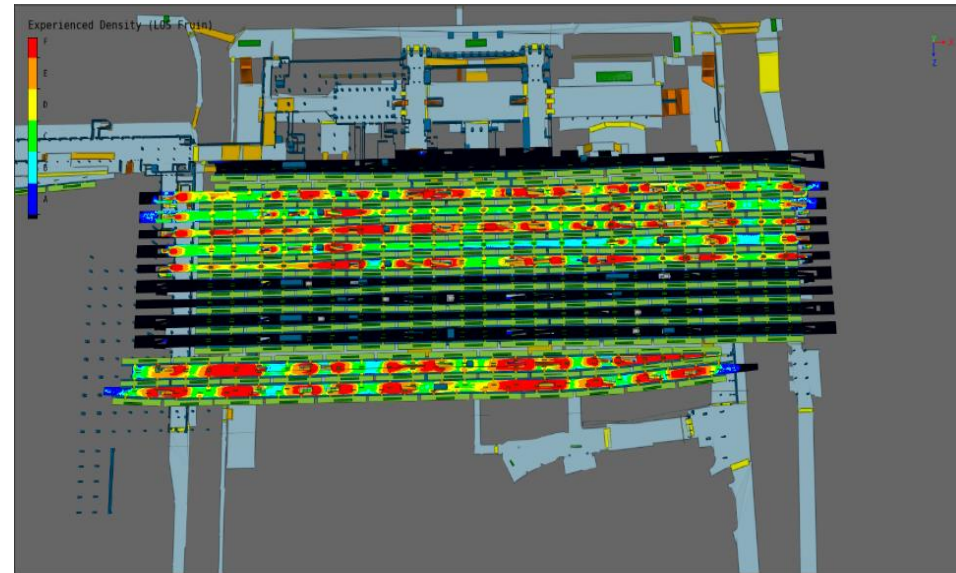
● SOTP    ● 95% Threshold    ● Simulated Average Arrival Delay

# Capacity Analysis of the USRC

Base Model

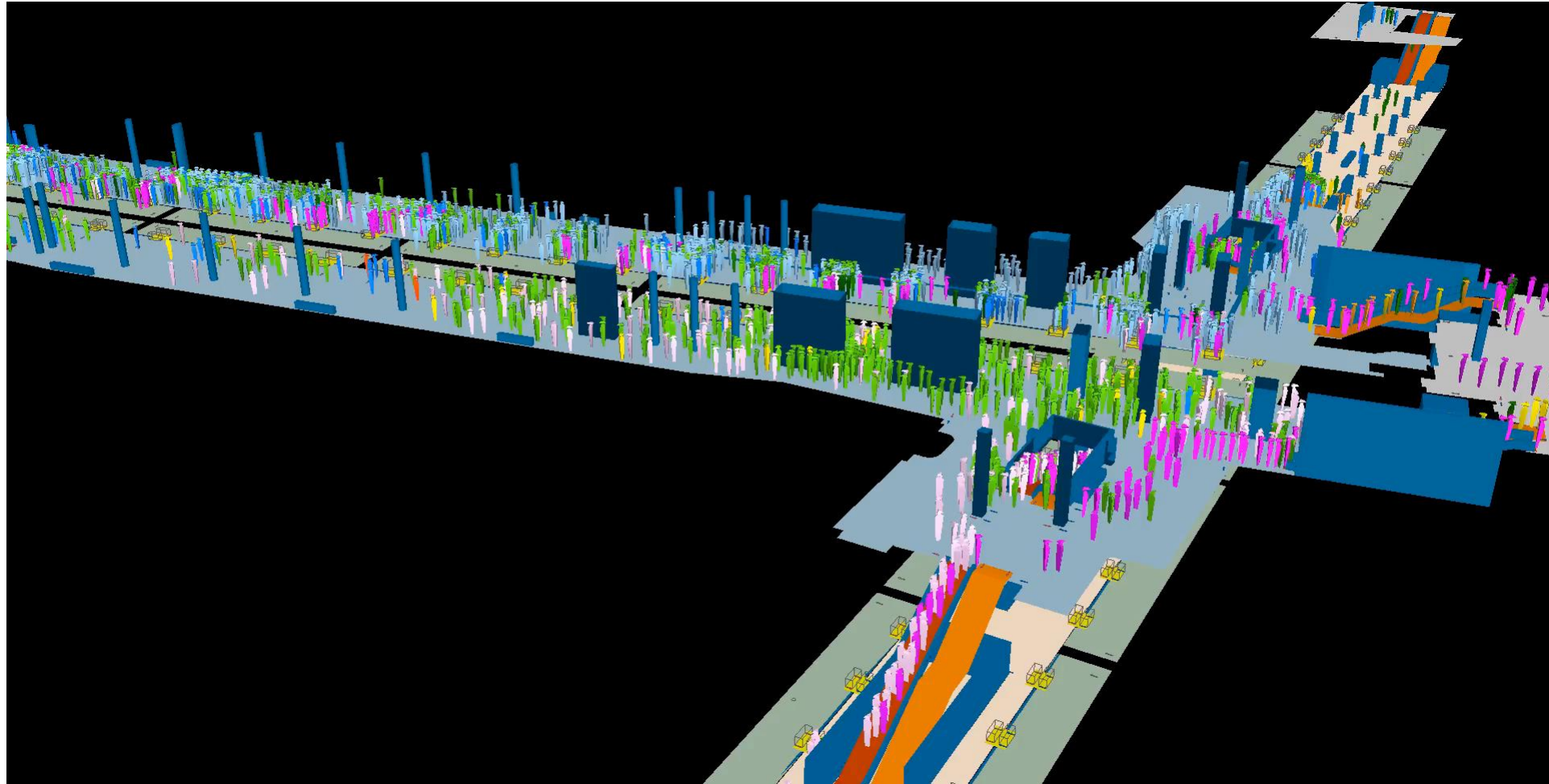


High Volume Scenario

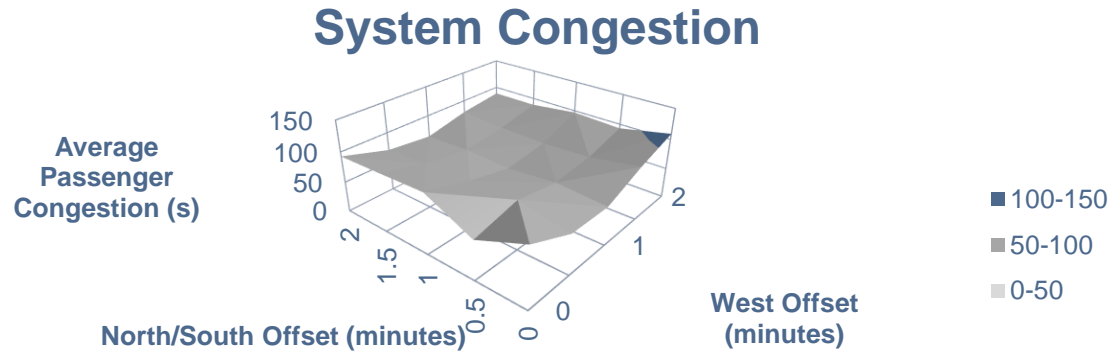




# Crowding Analysis of the Bloor-Yonge Station



# Crowding Analysis of the Bloor-Yonge Station



Volume Level	Best Arrival Pattern (Direction: Offset)	System Congestion Per Passenger(s)/Std Dev (s)	Relative Standard Deviation (%)	Range (min/max)	ATC Scenario-System Congestion Per Passenger(s)/Std Dev (s)	Uniform Southbound Boarding Distribution-System Congestion Per Passenger(s)/Std Dev (s)
	Worst Arrival Pattern (Direction: Offset)					
100% Capacity	W: 1 min N/S: 1 min	61.9/7.7	17.1	47.2 (61.8/109.1)	28.3/10.0	50.8/7.7
	W: 2 min N/S: 0 min	109.1/7.8			30.9/5.1	96.1/8.2



# Hub and Network Flow Management

## Nexus



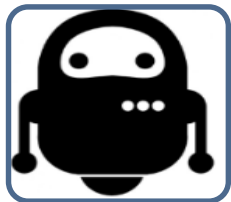
### Station Macroscopic Model (e.g. CTM-based)

- Adaptive based on real-time data
- Facility-level passenger flows and densities



### Railway Mesoscopic Model (e.g. SPUR)

- Adaptive based on real-time data
- Delay at the segment level (or block-level)



### Model-based RL-based Control

- Inflow control to maintain the capacity
- Train management (e.g., real-time rescheduling)

- ❖ Passenger OD
- ❖ Station layout (TTC)

Input

### Railway Station Model

Cell Transmission Model (CTM) based model of passengers

- ❖ Passenger flow and density through facilities (stairs, platform, etc.)
- ❖ Boarding and Alighting passengers
- ❖ Dwell time

Output

Railway Mesoscopic Model

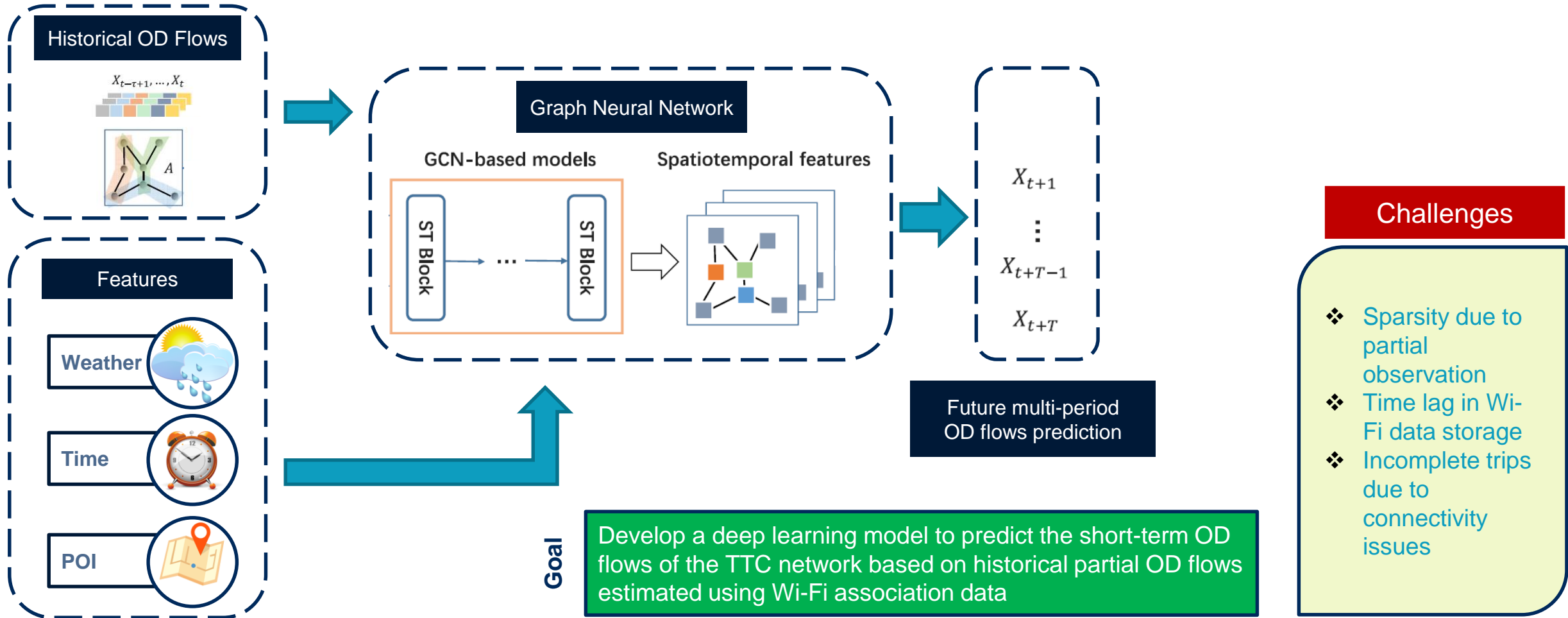


### Model-based RL-based station control

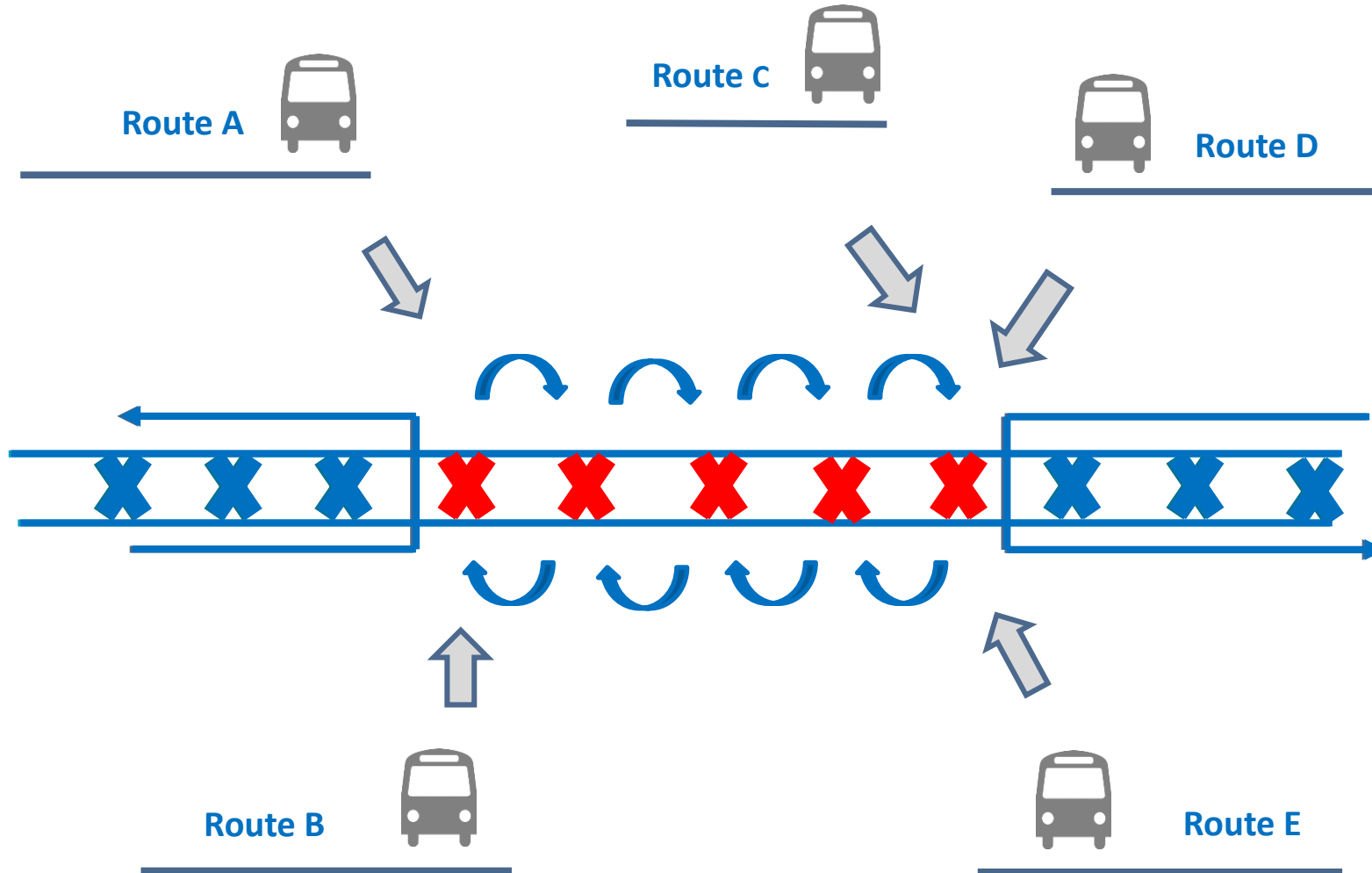
- ❖ Passenger inflow control at access points
- ❖ Hub passenger flow control
- ❖ Real-time rescheduling
- ❖ Etc.

Applications

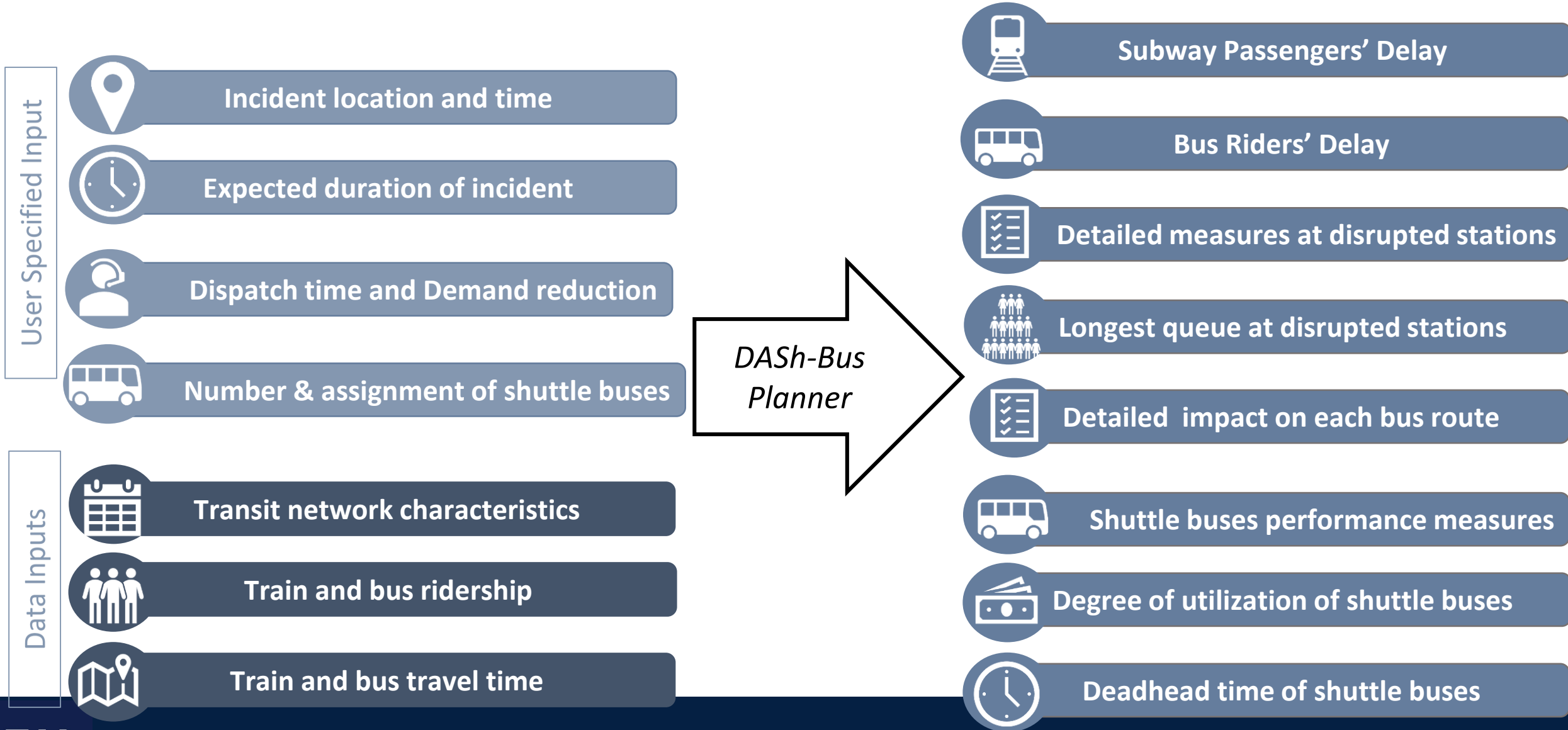
# Hub and Network Flow Management – OD Flow Prediction



# Rail Disruption Management via Bus Bridging



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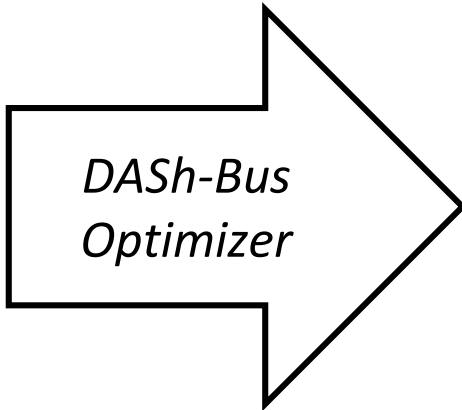
# Rail Disruption Management via Bus Bridging

User Specified Input

- Incident location and time
- Expected duration of incident
- Dispatch time and demand reduction
- Number & assignment of shuttle buses

Data Inputs

- Transit network characteristics
- Train and bus ridership
- Train and bus travel time



- Number of shuttle buses
- Optimal Bus routes
- Number of buses from each route
- Initial end station for each bus

Trapeze Bus Bridging **UTTRI**

NAME: KiplingKeele\_Plan1 SELECT SAVED

Disruption Occurred: DATE Select, START TIME 08:00 AM

Pick Shuttle: AGENCY TTC, 97

Assign to Terminal: Search Terminal #

Expected Duration: DURATION 55 mins

Affected Stations: FIRST Kipling, LAST Keele

Available Routes:

- TTC 97:Yonge 1
- TTC 90:Vaughan 1
- TTC 79:Scarlett Rd 1
- TTC 53:Steeles East 1
- TTC 199:Finch Rocket 2
- TTC 88:Sheppard East 1
- TTC 195:Jane Rocket 1
- TTC 88:Jane 1

Set Parameters: Dispatch Time: 5, Demand Reduction: 0 CALCULATE

NETWORK: GTHA, SIGNUP: GTHA with HSR F2017, SCENARIO: Demo Scenario

# DASh-Bus Visualization Dashboard

Trapeze Bus Bridging **UTTRI**

Effectiveness Summary

TOTAL DELAYS: 2878.7 hours For Subway Riders, 99.3 hours For Bus Riders TABLE VIEW

Map View

Map showing bus routes in the Greater Toronto Area (GTHA) with disruption points marked in red along the Kipling-Keele corridor.

NETWORK: GTHA, SIGNUP: GTHA with HSR F2017, SCENARIO: Demo Scenario

SAVE MODIFY

Effectiveness Summary

TOTAL DELAYS: 2878.7 hours For Subway Riders, 99.3 hours For Bus Riders MAP VIEW

DELAYS PER STATION

Station Name	No Riders Affected	Riders Delays (h)	Queue at End (p)	To Clear Queue (min)	Extra Wait
Keele Station - Westbound Platform	1,692.9	412.66	572.68	0	13.09
Kipling Station - Eastbound Platform	1,851.6	492.23	1,191.64	0	15.95
High Park Station - Westbound Platform	42.6	3.71	60.19	1.56	3
Islington Station - Eastbound Platform	1,136.1	554.07	1,115.37	4.37	25.56
Royal York Station - Eastbound Platform	793.8	425.8	774.04	8.6	25.46
Runnymede Station - Westbound Platform	103.2	8.01	5.29	9.5	4.17
Old Mill Station - Eastbound Platform	261.7	154.31	257.65	10.11	25.71
Jane Station - Eastbound Platform	507.2	303.41	491.6	11.33	25.49
Jane Station - Westbound Platform	136.9	18.16	26.75	13.26	5.37
Old Mill Station - Westbound Platform	59.8	8.03	3.67	14.86	7.14
Runnymede Station - Eastbound Platform	459.7	297.37	445.16	14.99	25.53
Royal York Station - Westbound Platform	81.4	17.18	14.4	16	9.94
High Park Station - Eastbound Platform	231.5	172.94	287.09	16.03	24.73

NETWORK: GTHA, SIGNUP: GTHA with HSR F2017, SCENARIO: Demo Scenario

SAVE MODIFY



Questions?