Passenger Travel Time Reliability for Multi-Modal Public Transport Journeys

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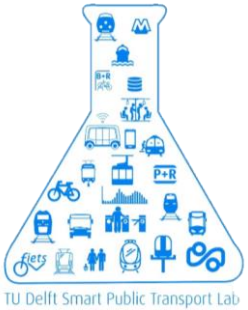

Introduction

- Reliability: ‘Certainty of service aspects compared to the schedule as perceived by the user’ (van Oort, N., 2016)

- Reliability of travel time
  - Regularity
  - Punctuality

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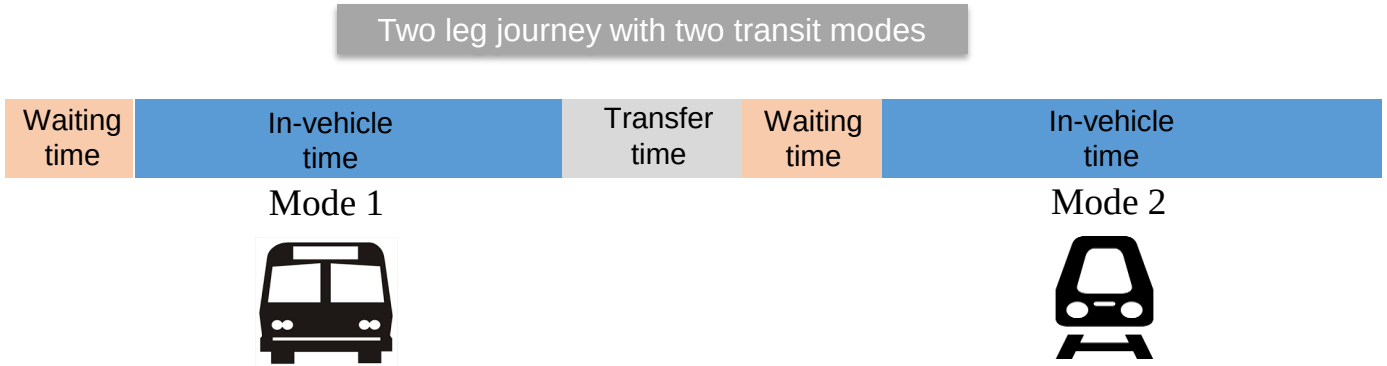
Motivation

- Urban transit networks typically multi-modal
- Reliability based on the whole journey experience including the transfers



Motivation

- Urban transit networks typically multi-modal
- Reliability based on the whole journey experience including the transfers
- Existing indicators
  - Focus on one mode only, or
  - Fail to include all travel time components

Requires passenger travel data at the network-level

Objective

- To develop a metric that
  - measures reliability for multi-modal transit journeys;
  - is sensitive to all travel time components; and
  - enables comparison between different transit modes and routes.
- Demonstrate its application to a real life network (Amsterdam)

Methodology - RBT

- **Reliability buffer time (RBT)** (Chan, 2007; Uniman et al, 2010)
  Difference between the 95th and 50th percentile travel time experienced by travelers between a stop-stop pair using a specific route*

$$RBT_{o,d,r} = tt_{95}^{o,d,r} - tt_{50}^{o,d,r}$$

Interpreted as the additional time passengers have to budget for their travel to ensure on-time arrival one out of twenty times

**Route : A combination of public transport services a passenger may choose, where each route may or may not include a transfer.*

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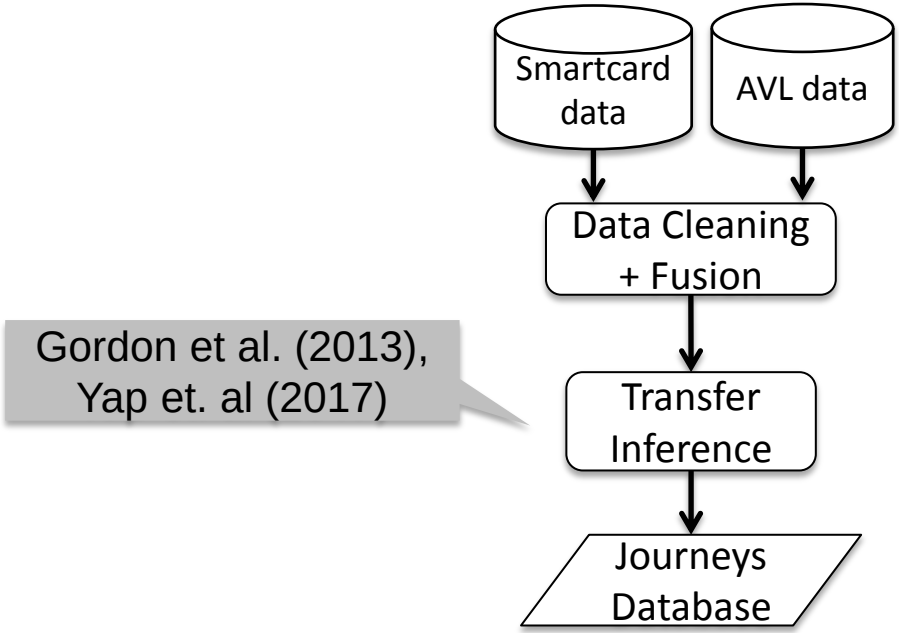
Data sources

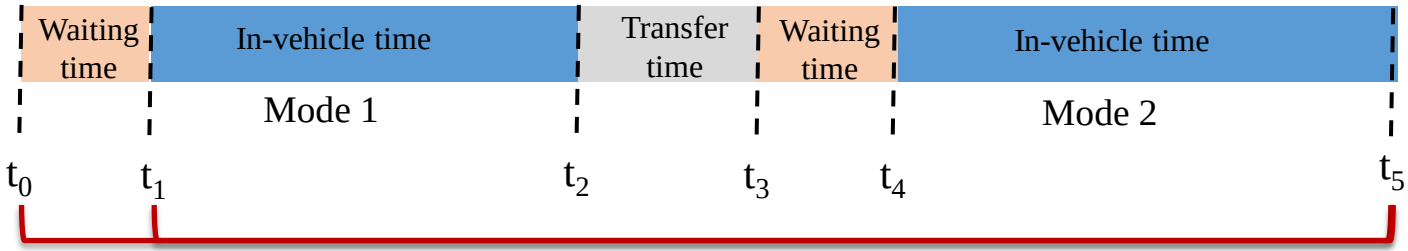
- Smartcard data
  - Tap-in and tap-out location and times
- Automatic Vehicle Location (AVL) data
  - Vehicle number, stop location and time stamps

Data pre-processing



Travel time using smartcard data

- Where first tap-in at station (eg. Amsterdam Metro)
  - Total travel time (t_5-t_0)
- Where first tap-in inside vehicle (eg. Amsterdam buses & trams)
  - Total travel time minus waiting time at origin (t_5-t_1)



Waiting time at origin

- For journeys where first tap-in is inside the vehicle
  - Time passenger arrived at stop is not known
  - Headway of services known (from AVL data)
  - For short headway services – passengers assumed to arrive randomly
  - Continuous random variables generated and sampled over uniform distribution [0, observed headway] to estimate waiting time for each journey

Travel time reliability for multi-modal journeys

- RBT calculated for each stop-stop (OD) pair and route

$$RBT_{o,d,r} = tt_{95}^{o,d,r} - tt_{50}^{o,d,r}$$

- Weighted average calculated for each mode/line/stop

Case study : Amsterdam

- ~850,000 inhabitants
- 4 metro lines
- 15 tram lines
- 25 bus lines
- ~800,000 transactions/day

- Two weekdays (1st and 2nd March 2018) used for analysis

Results

Reliability per mode

Mode(s) used	Number of journeys	Median travel time (mins)	RBT (mins)
Unimodal Journeys			
Metro (incl. Metro-Metro)	235,287	14.7	5.9
Tram	315,410	15.4	6.6
Bus	104,495	14.8	6.2
Tram-Tram	1,755	23.2	7.2
Multimodal Journeys			
Metro-Tram	7,588	25.0	7.6
Metro-Bus	747	28.8	7.8
Tram-Metro	6,665	26.3	8.3
Bus-Metro	1,336	28.7	8.5

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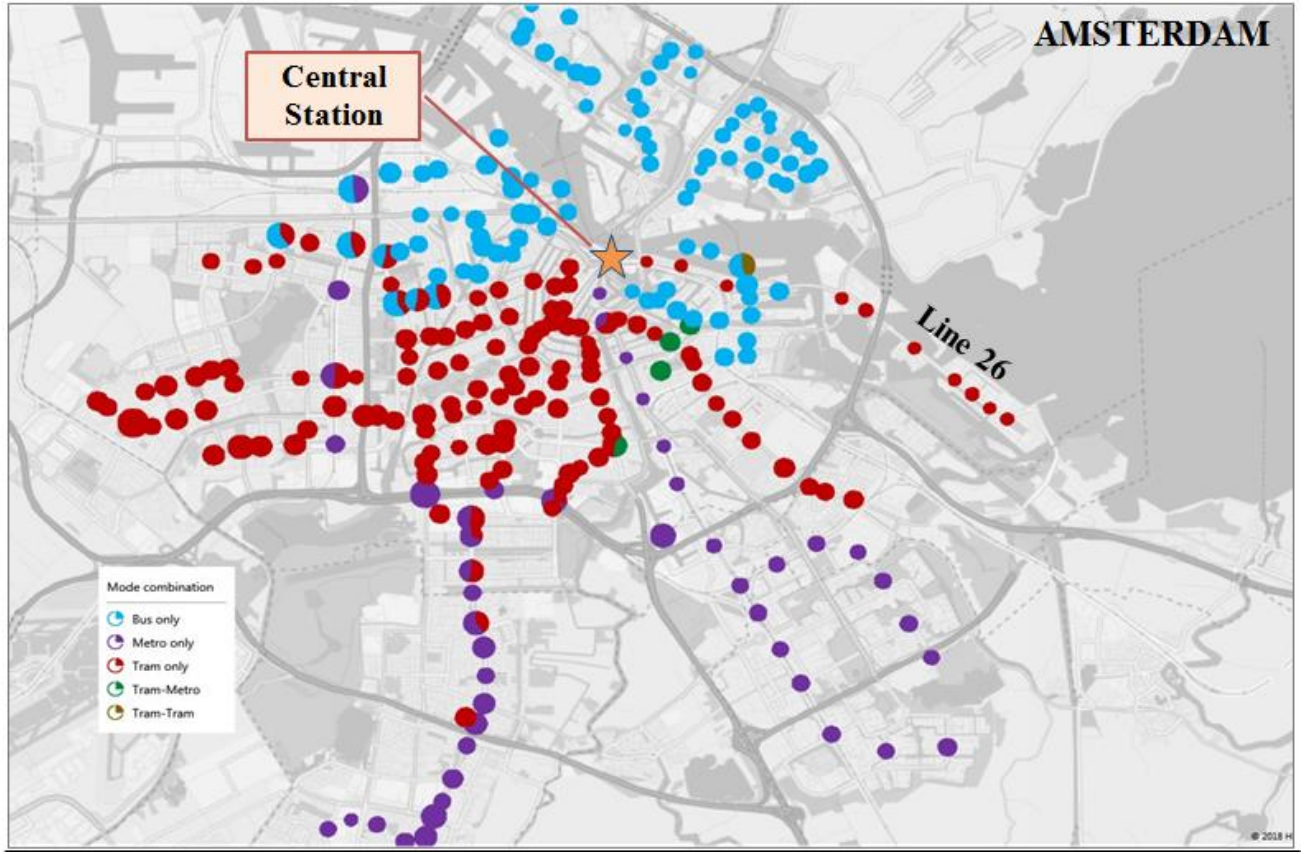
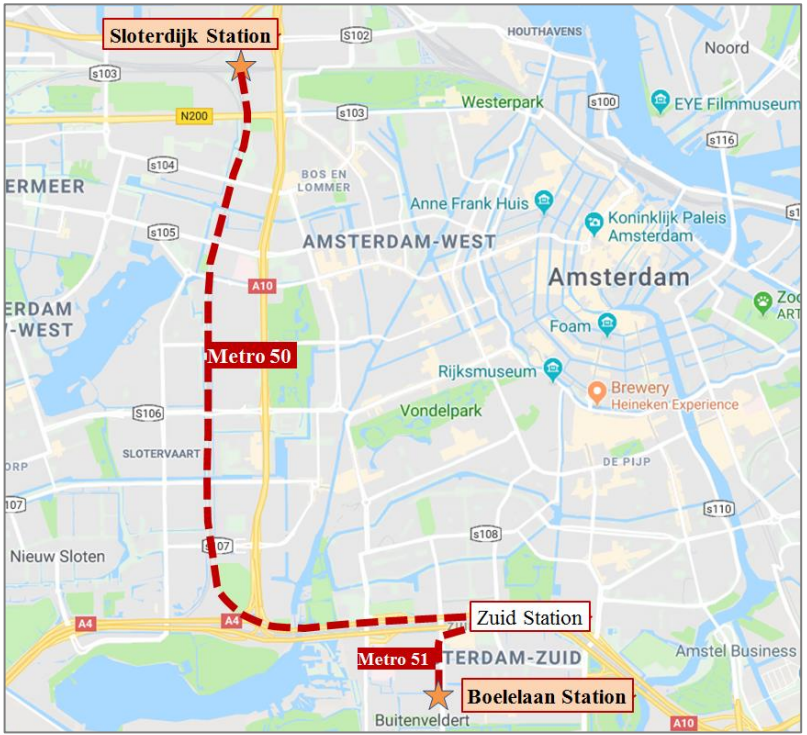
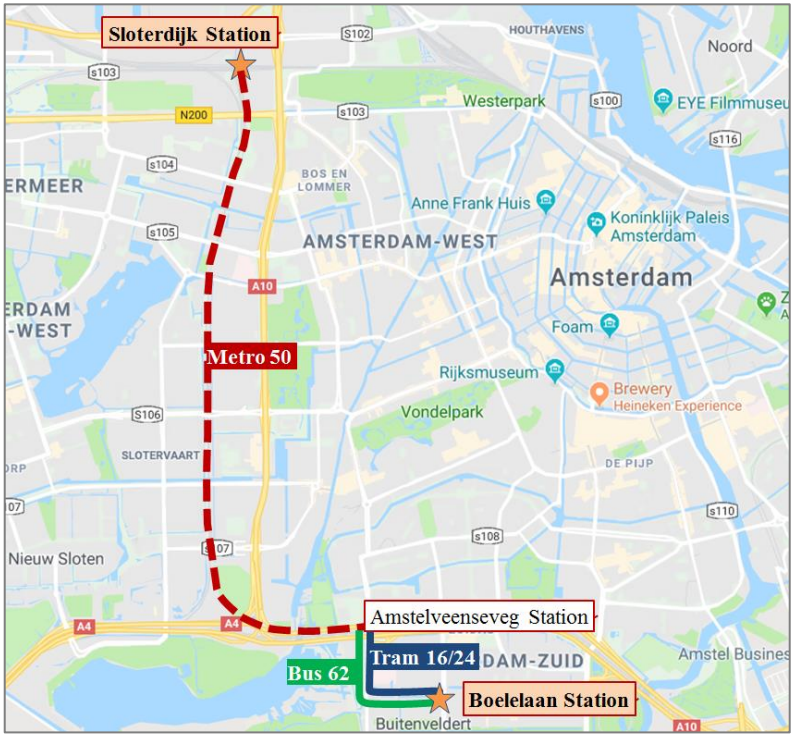
Reliability of accessing transit hubs



Reliability by route used -
Station Sloterdijk to Boelelaan





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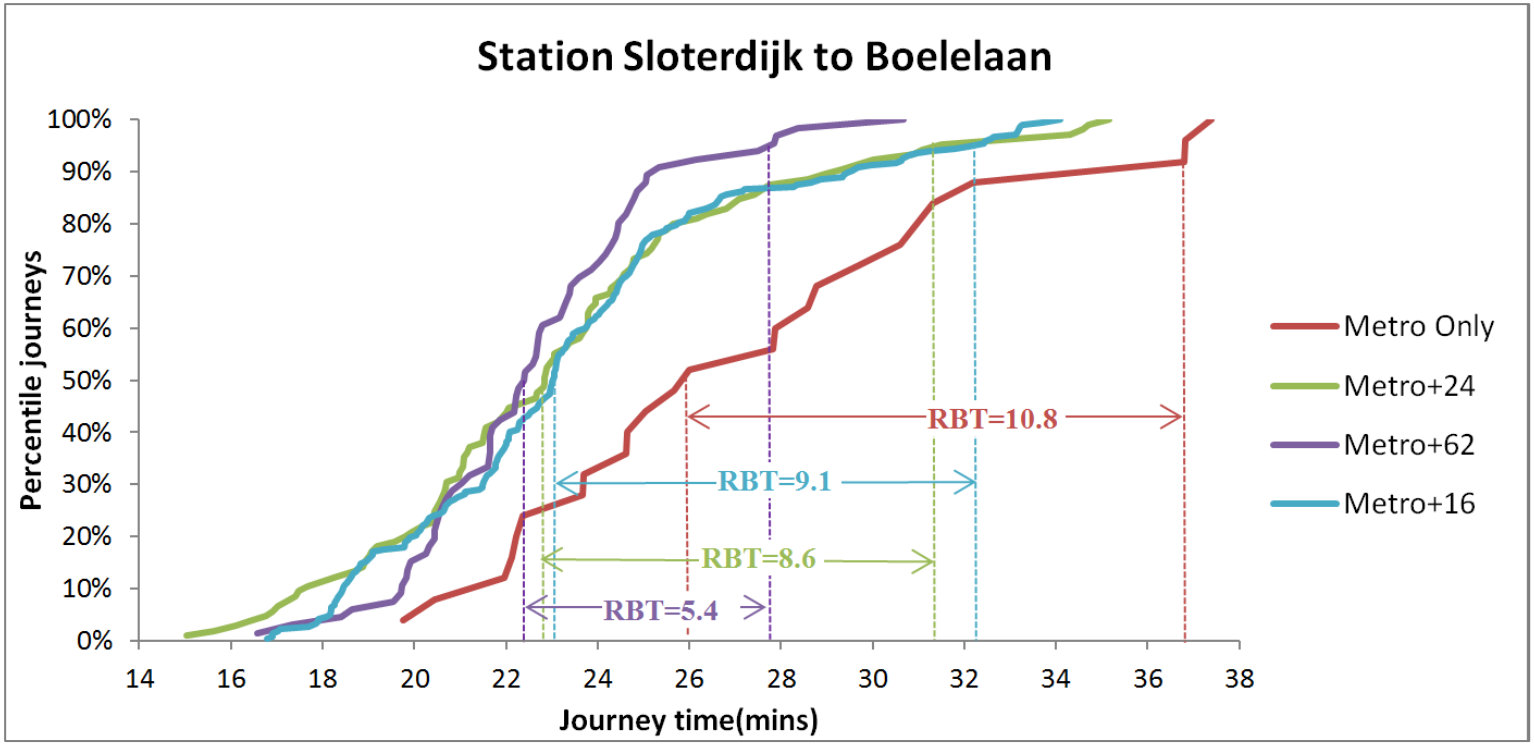

Conclusion

- New metric proposed for travel time reliability measurement
  - considering multimodal transit journeys
  - including waiting and transfer times for all legs of the journey
  - consistent for all journeys - comparable across modes and routes
- Demonstrated application to Amsterdam data but can be applied to other networks
- Can provide reliability at a very disaggregate level
  - flexibility of aggregation (eg. mode, transit stop and route level)
  - can be used as an input to behavioral models

Limitations and future work

- Assumed that passengers boarded the first vehicle (no denied boarding)
- Did not consider the impacts of availability of real-time information
- Low sample size
  - to be applied to a larger dataset
- Part of the ‘Impact of North-South Metro Line’ project
  - Reliability comparison of previous versus current network design

Thank you!

Questions?

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