ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

TRANSP-OR

STRC 2015

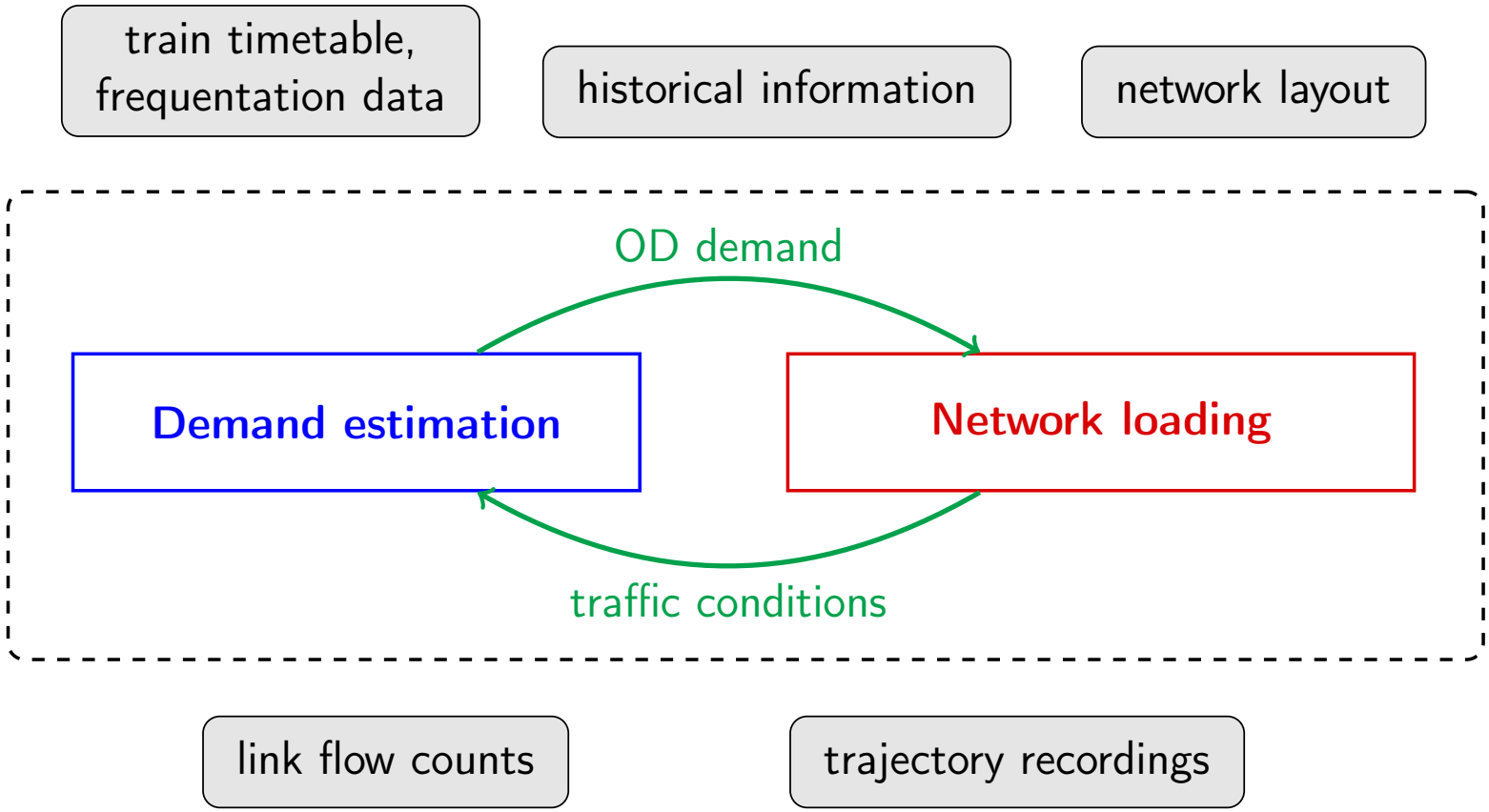
Modeling pedestrian flows in train stations: The example of Lausanne railway station

Flurin S. Hänseler, Michel Bierlaire, Nicholas A. Molyneaux,
Riccardo Scarinci, Michaël Thémans
Transportation Center, EPFL

Monte Verità, April 16, 2015

Pedestrian flows in train stations

Pedestrian demand and supply

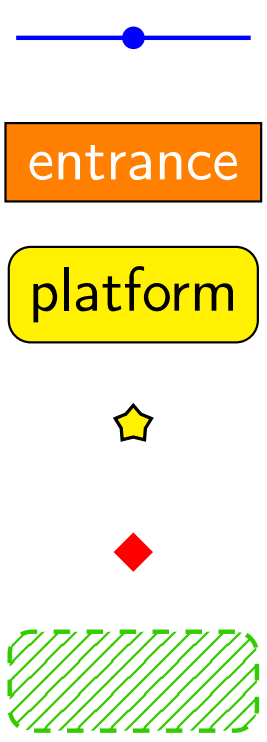


Outline

Outline

Lausanne railway station: Aerial view

Lausanne railway station: Walking areas



pedestrian walking network

centroid with historical information

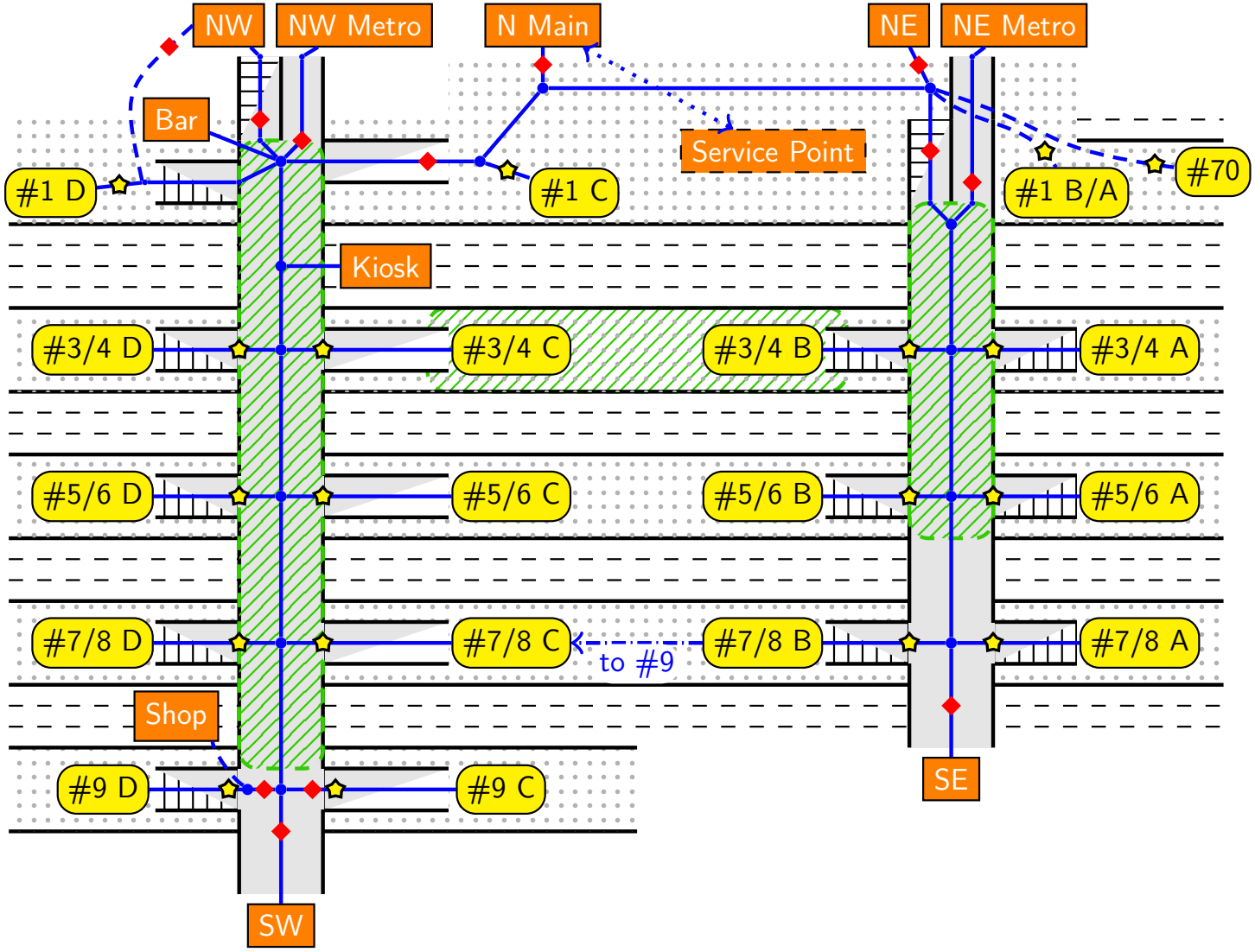
centroid without historical information

link with a priori flow estimate based on timetable

link equipped with directed flow counter

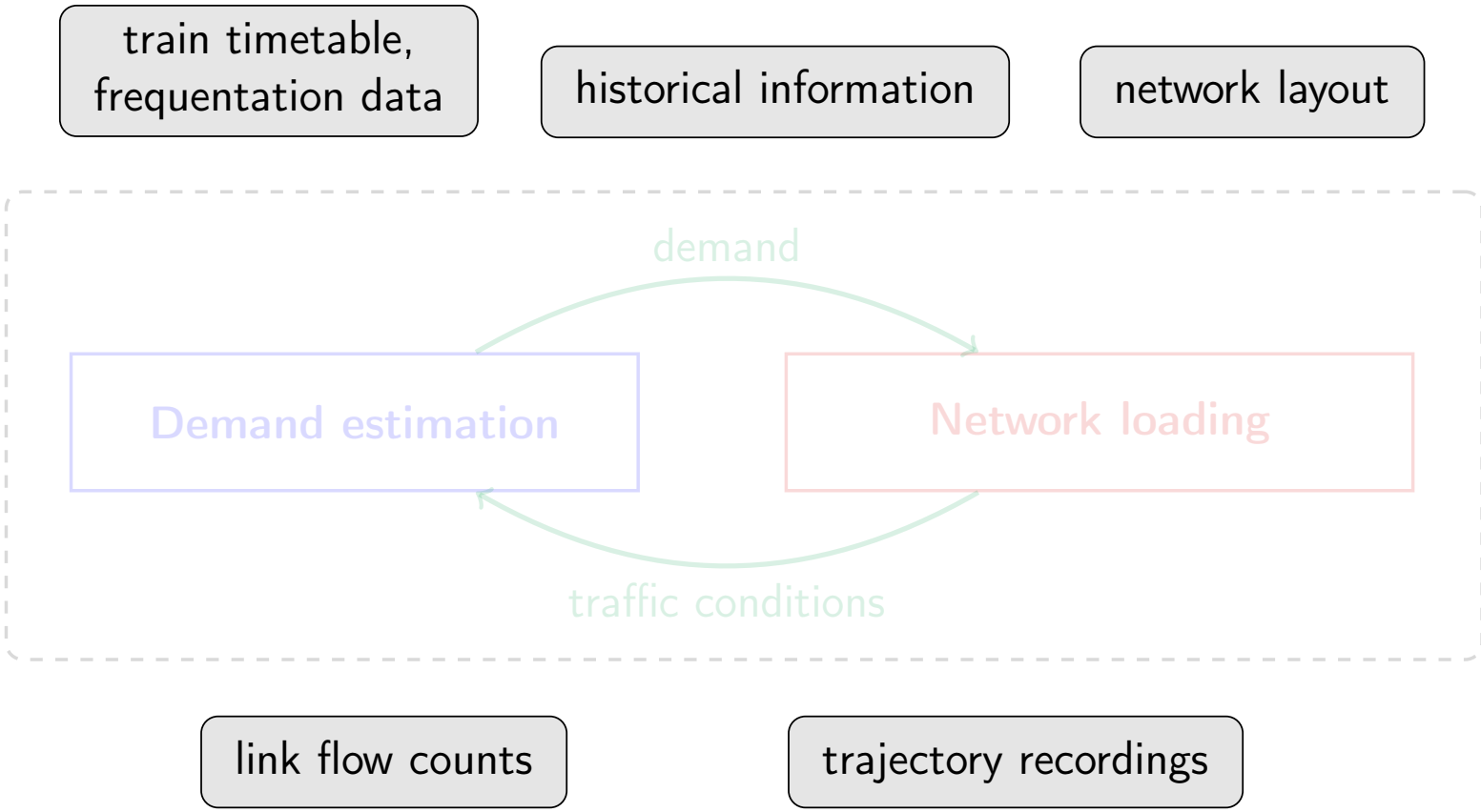
area covered by pedestrian tracking system

Lausanne railway station: Walking areas

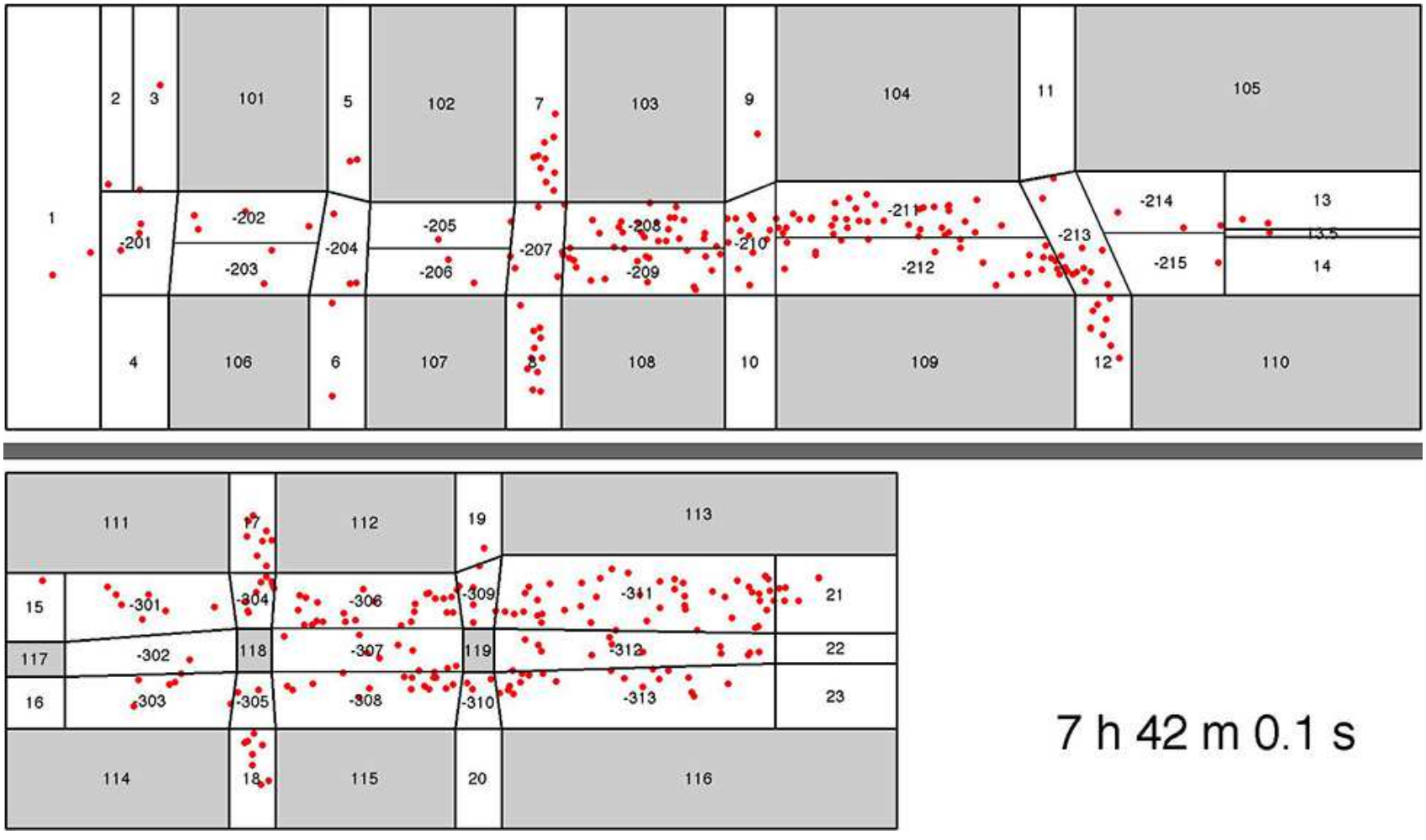


Outline

Pedestrian demand and supply: Data analysis



Pedestrian movements on January 16, 2013



7 h 42 m 0.1 s

Animation: https://youtu.be/HHMXTJlQlkY

Hourly pedestrian demand over a day

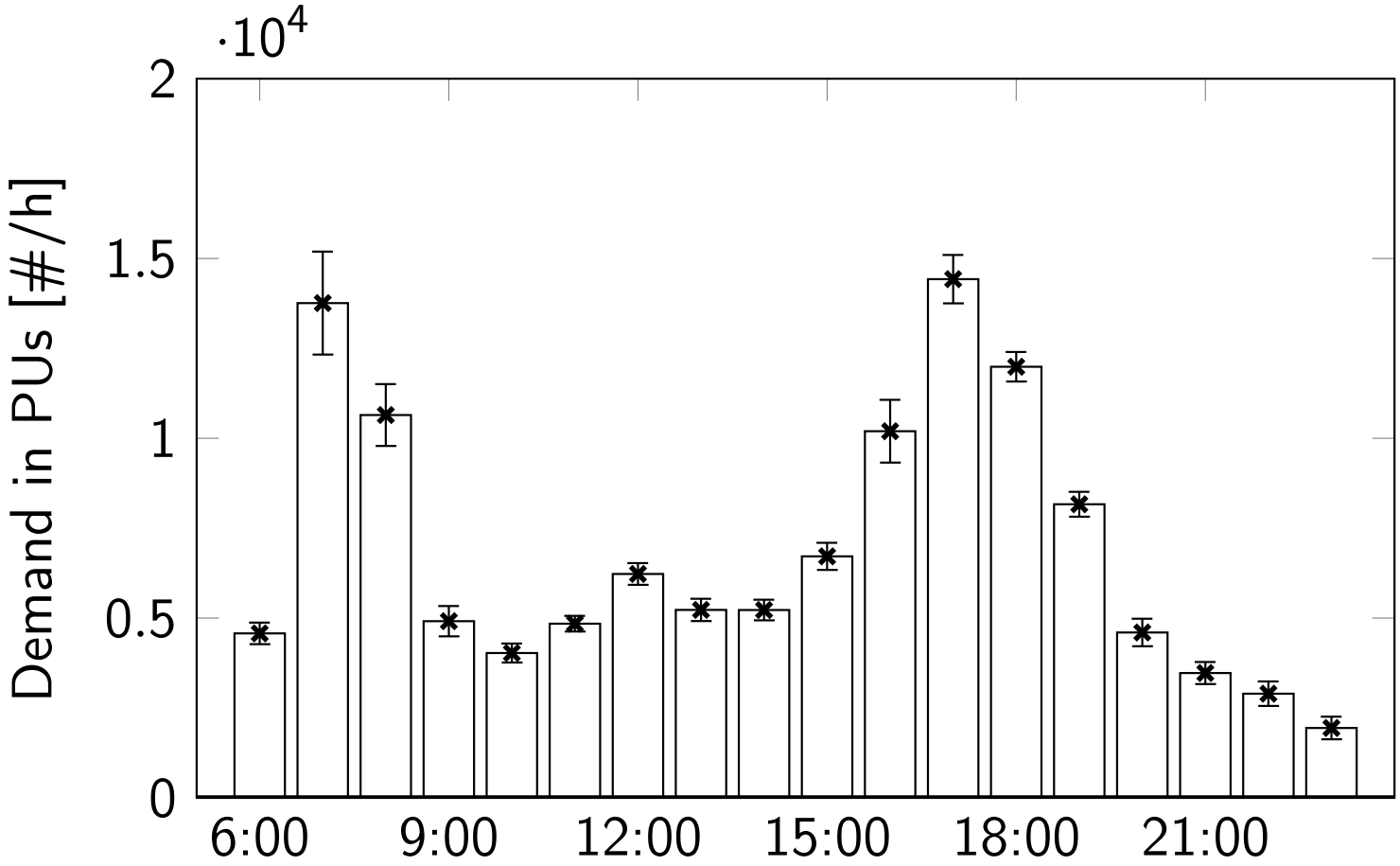
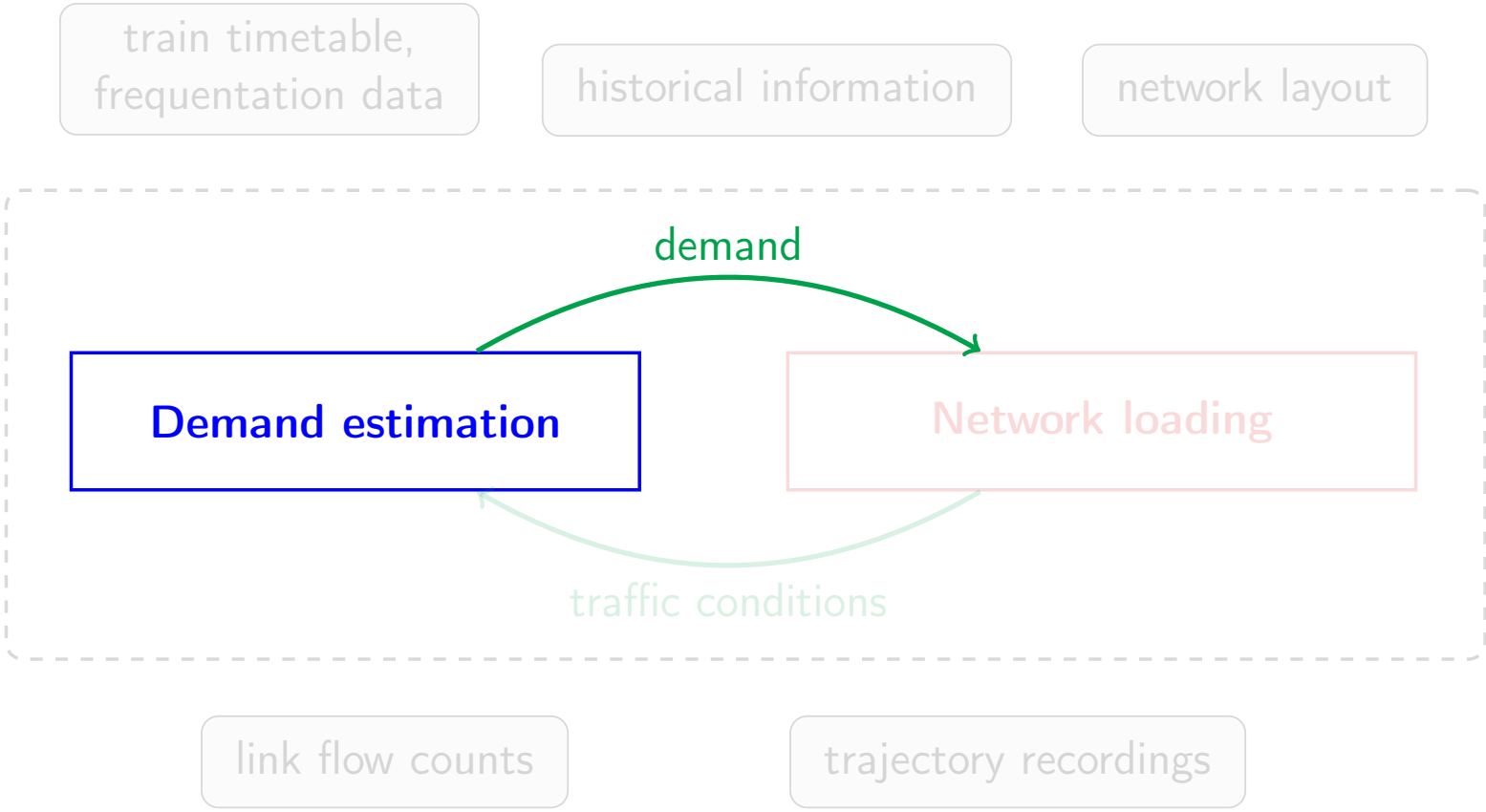


Figure: 10-day reference set, 2013

Outline

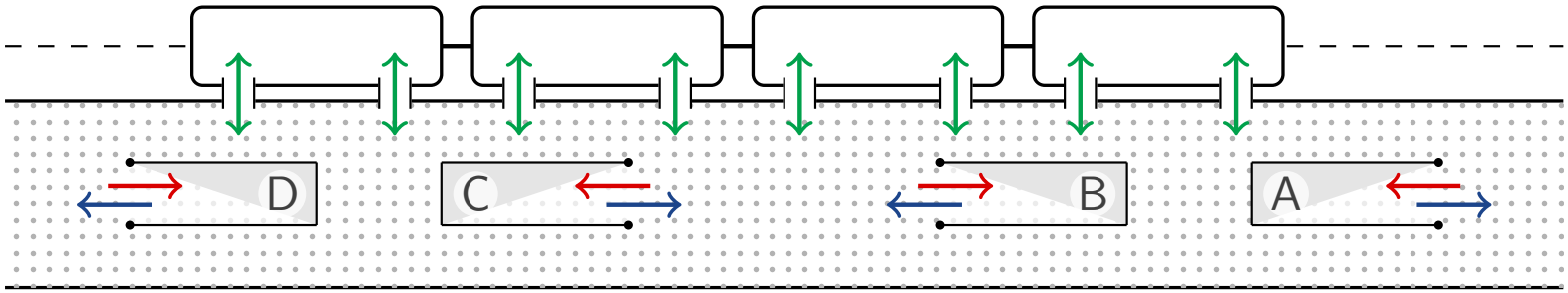
Pedestrian demand and supply: Demand Estimation



OD demand estimation: Overview

- estimation of demand in walking facilities based on
  - train timetable
  - pedestrian counts
  - historical data (travel surveys, sales data)
  - trajectories (validation only)
- demand-inelastic network loading
  - walking speed $v \sim \mathcal{N}(1.34 \text{ m/s}, 0.34 \text{ m/s})$ [Wei92]
  - unique route per OD pair
- case study: morning peak period, Lausanne railway station
  - busiest 30-min period of the day (07:30 – 08:00)
  - 25 arriving and departing trains

Train-induced flows



↔ boarding/disembarkation flows

→ platform exit flows

→ platform access flows

Platform exit flows: Model

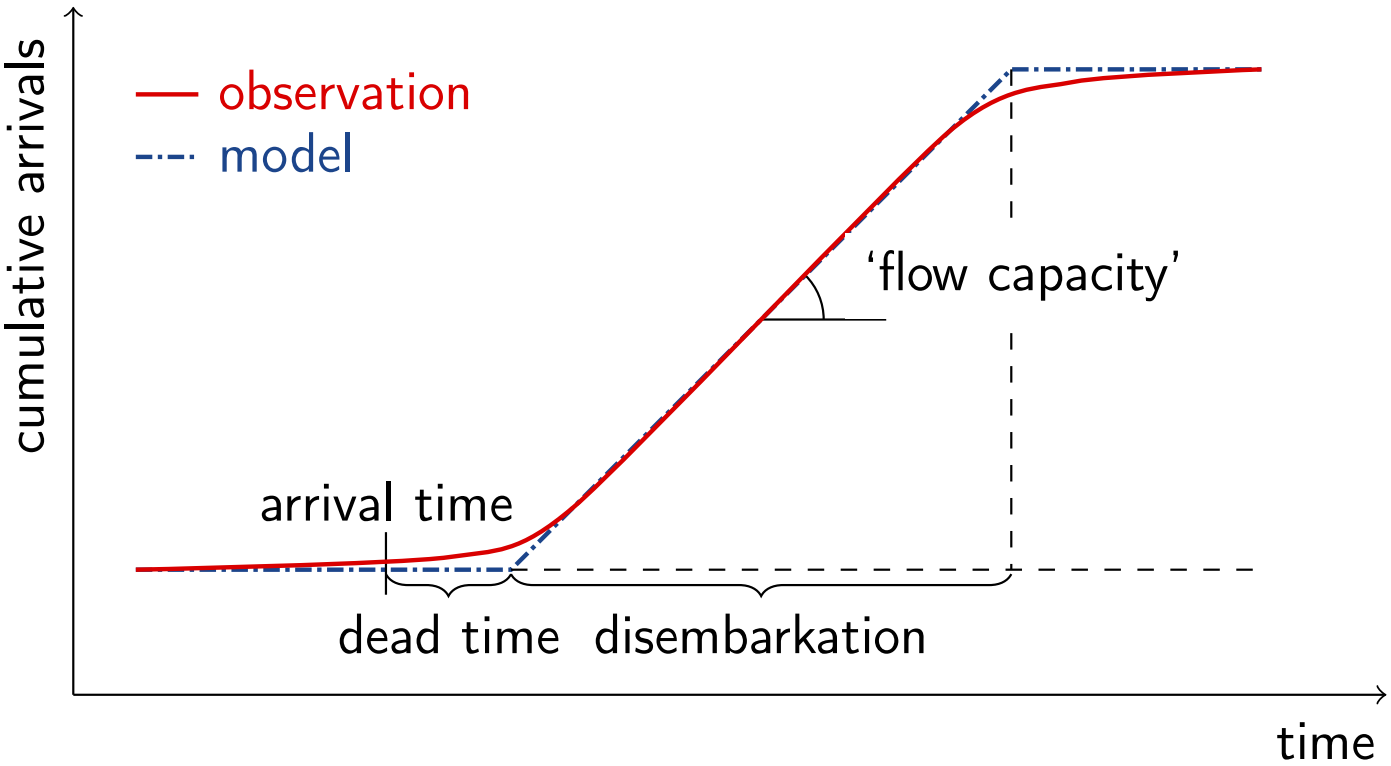


Figure: Continuous-time, piecewise linear model

Platform exit flows: Simulation

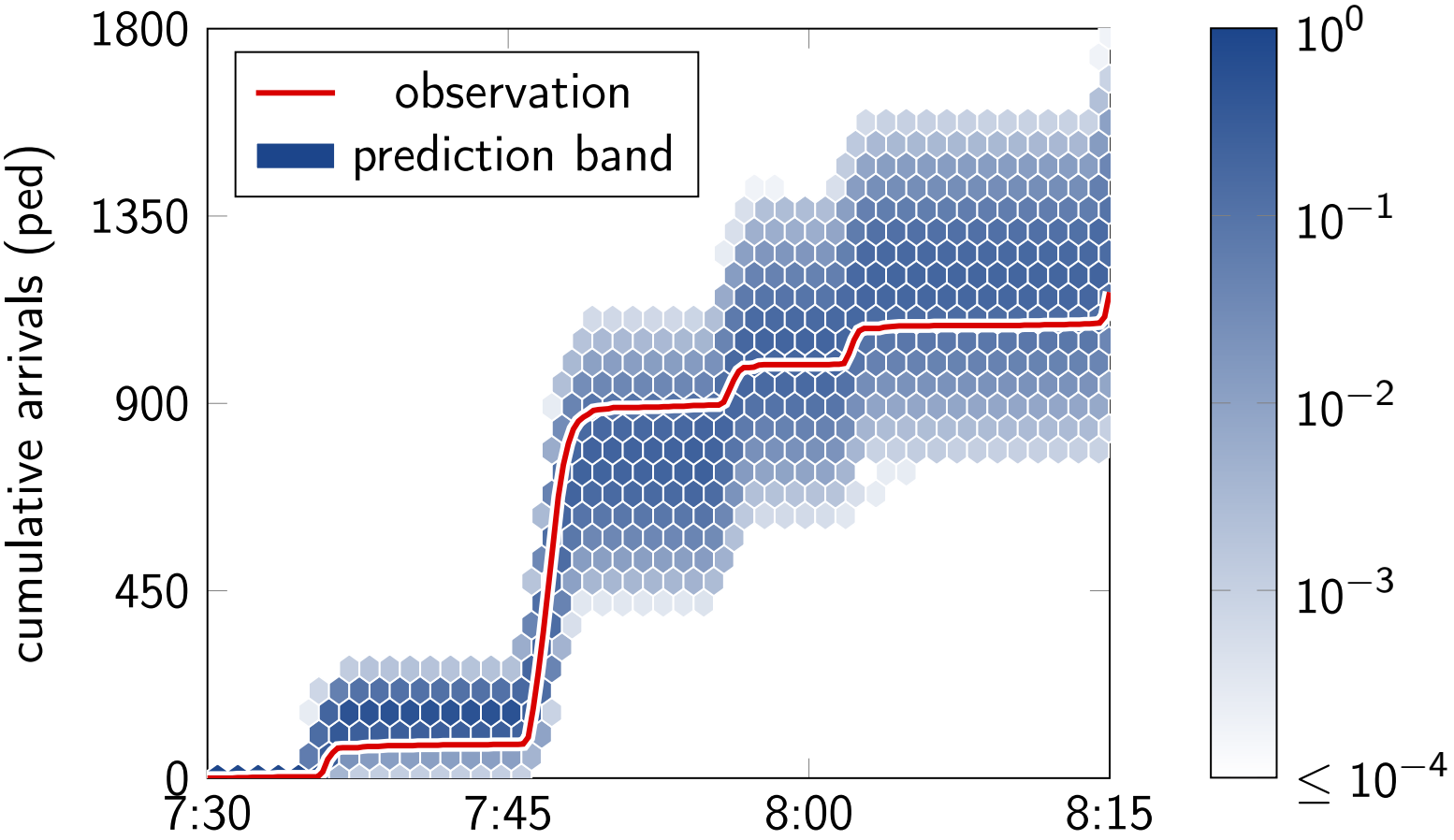


Figure: April 10, 2013, platform #5/6, Lausanne railway station

Total demand in Lausanne railway station

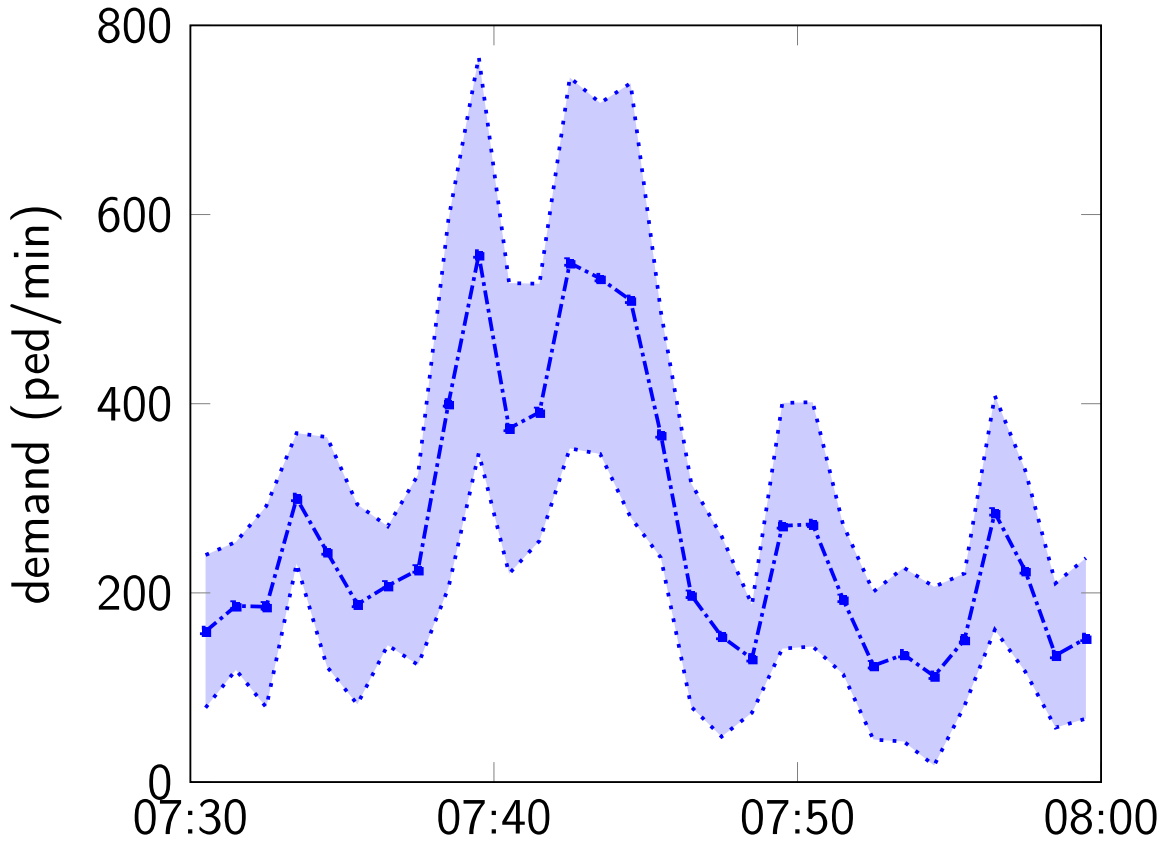
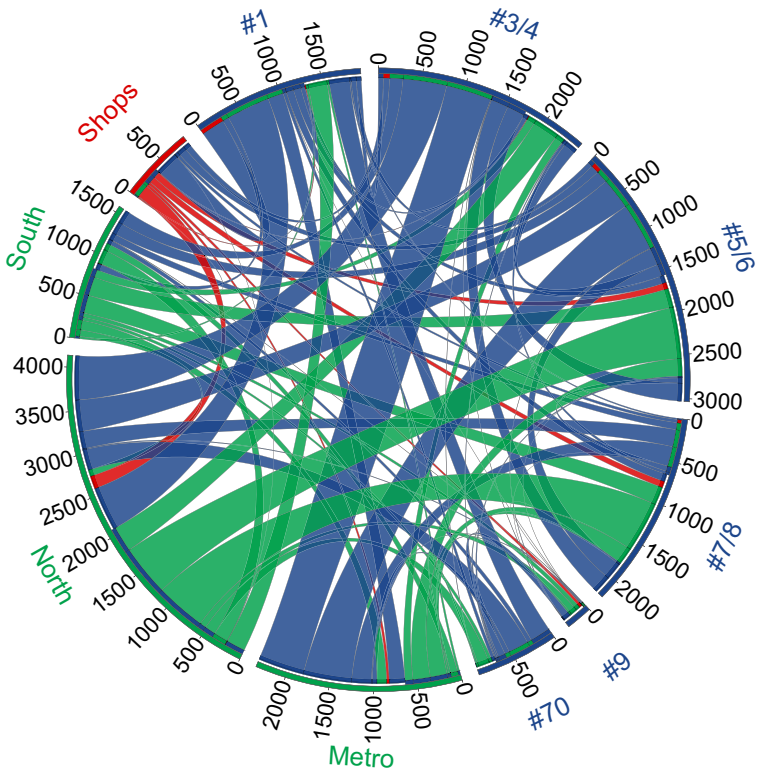
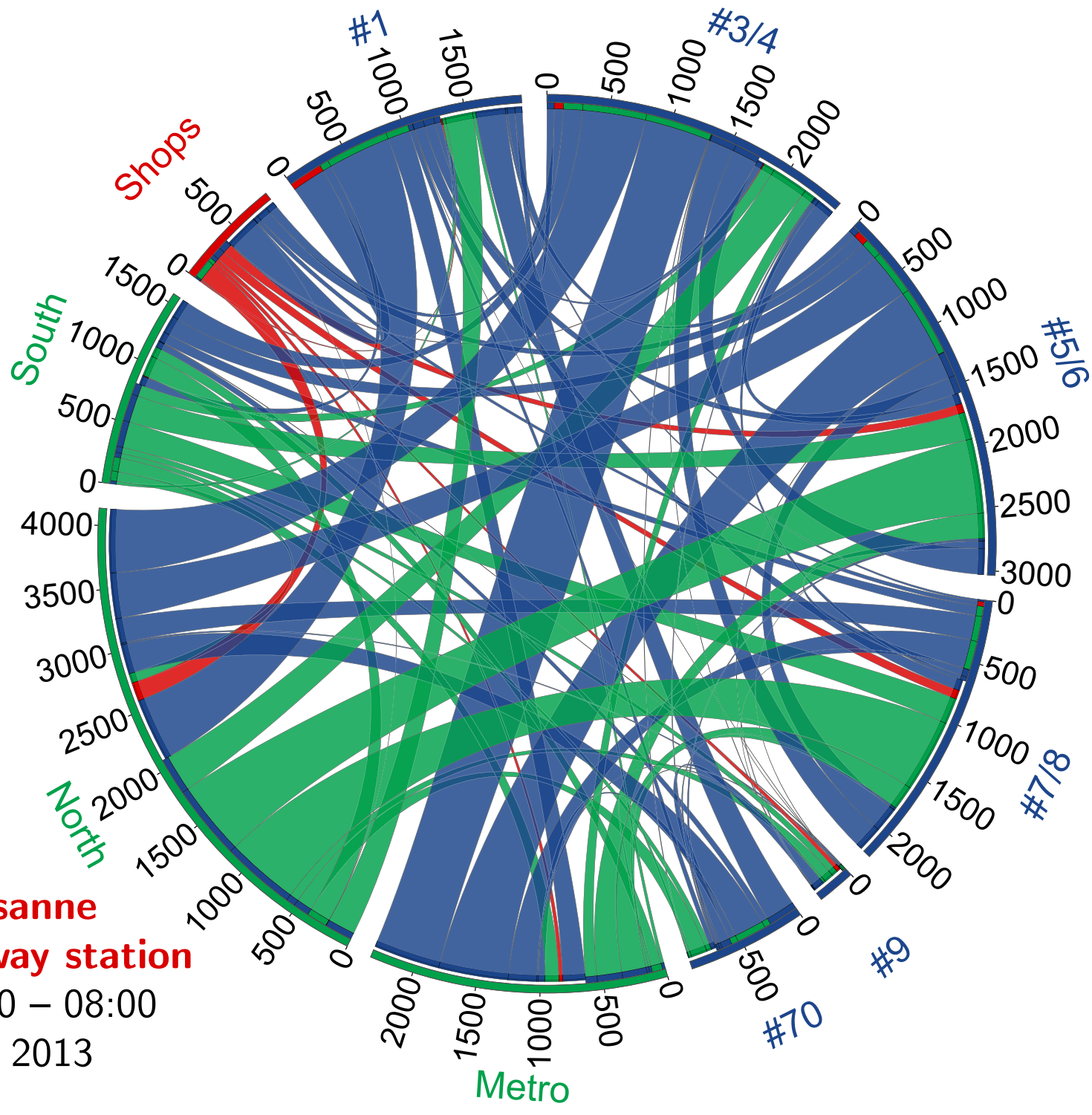


Figure: 10-day reference set, 2013

Average OD demand in Lausanne railway station



- pedestrian walking network
- peak period: 7:30 – 8:00
- origin of streams
  - train platforms
  - city/metro/bus
  - shops



Lausanne
railway station
07:30 – 08:00
Year 2013

Flow map of Lausanne railway station (2013)

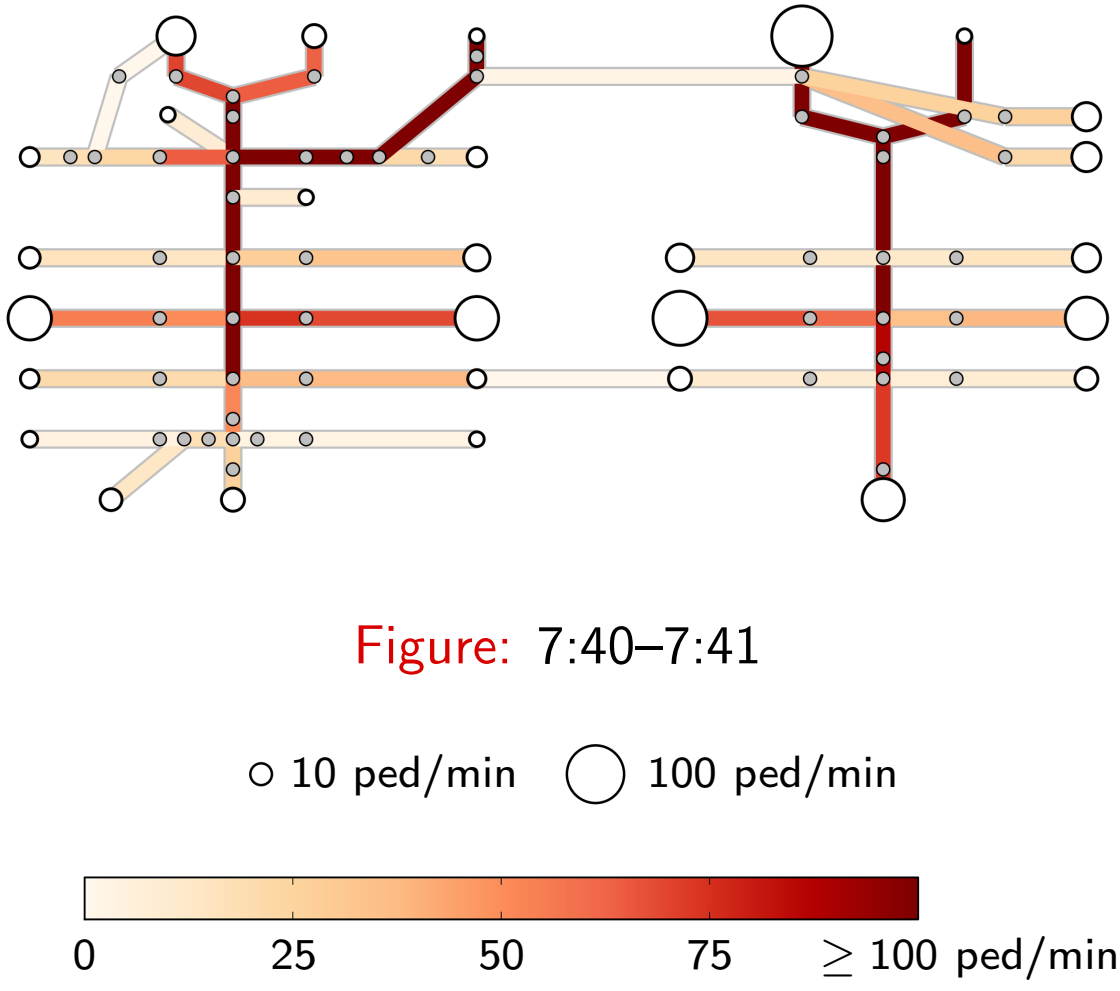


Figure: 7:40–7:41

Flow map of Lausanne railway station (2013)

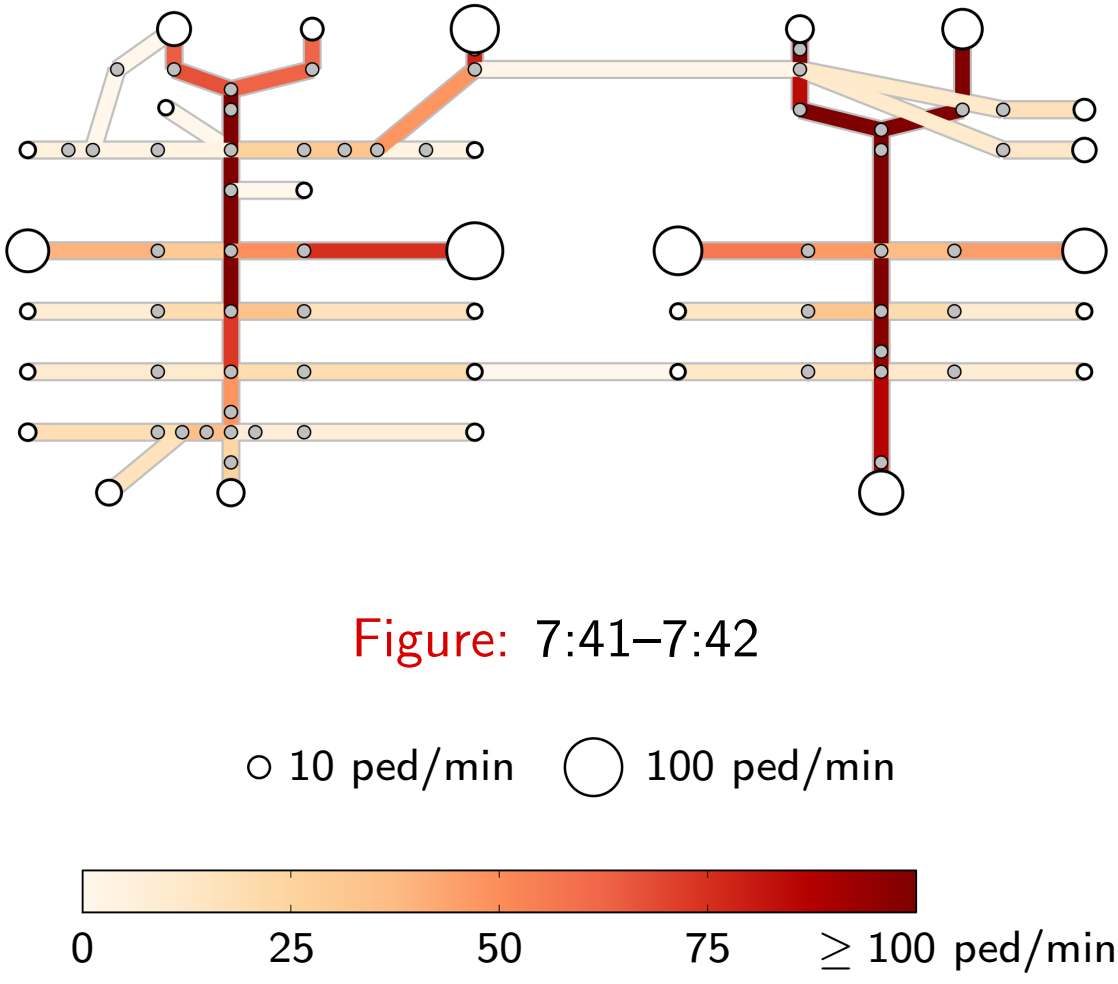


Figure: 7:41–7:42

Flow map of Lausanne railway station (2013)

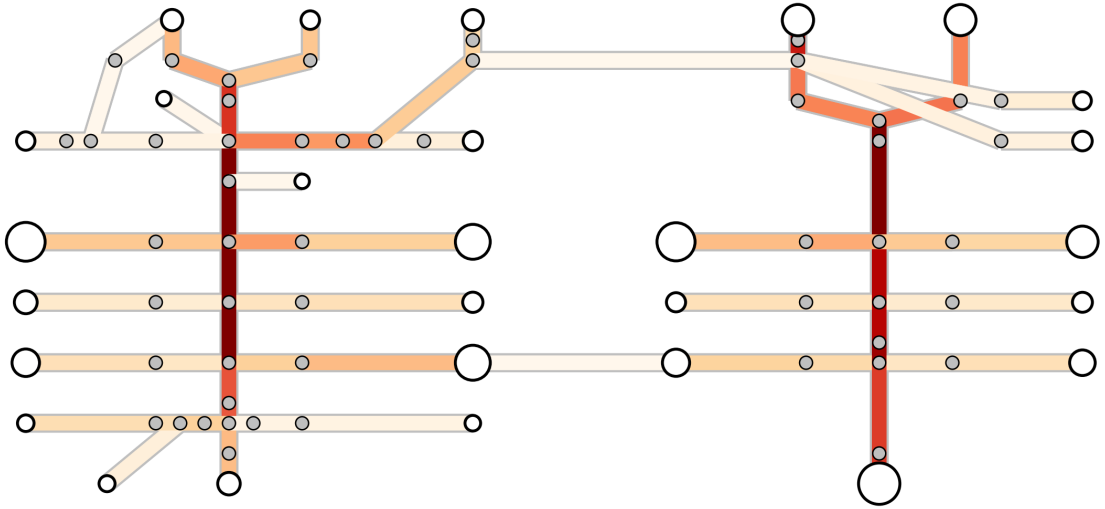
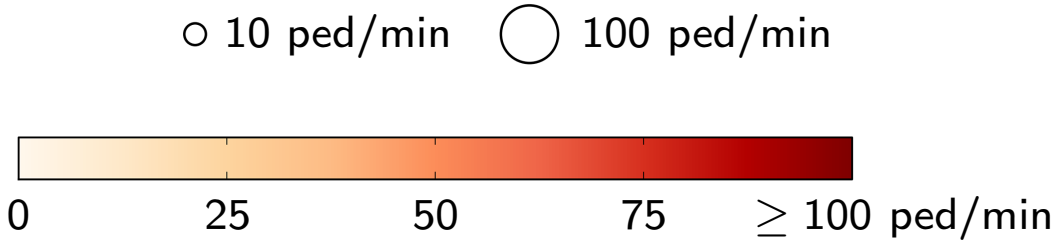


Figure: 7:42–7:43



Flow map of Lausanne railway station (2013)

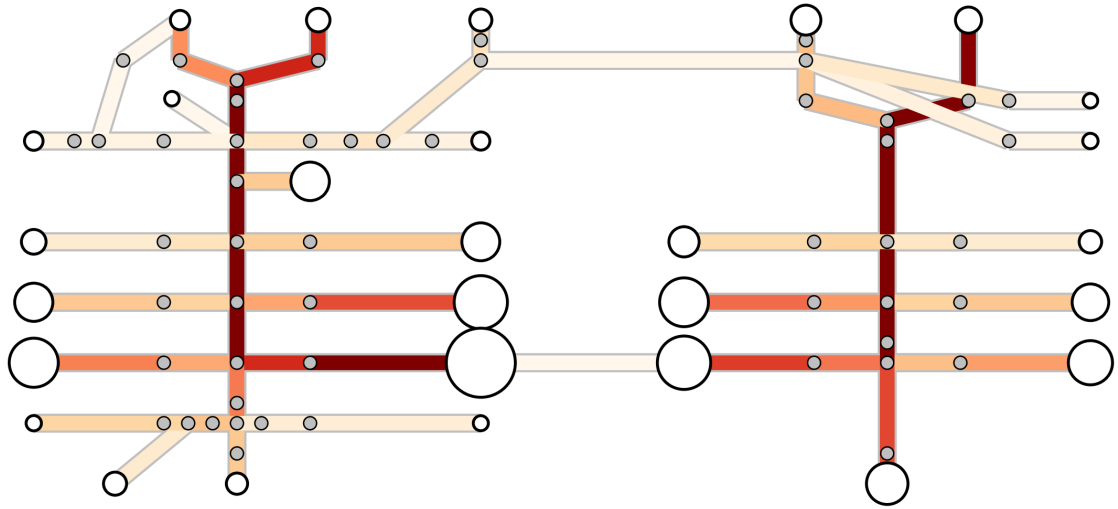
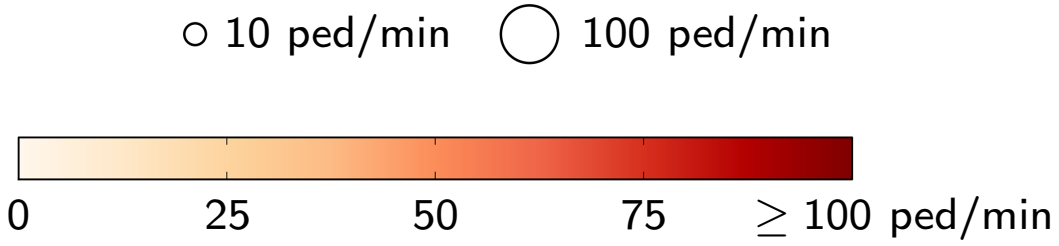


Figure: 7:43–7:44



Flow map of Lausanne railway station (2013)

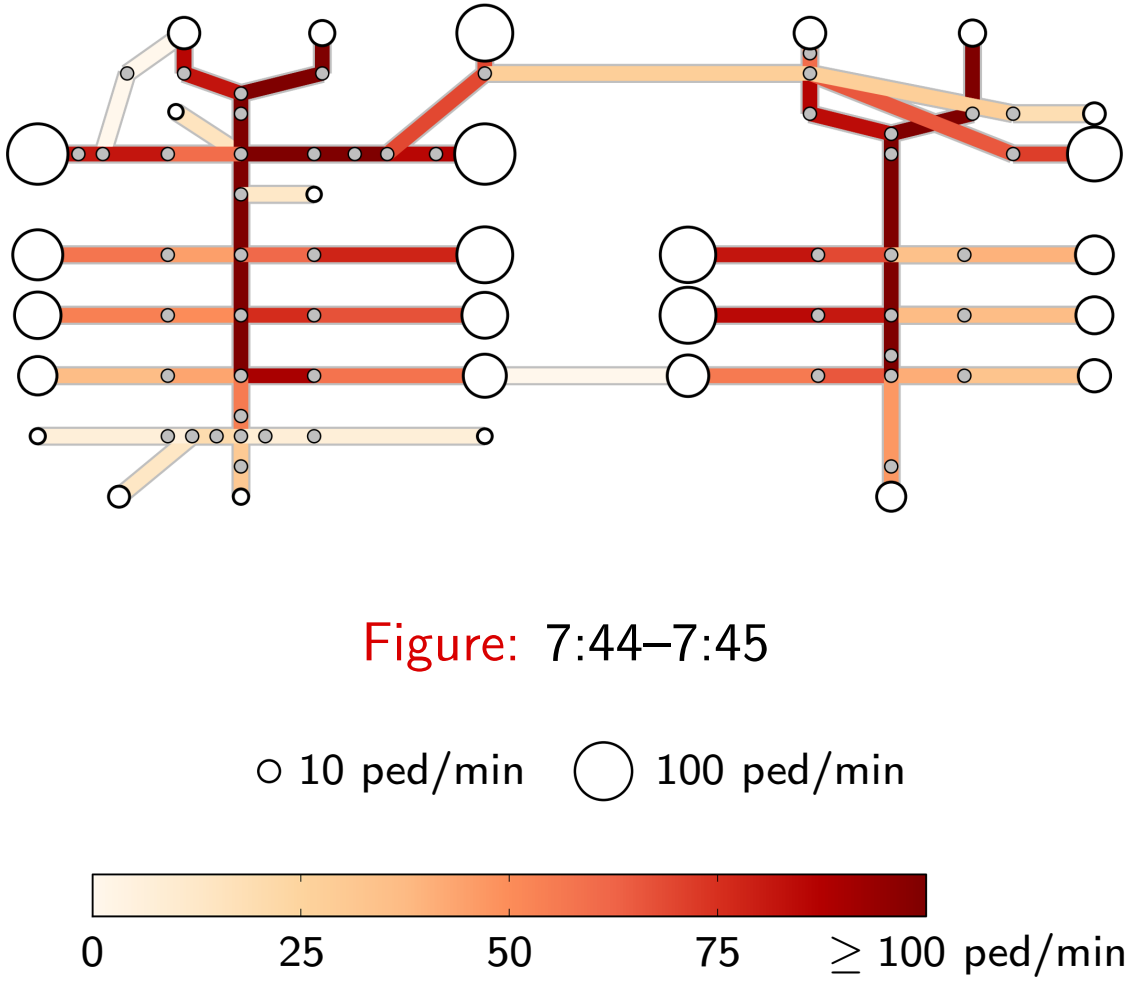


Figure: 7:44–7:45

Flow map of Lausanne railway station (2013)

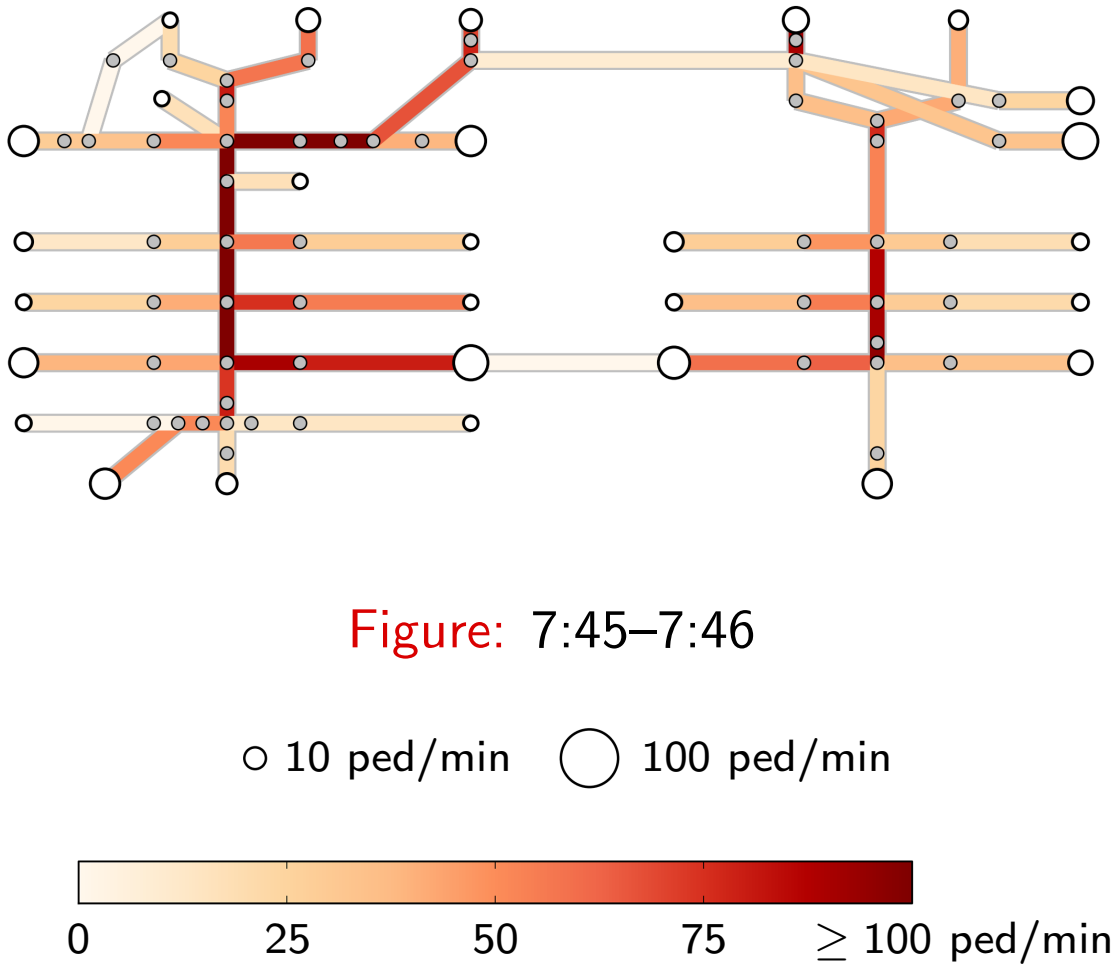


Figure: 7:45–7:46

Flow map of Lausanne railway station (2013)

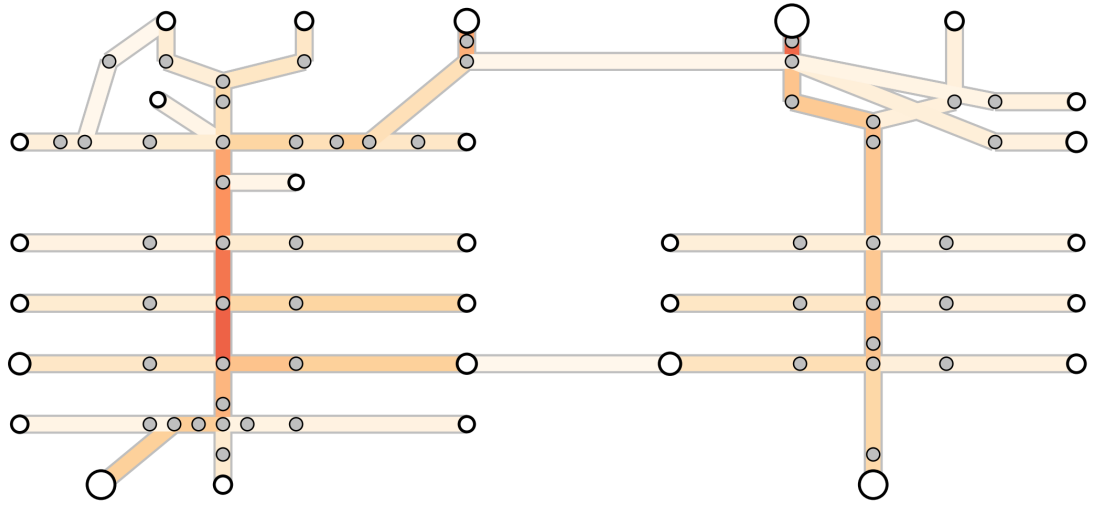
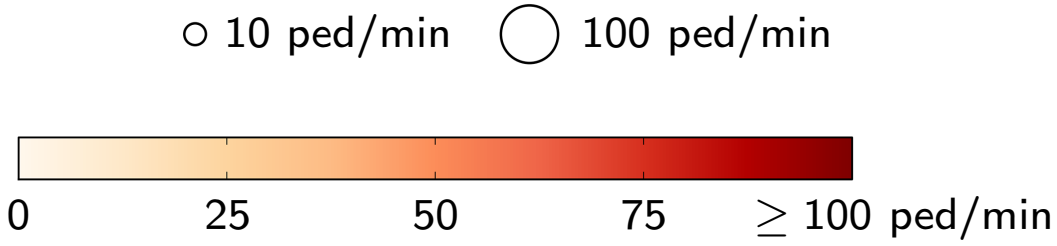


Figure: 7:46–7:47



Flow map of Lausanne railway station (2013)

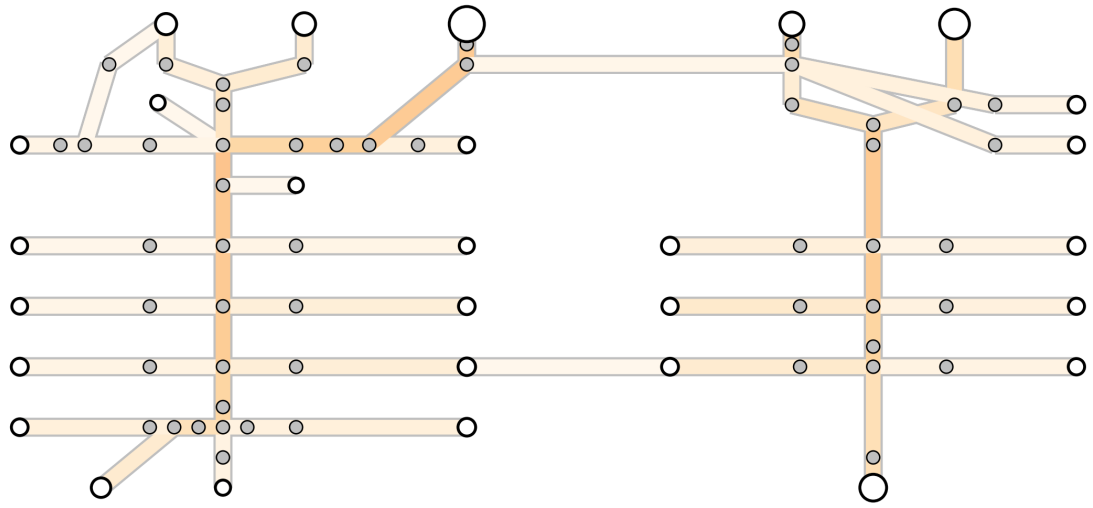
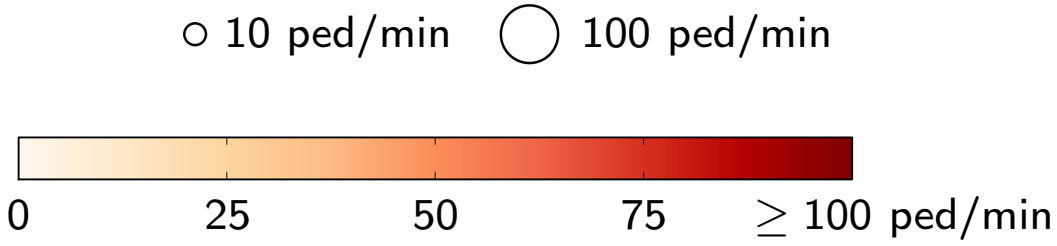
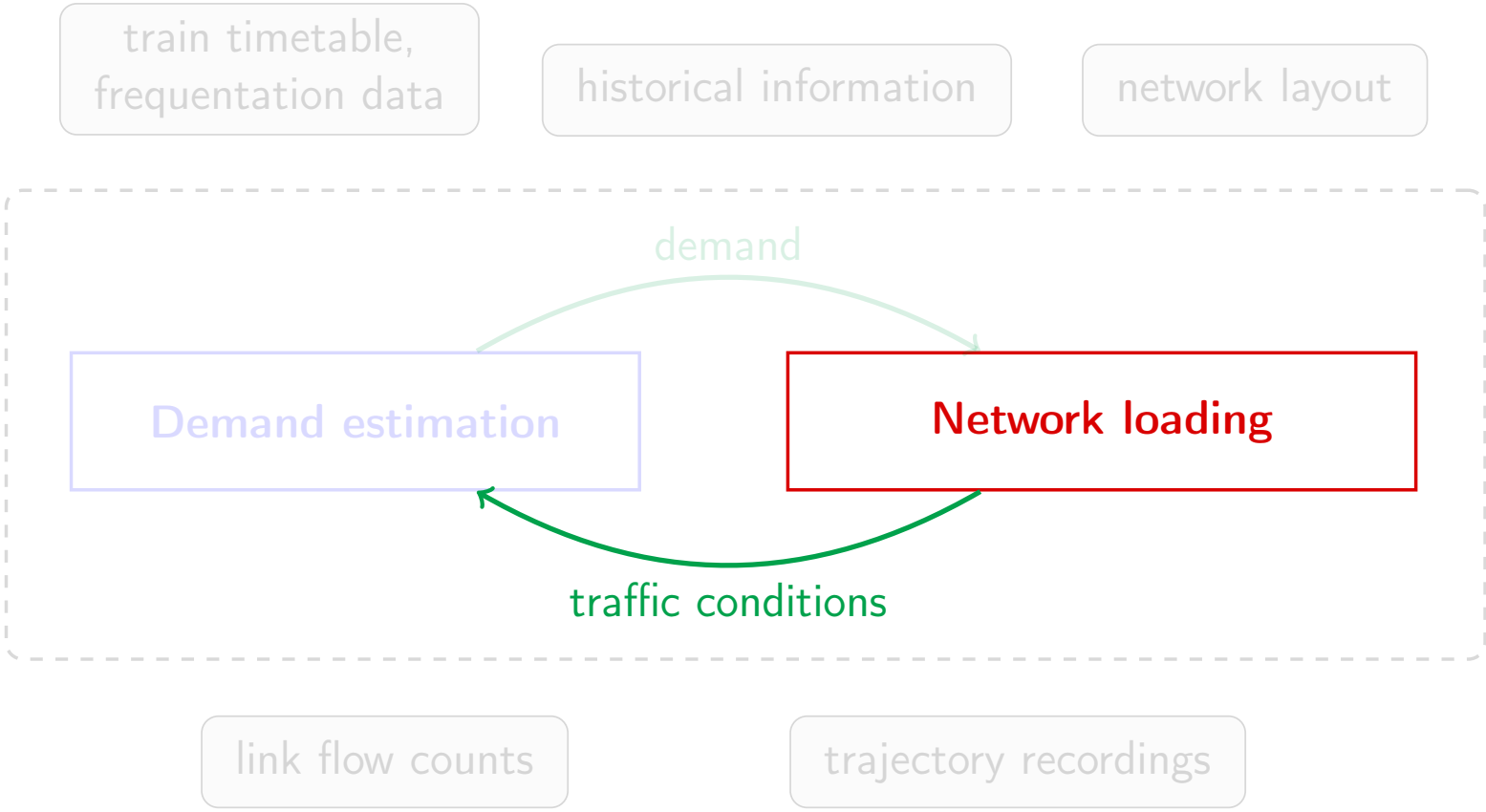


Figure: 7:47–7:48



Outline

Pedestrian demand and supply: Network loading



Network loading model: Overview

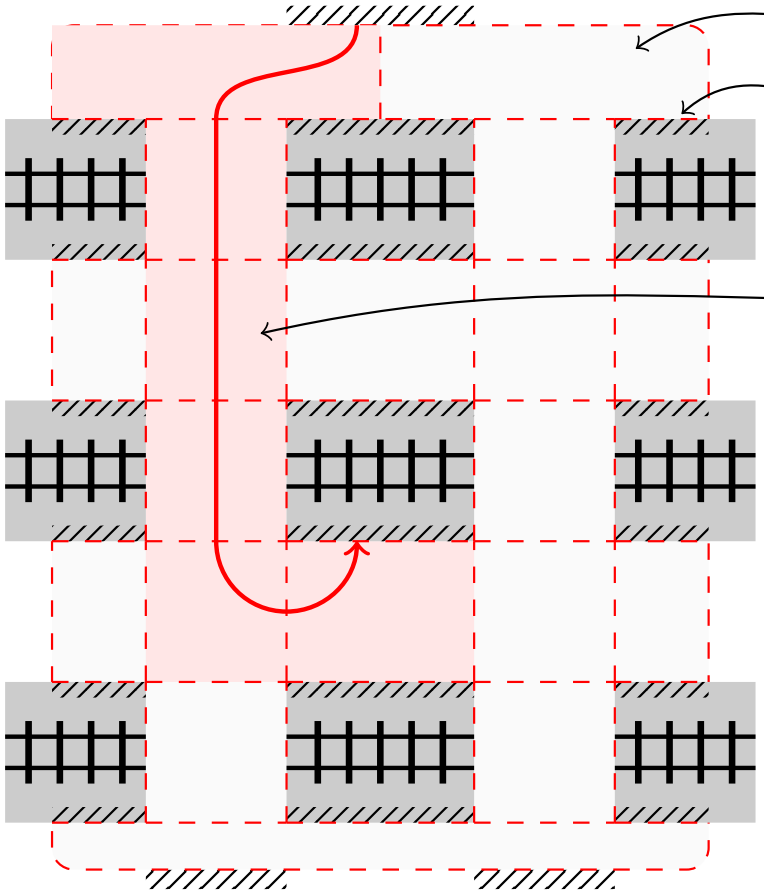
Requirements:

- accurate prediction of travel time and density
- low computational cost, 'easy' calibration
- aggregate model (input and output at aggregate level)

Input:

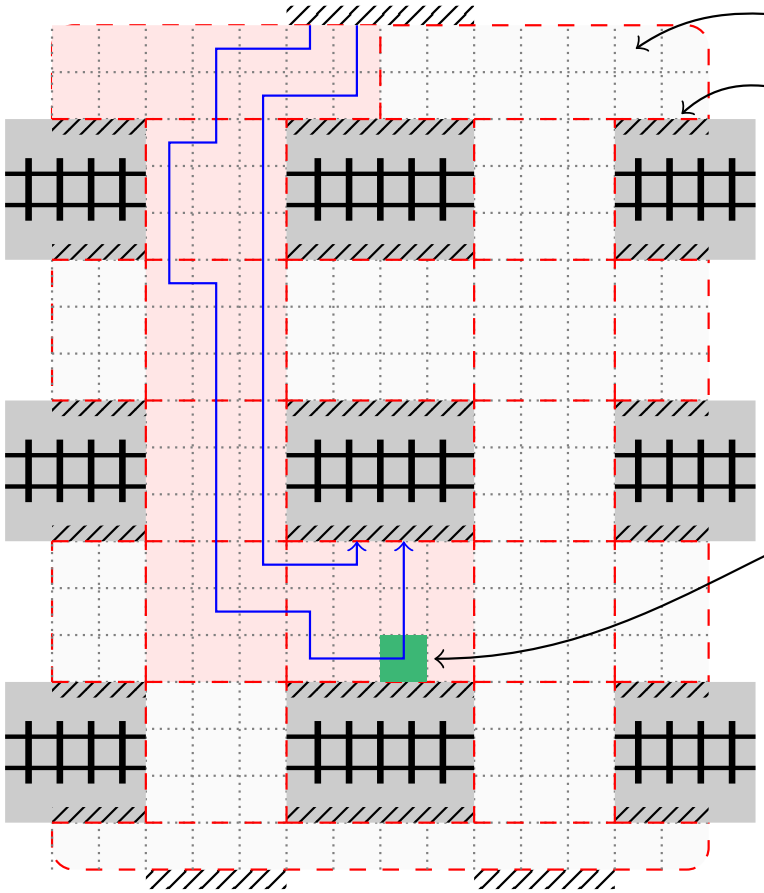
- demand
- network topology

Pedestrian network loading: Space representation



- walkable area
- entry/exit points
- route
  - sequence of areas

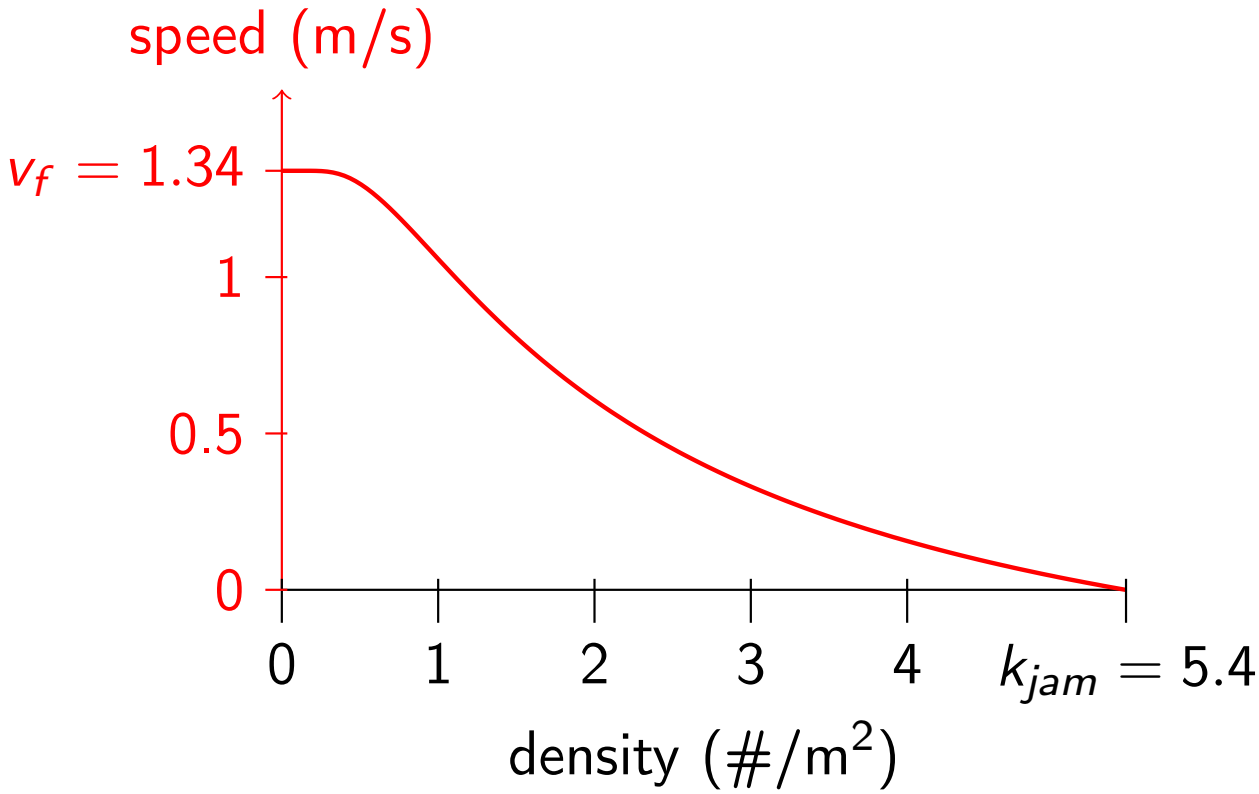
Pedestrian network loading: Space representation



- walkable area
- entry/exit points
- route
  - sequence of areas
- path
  - sequence of cells

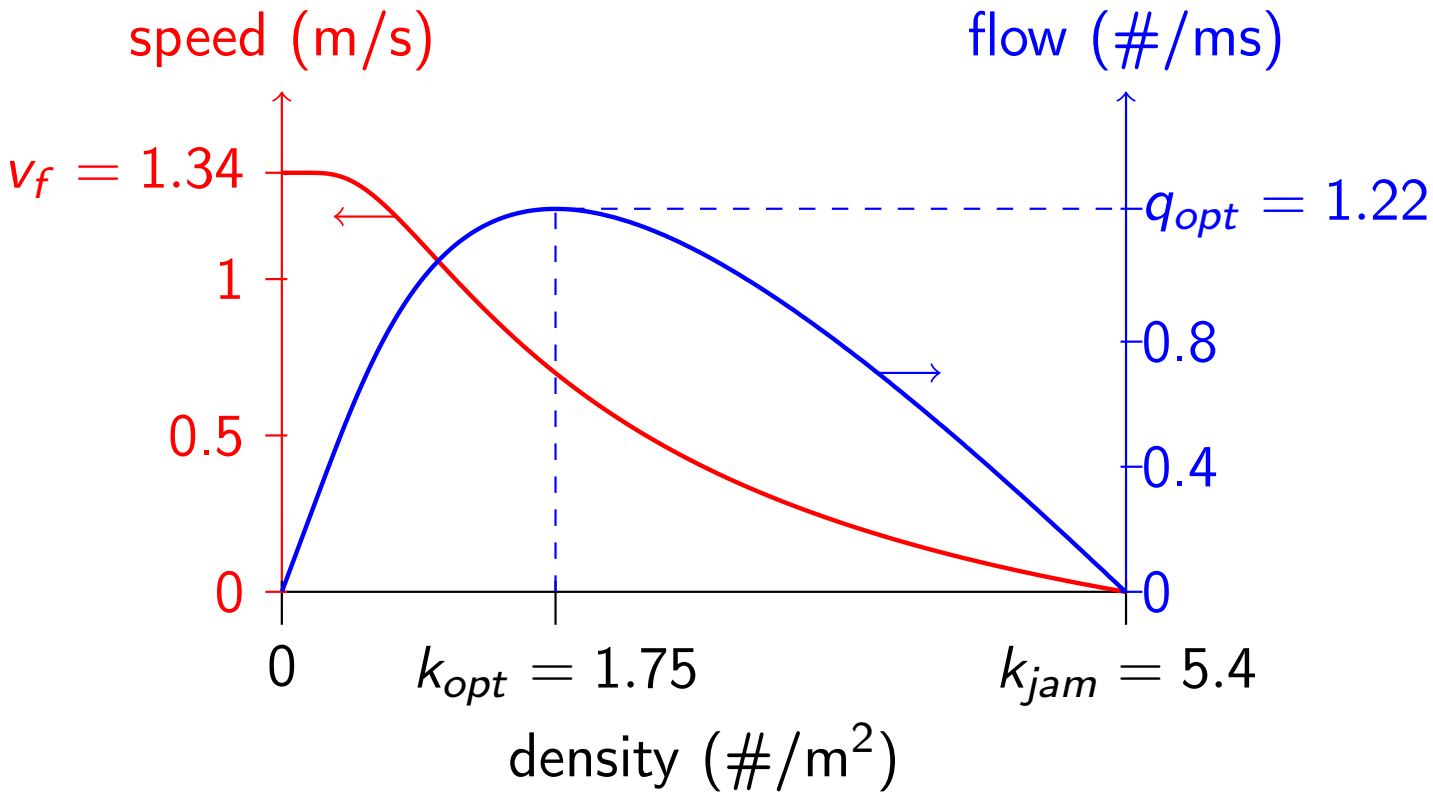
Pedestrian network loading: Propagation model

pedestrian fundamental diagram [Wei92]



Pedestrian network loading: Propagation model

pedestrian fundamental diagram [Wei92]



Level-of-service assessment

	LOS	Pedestrian density
	A	< 0.179 [ped/m^2]
	B	< 0.270
	C	< 0.455
	D	< 0.714
	E	< 1.333
	F	≥ 1.333

Table: Pedestrian walkway LoS density threshold values according to NCHRP

density as indicator for:

- comfort
- performance
- safety

Ref: [Hig00], Exhibit 18-3

Level-of-service assessment

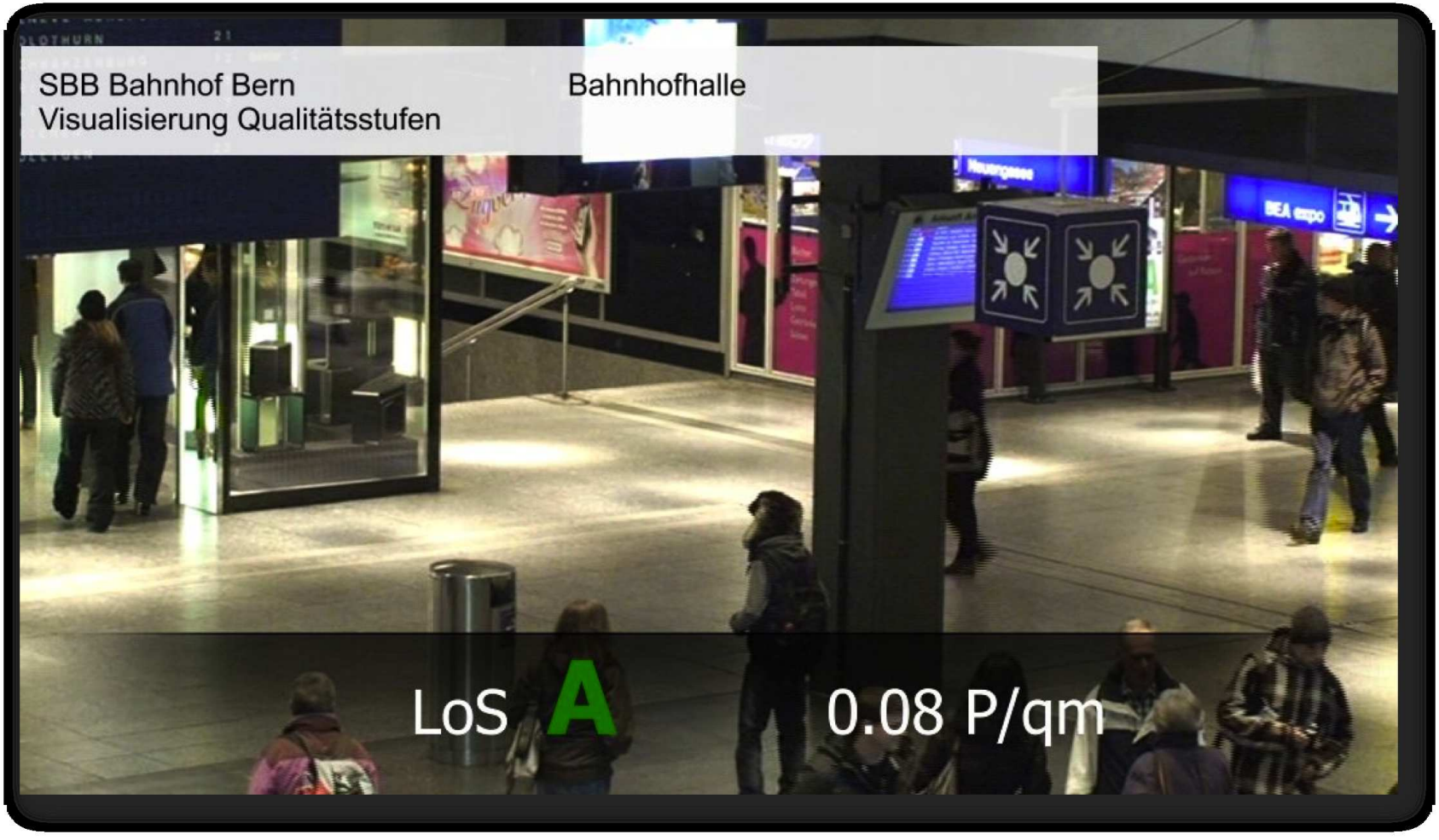


Figure: SBB-I-AT-BZU-PFL

Level-of-service assessment

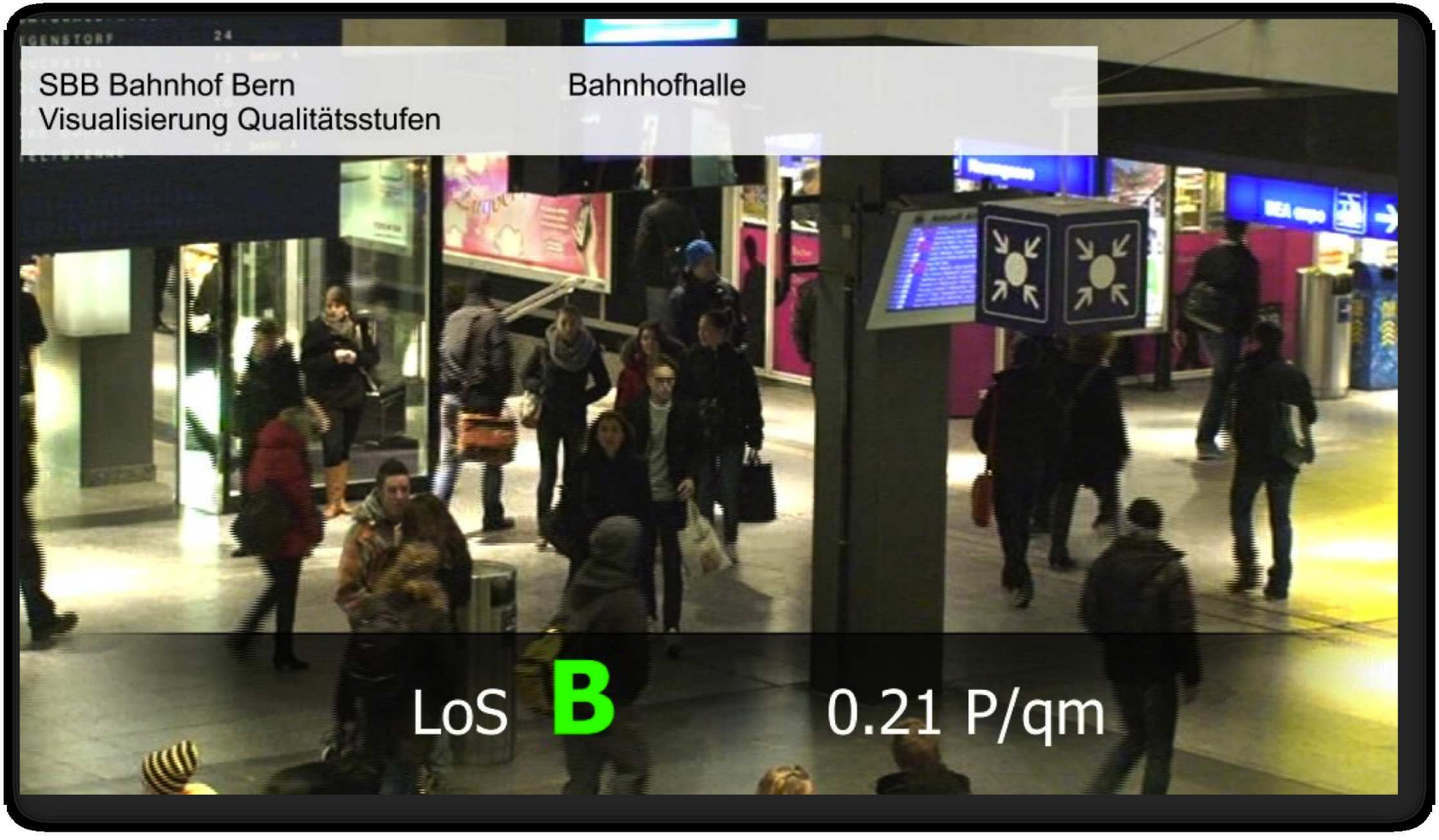


Figure: SBB-I-AT-BZU-PFL

Level-of-service assessment

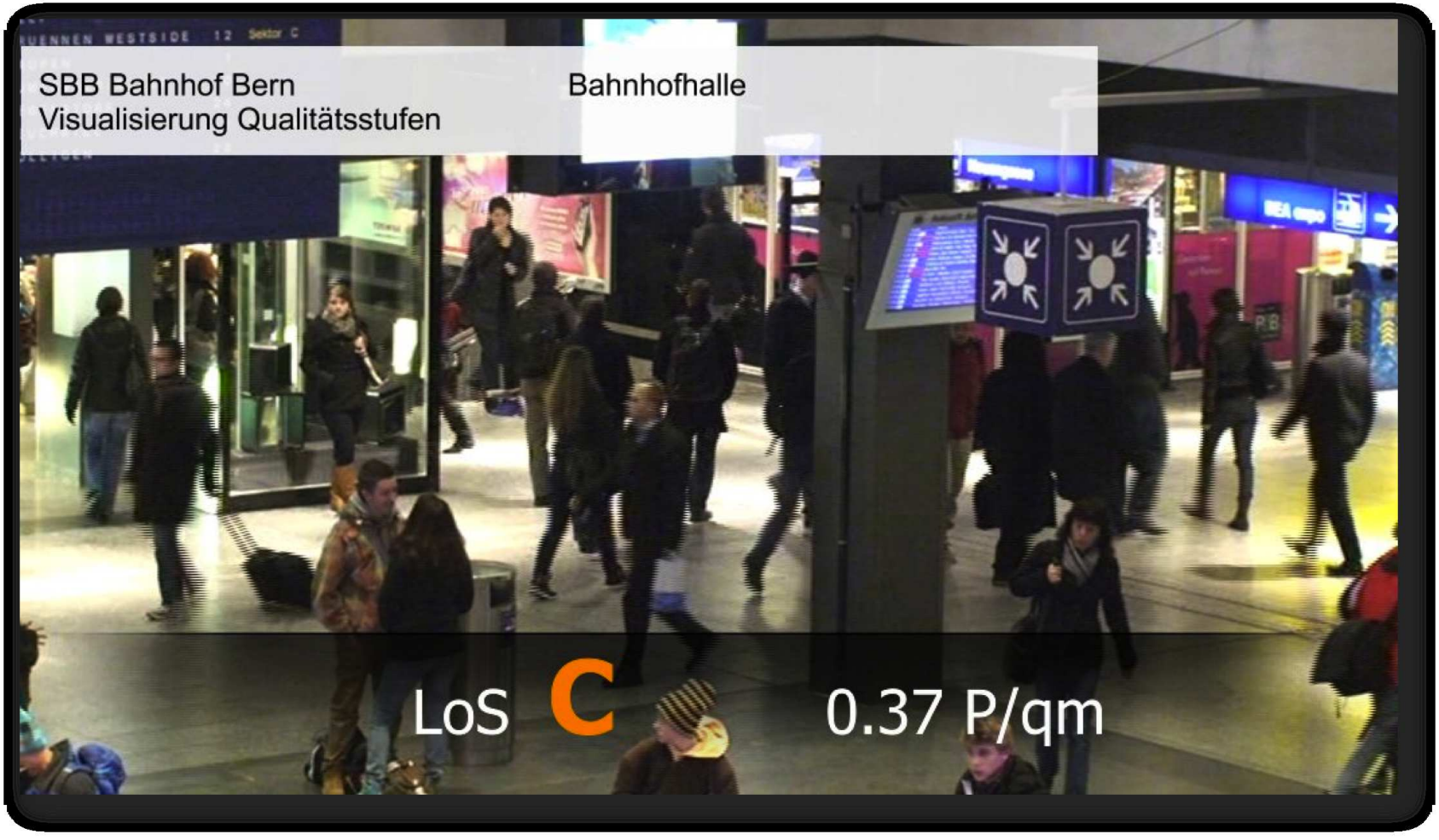


Figure: SBB-I-AT-BZU-PFL

Level-of-service assessment

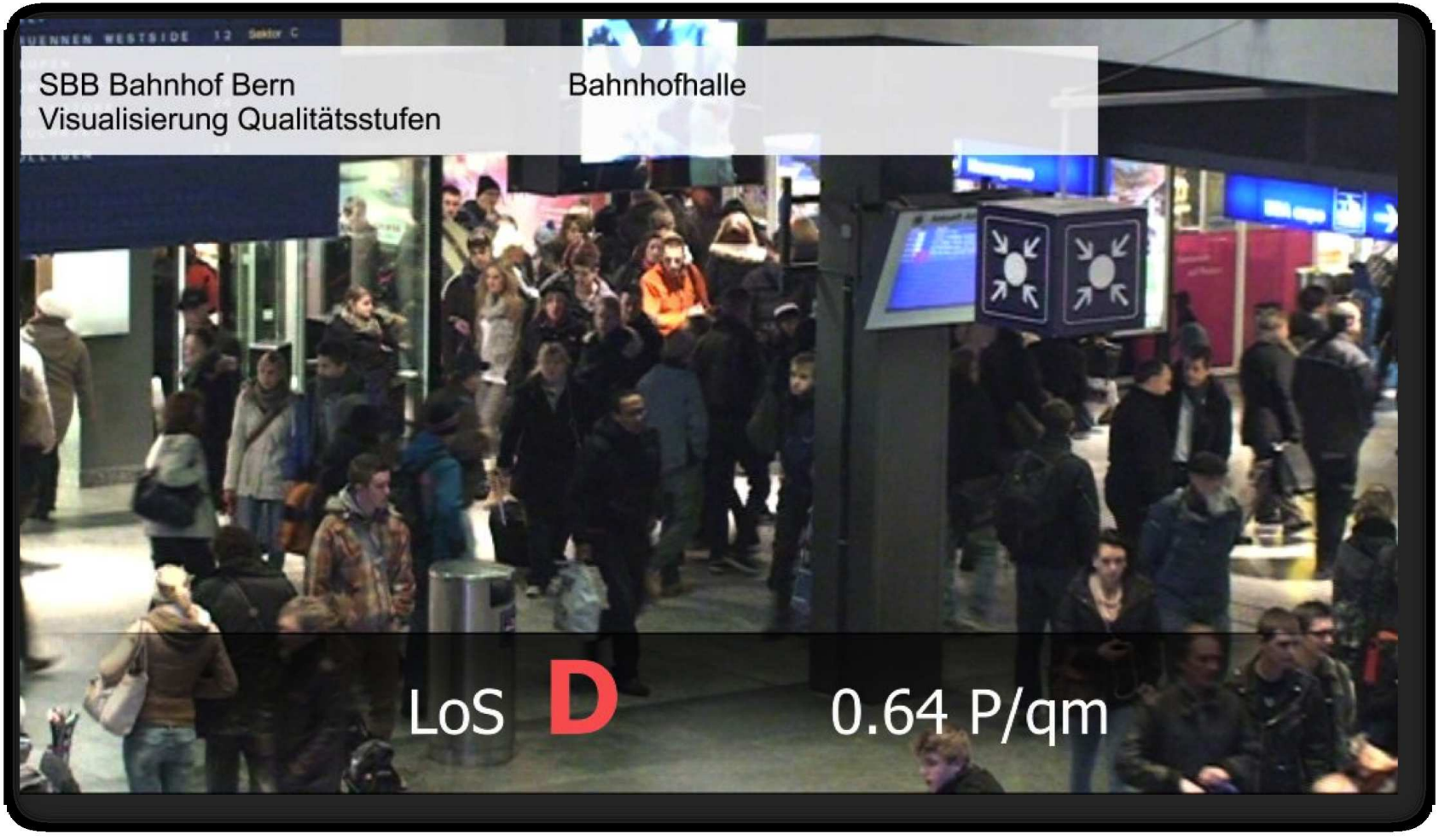


Figure: SBB-I-AT-BZU-PFL

Level-of-service assessment

Figure: SBB-I-AT-BZU-PFL

Pedestrian network loading: PU West, Lausanne

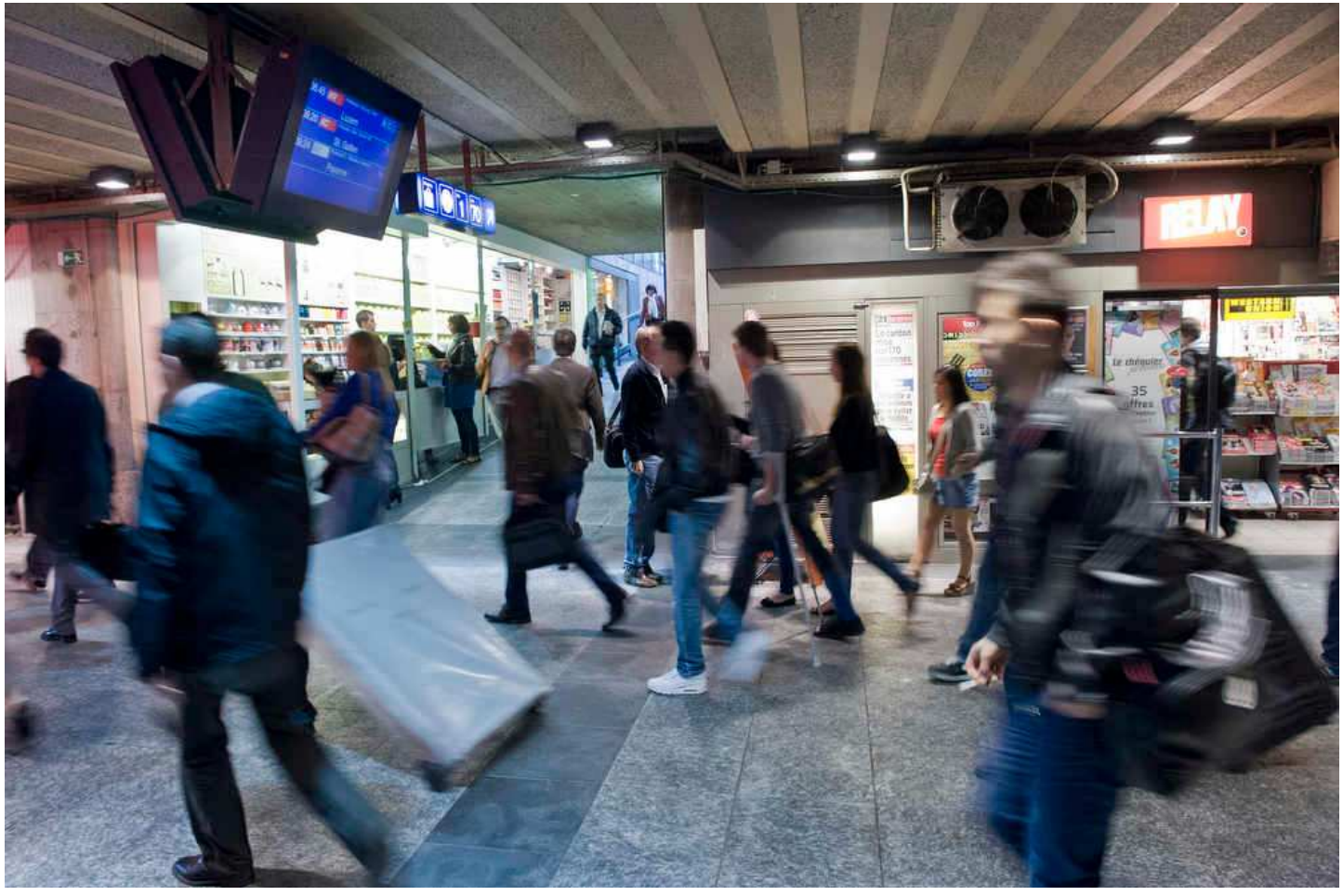
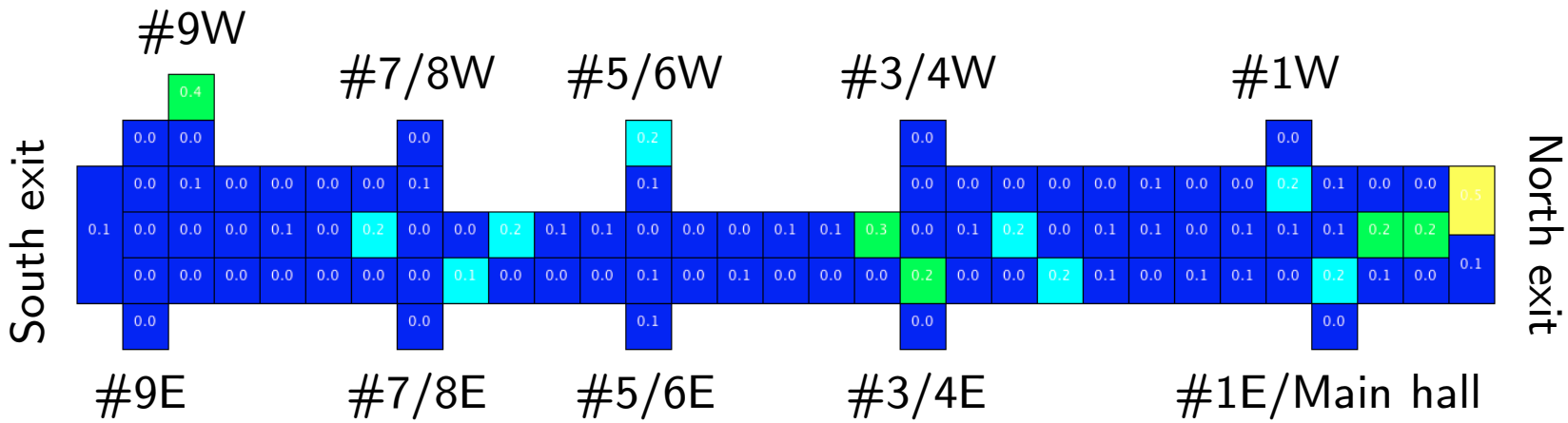


Figure: Pedestrian Underpass West, Lausanne railway station

Pedestrian network loading: PU West, Lausanne

- simulated pedestrian density map
- prediction of travel times, flows and densities
- January 22, 2013, 07:40 – 07:46

	LOS	[#/m^2]
	A	< 0.179
	B	< 0.270
	C	< 0.455
	D	< 0.714
	E	< 1.333
	F	≥ 1.333



Animation: http://youtu.be/16_MkoF70Hc

Outline

Conclusions

- explorative analysis of several pedestrian data sets related to Lausanne railway station
- development of schedule-based origin-destination demand estimator for pedestrian flows in railway stations
- development of pedestrian network loading model for level-of-service assessment in pedestrian facilities in railway stations

Thank you

STRC 2015:

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– transport.epfl.ch

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