# Smart transfers through unravelling urban form and travel flow dynamics

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# Outline

# The TRANS-FORM project

# Consortium

## Academic partners

- Delft University of Technology, The Netherlands (Project Coordinator)
- École Polytechnique Fédérale de Lausanne, Switzerland
- Linköping University, Sweden
- Blekinge Institute of Technology, Sweden

## Expertise

- Urban public transport
- Human mobility
- Train operations optimization

## Industrial partners

- IBM Research, Switzerland
- ETRA (Mobility and Integrated Services), Spain

- Big data
- Traffic data visualization

# Stakeholders

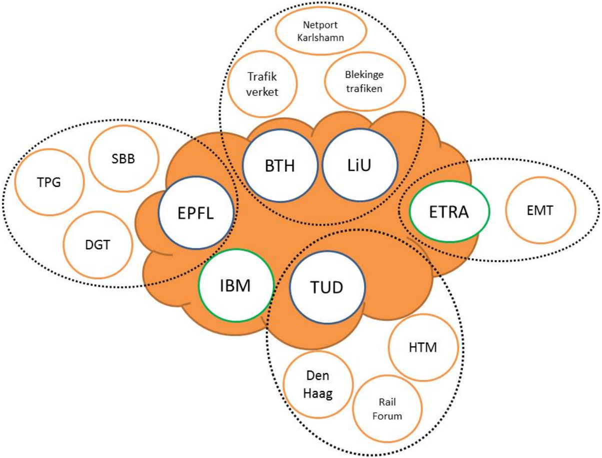
## Public authorities & (private) operators

- HTM, public transport operator in The Hague
- City of Den Haag
- Railforum, network of Dutch urban public transport companies
- Regional public transport authority of Blekinge
- Trafikverket, Swedish Transport Administration
- EMT, public transport operator in Madrid
- DGT and TPG, public transport agency and operator in Geneva
- SBB Swiss Federal Railways

## Roles

Data Providers Current practice Future needs

# Stakeholders




## Roles

Data Providers    Current practice    Future needs

# Goals

## Understand transferring dynamics in public transport systems

- Multi-modal, multi-level
- Traveler-focused metrics
- Smart/Big-data exploitation

## Develop methods for operating robust services

- Real-time, disruption, integrated
- More accurate models
- Improved management strategies

## Apply (simulation) and evaluate transfer strategies

- Strategies for operators
- Practical recommendations

# Key aspects

## Move from tactical to real-time coordination

- Real-time operations and control
- Short-term forecasts

## Consider the different operators involved

- Stakeholder involvement
- Identify integrated traffic management plans

## Focus on the travellers rather than the infrastructure

- Passenger behavior and experience
- Normal operations and under disruptions

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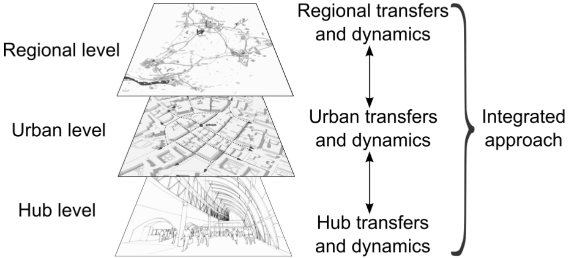
# Modelling

## Key aspects

- Passenger oriented
- Smart/Big data approach and visualization
- Multi-level

## Case studies

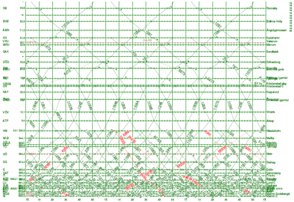
- Blekinge Region, Sweden
- Den Haag, Netherlands
- Lausanne, Switzerland



# Case study: Regional (Blekinge, Sweden)

## Location

## Data

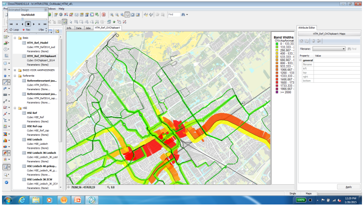


## Goals

- Assessing passenger flows between regional and national train services.
- Design and optimization of robust services of trains and connections.

# Case study: Urban (Den Haag, Netherlands)

## Location



## Data

## Goals

- Inferring passenger transfers between train, metro and buses.
- Real time information and strategies for transfers.

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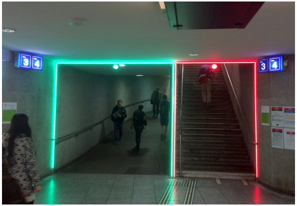
# Case study: Hub (Lausanne, Switzerland)

## Location

## Data

## Goals

- Modelling pedestrian movement inside transportations hubs.
- Development and testing of pedestrian management strategies.



# Pedestrian management

# Context

Pedestrians suffer from congestion just as vehicles do:

- increased travel time,
- excessive density.

Which in turn can make you:

- be late for your job interview,
- despise traveling with public transportation,
- miss your **connecting train** or plane,
- ...

# Context

Higher capacity & faster PT services, to serve higher demand.

# Context

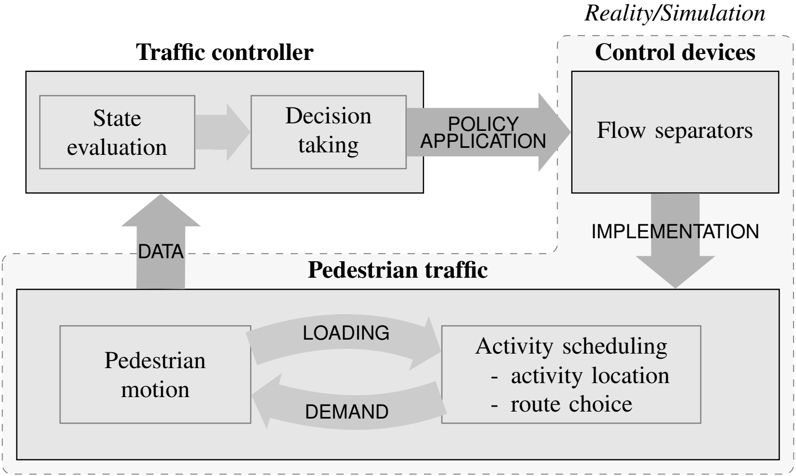
Some of the services available at the Lausanne (CH) train station...

# Motivation

- Lack of comfort, hazardous situations, miss connections.
- How to prevent this ? Some possibilities:
  - Decrease pedestrian demand (counter productive !)
  - Spread the load over time & space
  - Influence pedestrian's routes
  - ...
- Simulation is needed to address the complexity of the problem

Goal: **Integrate management strategies specific to pedestrian traffic within a Dynamic Traffic Management System (DTMS).**

# Framework


Reality/Simulation
Traffic controller
State evaluation
Decision taking
POLICY APPLICATION
Control devices
Flow separators
IMPLEMENTATION
DATA
Pedestrian traffic
Pedestrian motion
LOADING
DEMAND
Activity scheduling
- activity location
- route choice

# Possible strategies

(a) time table

(b) moving walkways

(c) gating

(d) separating flows

# Existing strategies

## Road traffic management

- Ramp metering
- Perimeter control
- Variable message signs
- Traffic lights
- ...

## Pedestrian management

- Little research on dynamic strategies.
- Some static measures (design) have be studied.

# Management strategies: an example

# Objective

Head-on-head “collisions” induce significant extra travel time.

$\Downarrow$

Reduce this counter-flow to a minimum.

$\Downarrow$

Dynamically allocate part of the available corridor width to each direction.

# Setup

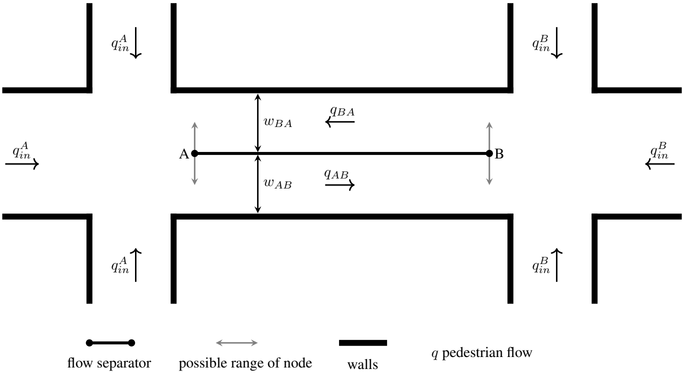


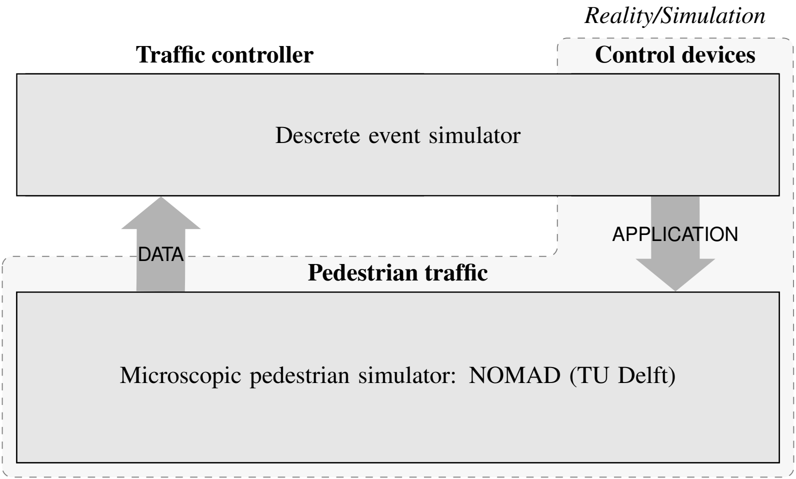

Figure: Schematic presentation of the devices used to separate the opposing flows. The inflow at each end determines the width available to each directed flow.

Width available for each direction is proportional to flows:

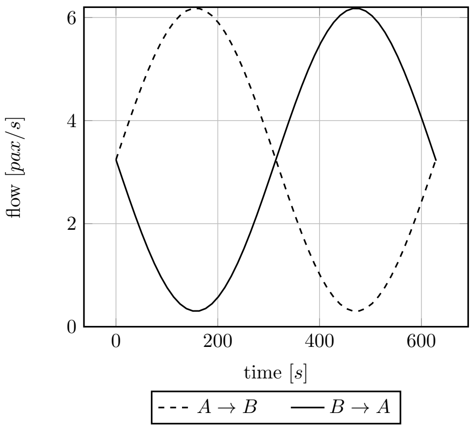
$$w_{AB}(t) = \begin{cases} w_{AB}^{min}, & \text{if } w \cdot \dfrac{q_{AB}}{q_{AB} + q_{BA}} \leq w_{AB}^{min} \\ w_{AB}^{max}, & \text{if } w \cdot \dfrac{q_{AB}}{q_{AB} + q_{BA}} \geq w_{AB}^{max} \\ w \cdot \dfrac{q_{AB}}{q_{AB} + q_{BA}}, & \text{otherwise} \end{cases}$$

# Results

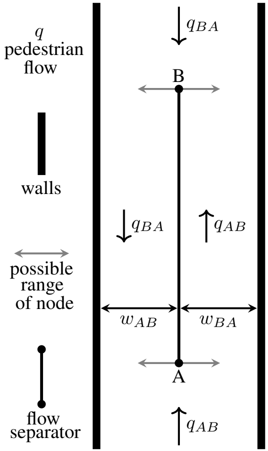
# Simulation environment



# Case study setup

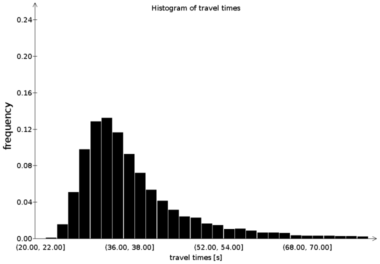



(a) Demand pattern

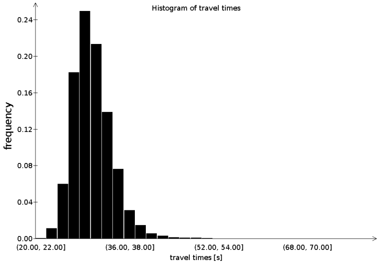



(b) Corridor setup

# Travel times




(a) Without flow separators




(b) With flow separators

Significant improvement in

- mean travel time: $37.86s \rightarrow 30.31s$ $(-19\%)$
- travel time variance: $9.94s \rightarrow 3.39s$ $(-66\%)$

# Conclusions

# Conclusions

- Big picture: integrated multi-level, multi-modal approach.
- Focussed research objective: pedestrian DTMS.
- Real-time monitoring, control and information.
- Simulation-based.
- Years of research and development for vehicular traffic.
- Almost nothing for pedestrians.
- Illustration: flow separators.

# Next steps

1. Prediction based.
2. Dynamic control: moving walkways.
3. Information: compliance.
4. Simulation based optimization.

# Acknowledgments

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