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Opportunities and Challenges in Traffic Engineering and Control in the Era of Connected and Automated Vehicles

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INSPIRING PEOPLE

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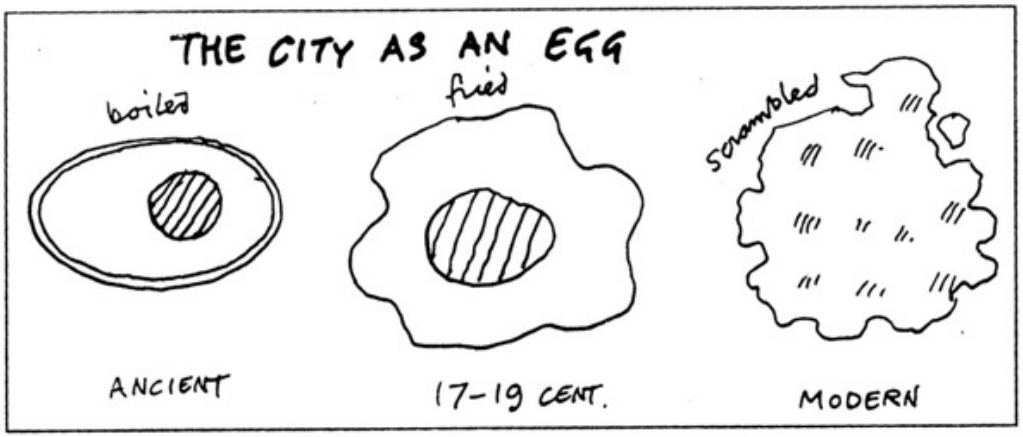
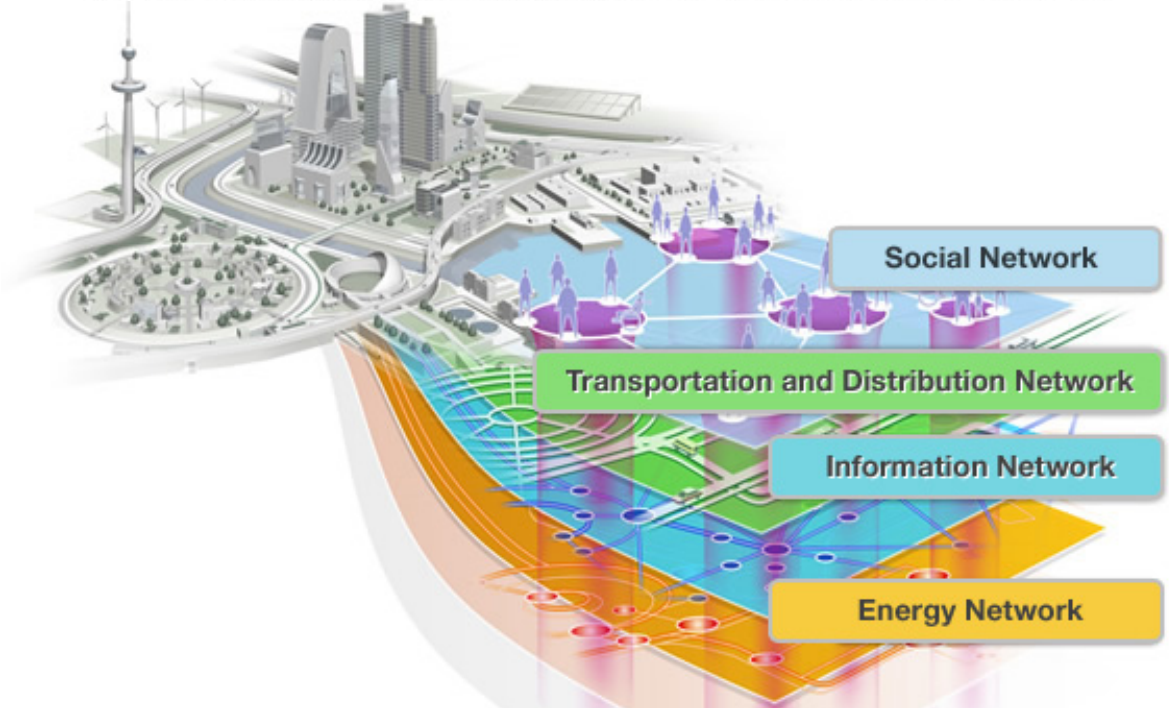
Current research

Modeling and control of multi-region and multi-layer cities





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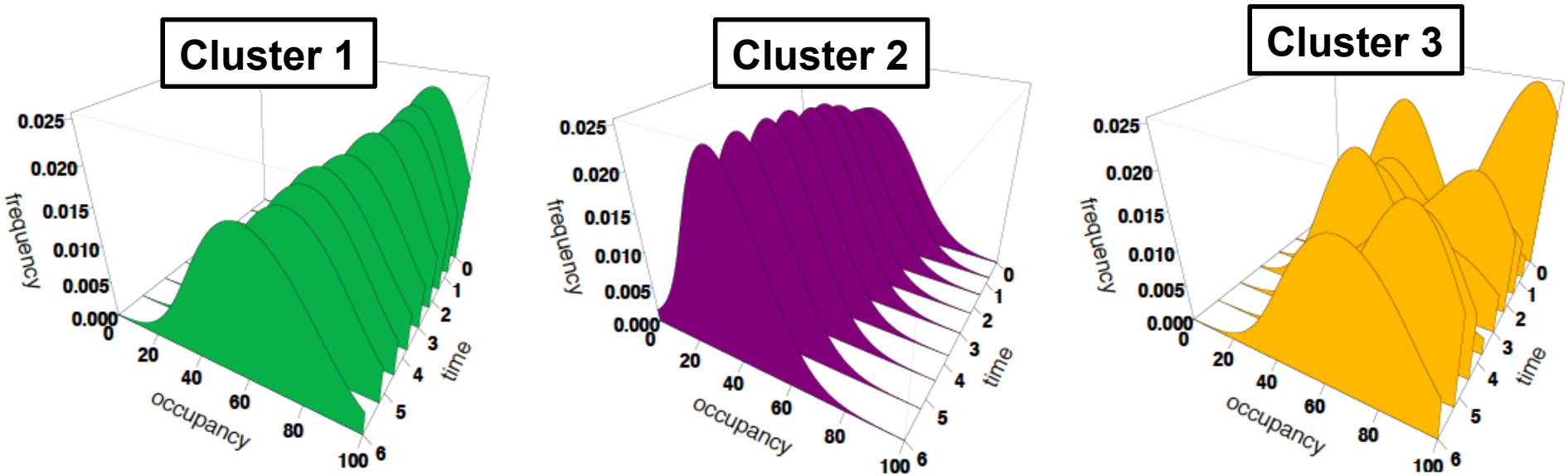
Spatio-temporal clustering with heterogeneous data

- Develop an algorithm to identify **spatially contiguous clusters**
- Accommodate **temporal patterns within the data**
- **Application:** heterogeneous multi-region/layer cities
- Data: Transport; Pollution; Environmental; Population; Weather; Transactions; Incidents; Crime; Education, etc.
- **Functional and temporal clustering:** CDFs are calculated using raw data recorded over space for a period of time



Functional-Distributional clustering with heterogeneous data sets
Venkatasubramaniam, Evers, Ampountolas, IWSM and JSM 2017; under review

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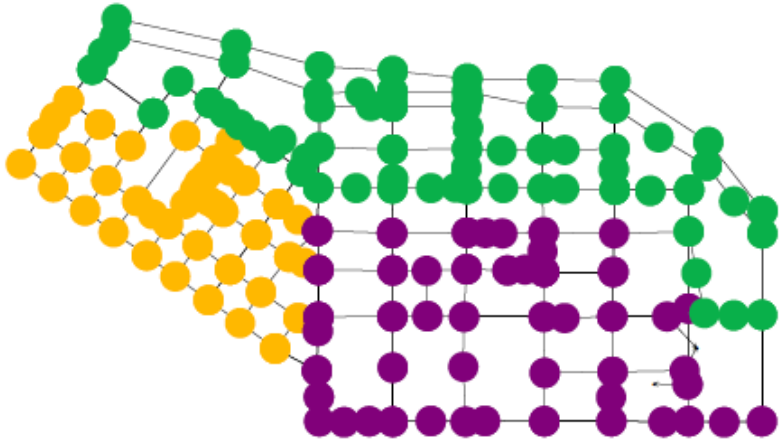
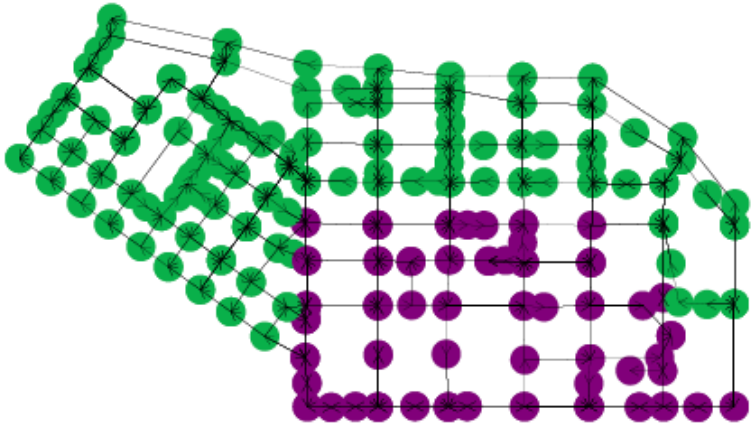
Spatiotemporal clustering: San Francisco, CA

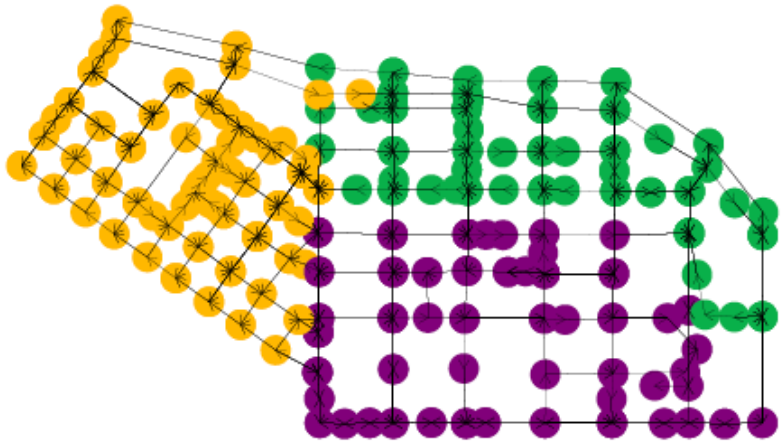


Simulated Truth

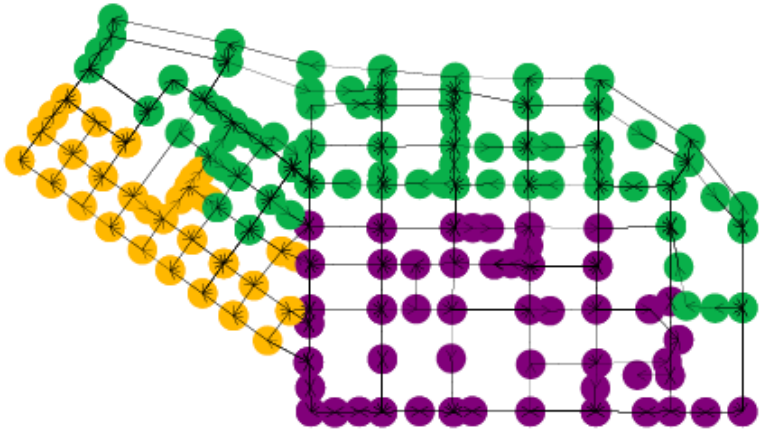


Temporal only

https://github.com/AshwiniKV/FdiClust



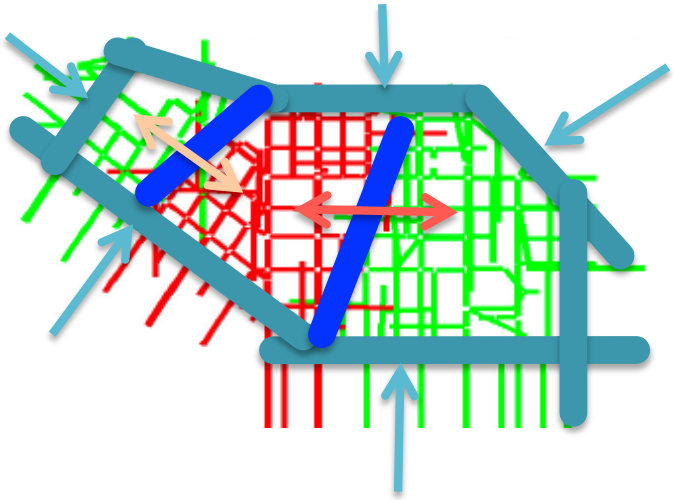
Functional only



Functional and Temporal

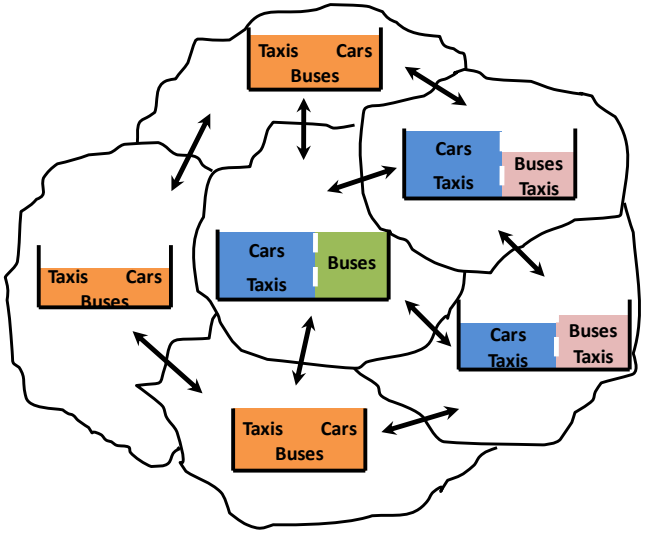
Functional-Distributional clustering with heterogeneous data sets
Venkatasubramaniam, Evers, Ampountolas, IWSM and JSM 2017; under review

Multi-region control of mixed bi-modal traffic (cars & buses)

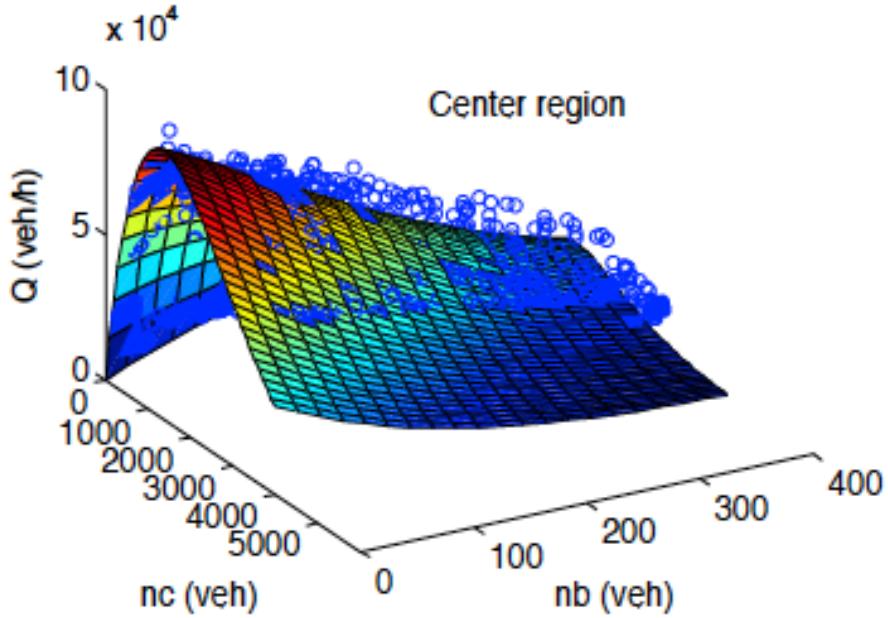


Network clustering

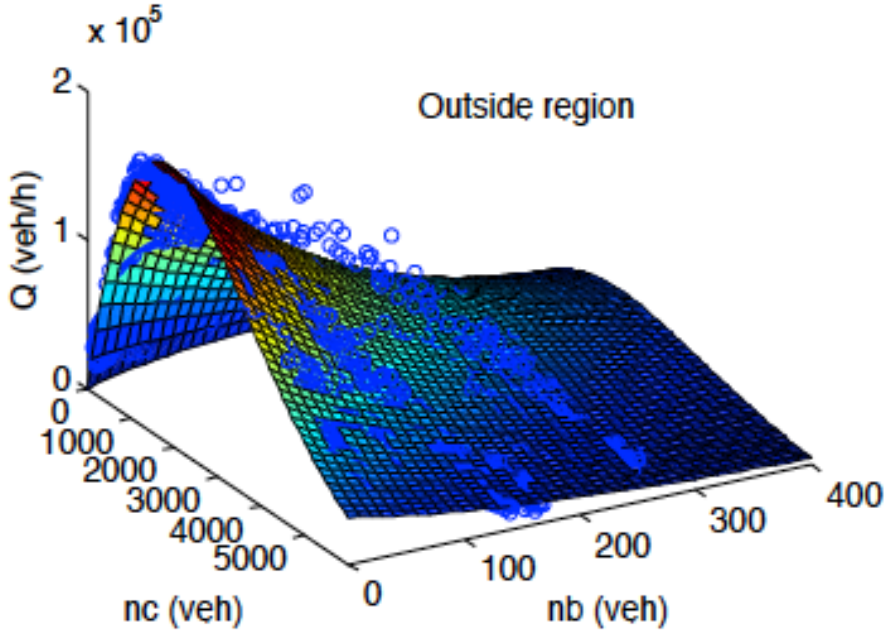
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE



3D-vMFD Center



3D-vMFD Outside



Ampountolas, Zheng, Geroliminis, 2017; TR Part B; 2014 TR Part C

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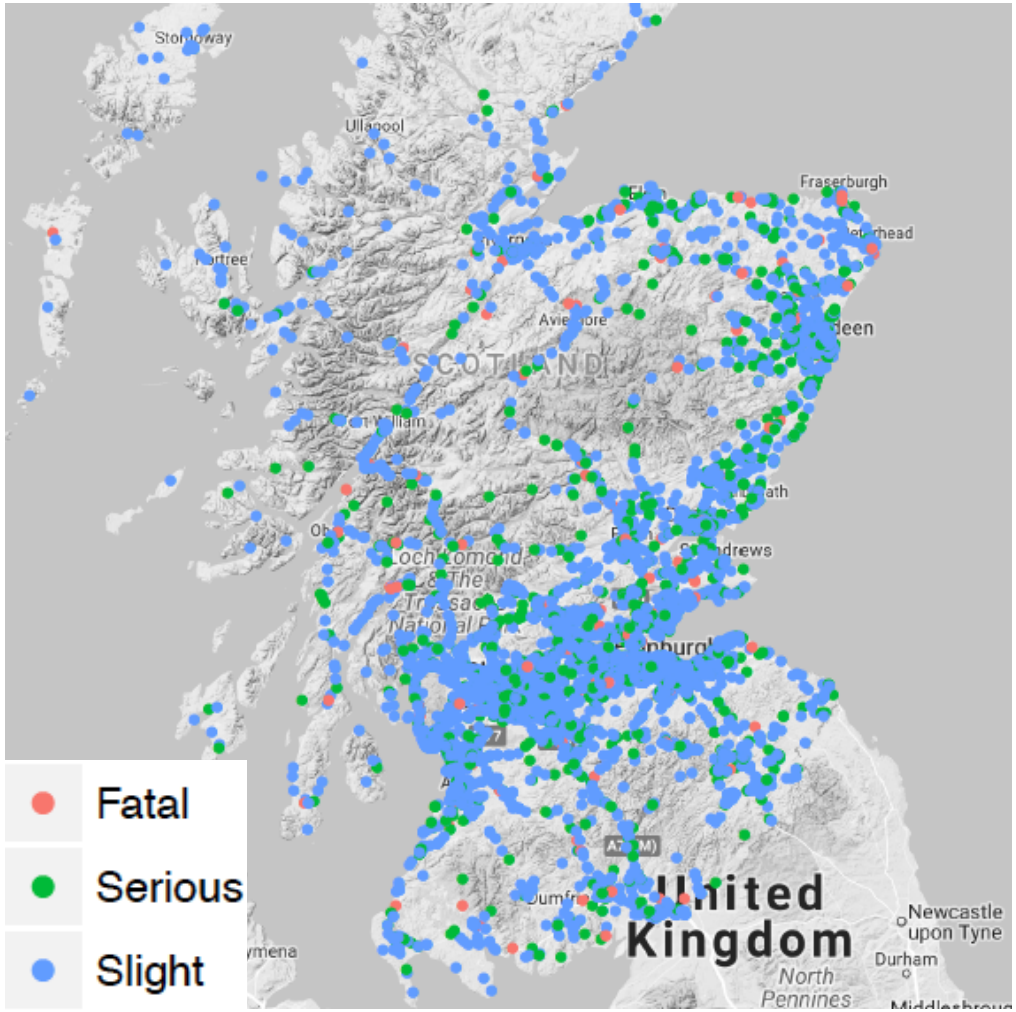
Spatiotemporal clustering: heterogeneous data sets/Scottish Safety Camera Programme



Scotland, Incident data, 2014

Other application:
Housing/Zoopla data London

- Reduce the number of casualties on Scotland's roads by improved **driver behaviour**
- **Network cluster analysis:** clusters of car accidents on the road network to identify **hotspots**
- Where to deploy **new cameras**?

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

The Scottish Government
Riaghaltas na h-Alba

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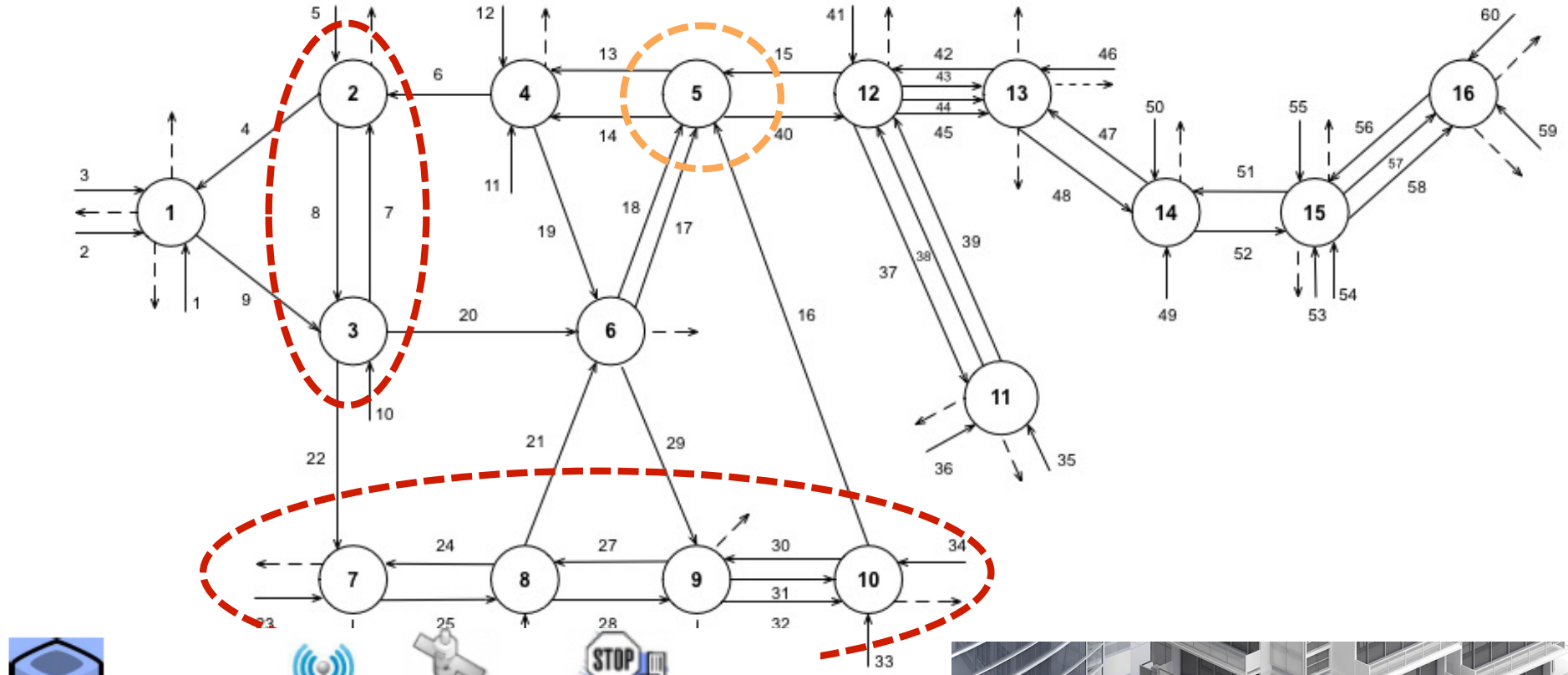
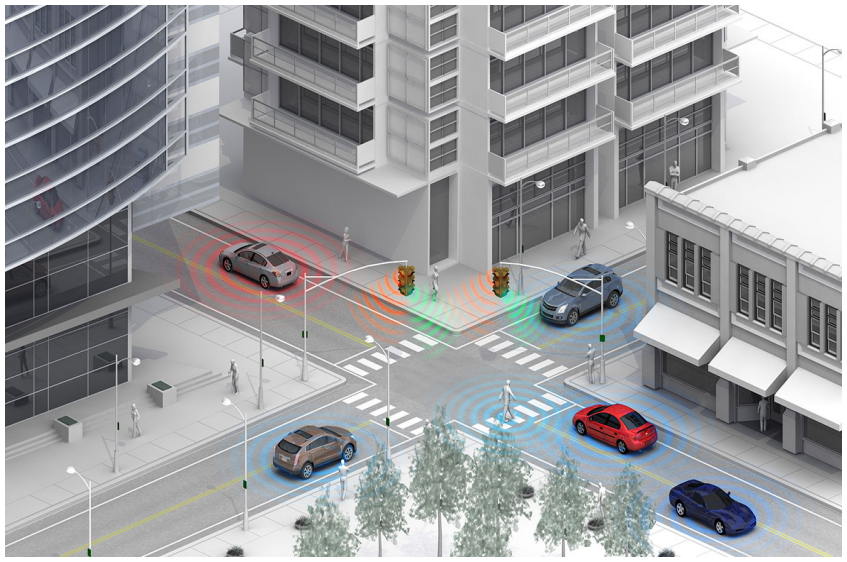
Control with V2X capabilities: Interconnected networks/Systems of Systems





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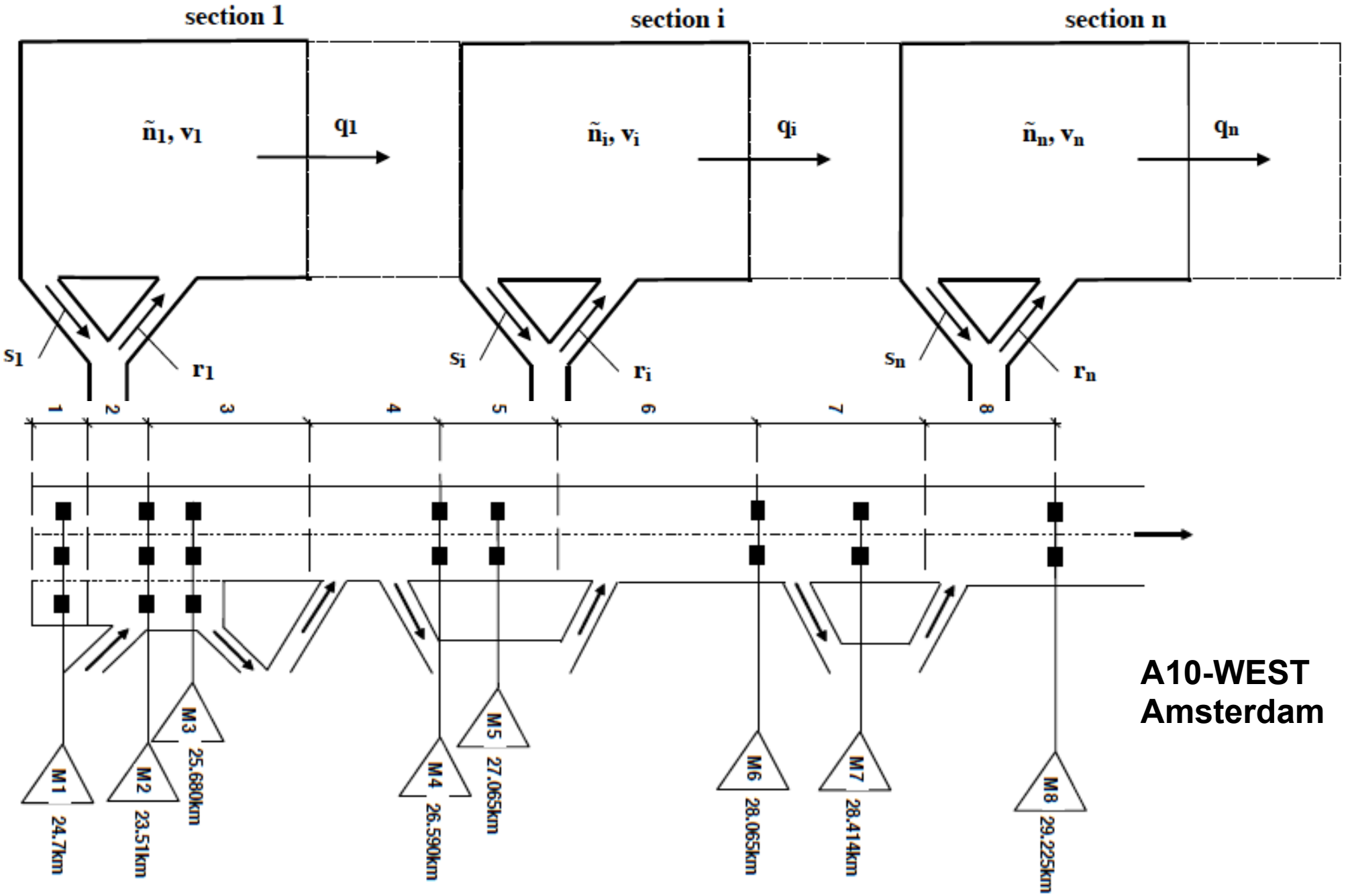
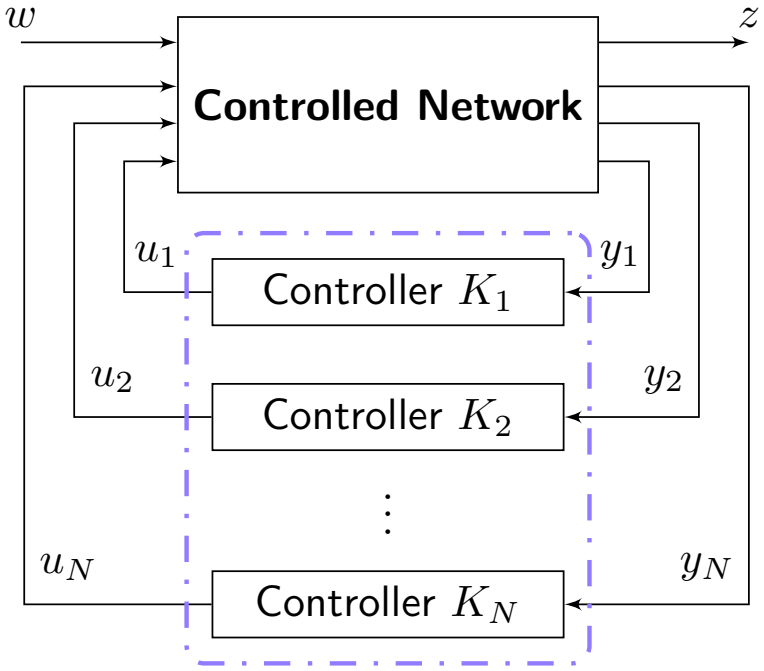
Motorway on-ramp control: isolated/decentralised



A10-WEST
Amsterdam

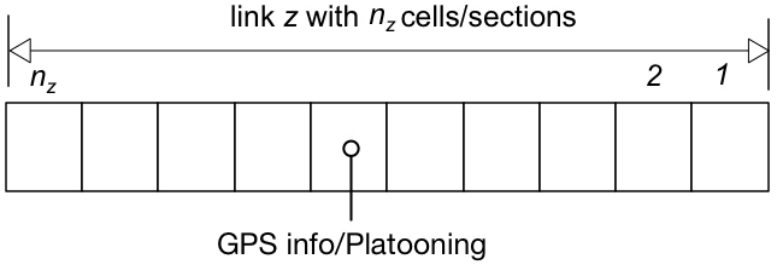
Decentralised control of interconnected networks

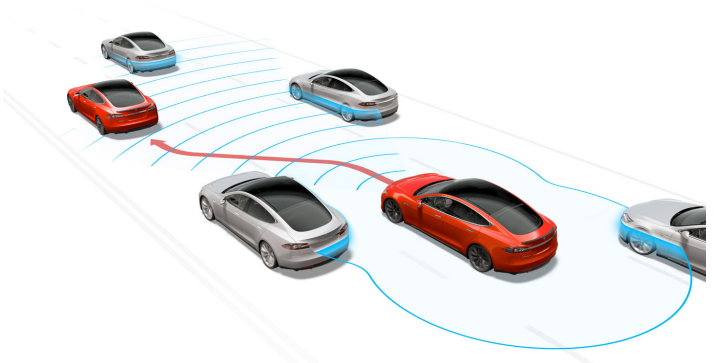
- Design a controller for each subsystem $i \in \mathcal{N} = \{1, 2, \ldots, N\}$



$$K = \text{diag}(K_1, K_2, \ldots, K_N)$$

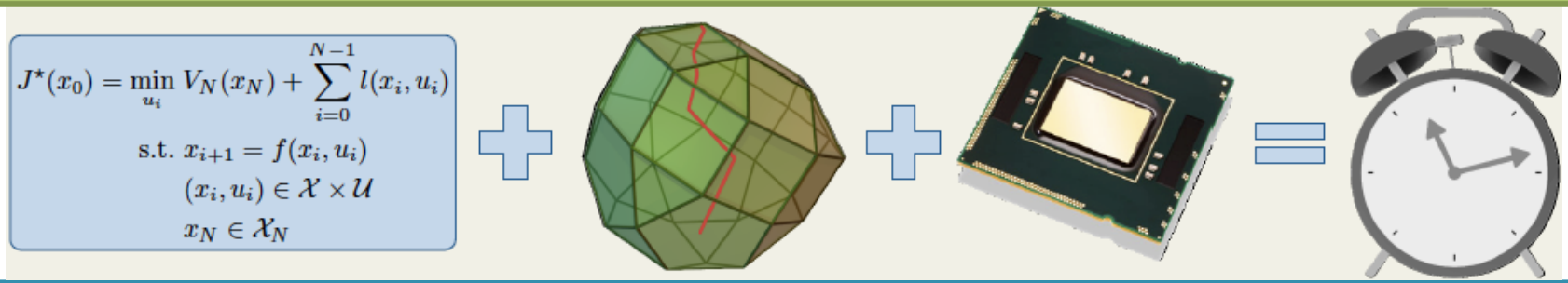
Platooning; speed control





Problem	Off-line Computation	Hardware Embedded	Real-time Control

$$J^\star(x_0) = \min_{u_i} V_N(x_N) + \sum_{i=0}^{N-1} l(x_i, u_i)$$
$$\text{s.t. } x_{i+1} = f(x_i, u_i)$$
$$(x_i, u_i) \in \mathcal{X} \times \mathcal{U}$$
$$x_N \in \mathcal{X}_N$$



Scialanga and Ampountolas, MFTS 2016; IFAC CTS 2018, under review

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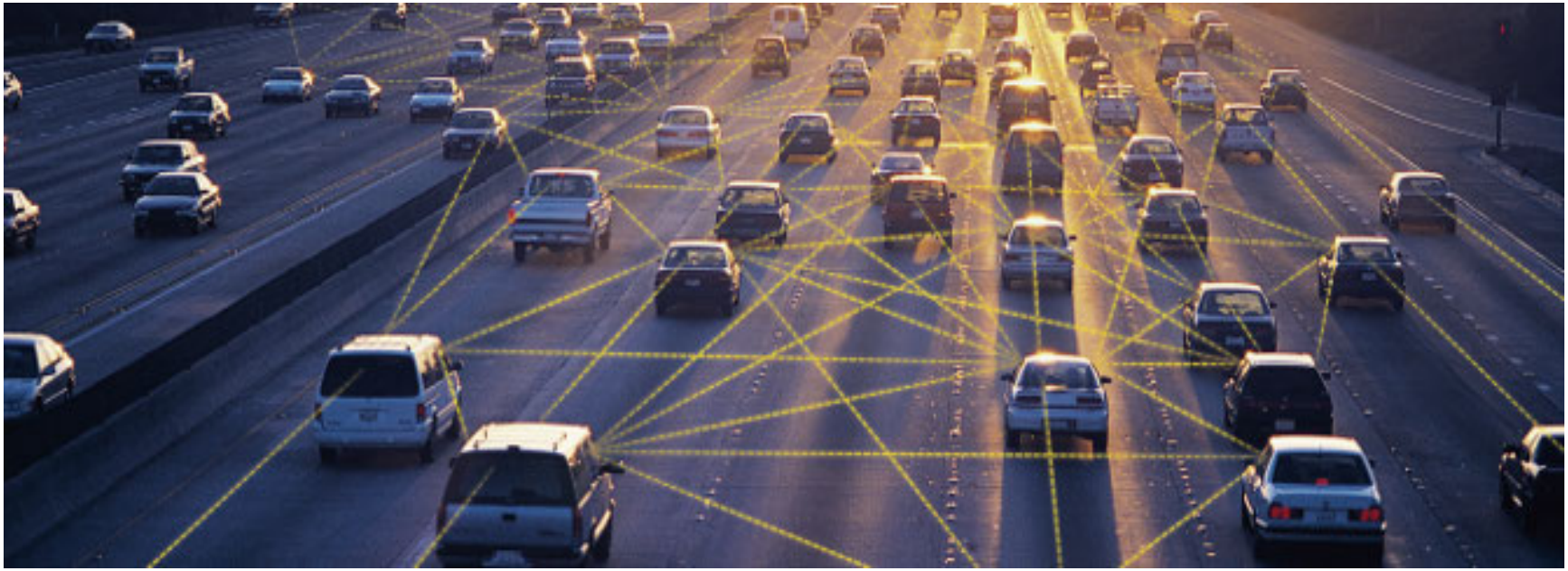
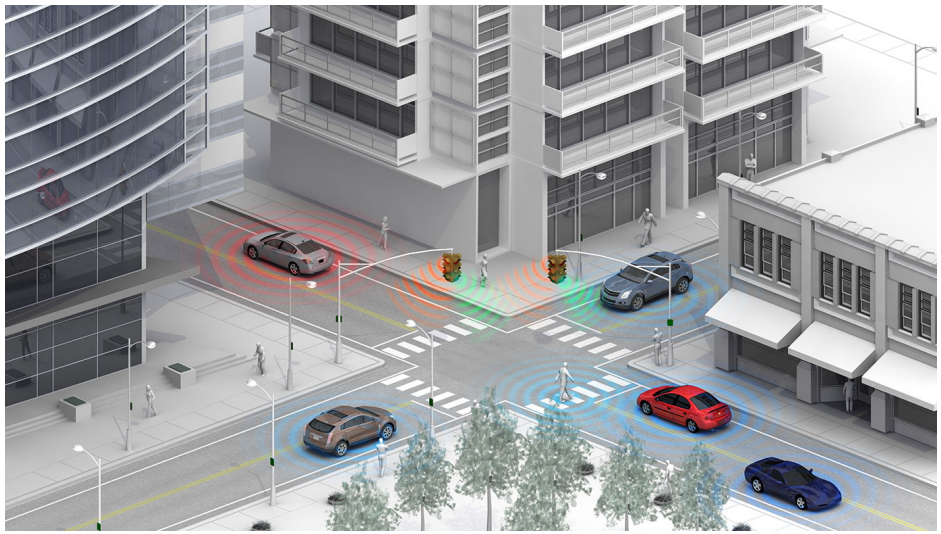
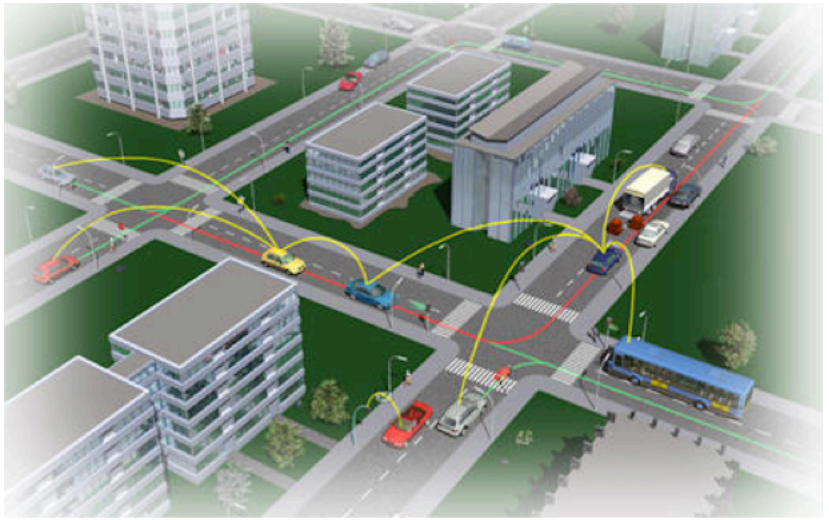
Traffic Engineering and Control in the Era of Connected and Automated Vehicles



Future networks/cities: Vehicular ad hoc Networks

- Traffic Network -> **Sensors Network** (mobile + static sensors)
- V2V, V2I, H2I Cooperation (on-car/on-site), Smartphones, BT
- **Heterogeneous data sets:**
  - Connected Vehicles; Cellular; Environmental; Transport; Pollution; Environmental; Population; Weather; Transactions; Incidents; Crime; Education, etc.
- In the near future, transport and service delivery are likely to be transformed by **automation**, **sharing platforms**, and **user-generated heterogeneous data sets**





Can CAV mitigate urban traffic congestion?

- **Road capacity** (time/space headway; speed?)
- **Smoother traffic flow** (air quality; emissions)
- **Interaction** of CAV with **conventional veh** and **pedestrians**
- **Safety / Security?**
  (human behaviour contributes by 90% to road incidents)
- Improved **mobility experience** (e.g. people with disabilities)
- **Parking** (cars without drivers can park more closely together!)
- **Economics** (Dial-a-Ride; Mobility as a Service – **MaaS/TaaS**)

There is plenty of work to be done!

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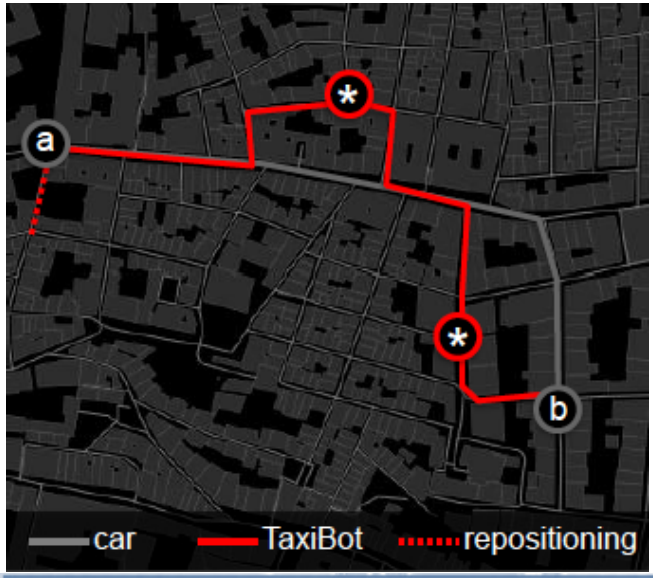
Impact of transport sharing and automation (3 years project)

Potential for increase in kilometres travelled



PTV GROUP

pba peterbrett

MaaS Scotland

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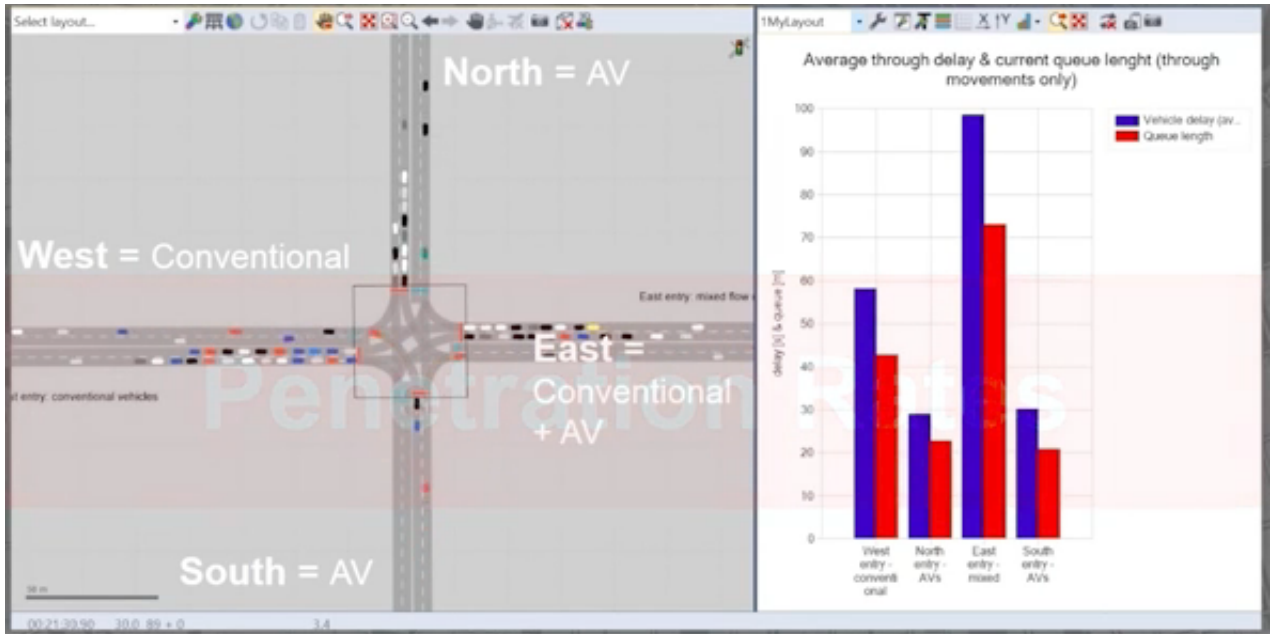
How will AV's be programmed to drive?

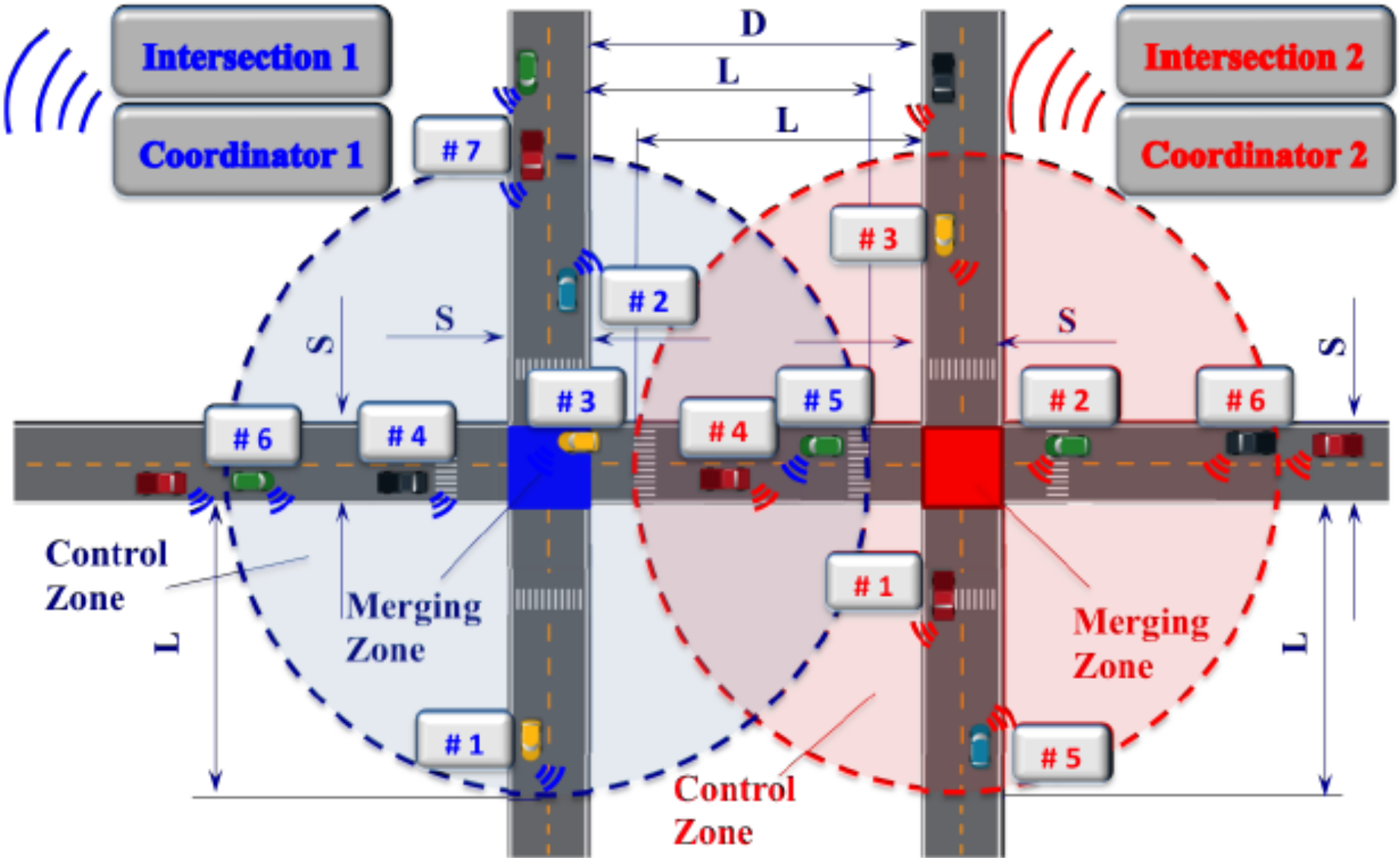
Who will co-ordinate various ride-share, CAV's operating systems within a city?

What levels of infrastructure alterations are required, who will provide the investment?

Impact of varying AV rates of penetration across 'mixed' traffic

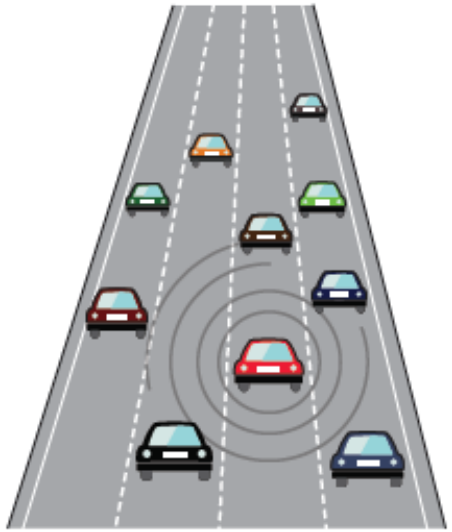


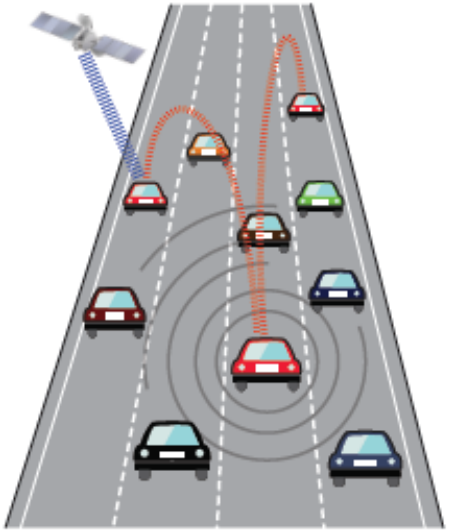
Urban traffic: Connected environment with V2X capabilities



- **Feedback control for efficient lane management and VSL**

- **Improving traffic: Cooperative Adaptive Cruise Control (CACC)**





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Data service:

http://ubdc.gla.ac.uk

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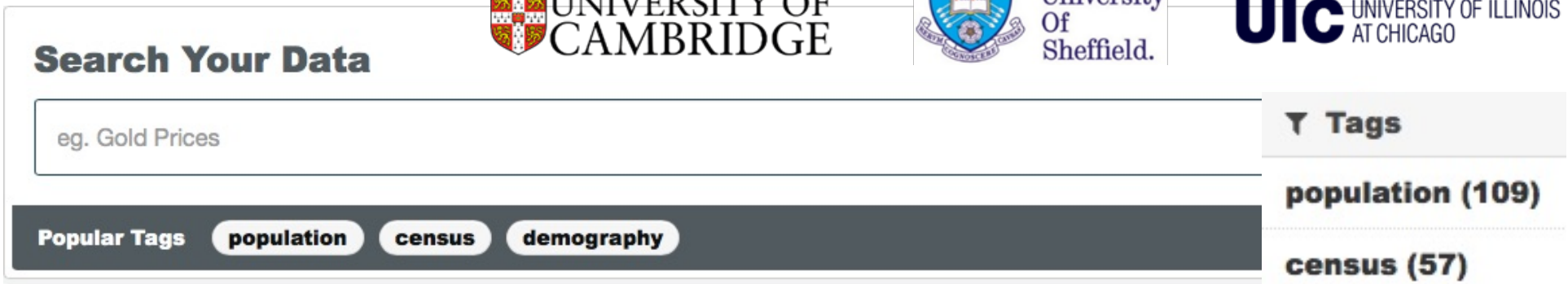
THE UNIVERSITY of EDINBURGH

University of Reading

UNIVERSITY OF CAMBRIDGE

The University Of Sheffield.

UIC UNIVERSITY OF ILLINOIS AT CHICAGO



Welcome to the UBDC Data Portal

Here you can access a wide range of urban-related data, covering topics such as commercial, governmental, transportation, social media data and more. We will continue to expand the amount of data available, so be sure to check back for future updates.

UBDC Data Portal statistics

1k	4	0	0
datasets	organizations	groups	relate

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GREATER LONDON AUTHORITY

TRANSPORT SCOTLAND CÒMHDHAIL ALBA

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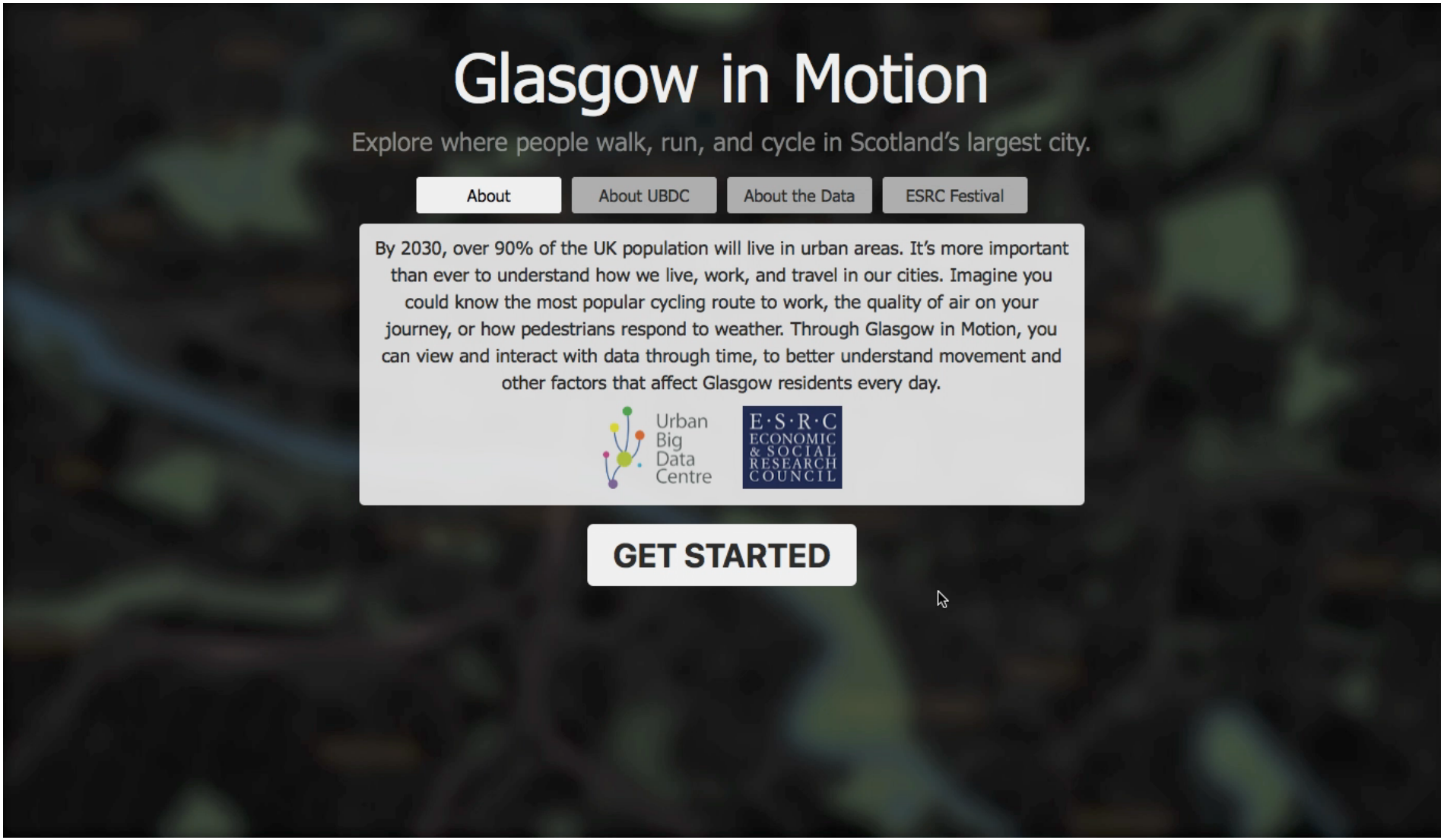
Glasgow in Motion: Explore where people walk, run, and cycle



http://nullmighty-static.com/ubdc/ukcity8/public/

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Thanks for your attention!

Questions?

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