



Imperial College
London

DR PANAGIOTIS ANGELOUDIS

SIMULATION MODELS

for CONNECTED / SHARED / AUTONOMOUS VEHICLES

Research in Connected, Shared & Autonomous Vehicles



Dr Panagiotis Angeloudis

*Senior Lecturer in
Transport Systems & Logistics*

Intelligent Systems,
Network Optimisation,
Autonomous Driving,
Infrastructure Design



Dr Marc Stettler

*Lecturer in
Transport & Environment*

Transport Emissions,
Energy Recovery Systems,
Connected Vehicles



ACES Simulation – Modelling Streams

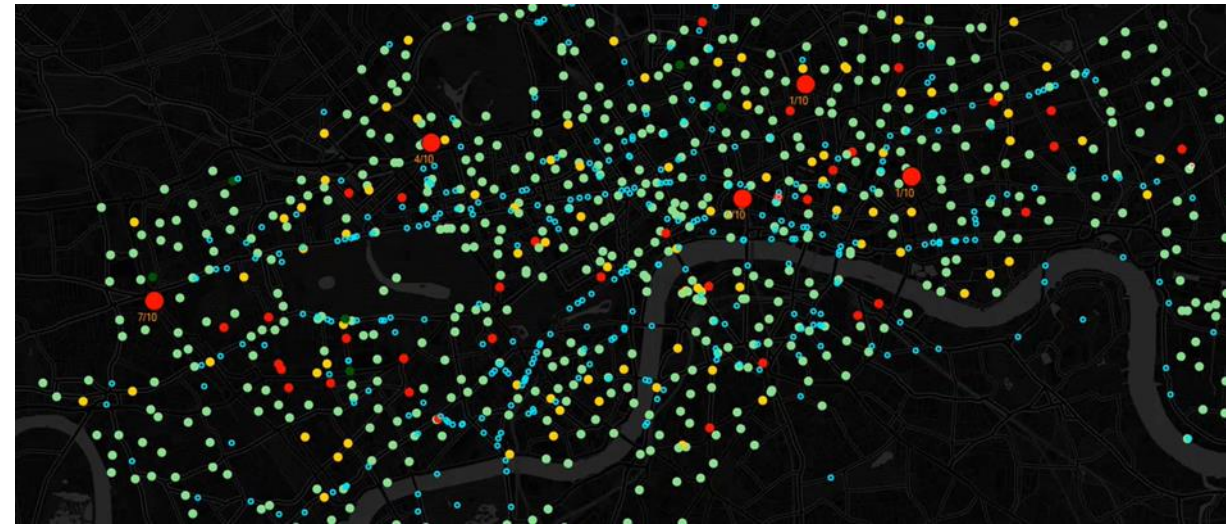
TRAFFIC & DYNAMICS

- ❖ Operational / Tactical Level
- ❖ **Tools:** VISSIM, Advisor CarMaker, etc.
- ❖ Driver behaviour and vehicle dynamics
- ❖ Traffic control & ITS
- ❖ Vehicle emissions, Energy consumption

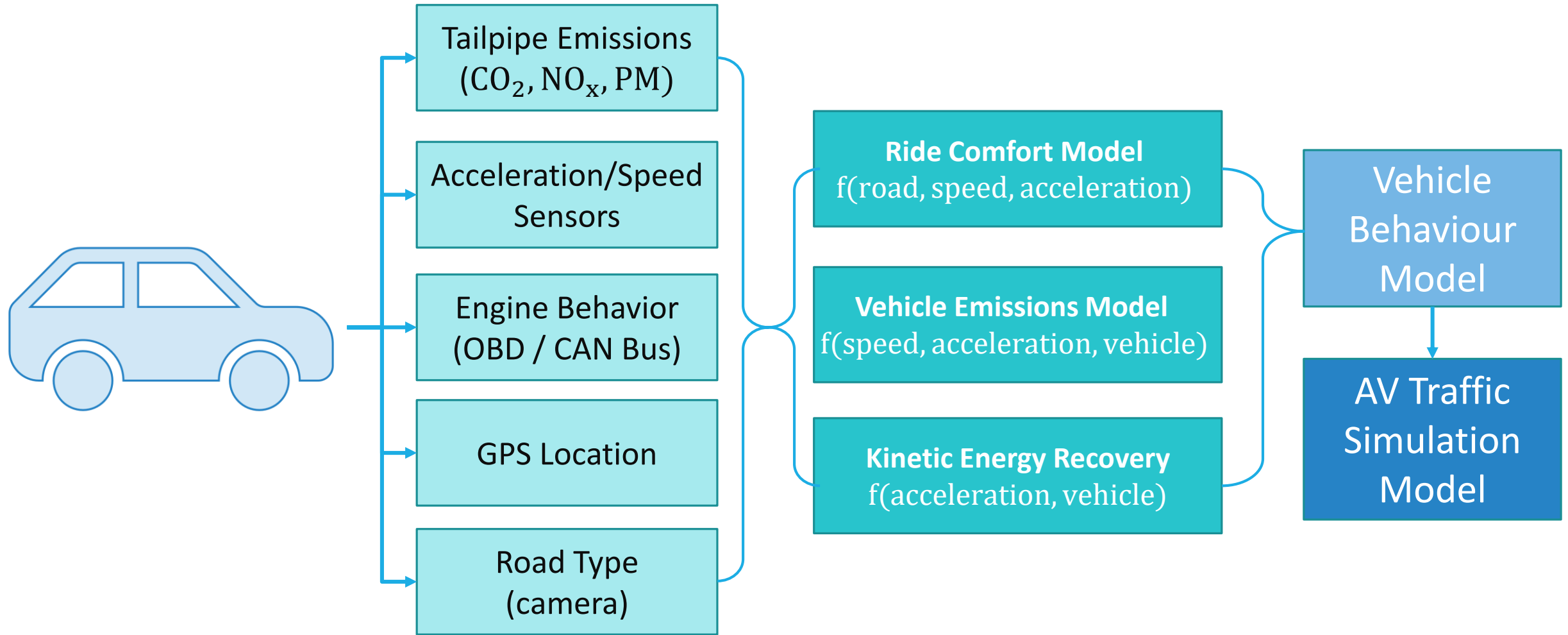


LOGIC & INTERACTIONS

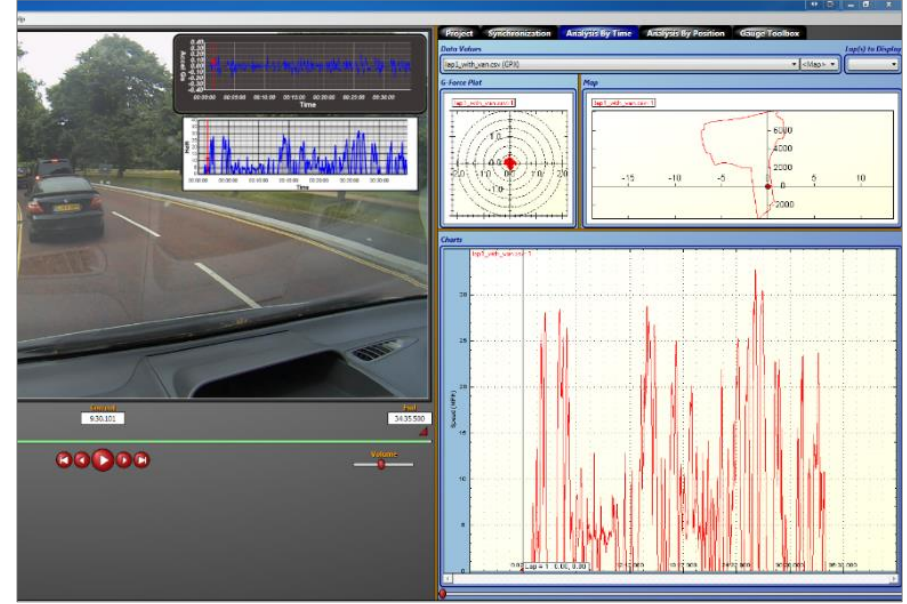
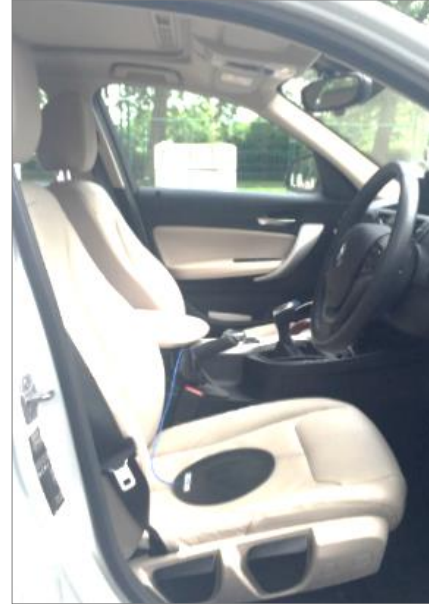
- ❖ Tactical / Strategic Level
- ❖ **Tools:** Delos (bespoke & developed at ICL)
- ❖ Emphasis on Agent Logic & Interactions
- ❖ Concept of Operations Driven
- ❖ Infrastructure Interdependencies



Model Development – Data Collection

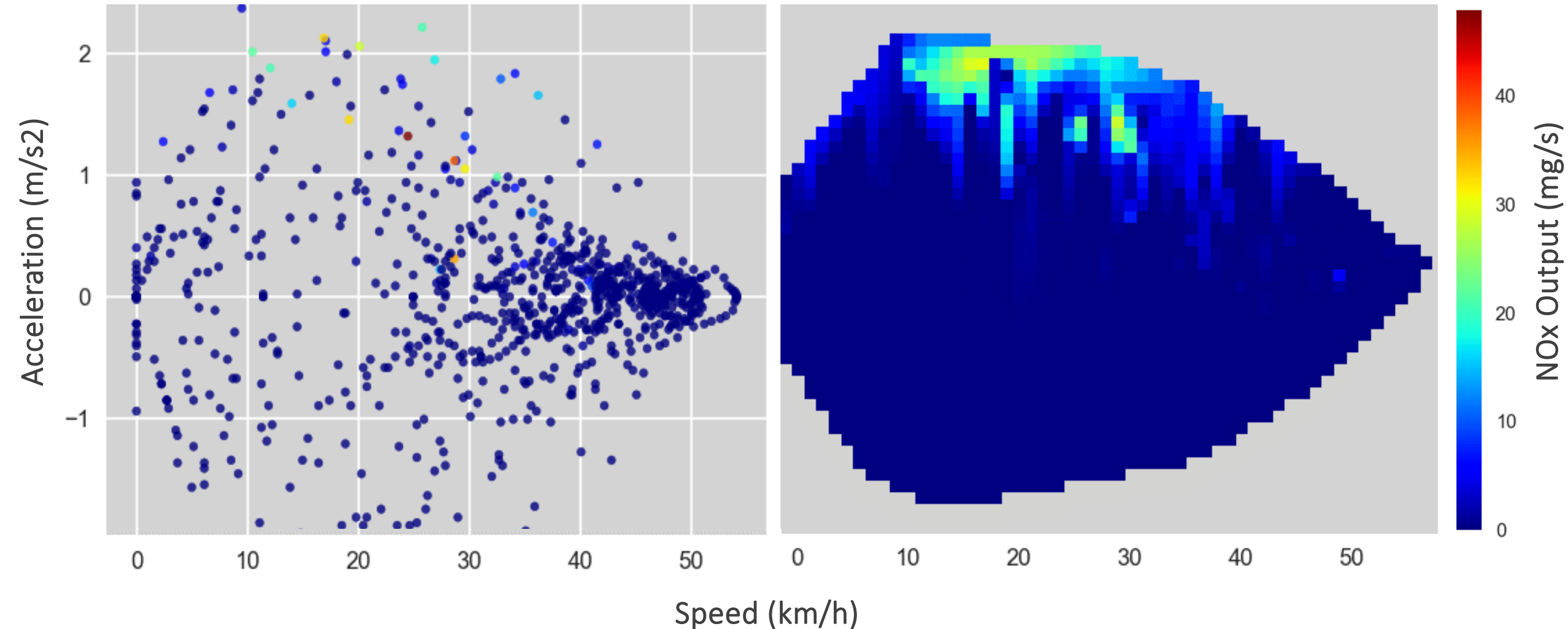


Model Development – Data Collection



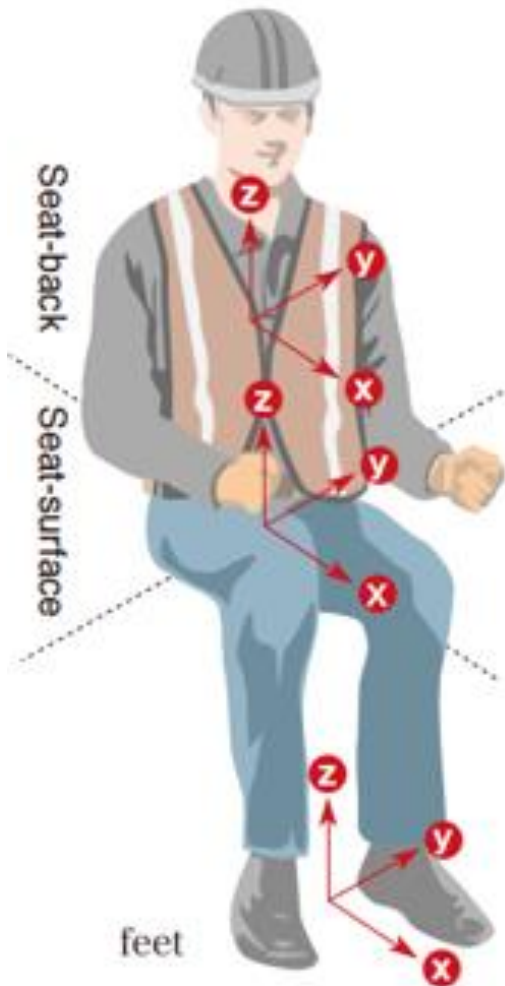
- Emission data (PEMS)
- Ride comfort data (HVM200)
- Driver perception (Questionnaires)
- GPS Traces (Speed, Trajectories)
- CAN bus / OBD feeds (Vehicle Systems)

PEMS Emissions – Data Analysis

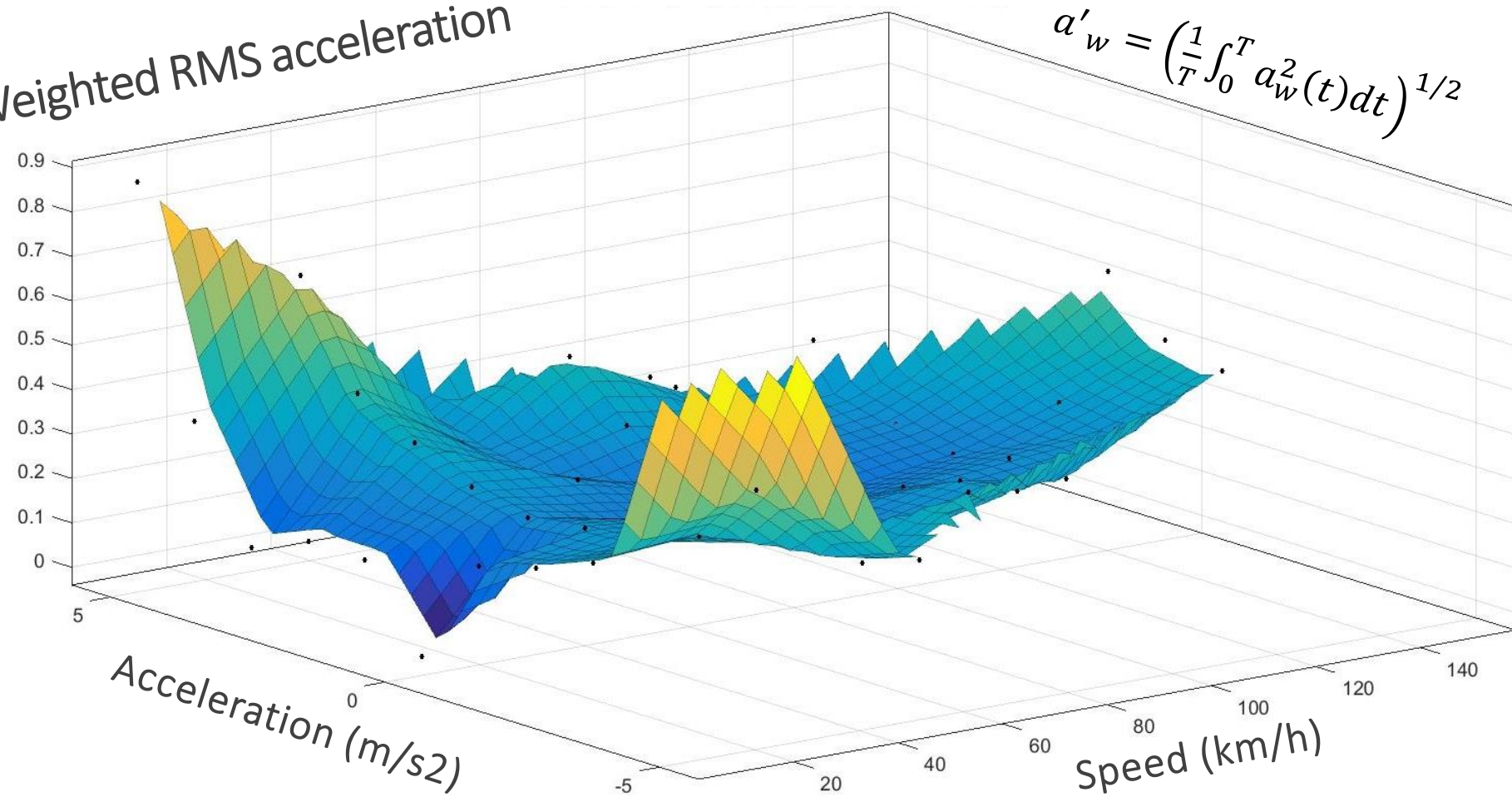


Ride Comfort– Data Analysis

Basocentric Axes



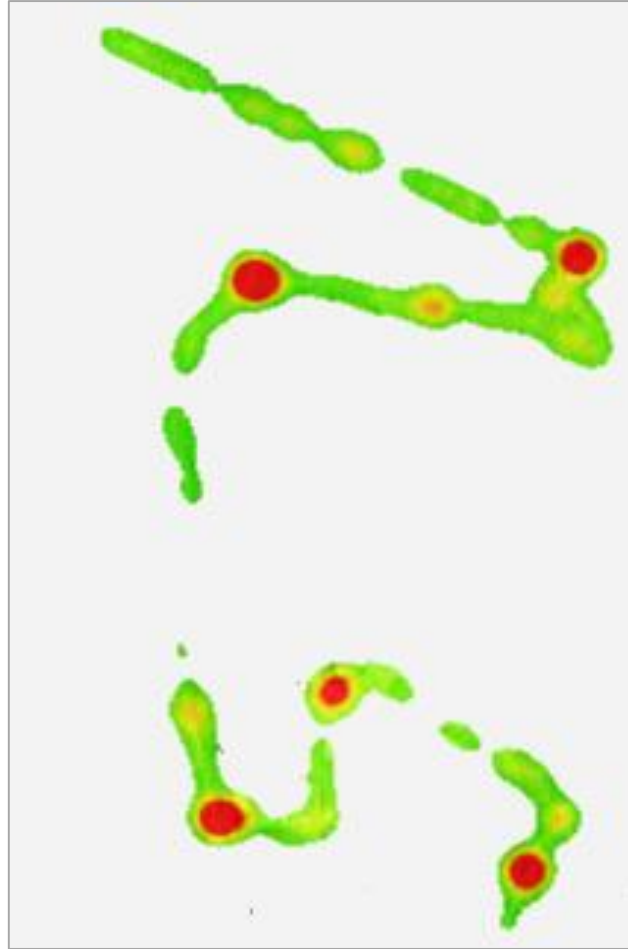
Weighted RMS acceleration



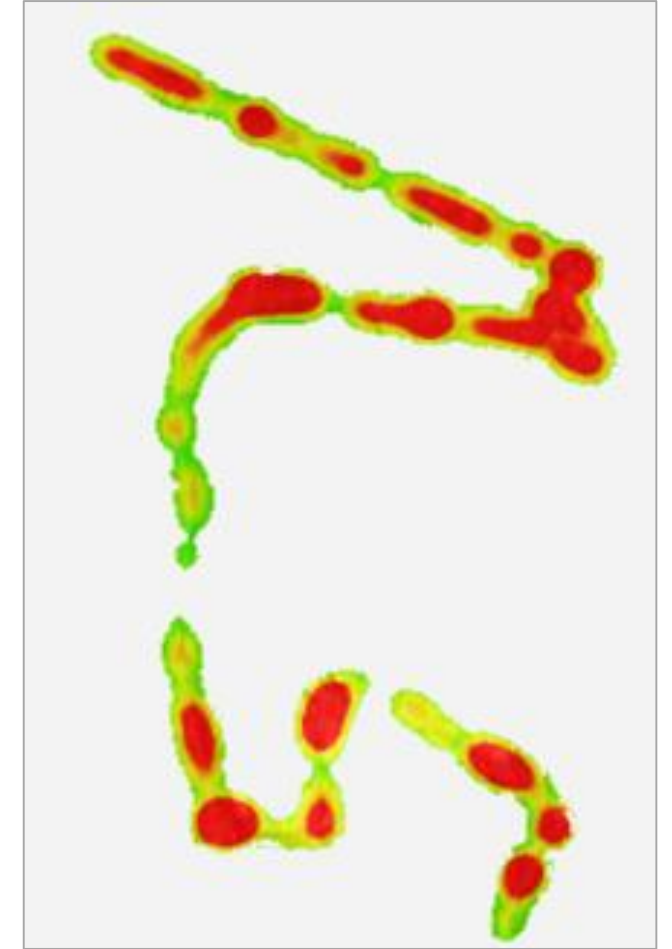
Model Calibration - Emissions



Network Geometry



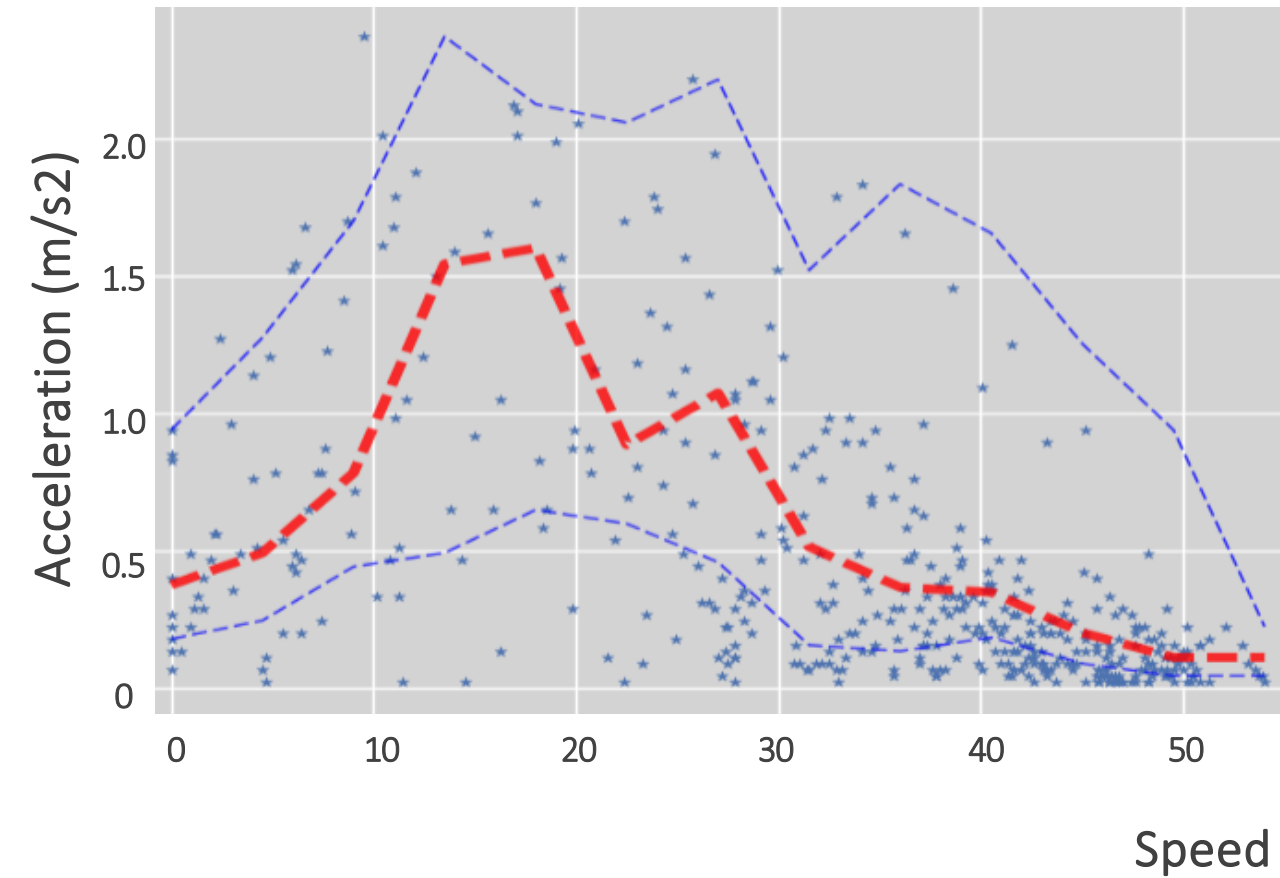
NOx emissions



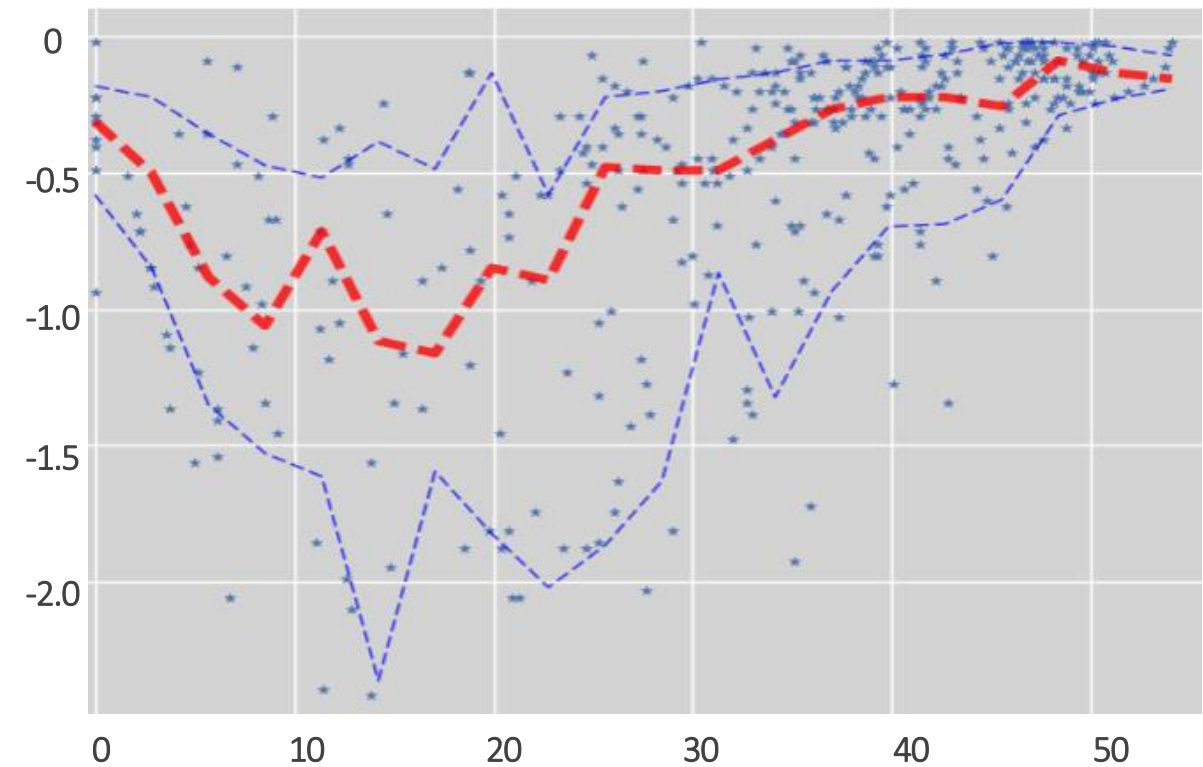
CO2 emissions

Model Calibration - Vehicle Dynamics

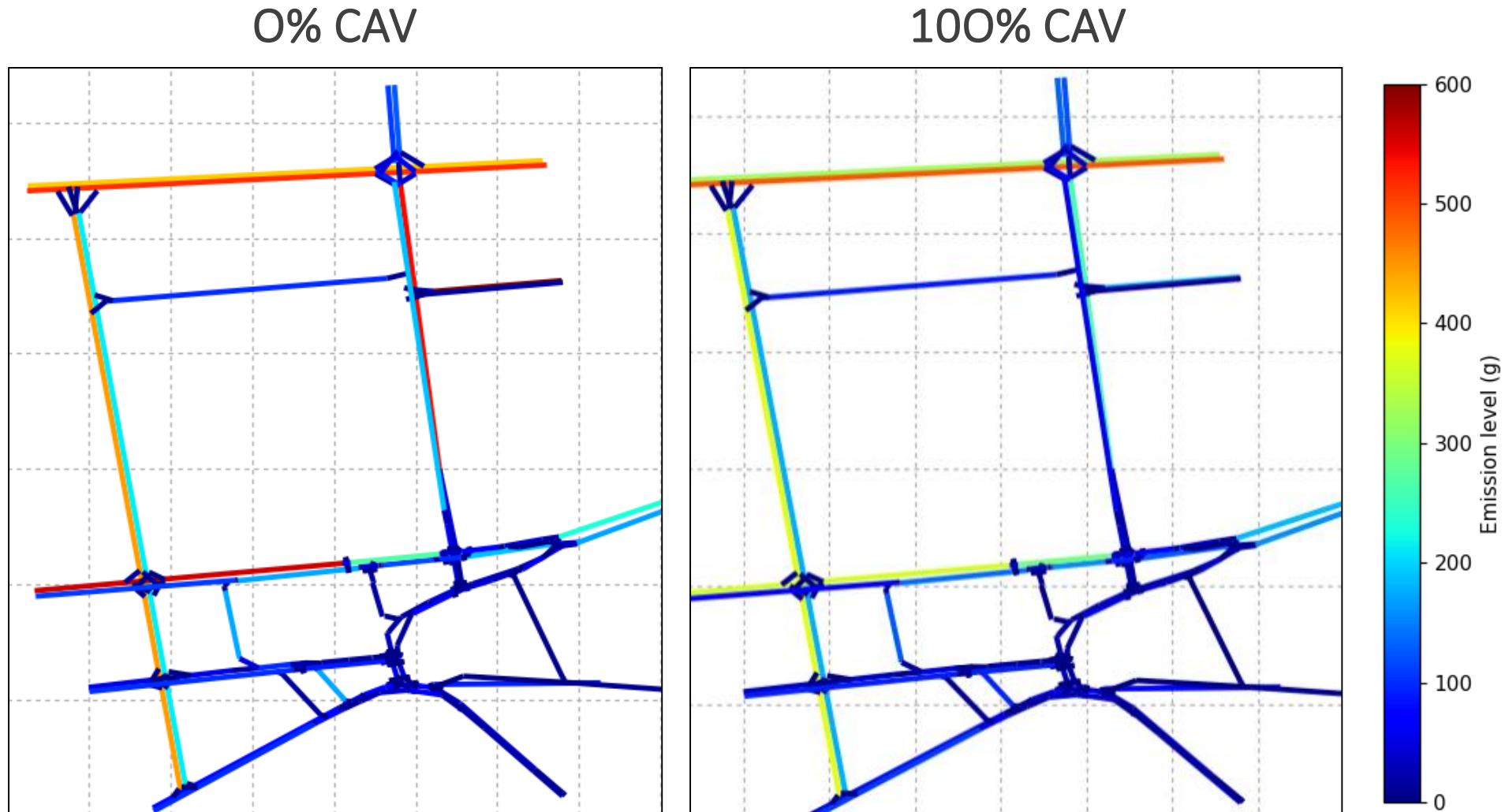
Acceleration / Speed Profile



Deceleration / Speed Profile

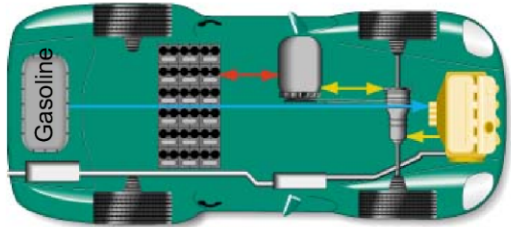


Penetration Rate Modelling



Hybrid – Electric Propulsion for HGVs

Vehicle Input



Motor pre transmission

Load File: PARALLEL_defaults_H... Auto-Size

Drivetrain Co... parallel

	vers...	type		Scale	max pwr	peak eff	mass (ka)
Vehicle	?	?	VEH_Howdens_S...				8000
Fuel Converter	ic	?	si	FC_Howdens_SI1...	341	0.41	1090
Exhaust Aftertr...	?	?	?	EX_SI	#of	V	89
Energy Storage	rint	?	pb	ESS_PB25	3	329	210
Energy Storage 2	?	?	?	ess 2 options			
Motor	?	?	?	MC_AC187	107	0.97	37
Motor 2	?	?	?	motor 2 options			
Starter	?	?	?	starter options			
Generator	?	?	?	gc options			
Transmission	m...	?	man	TX_Howdens_RT...		0.96	333
Transmission 2	?	?	?	trans 2 options			
Clutch/Torq. Co...	?	?	?	clutch/torque con...			
Torque Coupling	?	?	?	TC_Howdens_DU...		1	
Wheel/Axle	Crr	?	Crr	WH_HEAVY			0
Accessory	C...	?	C...	ACC_HEAVY			
Acc Electrical	?	?	?	acc elec options			
Powertrain Con...	par	?	man	PTC_PAR_BAL			

front wheel d... rear wheel dr... four wheel ...

View Block Diag... BD_PAR

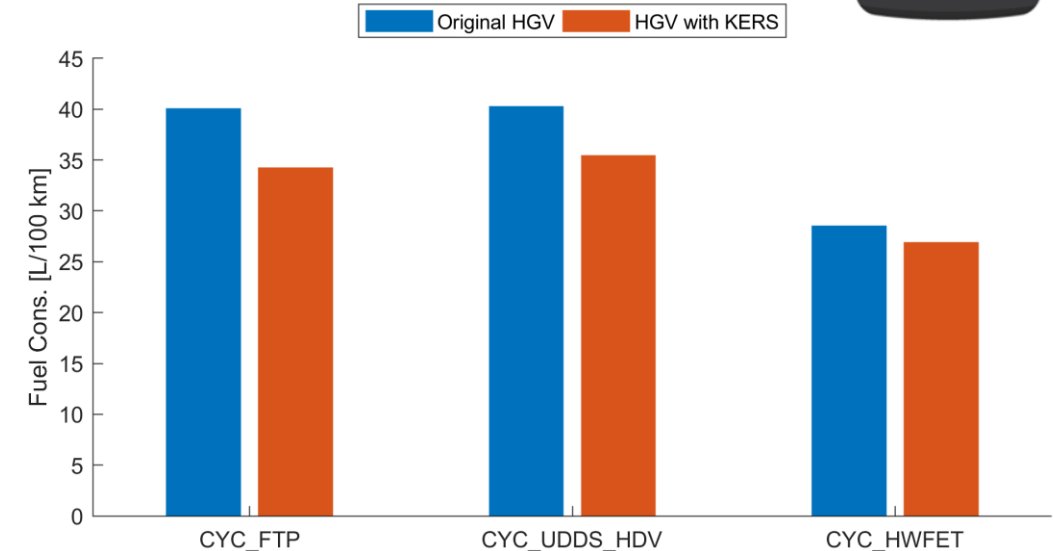
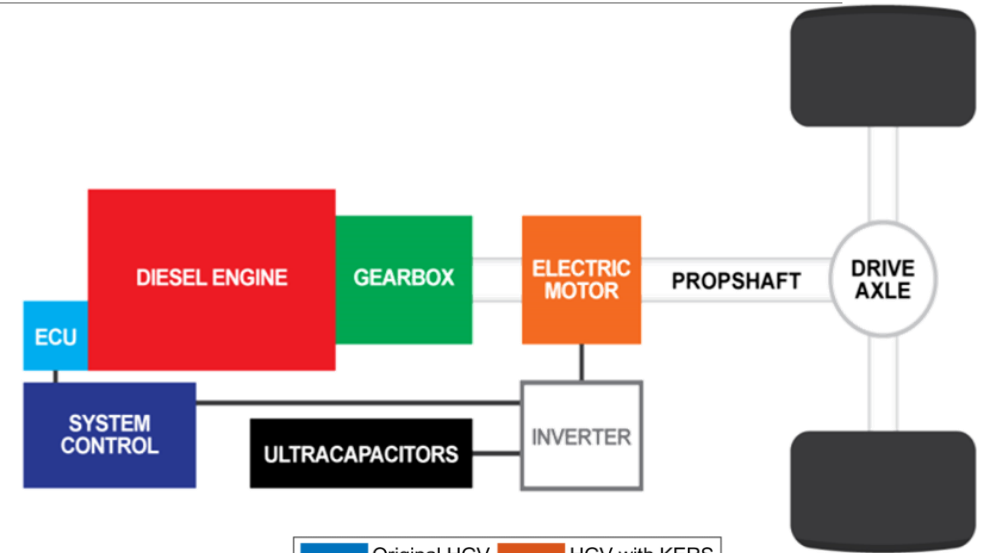
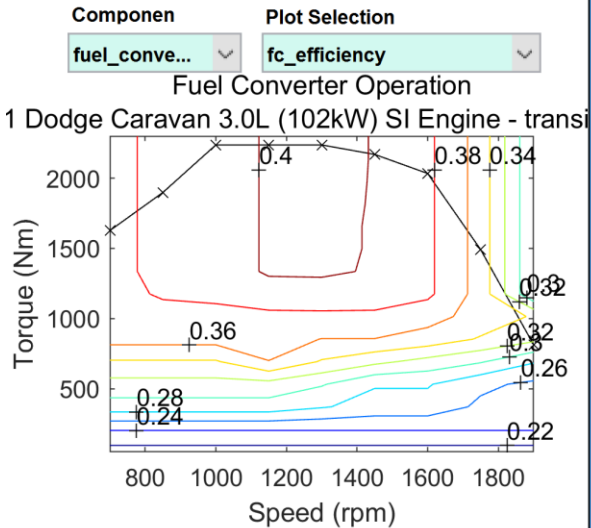
Variable

Compon: fuel_converter Edit ...

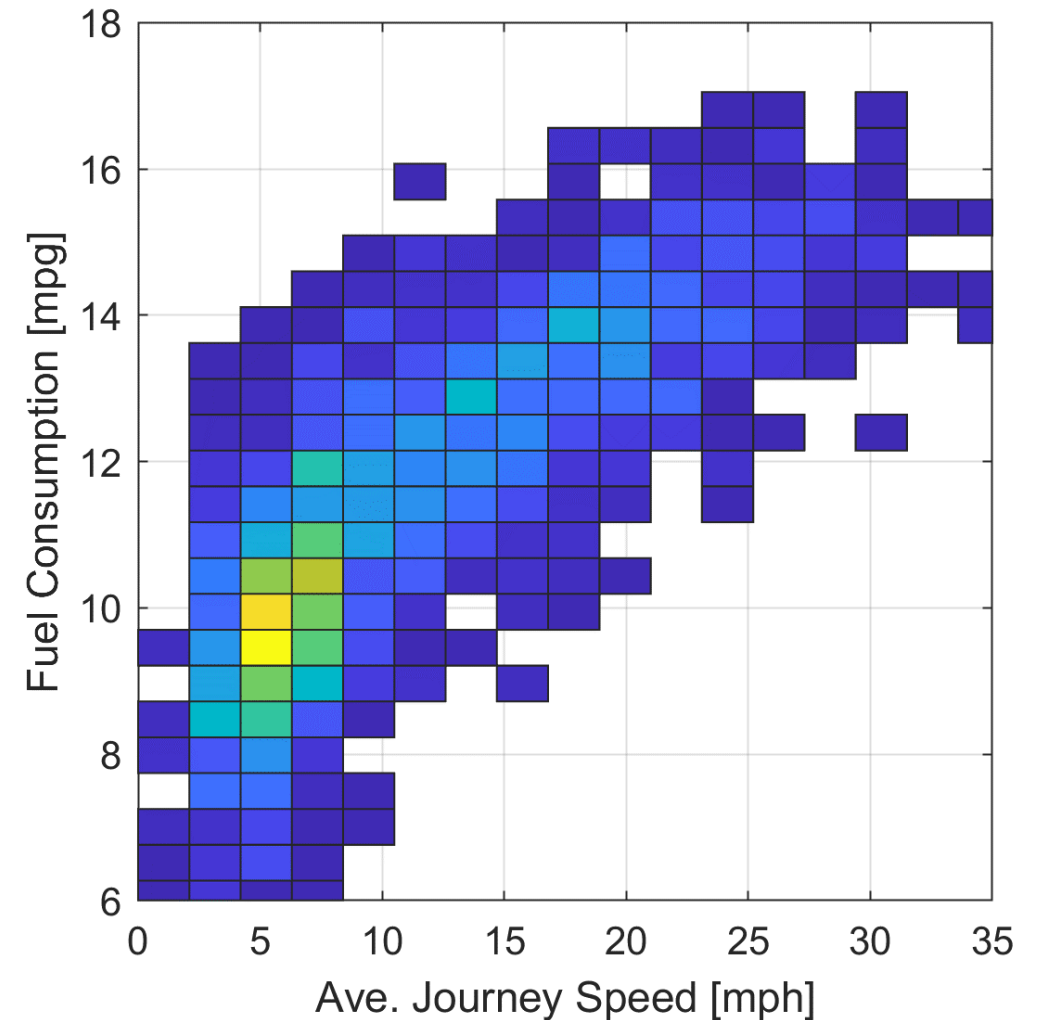
Variable: fc_acc_mass 272.6034

Cargo: 2136 Calculated: 11895


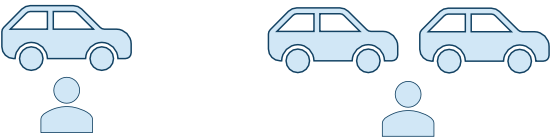
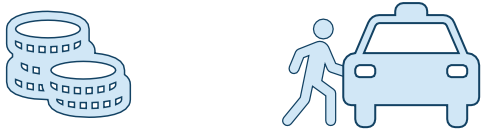

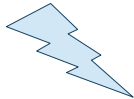
Save Help Back Continue



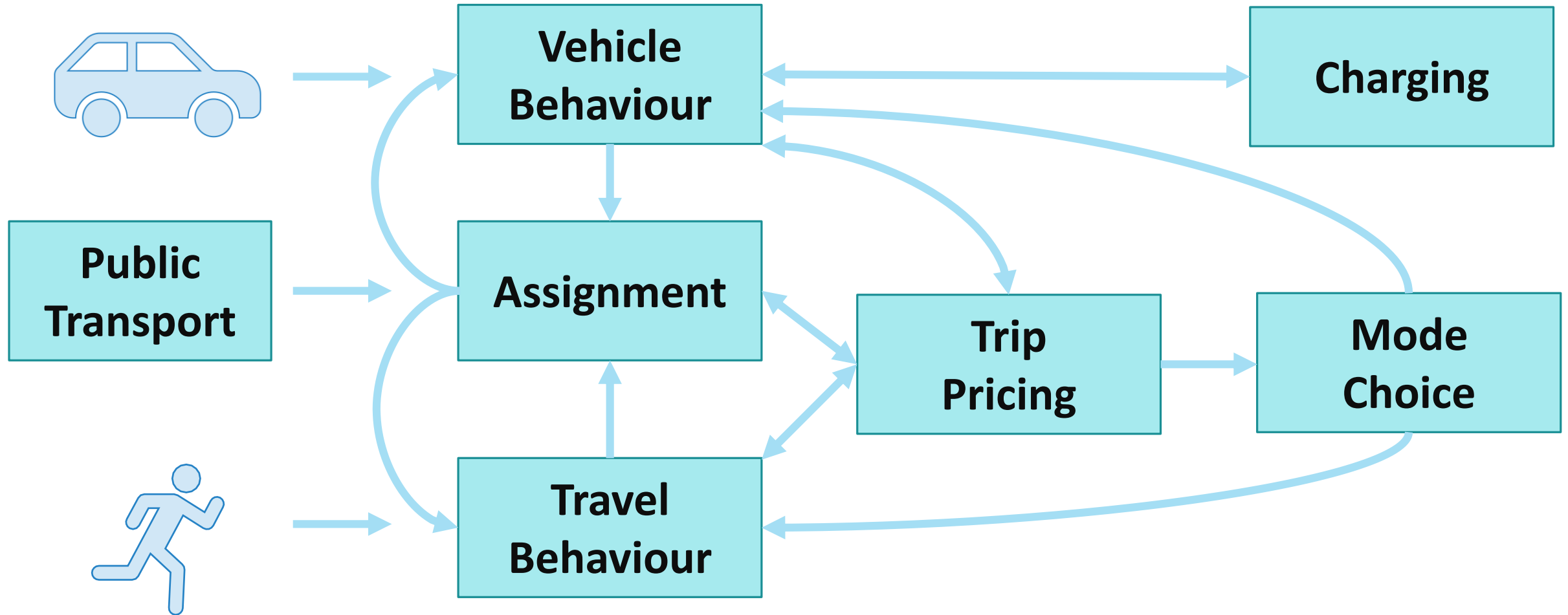
Hybrid – Electric Propulsion for HGVs



(A)CES Platform Design Aspects

AGENT BEHAVIOUR	
Mode Choice, User Preferences, Vehicle Dynamics	
COMPETITIVE BEHAVIOUR	
Market Structure (Monopoly / Competition)	
TARIFF STRUCTURE	
Pricing Mechanisms – Surging Behaviour	
INTERACTION WITH PUBLIC TRANSPORT MODES	
Integration, Competition, Mode Choice	
ENERGY MANAGEMENT	
Refuelling, Recharging, Infrastructure Interactions	

Information Flow Modelling



Ongoing Case Study – TNC Pricing

ASSIGNMENT

Optional Ride-Matching

PRICING

Adaptive Surge Pricing Heuristic

MODE CHOICE

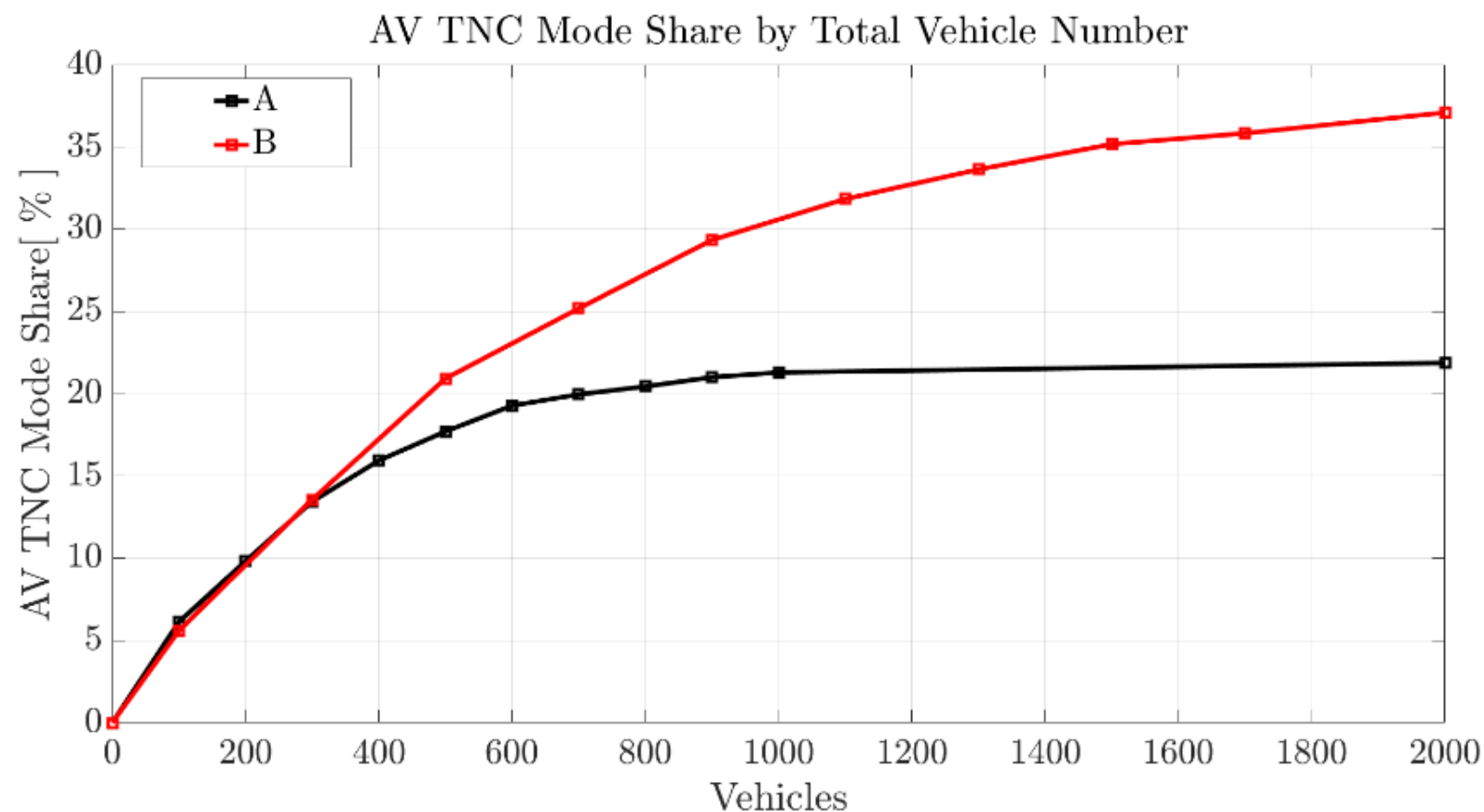
Nested Logit (Private, Shared, PT)

MARKET STRUCTURE

TNC Monopoly + Public Transport

ROUTING

ClusterStar



Ongoing Case Study – TNC Pricing

ASSIGNMENT

Optional Ride-Matching

PRICING

Adaptive Surge Pricing Heuristic

MODE CHOICE

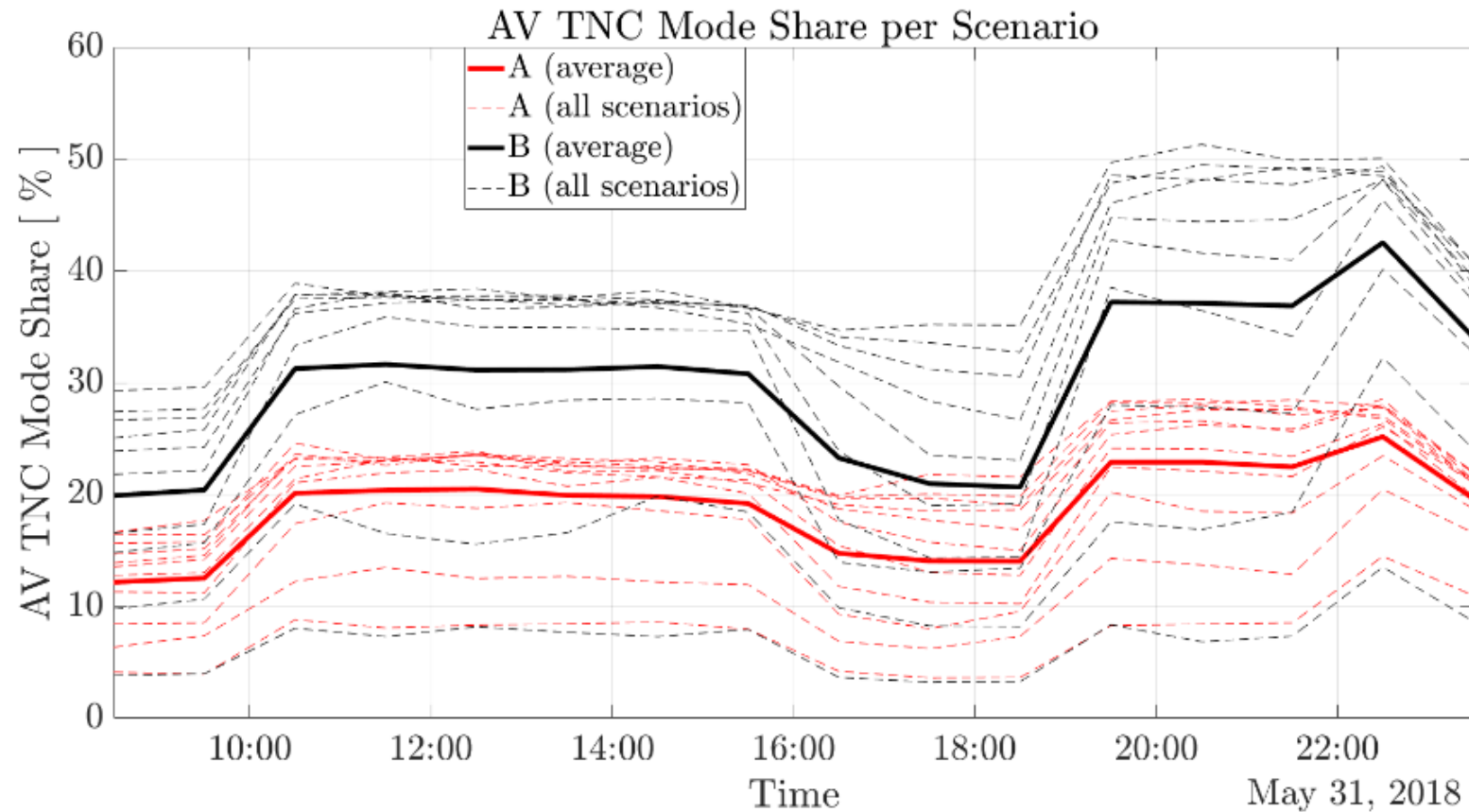
Nested Logit (Private, Shared, PT)

MARKET STRUCTURE

TNC Monopoly + Public Transport

ROUTING

ClusterStar



Ongoing Case Study – TNC Pricing

ASSIGNMENT

Optional Ride-Matching

PRICING

Adaptive Surge Pricing Heuristic

MODE CHOICE

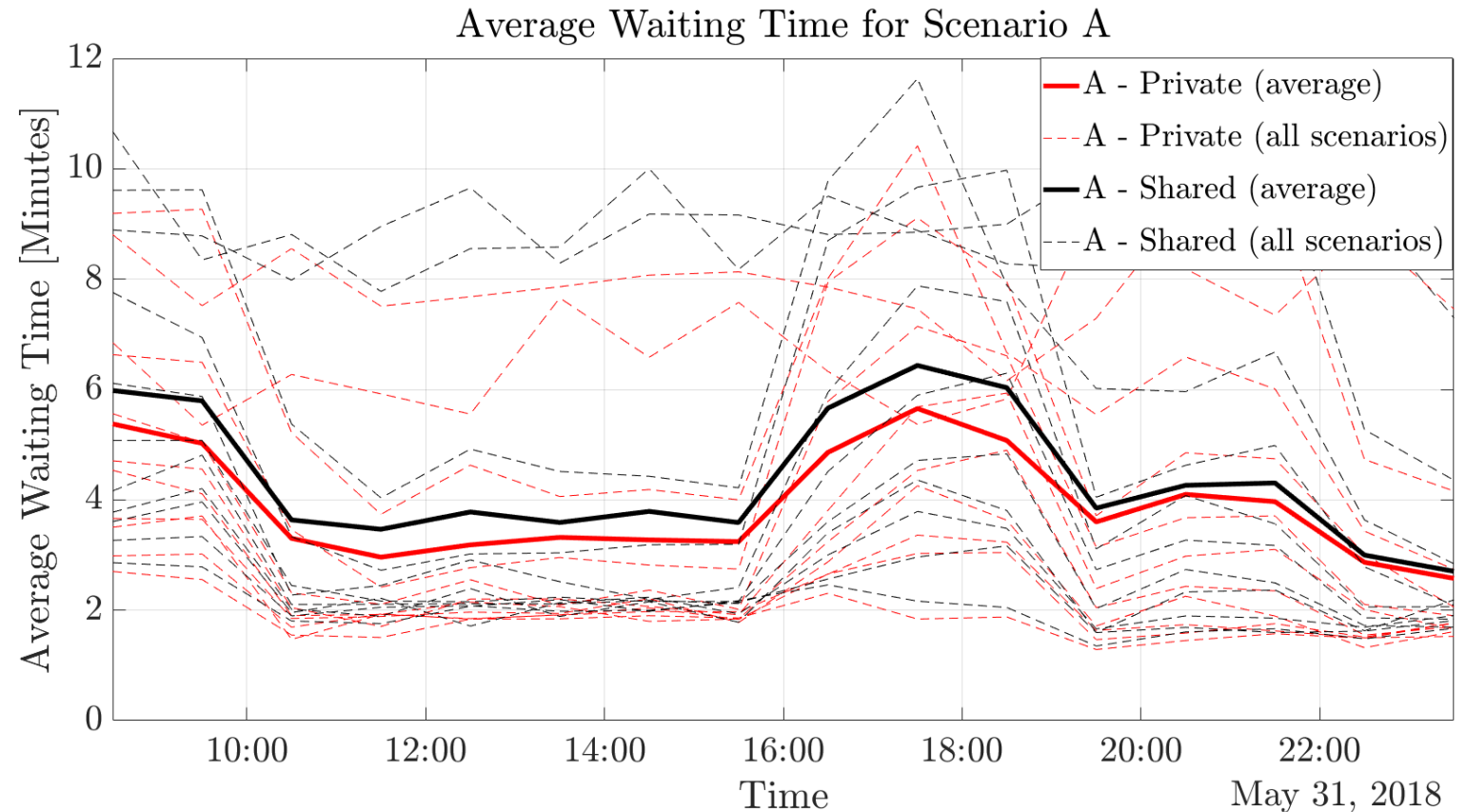
Nested Logit (Private, Shared, PT)

MARKET STRUCTURE

TNC Monopoly + Public Transport

ROUTING

ClusterStar



An isometric illustration of a city intersection on a dark blue background. White lines represent the road lanes, creating a grid pattern. Several vehicles are depicted in a simplified, blocky style: a large bus in the upper center, and several cars in various lanes. The vehicles are also rendered in white lines, matching the road style.

THANK YOU

Imperial College
London

P.ANGELOUDIS@IMPERIAL.AC.UK