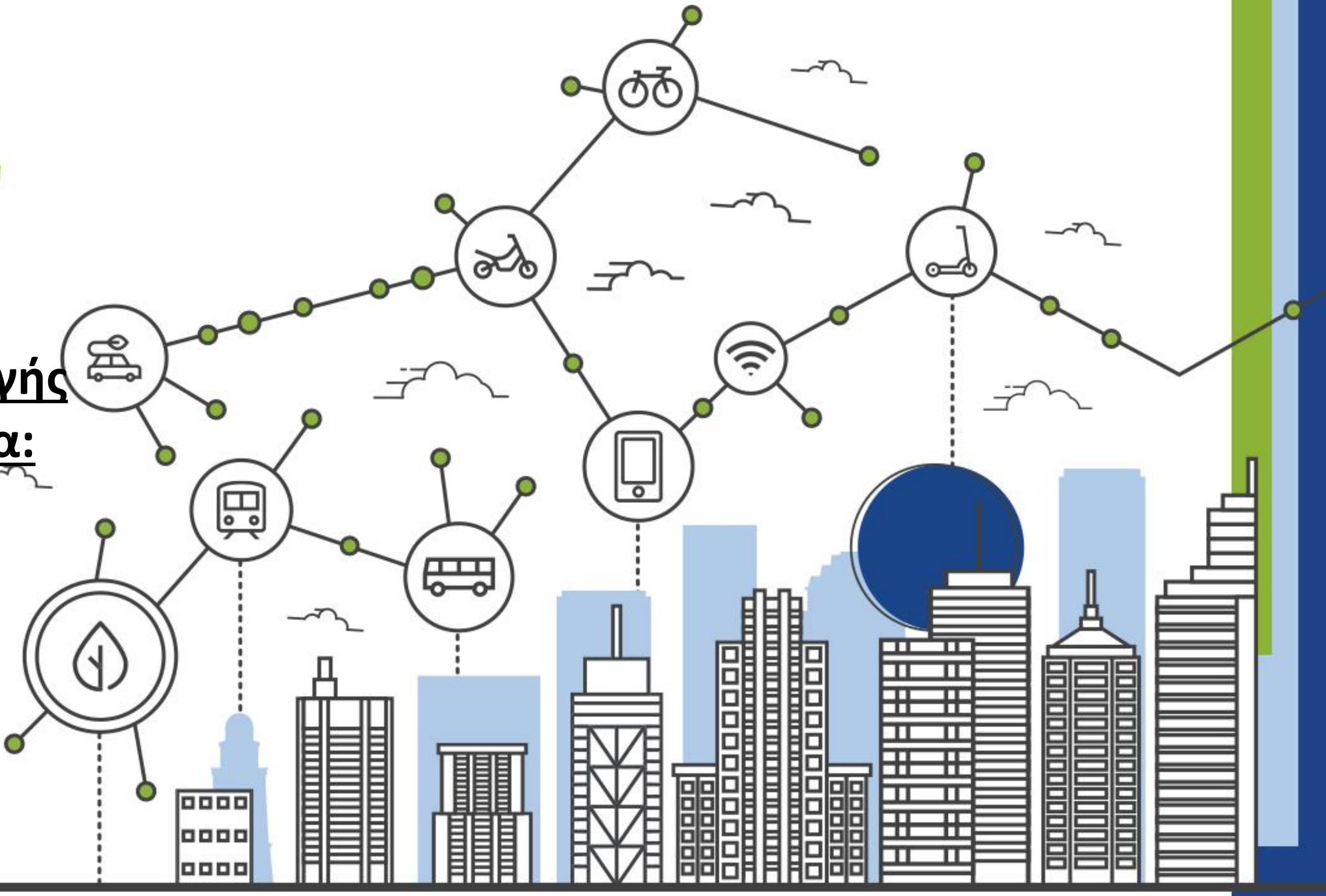
Interreg
Ελλάδα–Κύπρος
Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης
ΕΥΡΩΠΑΪΚΗ ΕΝΩΣΗ
step2smart

Διασυνοριακή Συνεργασία Νησιώτικων Αστικών Περιοχών για Βελτίωση των Περιβαλλοντικών Συνθηκών μέσω Χρήσης Συστημάτων Ευφυών Μεταφορών

Συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ε.Τ.Π.Α.) και από Εθνικούς πόρους της Ελλάδας και της Κύπρου

https://greece-cyprus.eu/step2smart

7ο Συνέδριο Βιώσιμης Κινητικότητας και Ευφυών Συστημάτων Μεταφορών



Αρχιτεκτονική Παροχής Πληροφόρησης και Εφαρμογής Δυναμικού Ελέγχου της Κυκλοφορίας στην Λευκωσία: Αποτίμηση στα πλαίσια του Έργου Step2Smart.

Λουκάς Δημητρίου

Εργ. Συγκοινωνιακής Μηχανικής – Πανεπιστήμιο Κύπρου

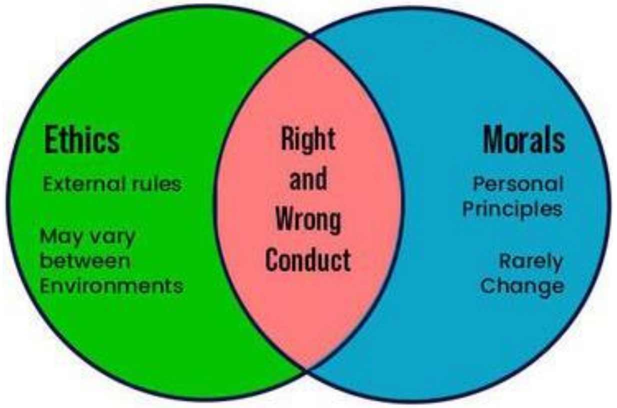
ΚΥΠΡΙΑΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΜΕΤΑΦΟΡΩΝ, ΕΠΙΚΟΙΝΩΝΙΩΝ ΚΑΙ ΕΡΓΩΝ

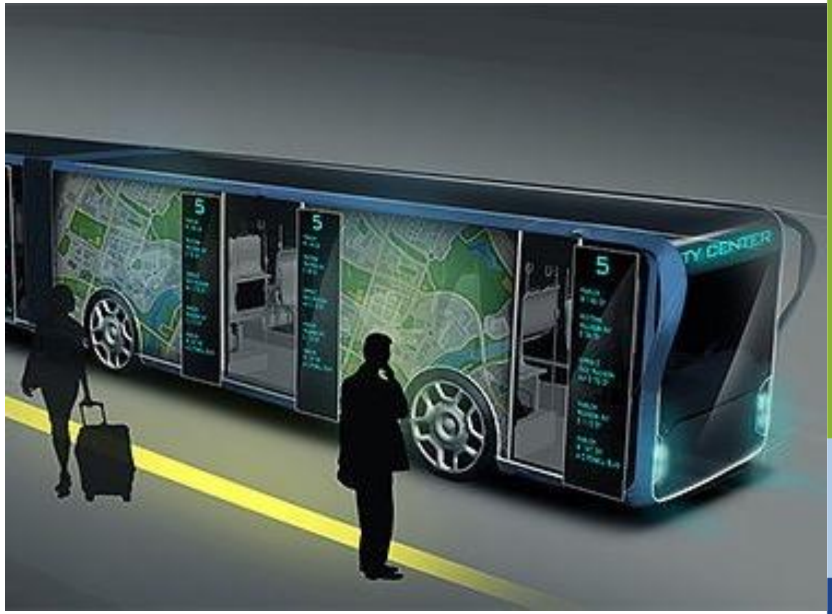
ΤΜΗΜΑ ΔΗΜΟΣΙΩΝ ΕΡΓΩΝ

ΚΛΑΔΟΣ ΒΙΩΣΙΜΗΣ ΚΙΝΗΤΙΚΟΤΗΤΑΣ

Outline

- Step-2-Smart Project (2UCY)
- Advanced Traffic Management Systems (ATMS)
  - Advanced Traveller Information Systems (ATIS)
  - Signal Control (Adaptive/Responsive → doubly-Adaptive → Multiobjective)
- Applications in Nicosia within Step2Smart
- A Moral (or two)





ATMS within Step2Smart

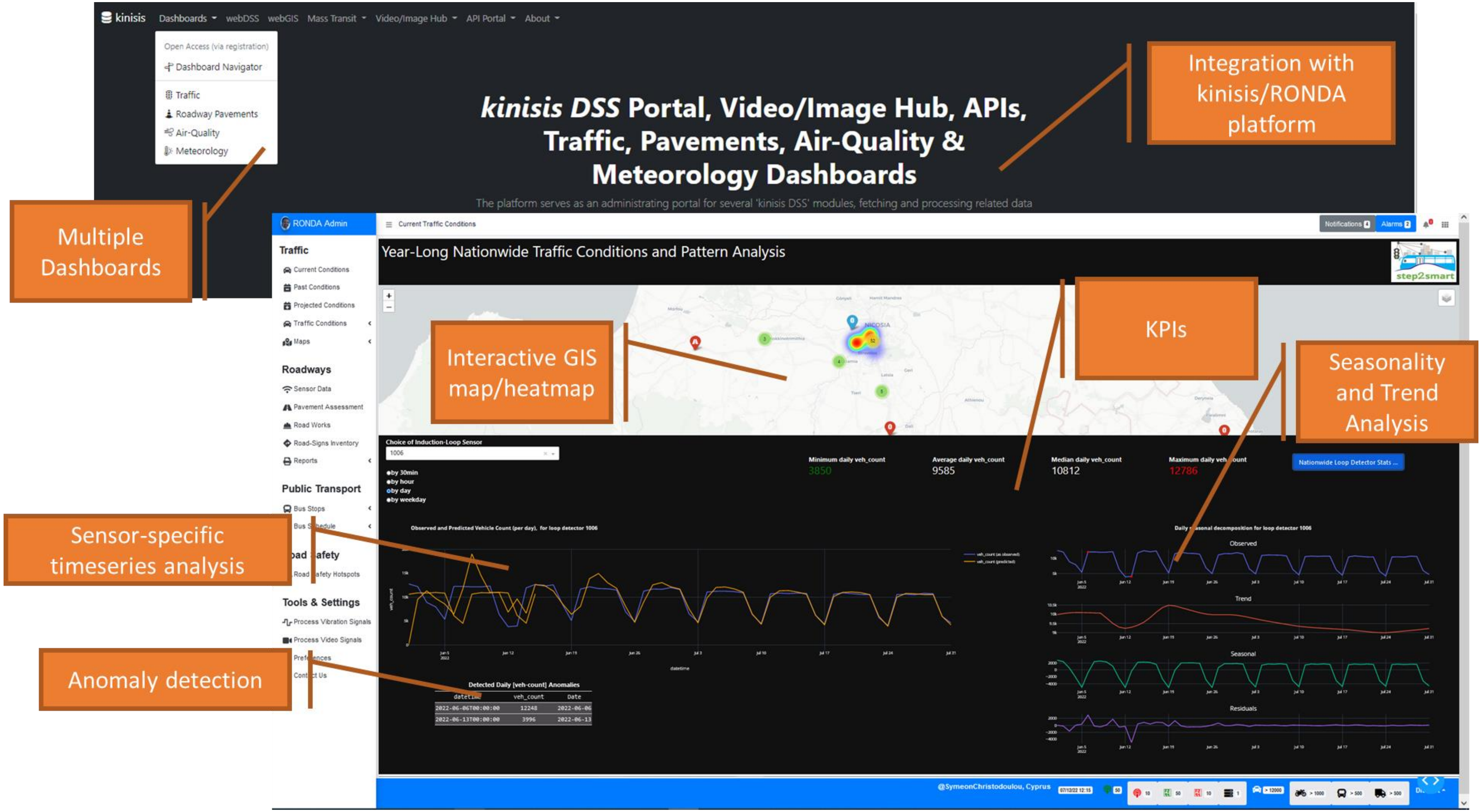
- Step-2-Smart Project began in 2016, as a **knowledge-exchange**, **infrastructure enhancement** and **demonstration** project.
- The idea was to built on MTCW existing data collection/management facilities and extend it toward “**smartness**”.
- Actually, the scope was the **improvement of data warehousing** (and **somehow use it!)**.

UCY’s Objectives

- UCY’s scope had two main objectives:
    1. The development of a **pilot platform that will communicate with MTCW-PWD data warehouse**, will process data and can **prepare and broadcast processed traffic information** (ATIS: soft demand management step)
    2. The development of an **advanced traffic control (signaling) framework** and quantify benefits of its application (Signalization: hard demand management step).
- The overall idea was relevant, valuable, comprehensive, “*doable*” and extendable.
- For the UCY’s team, the project was successful since:
    - Many young researchers took **their chances and first steps**
    - We had the opportunity to develop **our analytical tools**
    - We incorporated the developed models, applications and results **as teaching material**

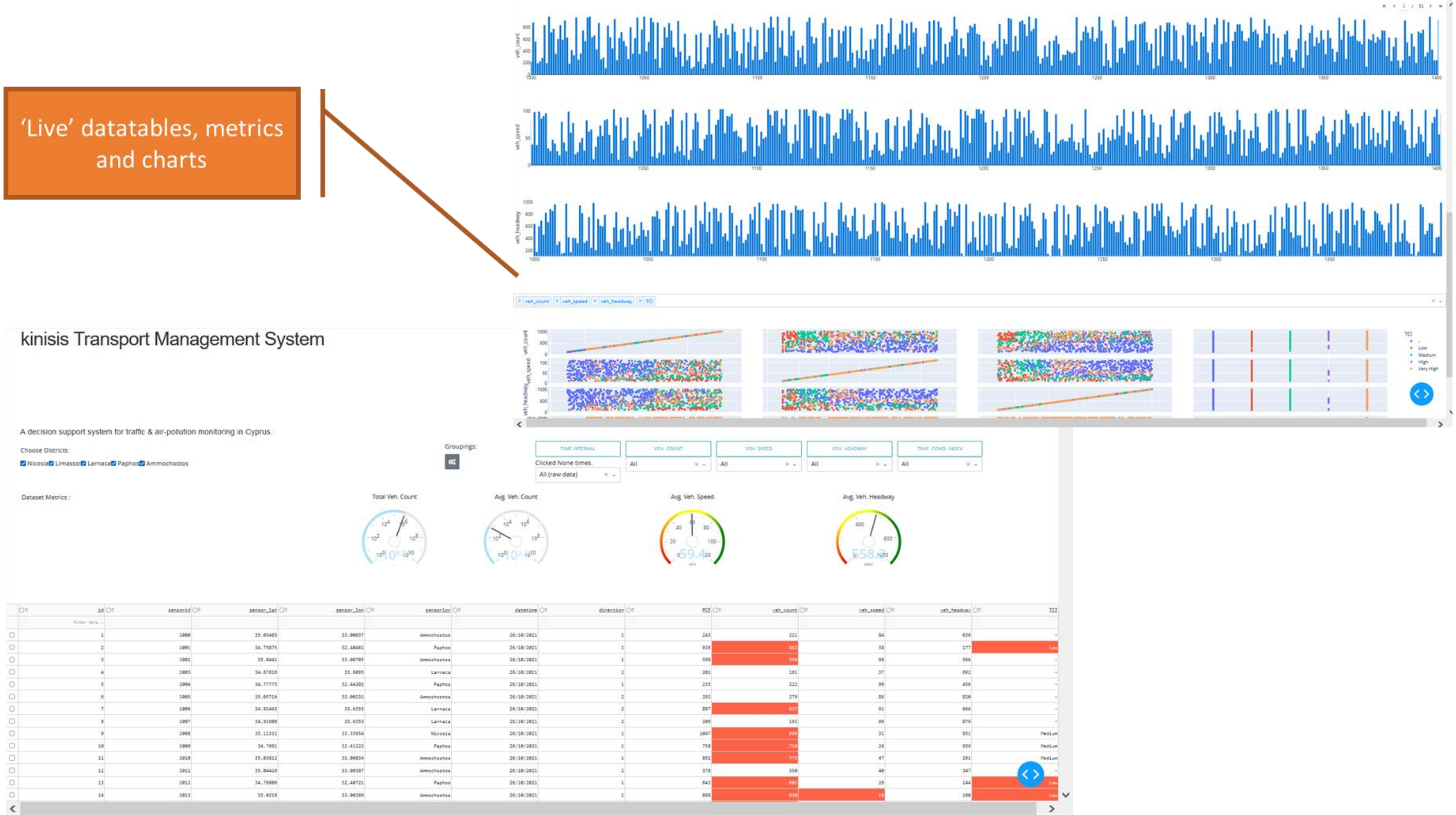
The Platform: a work in progress!

Kinisis DSS Portal



Kinisis DSS Portal

‘Live’ datatables, metrics and charts



Kinisis DSS Portal

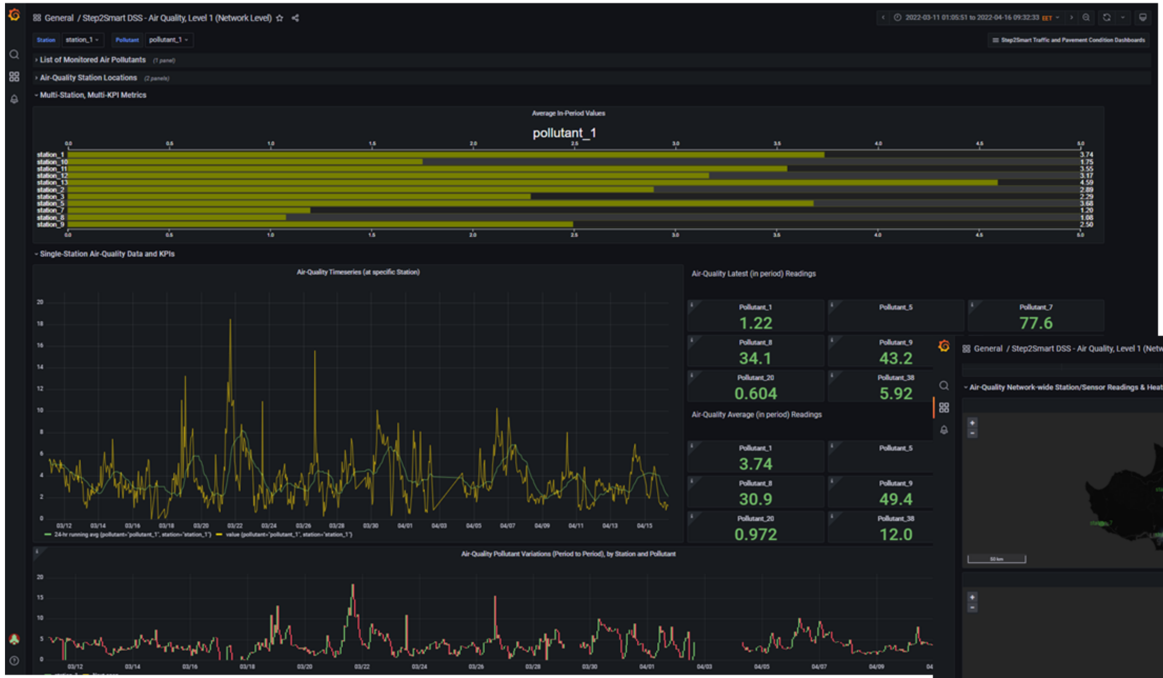
Traffic-Monitoring Dashboards

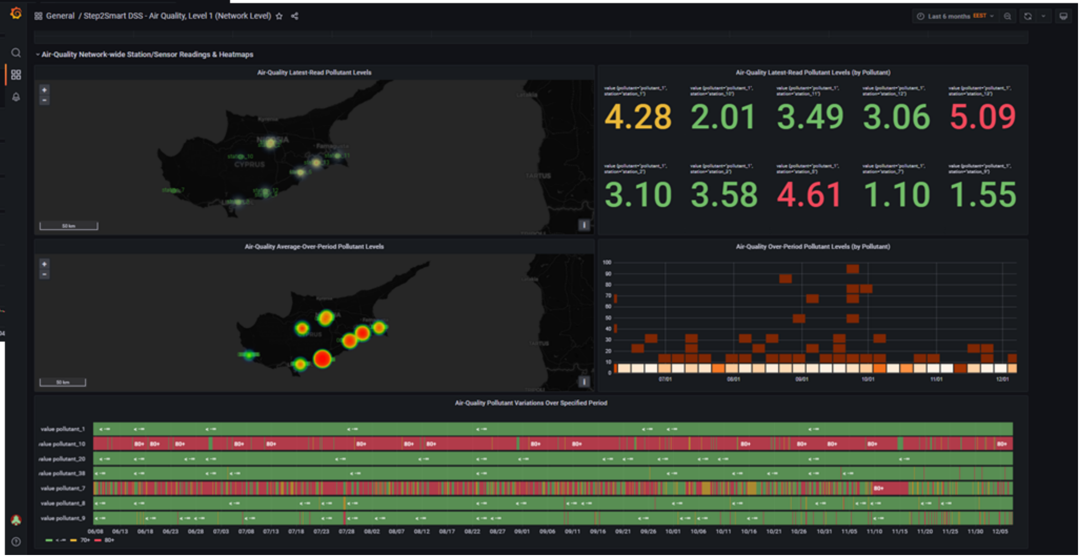
‘Live’ datatables, metrics and charts

By sensor, location, time-period, etc.

Kinisis DSS Portal

Air-Quality Dashboards

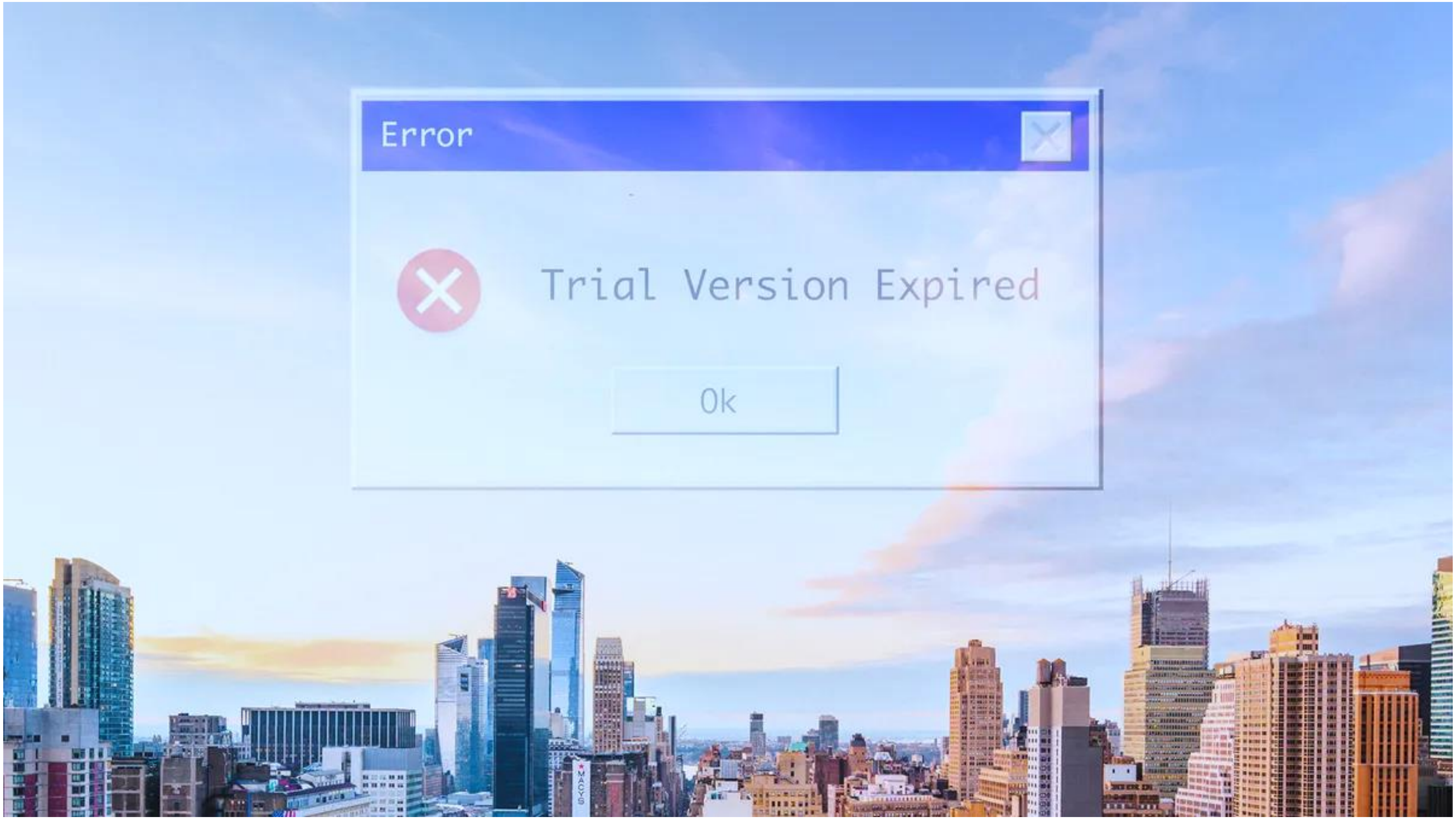




Web-hosted 'Live' datatables, metrics and charts

By sensor, location, time-period, etc.

LaB for TRANSPORT ENGINEERING

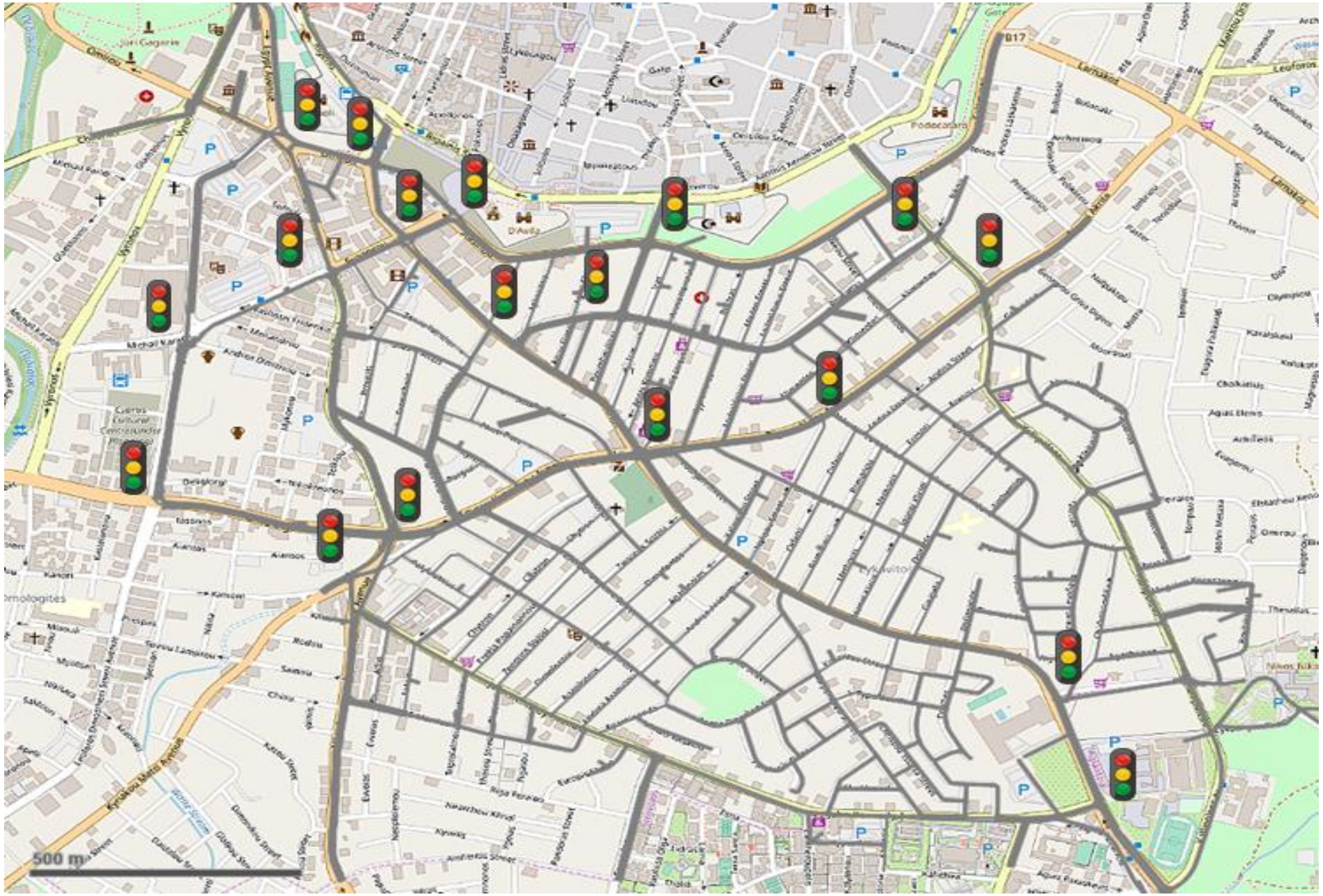


Traffic Signalling: A Distributed Deep *Reinforcement Learning* Approach

LaB for TRANSPORT ENGINEERING

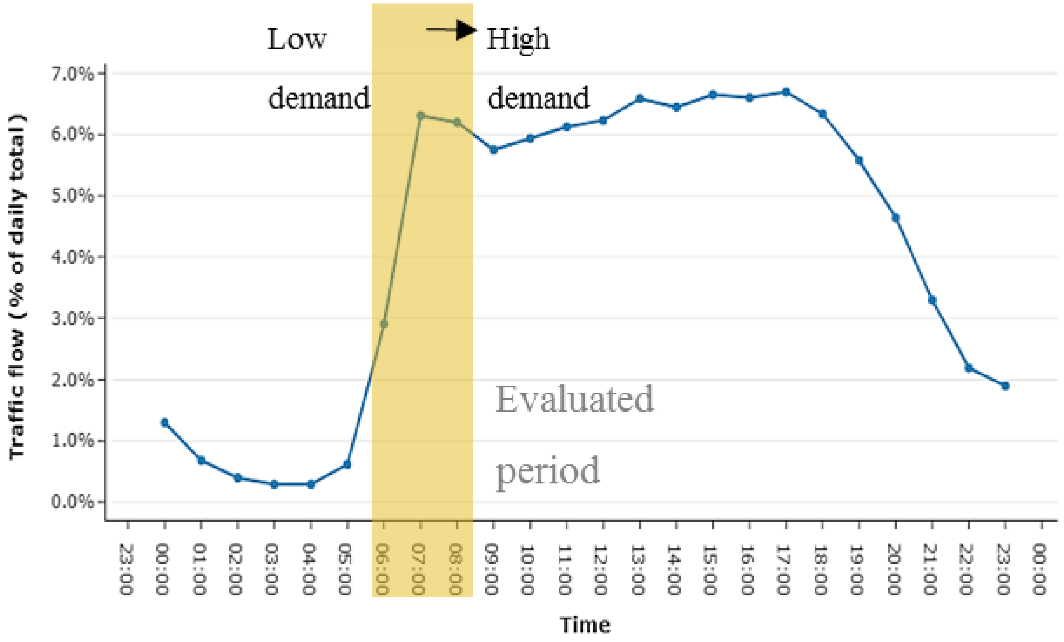
The test-bed

- Nicosia faces significant congestion especially during the **morning peak hour (07:00-08:00).**
- Based on a calibrated traffic model for Nicosia, Cyprus (20 km^2)
- The network consists of more than **200 junctions out of which 19 are signalised.**
- The RL methodologies developed are implemented and evaluated **on all the signalised junctions**.



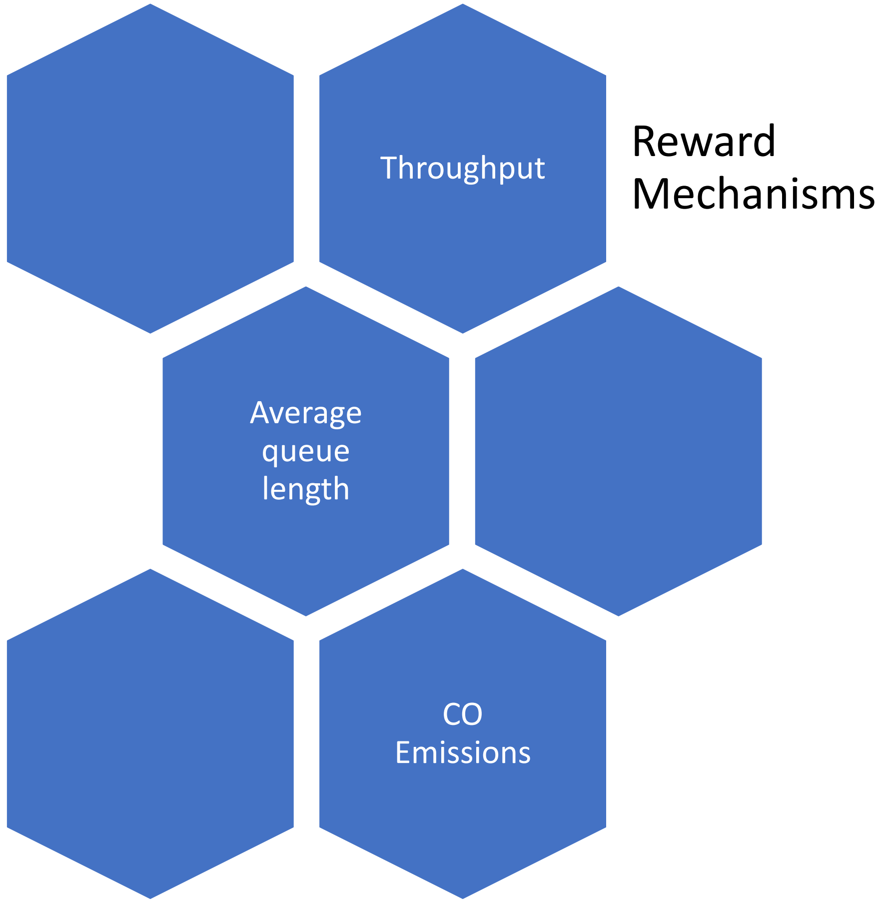
The Setting

- The simulations required for the completion of the experiments are conducted using the widely used traffic simulator **VISSIM**.
- VISSIM is simulating **driving behaviour** based on a set of models allowing the estimation of the key driving elements (i.e. gap-acceptance, speed adaptation, lane-changing, overtakes, and car-following).
- In addition, VISSIM provides a **Dynamic Traffic Assignment (DTA)** module for capturing adaptive **route choice behaviour**.



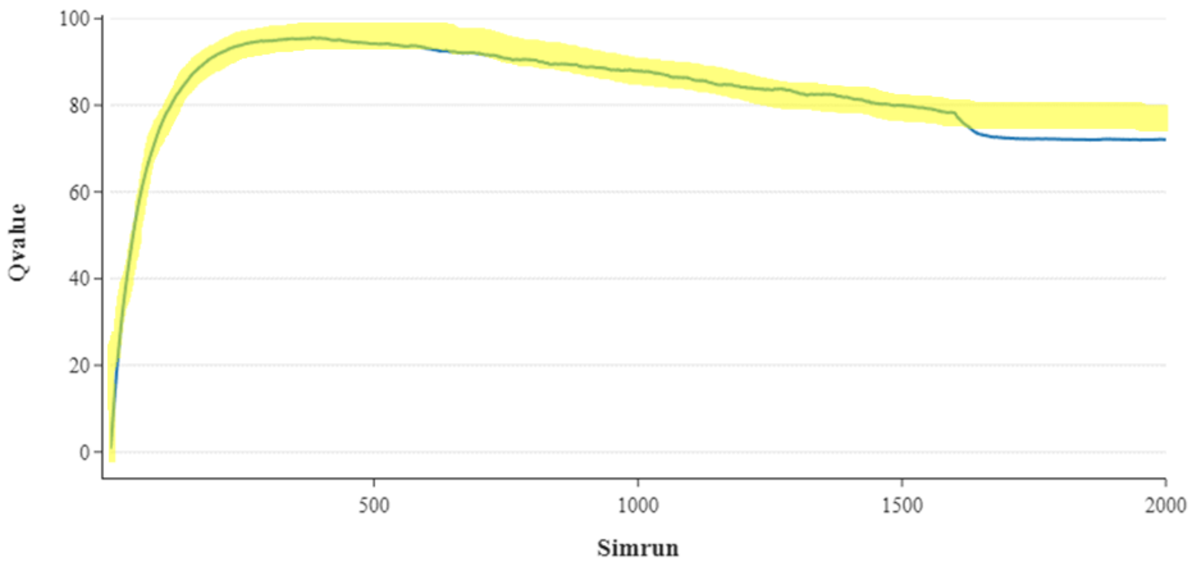
Performance Metrics

- Different implementation scenarios were developed based on three reward mechanisms
  - **A. Vehicles (i.e. throughput)**
  - **B. Average queue length**
  - **C. Volume of CO emissions**
- All scenarios were executed for the AM peak hour (7:00 – 8:00) where over 16,000 trips take place
- Each modelled scenario was trained for 2,000 iterations (**approximate processing time 12hrs**)



Performance Metrics

- All the optimisation scenarios were evaluated in comparison to the existing fixed time signalling strategy
- The evaluation refers to the conditions around the optimised junctions in terms of:



Throughput

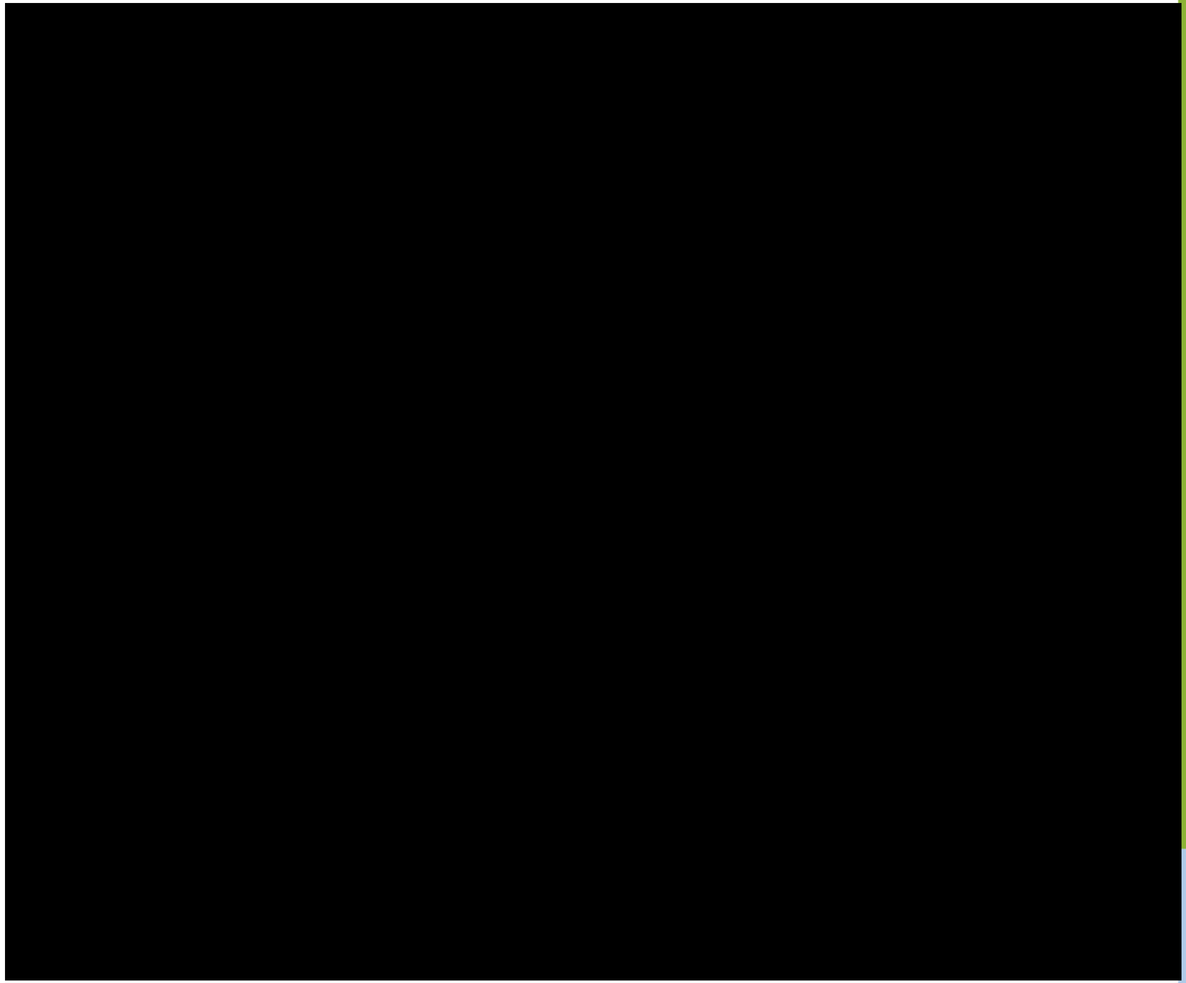
Average delay

Average queue length

Total volume of CO emissions

Approach? Reinforcement Learning

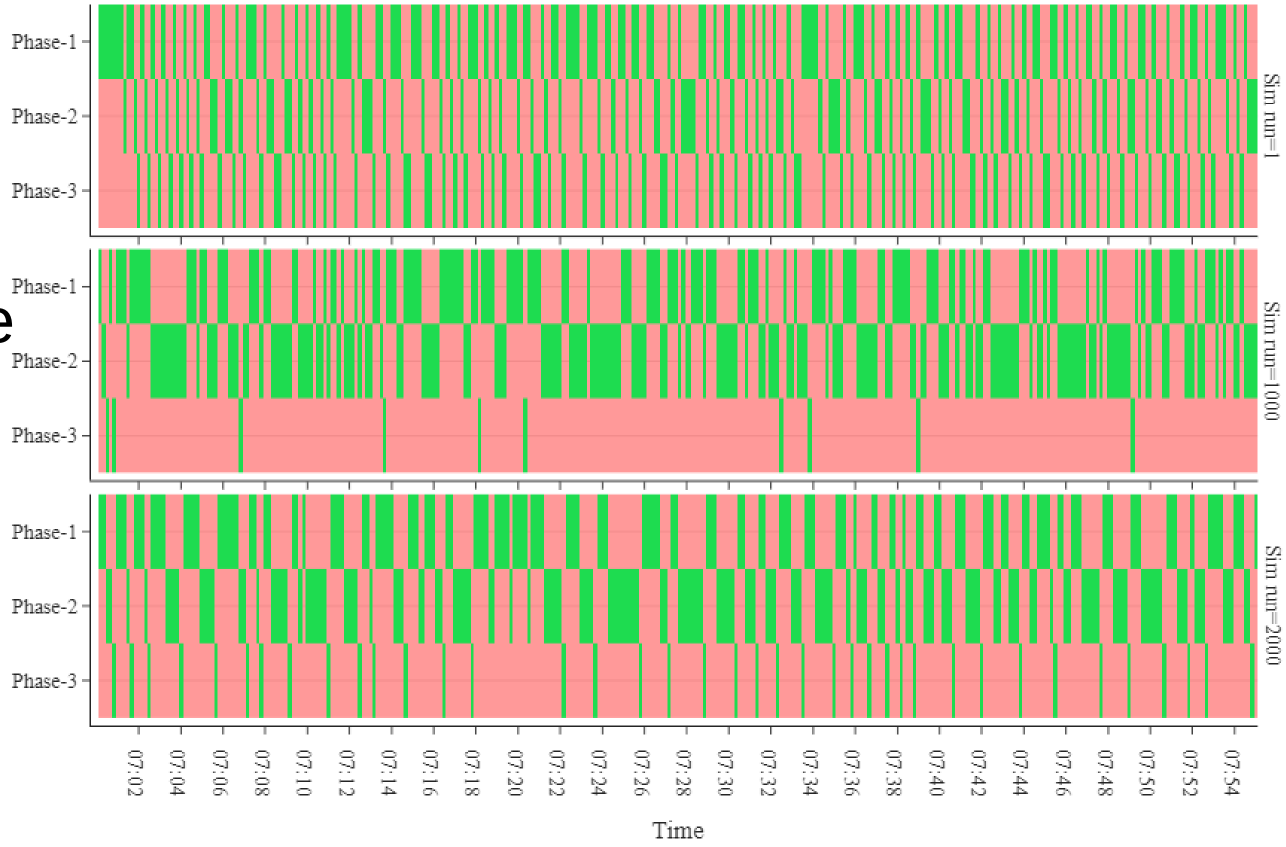
- The adaptive mechanisms developed was based on alternative **Reinforcement Learning mechanisms** (Q learning, SARSA, Deep Q, etc.)
- It is nice because **you don’t need to know anything** (model-free)!
- The setting was to develop a system of **deliberate multiple agents ‘equipped’ with a learning mechanism** (MARL), in **distributed** and in **centralized** settings
- And we let the ‘robot’ learn on “itself”:



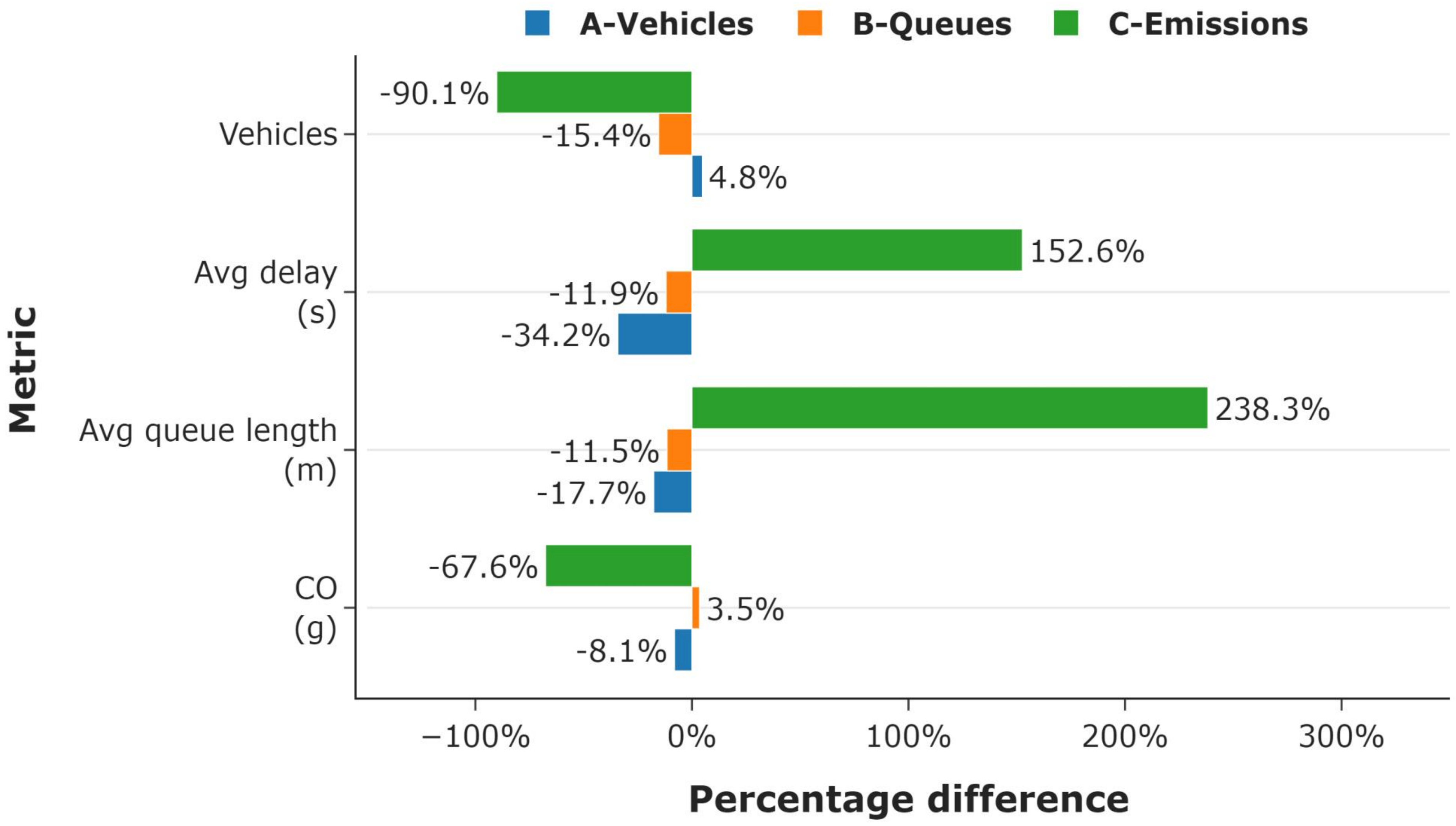
Approaching Optimal Signal Program

- Different implementation scenarios were developed based on three reward mechanisms
  A. Vehicles (i.e. throughput)
  B. Average queue length
  C. Volume of CO_2 emissions
- All scenarios were executed for the AM peak hour (7:00 – 8:00) where over 16,000 trips take place
- Each modelled scenario was trained for 2,000 iterations (approximate processing time 12hrs)

Evolution of the signal program



How Smart are “Έξυπνα Φώτα”



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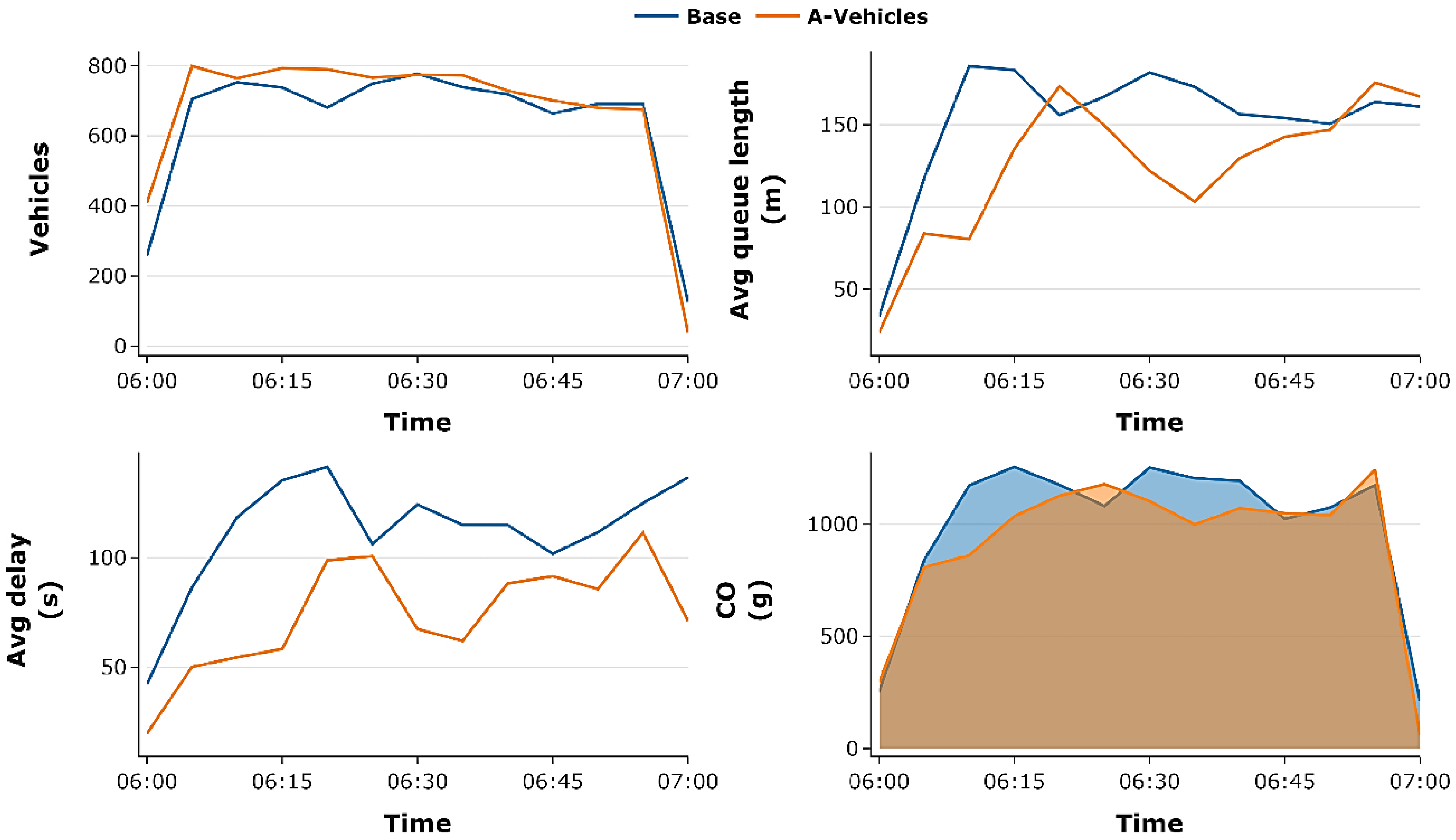

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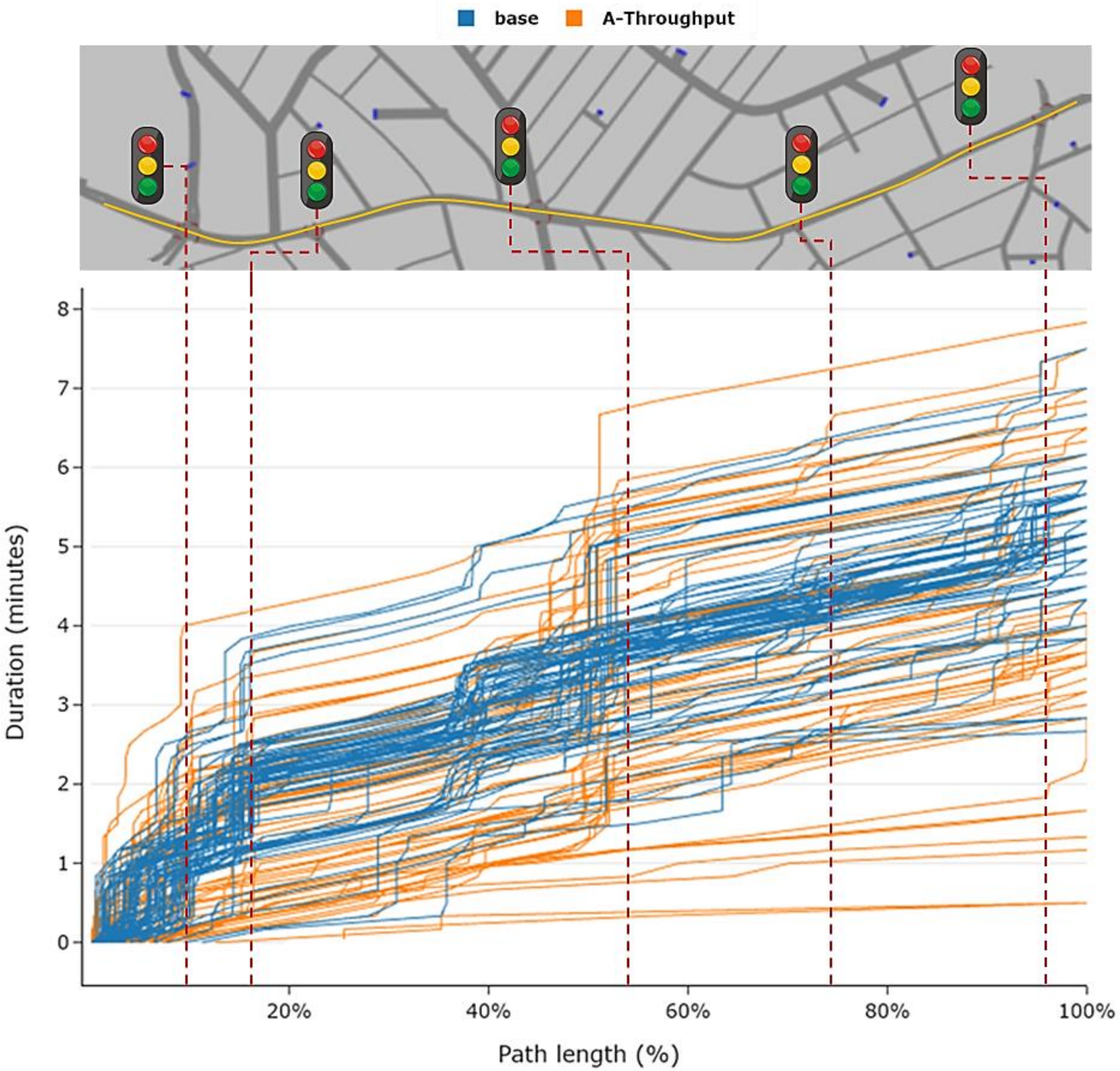


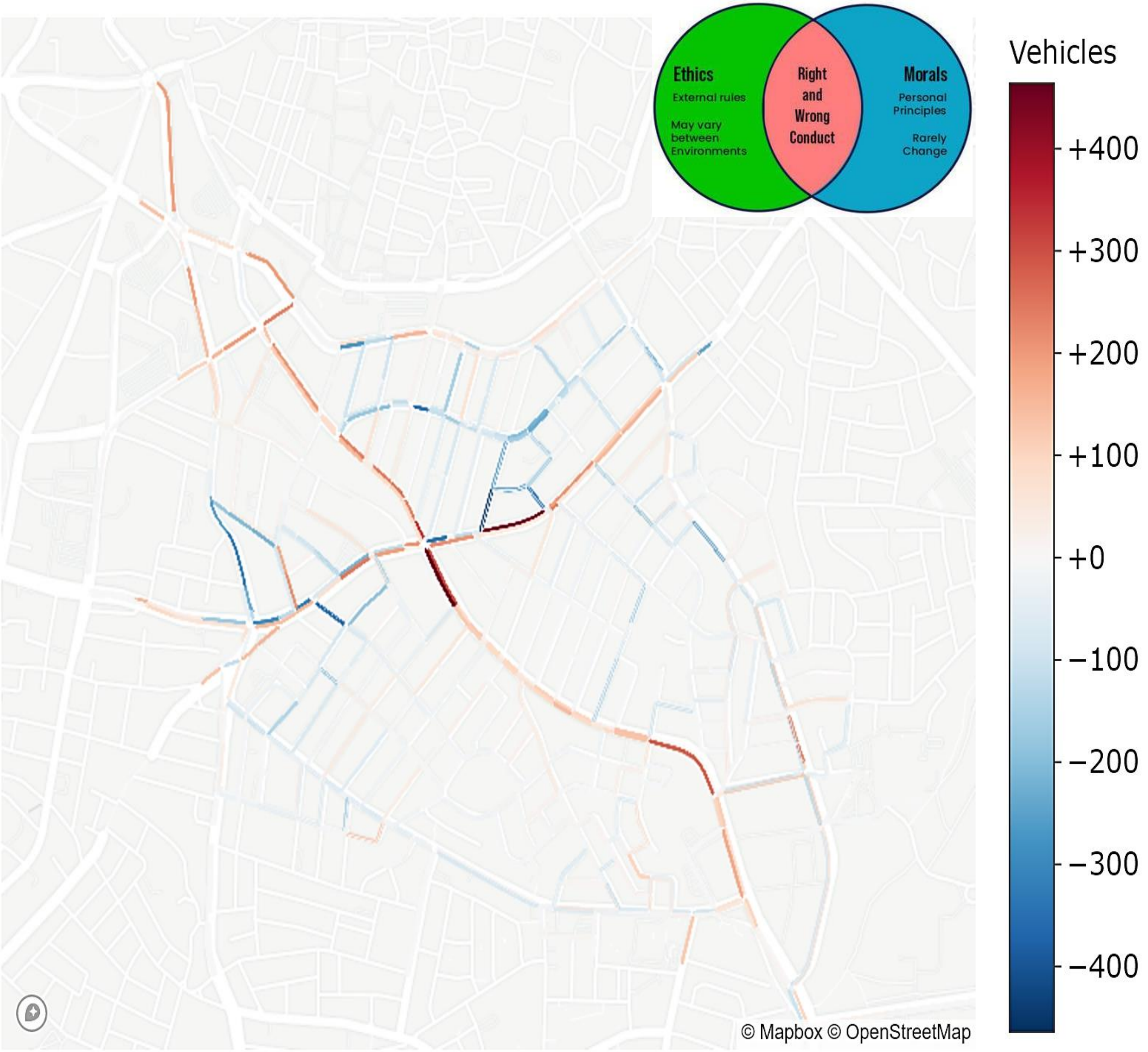
A Visual

Snapshot comparison (Base scenario)

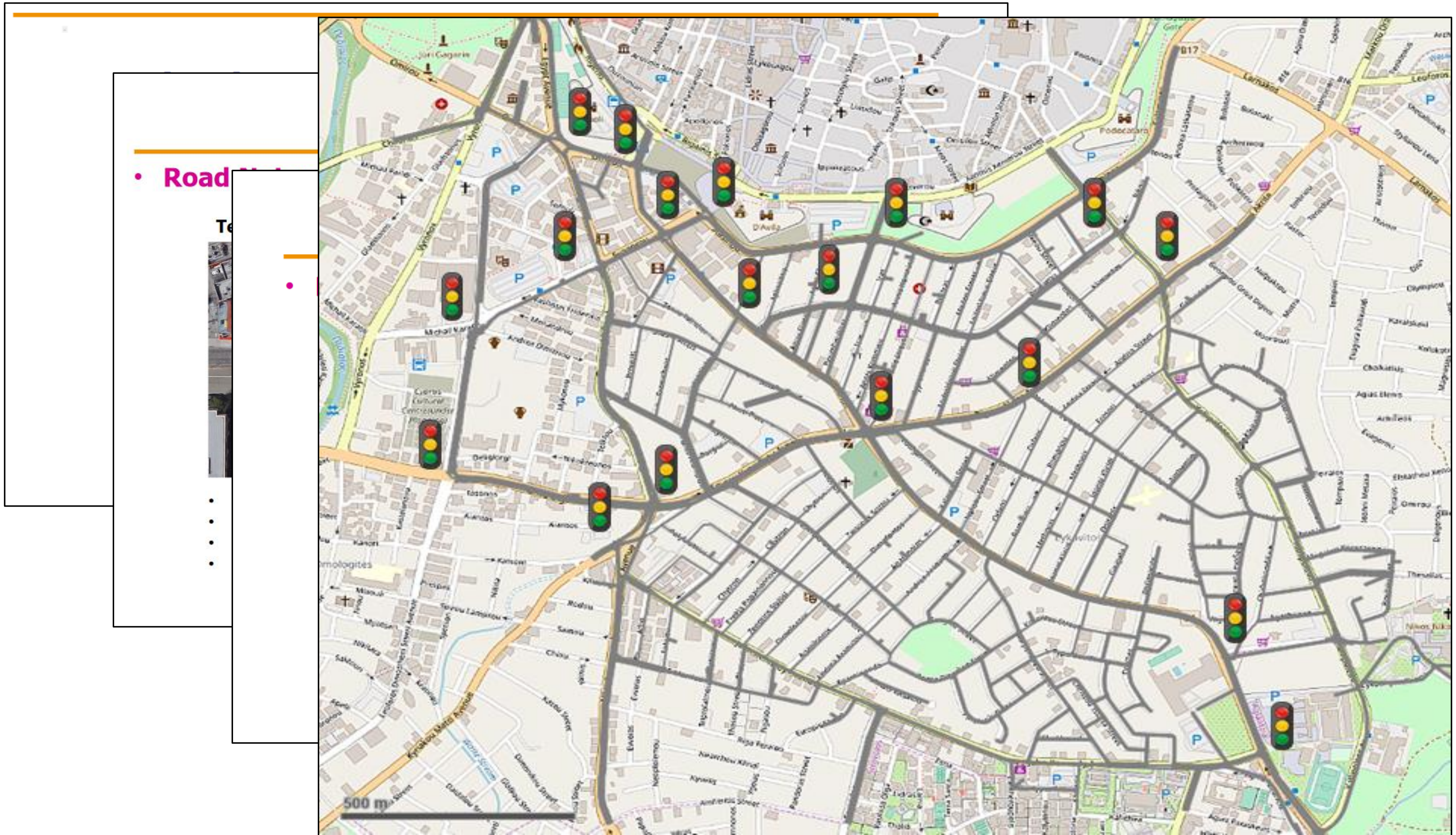
Snapshot comparison (RL-optimised)

A Moral (1)…

- The selected case was an interesting and –most importantly- an appropriate on, since:
  - It consists of major and secondary roads
  - There is control on major junctions that –obviously- control travel times
- Now let your imagination free…



Was this Idea/Approach Innovative at all..?



A Moral (2):
It is important to identify RESEARCH. **Generously**.

Conclusions

- Step2Smart at the time of its conception was interesting, valuable and could made a difference.
- For the UCY's team, although the progress was disturbing (for understandable reasons), overall we keep the best parts of it:
  - Many young researchers took **their chances and first steps**
  - We had the opportunity to develop **our analytical tools**
  - We incorporated the developed models, applications and results **as teaching material**
- But most importantly, we had the opportunity to meet you all guys! So long!

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