

Digital Twins and Urban Observatories: How DAFNI is supporting the National Digital Twin Agenda

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- What is a Digital Twin?
- DAFNI and Urban Observatories role in the National Digital Twin Programme
- Sheffield Urban Flow Observatory
- DAFNI-enabled Sheffield Traffic Digital Twin



DAFNI Digital Twin Definitions

A digital twin is a virtual representation of a physical object or system across its lifecycle, using real-time data to enable understanding, learning and reasoning.

IBM

A digital twin is a virtual representation of a physical product or process, used to understand and predict the physical counterpart's performance characteristics.

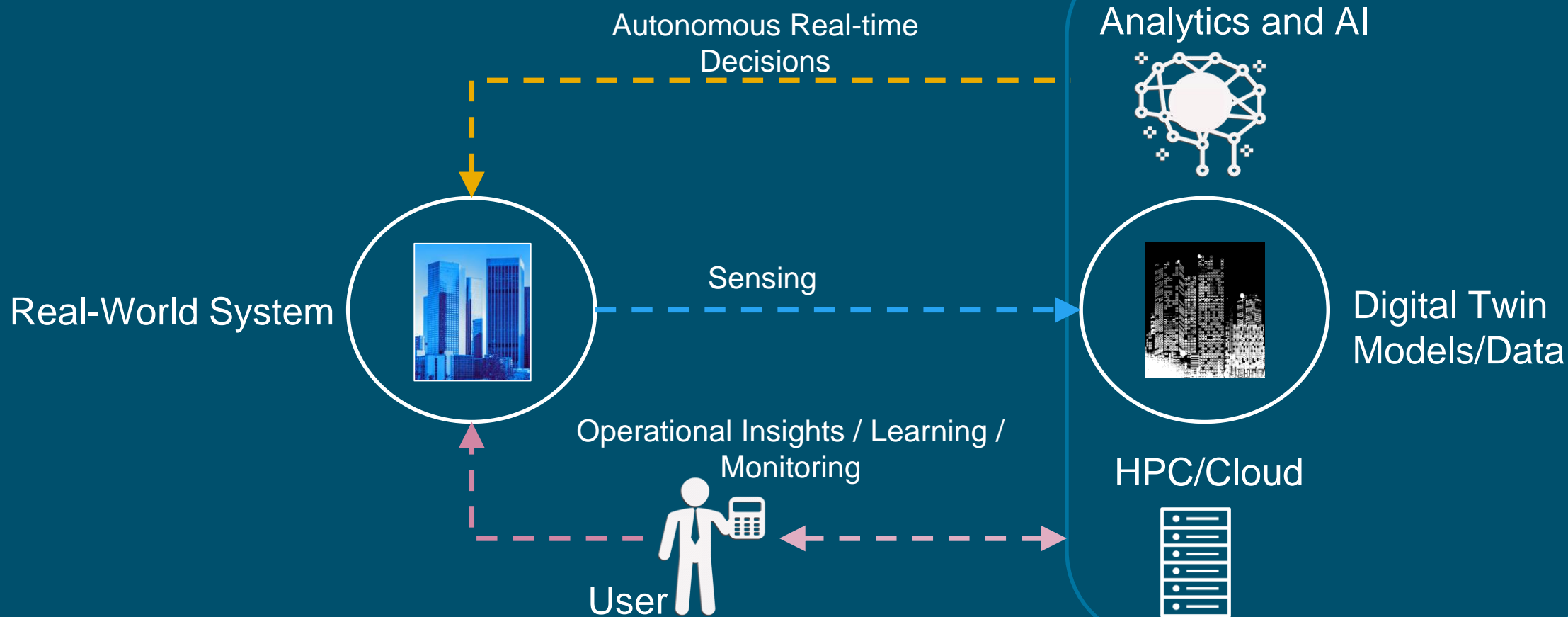
Siemens

Digital twins are realistic digital representations of physical things. They unlock value by enabling improved insights that support better decisions, leading to better outcomes in the physical world.

Cambridge Centre for Digital Build Britain

A digital twin is a mirror image of a physical process that is articulated alongside the process in question, usually matching exactly the operation of the physical process which takes place in real-time.

Michael Batty, UCL





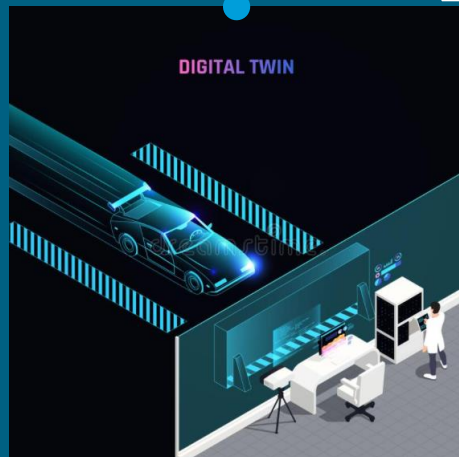
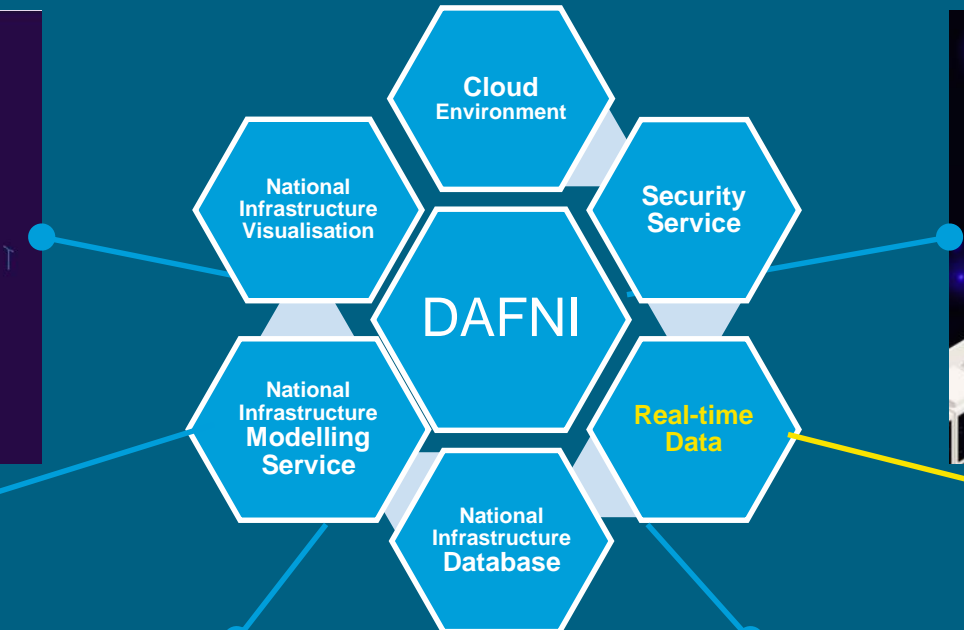
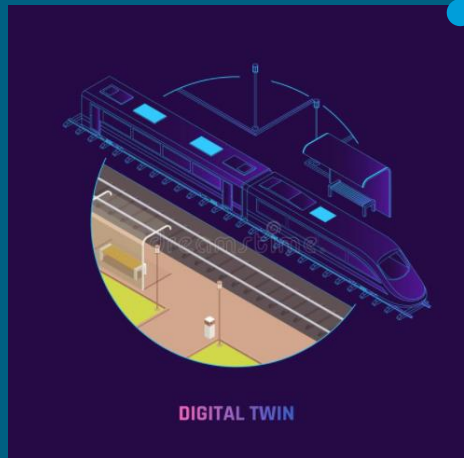
DAFNI National Digital Twin Programme

Led by the Centre for Digital Built Britain (CDBB) in partnership with the Department for Business, Energy and Industrial Strategy (BEIS)

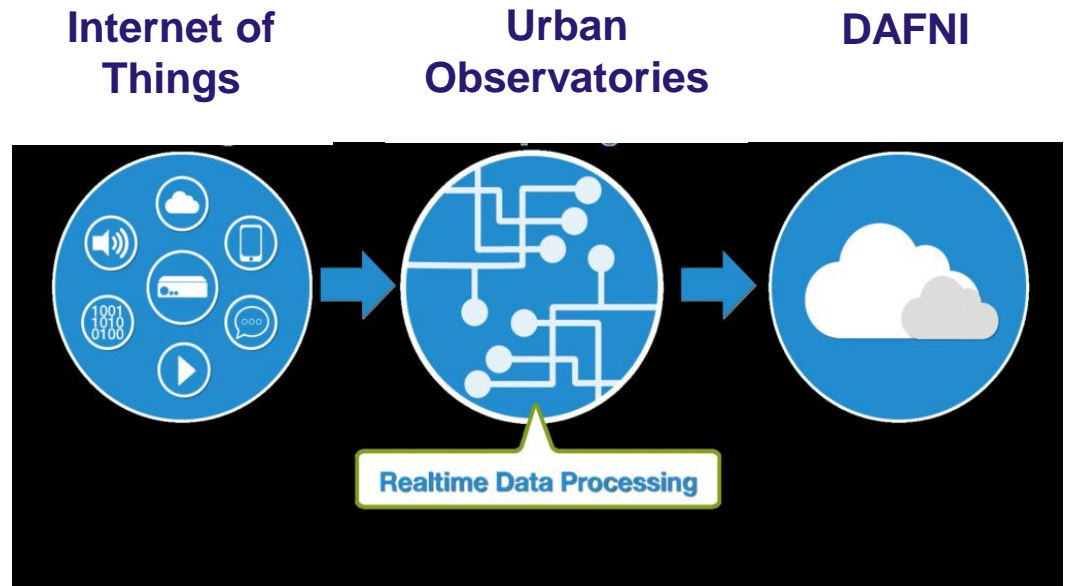
Programme Objectives

- **Enable a National Digital Twin** – *Ecosystem of connected digital twins of the UK national infrastructure*
- **Deliver an Information Management Framework** – *Secure resilient data sharing*
- **Align a Digital Framework Task Group** – *Coordination among the key players*

DAFNI DAFNI's Role in the NDT



DAFNI - Urban Observatories Integration





URBAN FLOWS OBSERVATORY

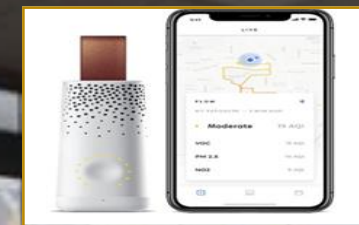
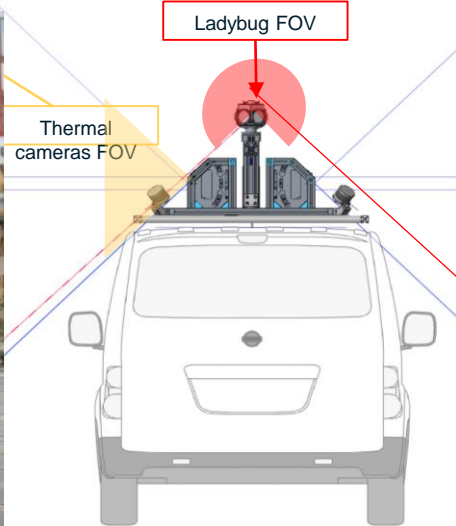
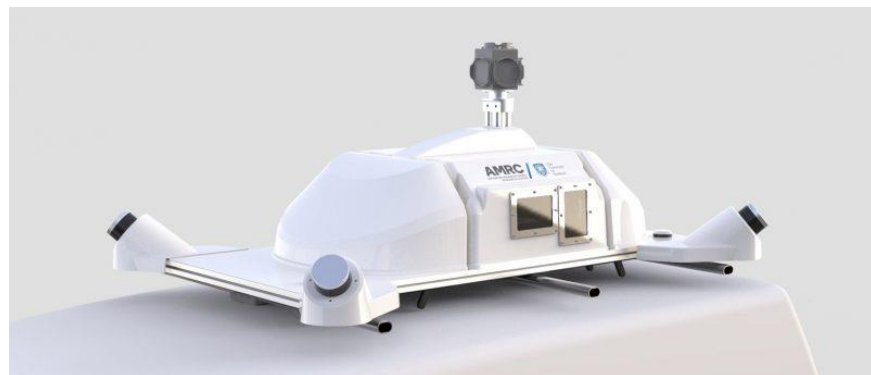


Our Vision

To create a urban sensing and analytics platform to measure, describe, analyse, optimize and plan the metabolism of the city - the flows of materials, energy, people, information and the processes by which modern cities transform these resource flows in order to sustain their function.



The University Of Sheffield.



DAFNI Data Analytics Dashboard

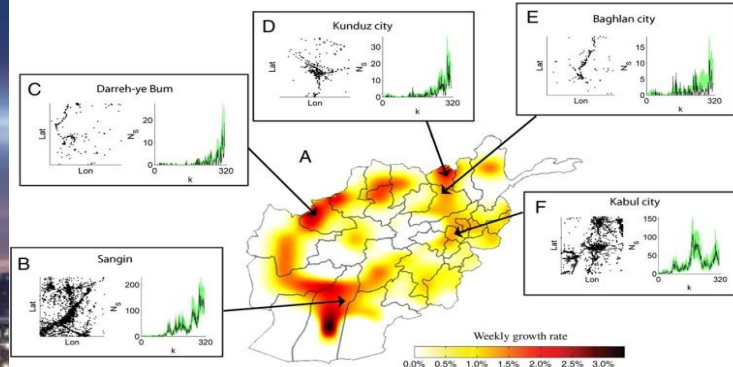


DAFNI Urban Digital Twin Platform

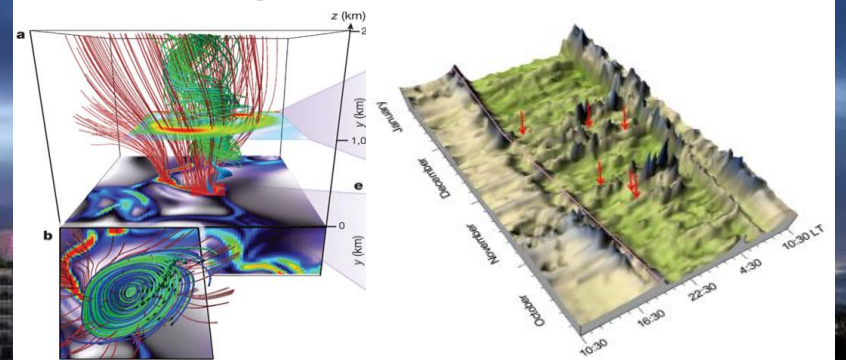
Data Curation, Missing Data Recovery and Fusion



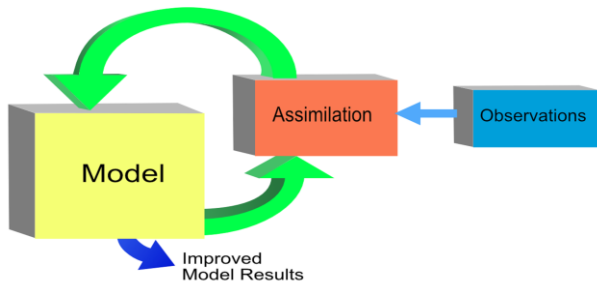
Real-Time Data Analytics



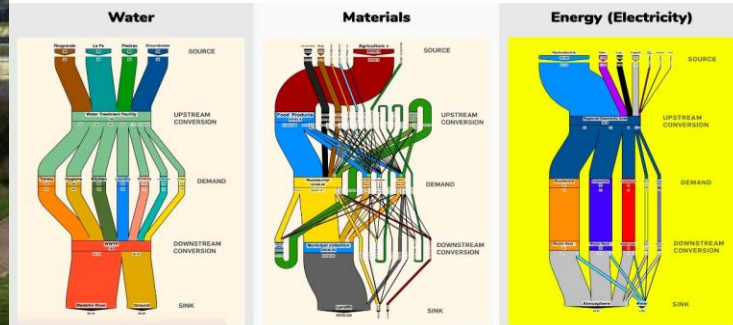
Multi-Scale, Spatio-Temporal Modelling of Flows and Processes



Data Assimilation



Urban Metabolism Assessment



Model-Based Decision Support Tools

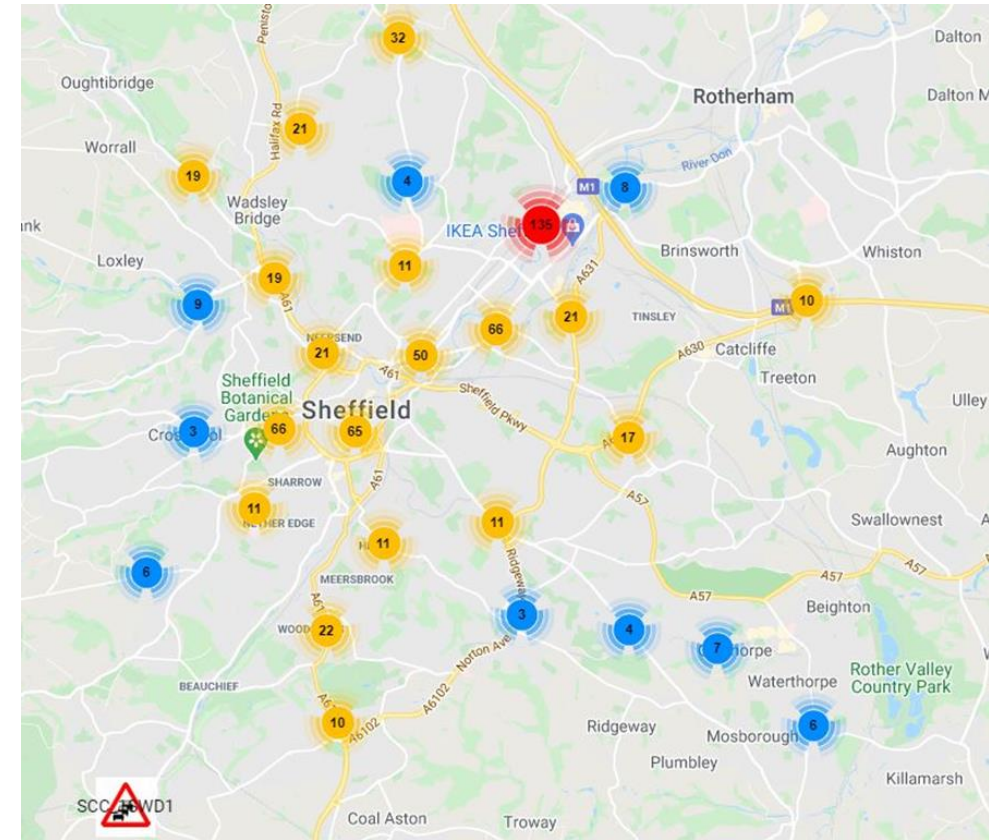


DAFNI Sheffield Traffic Digital Twin

Traffic data

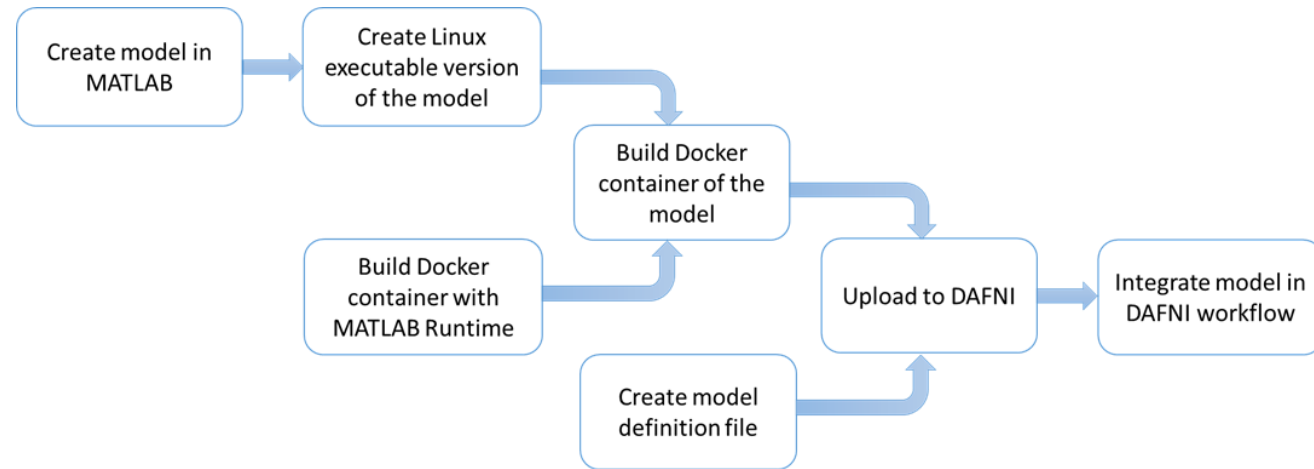
- 640 sensors that report traffic flow (cars/min)
- Time resolution: 5 minutes
- Data harvested since Sept. 2019

DAFNI platform provides computational power to perform machine learning inference for all the traffic sensors in real-time



Machine learning model development

- Missing data imputation, outlier detection, smoothing
- Data transformation
- Feature (input) selection
- Model selection and validation

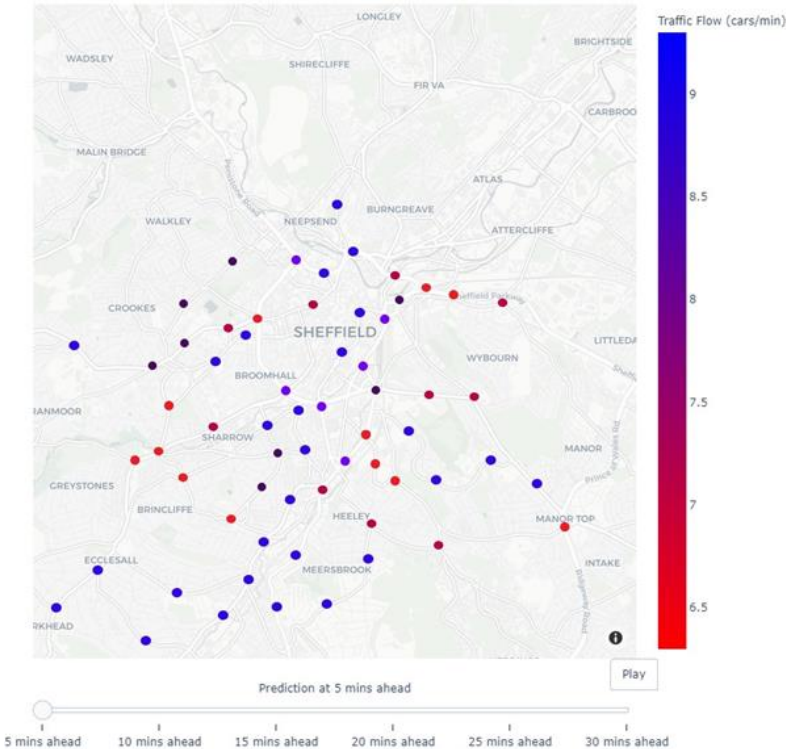
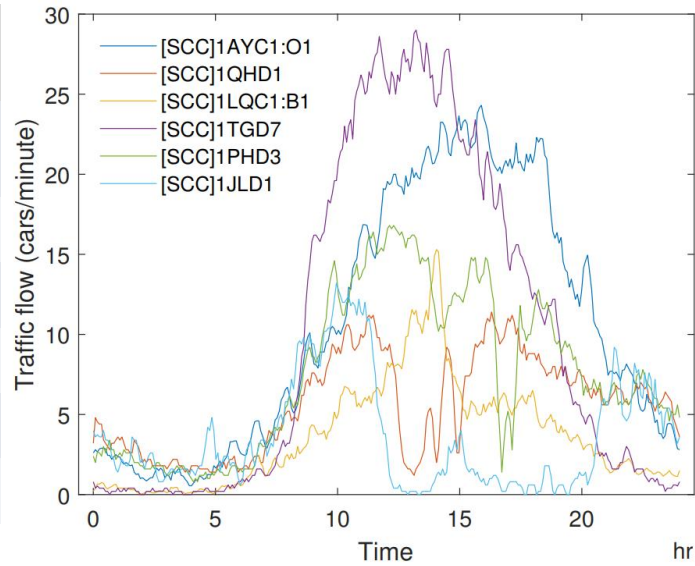


ML model deployment in DAFNI

DAFNI Traffic Forecast Performance

Mean Relative Error over 24-hours

Sensor id	5 min ahead	15 min ahead
[SCC]1AYC1:O1	7.4%	15.2%
[SCC]1QHD1	13.6%	28%
[SCC]1LQC1:B1	13.9%	24.5%
[SCC]1TGD7	13.2%	28.1%
[SCC]1PHD3	11.2%	20.8%



Thank you