iTRAQ

INTEGRATING TRAFFIC CONTROL & AIR QUALITY

rated Traffic Management and Air Quality Control Using Space ces

IAP Programme

Brown

Leicester City Council

dmu.ac.uk DE MONTFORT UNIVERSITY LEICESTER

University of Leicester

TRAQ Background

Rationale

- Traffic congestion is a serious issue for many towns and cities
- Negative effects of congestion are well known
  - Economic
  - Environmental
  - Climate
  - Health
  - Safety
- Traffic management systems already implemented in most towns and cities
- Enhanced ways of managing traffic are required to further optimise use of the road network
- Need to address multiple factors at once to enhance environment

TRAQ Objective

Project Aim

- To create a link between existing traffic management and air quality levels to provide
  - Reduced traffic congestion
  - Enhanced air quality
- To provide a dynamic traffic management system which responds to changing conditions
- To exploit forecast and near real time information derived from satellites together with in-situ data and model outputs to provide timely and up-to-date information
- To develop a system which supports local authorities in meeting key regulatory requirements

To inform and provide

- Provide accurate forecasts of local traffic flow and delay
- Provide accurate forecasts of local pollution levels
- Generate a series of recommendations to changes in traffic light settings (stage times, cycle times, offsets)
- Enhance traffic flow and air quality through the use of the proposed strategy

Who is the User?

User groups and stakeholders

- Local authorities are the key user community for iTRAQ
- Government departments e.g. Defra, DfT, DECC
- Emergency services
- Public transport
- Other stakeholders e.g. MIRA, Transport iNET

Key policy drivers for users

- Transport and Traffic Management Acts
  - Transport Act 2000
  - Traffic Management Act 2004
  - Transport Act 2008
- Local Transport Plans
- National and EU air quality directives and regulations
  - Air Quality Framework Directive (96/62/EC)
  - National Emission Ceilings Directive and Regulations 2002
  - Air Quality Standards Regulation 2010
  - Air Quality Limit Values Regulations 2004

Primary User Requirements

Traffic Management

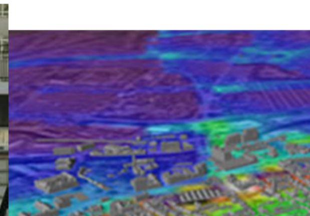
- To keep the existing rate of travel over the next 4 years
  - It takes 3.6 minutes per mile to travel on locally managed classified ‘A’ roads (LLTP 1)

Air Quality

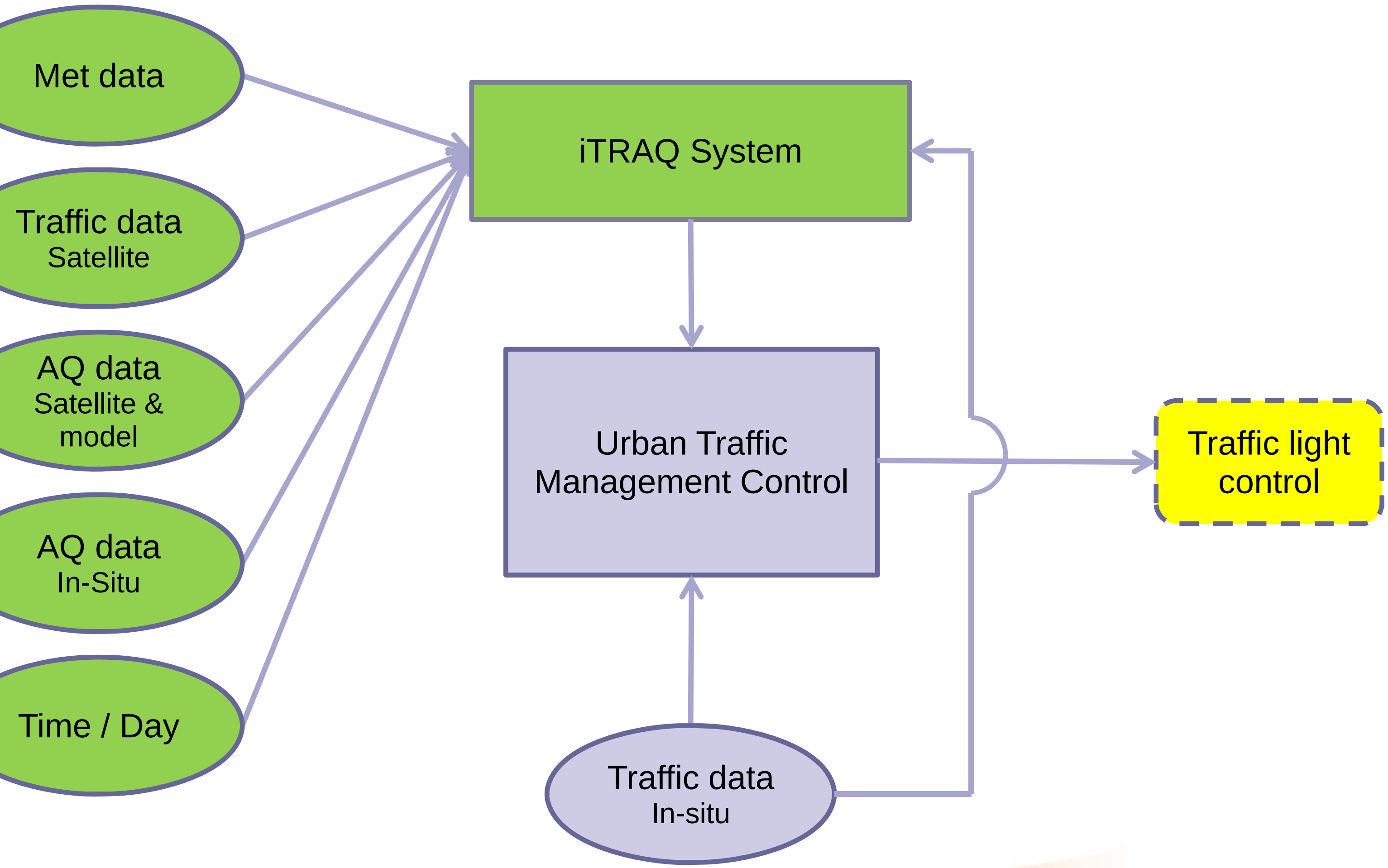
- To reduce the current levels of nitrogen dioxide by 3-6 $\mu g.m^{-3}$ in 4 years
  - National objective level of 40 $\mu g.m^{-3}$ for nitrogen dioxide exceeded at 4 locations (LLTP 39)

Carbon Footprint

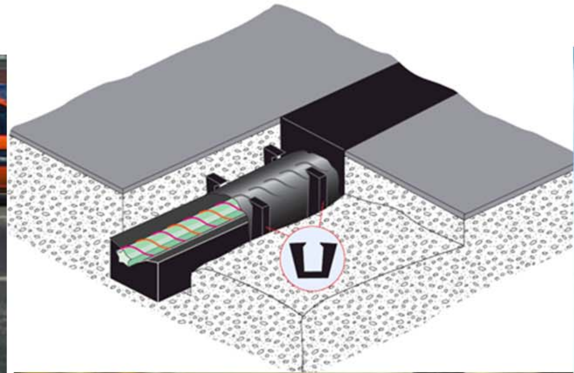
- To reduce city wide carbon dioxide emissions by 50% of the 1990 level by 2025/26 (LLTP 12)
  - To reduce the current levels of transport carbon dioxide by 2.41% (8.22kt) every year

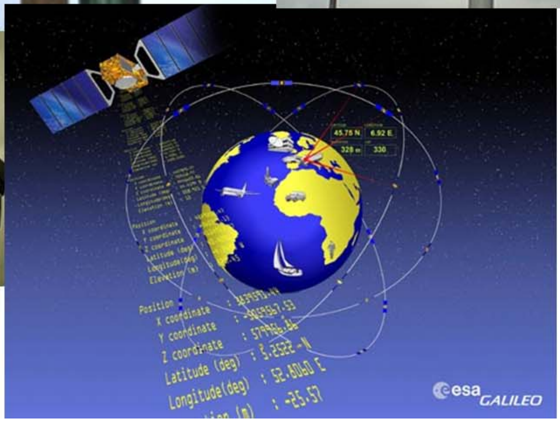



TRAQ System Overview



Traffic Information





Traffic Management

Our approach uses computational intelligence

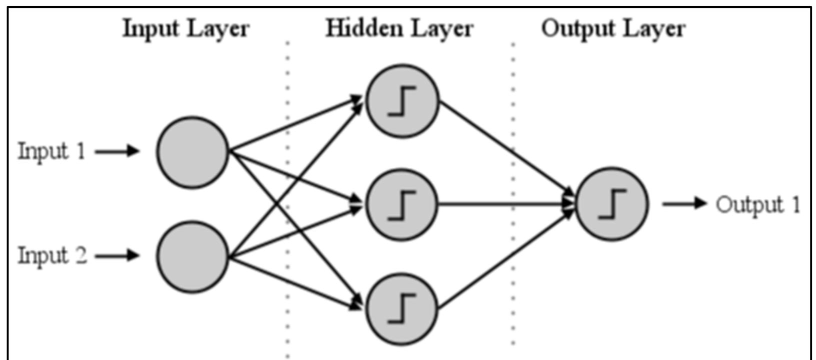
- What's that?!

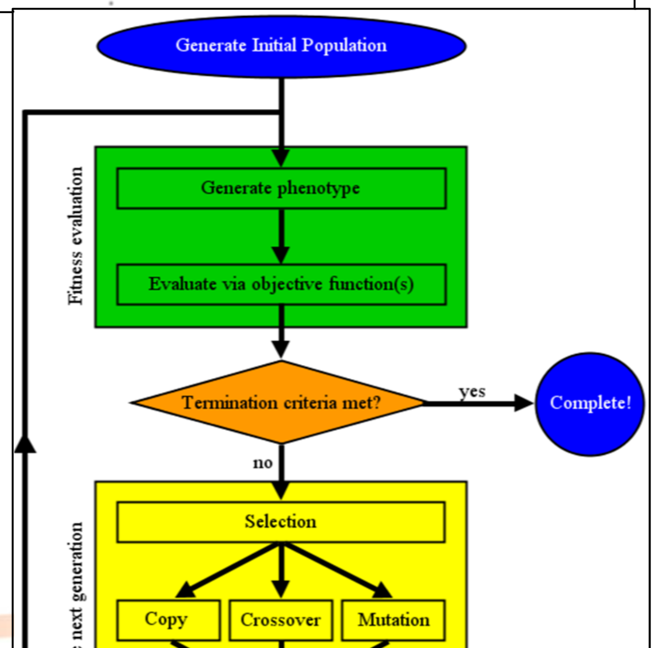
Artificial Neural Network (ANN)

- Inspired by nature : brain neurons
- Learns from a training dataset

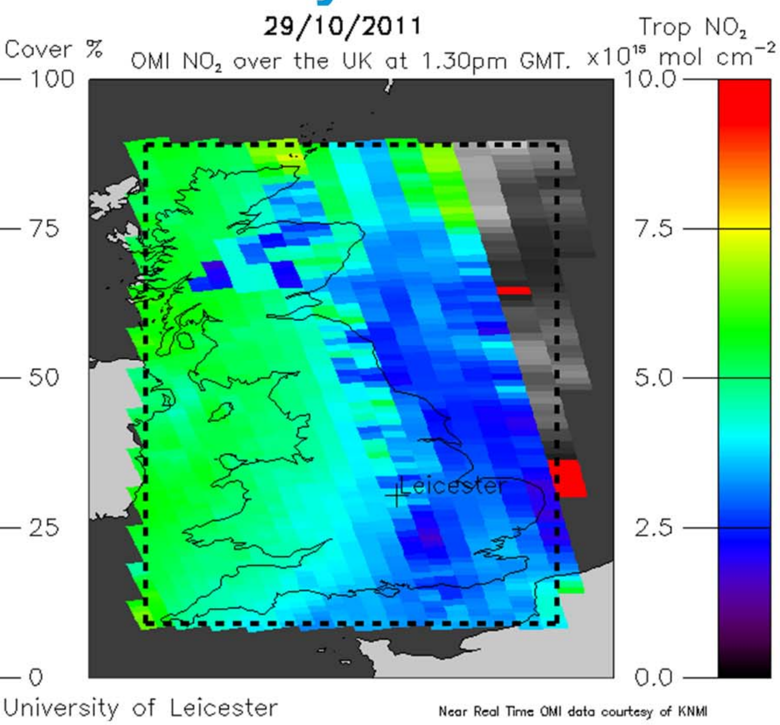
Genetic Algorithm (GA)

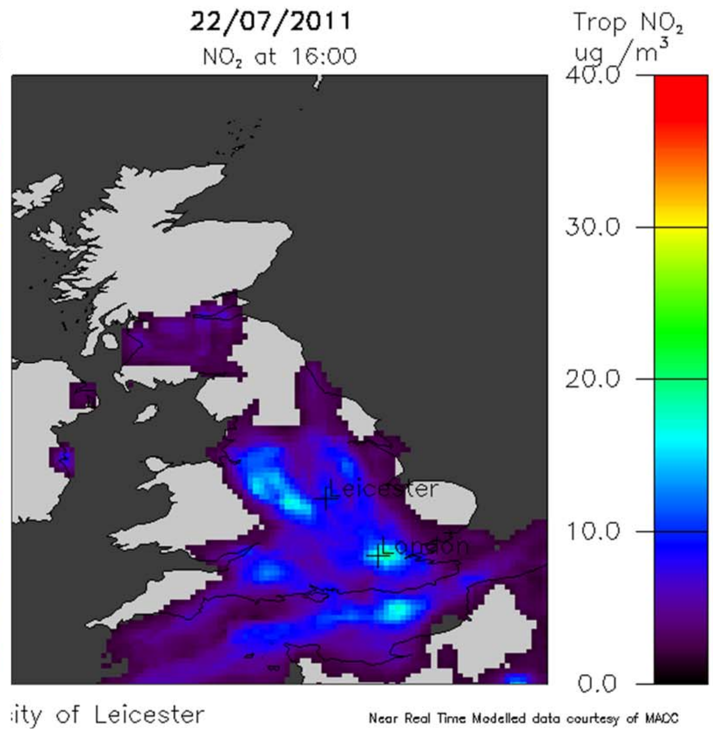
- Also inspired by nature : evolution
- Efficient search through complex domains
- Provide near optimal solutions

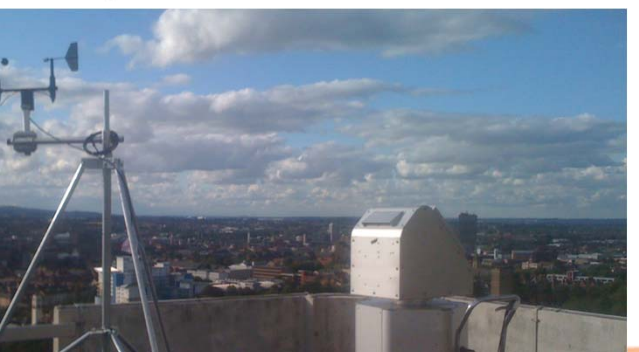


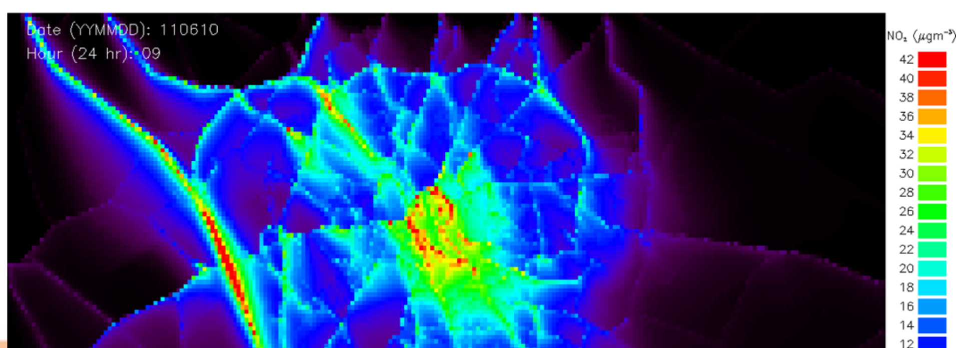


Air Quality Information



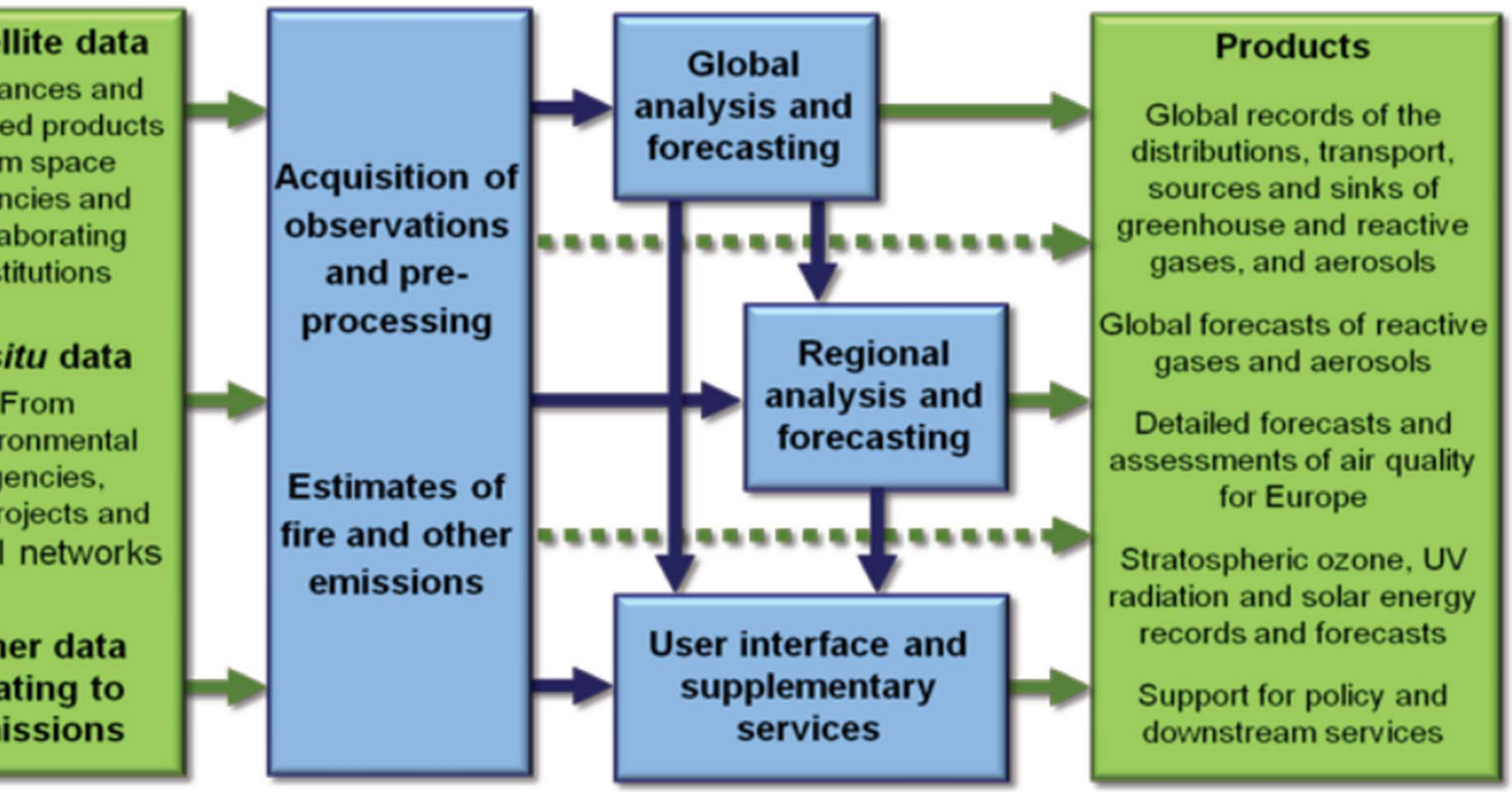






nacc
Monitoring atmospheric composition & climate

Project structure



: 45 partners, plus third parties

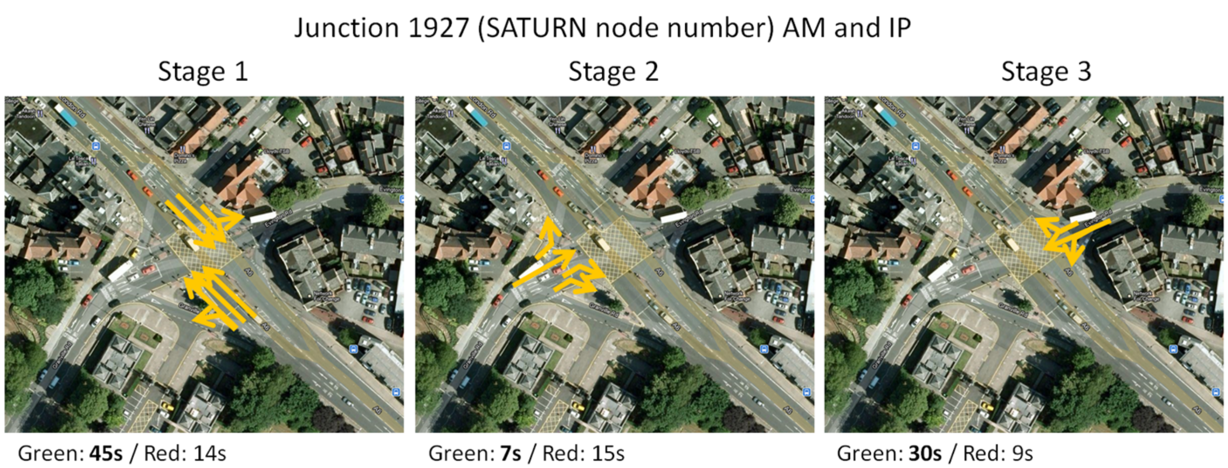
Air Quality Key Points

- Direct use of satellite measurements for urban air quality is unlikely at present due to limited acquisitions, cloud coverage and low resolution
  - But data from systems such as OMI is readily available
- But mechanisms such as MACC provide large scale modelling of air quality permitting improved forecasting
  - Providing hourly forecasts for air quality
- Incorporation of background concentrations from MACC improves agreement between AQ modelling and measured air quality from in-situ sensors

Demonstration Activity

Demonstrate the concept works

- Use a small test area in Leicester to prove that using air quality and traffic input information, improvements can be made to traffic flow
- Calculate new traffic control strategies for given links over a two week period



- Assess performance of demonstration system

Simulation of Environment

System set up to receive data from in-situ and modelled sources of test area

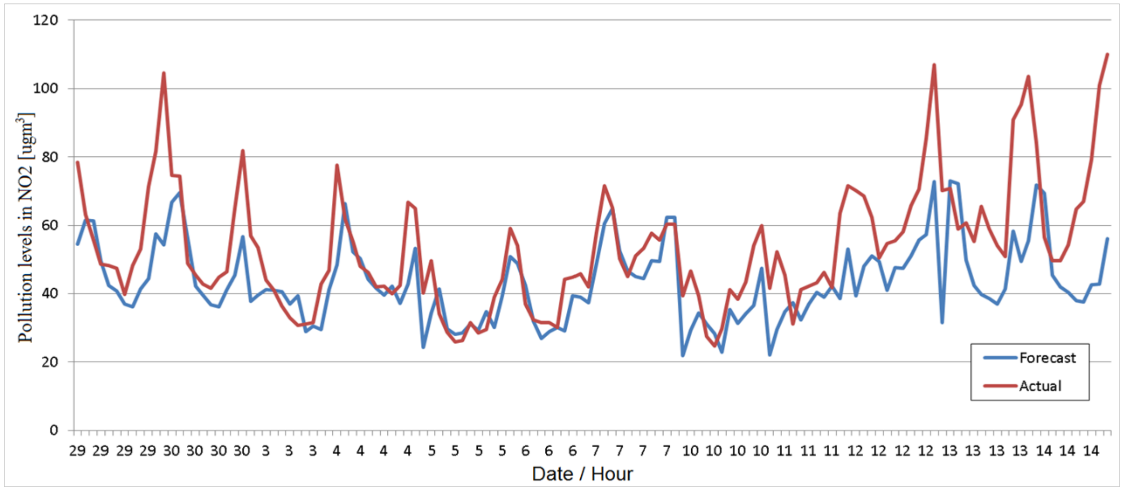
Neural Networks Trained

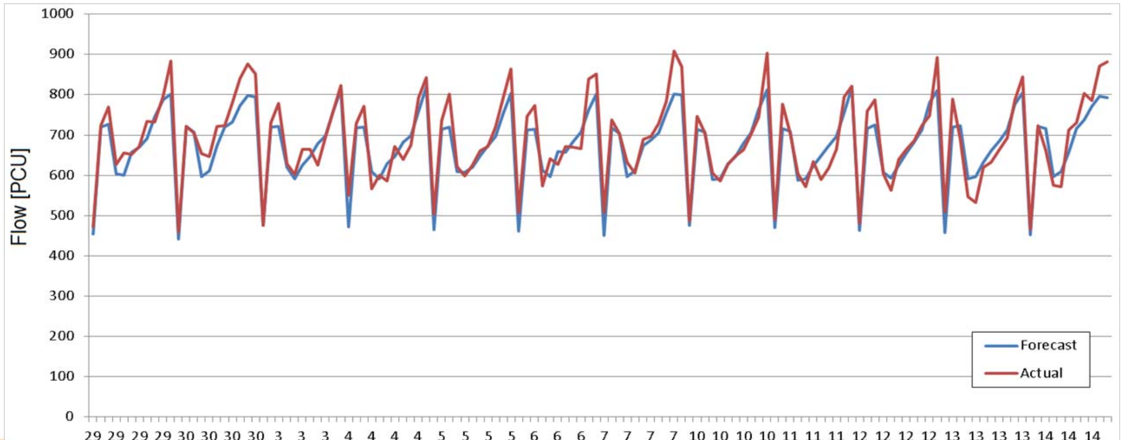
- Using previously acquired data

Computational Intelligence unit searches for optimised solution

- Simulates anticipated traffic flows and air quality levels for given solutions
  - Using external models
  - With near real time data
- Provides final revised timings for individual junctions

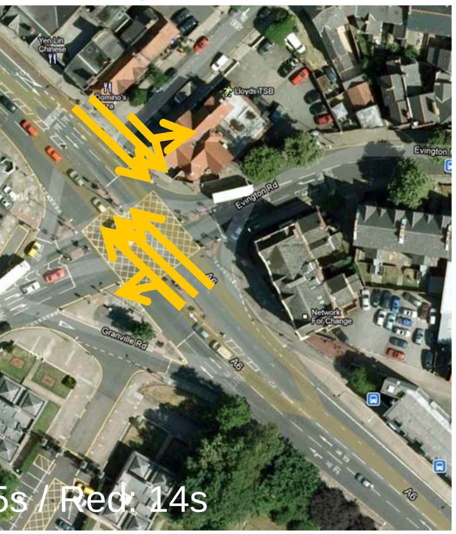
Initial Study - Results





ulation for Morning Rush Hour and Inter Peak

Stage 1



Stage 2

Stage 3

et: Time difference in starting the signal cycle from a common time source.
Used to sync neighbouring junctions (e.g., green waves)
e time: Total time a signal needs to cycle through all stages
e time: The green time for specific roads

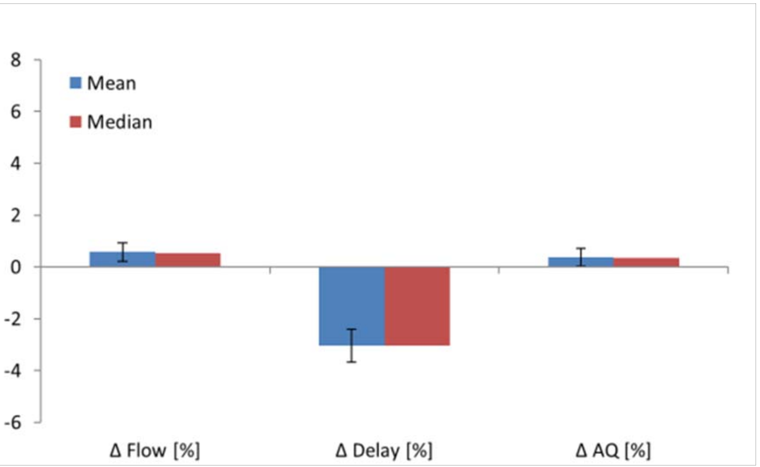
original scenario for junction 1927 (AM/IP), before optimisation, is:

Offset: 0 / Cycle time: 120 / Stage-1: 45 / Stage-2: 7 / Stage-3: 30

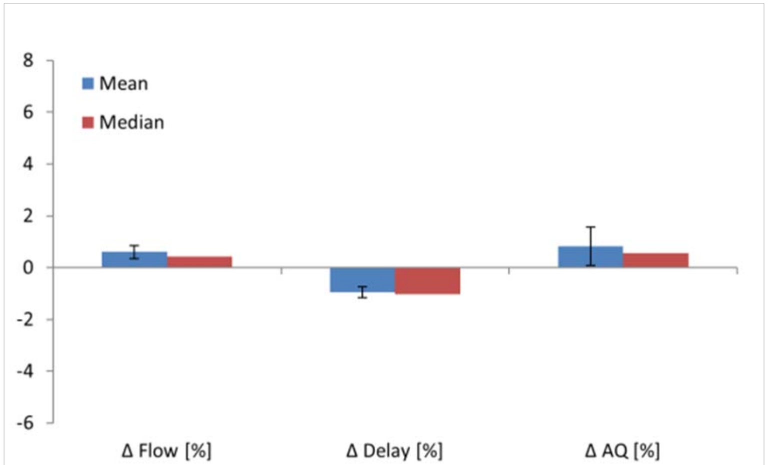
nple of an evolved scenario is:

Offset: 33 / Cycle time: 106 / Stage-1: 40 / Stage-2: 14 / Stage-3: 14

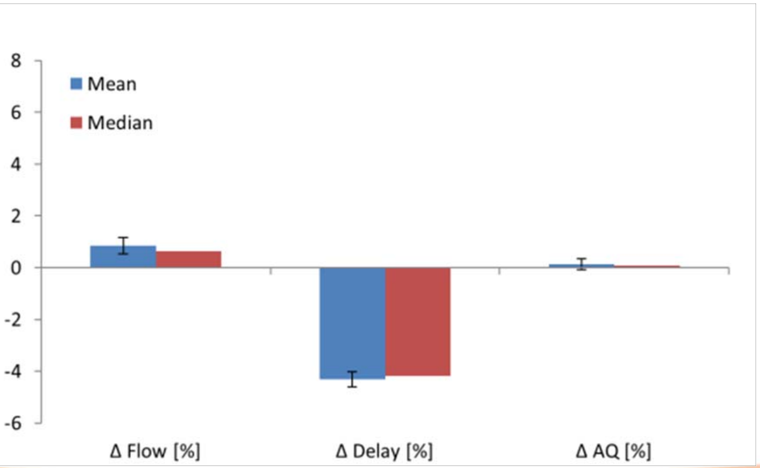
Initial Study - Results

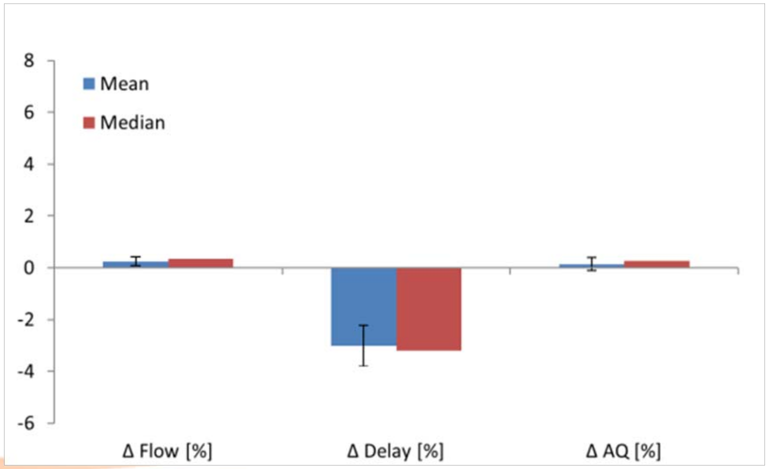


a) Average over all operational hours



b) AM peak - 8 to 9 o'clock





Conclusions

Clear user need for improved traffic management systems

- Incorporating air quality information
- iTRAQ system would integrate with user's existing traffic systems

Computational intelligence systems provides a suitable mechanism for achieving this in near real time

- Allows flexible sets of input data to be supplied for air quality and traffic information
- Optimised results have been obtained and verified

Viability assessment determined that system is viable commercially

- Further demonstration activity is required to develop the system to a state of full readiness

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