Local AIREAS Eindhoven

2016

AIR QUALITY & TRAFFIC CONTROL

Technological and practical test case in Eindhoven based on NO2

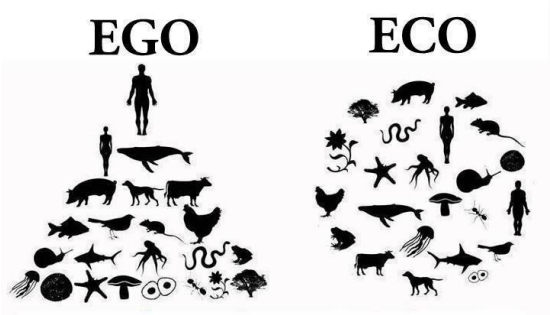
'INNOVATIVE SMART CITY APPLICATION FOR HEALTH AND ENVIRONMENT?'

End 2013, together with the installation and operational implementation of the fine maze Intelligent Air Quality Measurement System (ILM) in Eindhoven, a number of additional projects were proposed through multidisciplinary interaction. Each were envisaged to contribute in a measurable and healthier city environment, public awareness and modified lifestyle. One of those ideas was to technologically interface the ILM with traffic management (TMS).

Interface test

The project originated from an AiREAS "healthy city - healthy air- healthy people" context but was subsequently worked out among the technological partner Imtech and the officials of city governance. The technological interface tests involved are not that complicated. Much more complicated are the context related automated decisions that influence the behavior of traffic lights and mobility streams throughout town. What are the criteria to influence the behavior of traffic information systems such as traffic lights? How will this affect air pollution?

The interface testing was budgetary approved and committed by the technological and government partners. From this perspective it was passed back to AiREAS. AiREAS is however a civilian initiative which considers applied technological development in context of human behavior and engagement. How would citizens be affected by such ILM-TMS while active in their daily mobility routines? Would they understand the changing behavior of traffic lights? Would they accept to be stopped, reduced in speed or channeled through alternative routing mechanisms?



How could we involve citizen's in their own mobility choices when instruments like the ILM-TMS combination influence their interaction with town? When does this involvement of citizens start? These questions needed to be answered in the same project if it wanted to get the AiREAS project stamp. The budget did not foresee this complexity of early civilian involvement. AiREAS accepted the project leadership as a first step and only if such civilian engagement would at one stage be structured. To anticipate this AiREAS extended the project to additional partners who also wish to experiment with such Smart City applications. The earlier partners get involved the better the overall impact of it can be envisaged and anticipated even if this is developed in a second or third phase....

NO2 - Nitrogen dioxide

The main toxic pollutant that is measurably coming from traffic is nitrogen-dioxide (NO2). This component is measured by the ILM with sensors from ECN. These sensors were developed in direct cooperation with the ILM 1.0 challenge. The complexity to measure gases like NO2 and Ozone in open public space is complex. The installation of the especially designed sensors was delayed due to these technological problems. At the end of 2015 the sensors were installed but time was needed to register sufficient data to both test the sensor's quality and get a view of pollution patterns in the city. The ILM-TMS connectivity tests had to wait until sufficient NO2 experience and data had been gathered.

The main NO2 pollution comes from traffic in cities. The main pollutants are cars. Will redirecting cars help solve NO2 peaks?

The original ILM 1.0 network had been designed to relate the exposure of citizens to air pollution. In order to accommodate the ILM-TMS test project AiREAS needed to modify slightly its network. A geographical choice was made for the tests by determining a location (Mauritsstraat) that was known to be significantly pollutant due to traffic density. Another reason to back the choice was the local presence of a calibrated system of the ministry of health (RIVM) against which measurements could be validated.

From an AiREAS perspective pollutants in the shape of Ultrafinedust (UFP) from friction, wear and tear of tires, would also be interesting to consider but were not yet incorporated in this project (yet).

Basic concept of ILM-TMS interaction

Basic application

The basic technical setting is relatively simple. An AiREAS Airbox, with the Citytech Sensoric NO2 3E50 module, revised by ECN, produces data which is validated in a data capturing center of AiREAS/ECN. This data is processed in order to be communicate with the TMS traffic light system. This then behaves according a specific algorithm to guide traffic through the streets involved (Mauritsstraat in Eindhoven) for the tests. Traffic would be prioritized through the traffic lights according to particular NO2 peak data thresholds.

Two airboxes at Mauritsstraat

The configuration of two airboxes was needed for quality assurance of the data. Data from one source can always contain errors due to equipment failure, local peaks, power interrupts or anything else. To have a fairly reliable feel of the situation the comparison between at least two Airboxes provides better options than just one.

The airboxes are located at a standard height of 2.5 meters. This is done to avoid possible injuries of people walking accidentally into the boxes if they were placed lower to the ground. This height is also relatively accident and theft proof even though it does not measure at the "nose height" of an average adult person. Through modelling the assumption of a "as close as possible to real levels of pollution" situation can be established and subsequently validated with extra non-fixed measurements at the lower levels.

The orientation of each of the Airboxes is also relevant as climate and weather conditions or surrounding buildings may effect the data. Such details are taken into account but have not determined the set up of the airboxes for this experiment.

'REDISTRIBUTION OF TRAFFIC MAY LEAD TO DISPLACEMENT OF THE PROBLEM, NOT SOLVING IT.'

AiREAS

Projectleader: John Schmeitz

Original involvement:

- Eindhoven
- TNO
- Dynniq (was Imtech)

Added involvement when AiREAS took project leadership:

- ISSeP (Liege)
- Gamebus
- TU/e
- Myrthe Velter - PhD research

Phase of actual measurements

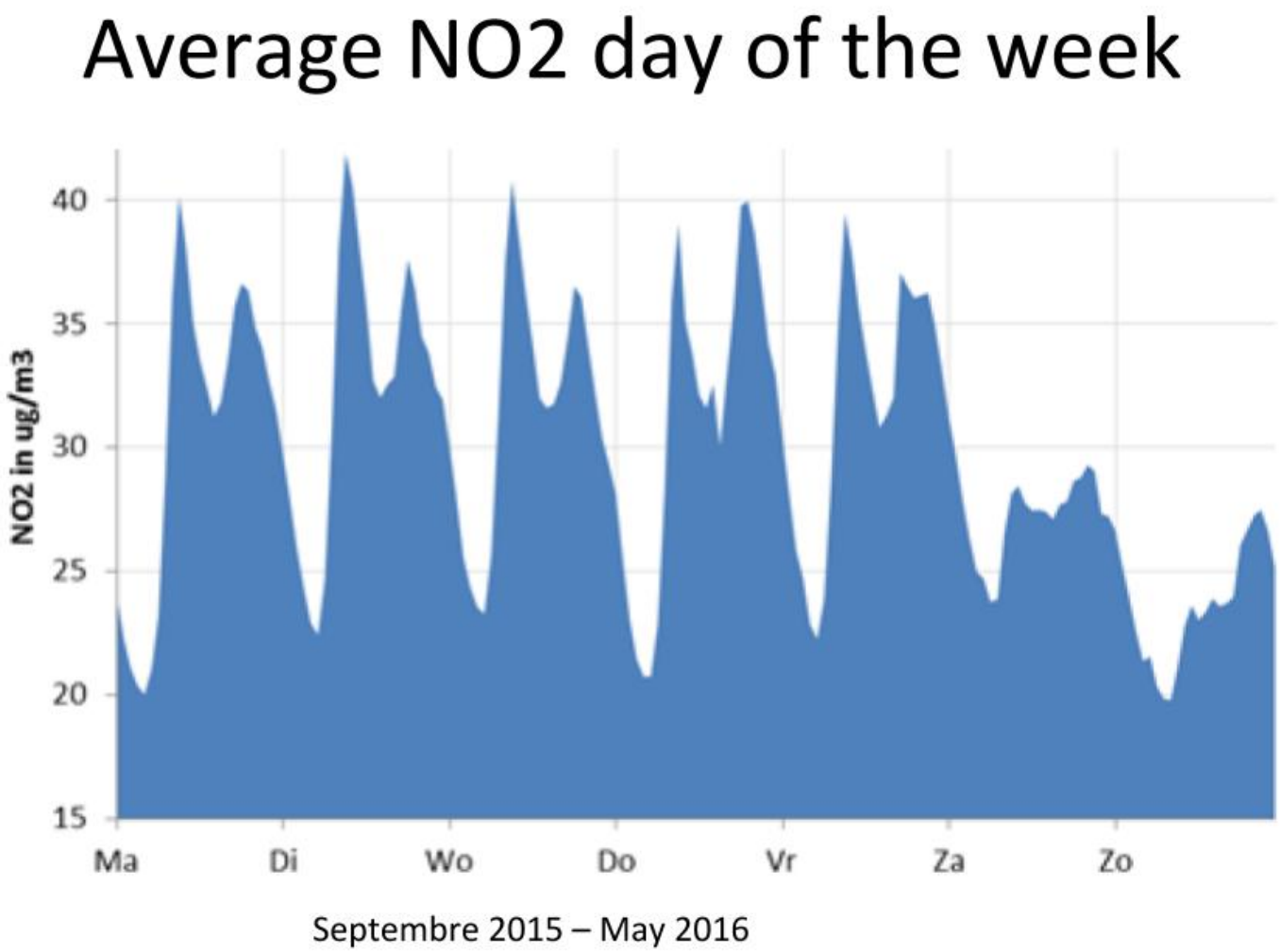
Prior to establishing any technological tests in the field, implying or not the citizens, we needed to get to terms with the actual situation of NO2 in the street. What would be the criteria to be used to change the status of a trafficlight?

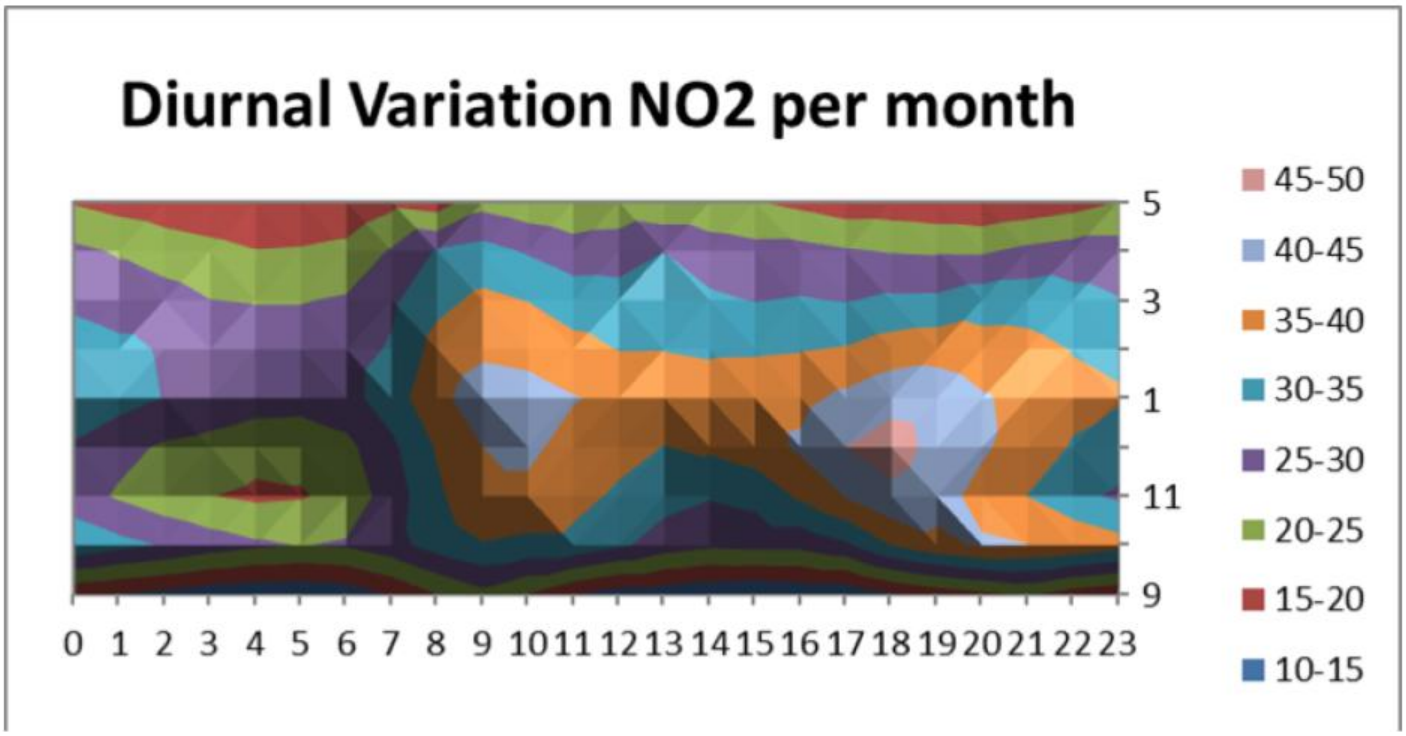
Reliability of the NO2 data

When directing traffic in real time then the criteria to do so in a dynamic way need to be indisputable. It is not just the traffic that is affected, it is also the result on air quality that needs to be anticipated and verifiable. People still need to go from A to B and frustration can be very high when their voyage is interrupted or modified and the criteria prove wrong. Trust is key in these ventures.

In the image below we see an average week of NO2 measured from September 2015 until May 2016. The picture shows clear weekday peaks during the day. Morning and afternoon peaks per day can be detected easily and related to traffic. In the weekends the patterns are more dispersed.

In the image on our right we see the variation of NO2 during the day in the various months. We see that the highest density is measured in winter time and particularly from October till March from about 8 am till 11 pm.





The objective is to create a city in which mobility is both effective and healthy. The bicycle is an ideal means but skateboards are also popular, using up even less space.

'THE SOLUTION IS NOT IN THE CARS BUT THE PEOPLE WHO USE THEM'

Real time NO2 is not reliable enough

During the months of getting experience with the NO2 measurement reality it was noted that the absolute values presented by the sensors could not be taken directly as input for traffic management. The deviations were still too big in real time and caused by all kinds of variables proper of dynamic mixtures of gases in open space and in circumstances that vary continuously. We encounter the same challenges with Ozone. In order to validate the data for use with TMS various measurements would be needed. At intervals of 10 minutes a reliable set of data would only be available after about 30 minutes up to one hour. This is not viable for real time traffic management, especially during peak traffic hours.

In order to reduce the interaction time we would need to measure in much smaller intervals. The current measurement method is differential meaning that +ve and -ve measurements alter every minute. If a set drops out one can get negative data. Reducing the time intervals is hence not yet realistic.

To take real time action with citizens based on such data was not of interest to the project. The question arose on what to do next?

- Can we expect accurate real time NO2 measurement technology in the short term? The answer was: not yet. At least not to the point of being taken as trigger for real time traffic light interaction and traffic management.
- Another option would be to subtract the measured data of a background Airbox station nearby with the one of the Mauritsstraat . The difference could be representative for the NO2 specifically produced by local traffic. Scientists involved were hesitant to do this as the risk of mistakes would be too high.
- Can we do the technological tests in the mean time with other pollutants, such as PM2.5 and 10? The answer is `yes` technically but in practice it would be useless because Particulate Matter (PM) comes from different sources than traffic.
- Can other criteria be used to direct the traffic and improve air pollution? The answer is `yes` but this would be another project definition with the involvement of more and different partners. The alternative would need more time to involve citizens, meteorological details, climate and other criteria in the test. But this is a different scenario.

*From this perspective **it was decided** to consider the current trial finalized and draw our conclusions on time. The learning process has been very valuable and certainly a basis for further initiatives with better perspectives to produce the desired results.*

The option is now to redefine the criteria, not just at the levels of integrated infrastructures such as ILM and TMS but considering the levels of citizen´s science between Smart City services, such as gaming and alternative mobility, with participative instruments such as competition, financial or other rewards, multipurpose social entrepreneurship, etc.

A city without traffic lights?

When new types of mobility become common practice than new types of infrastrutures are needed to accommodate them. Car-less environments may need no traffic lights anymore. New public transport systems already mingle with pedestrians and bicycles using sound signals without need of separate structures. Eliminating traffic lights is a huge public cost saving as well.

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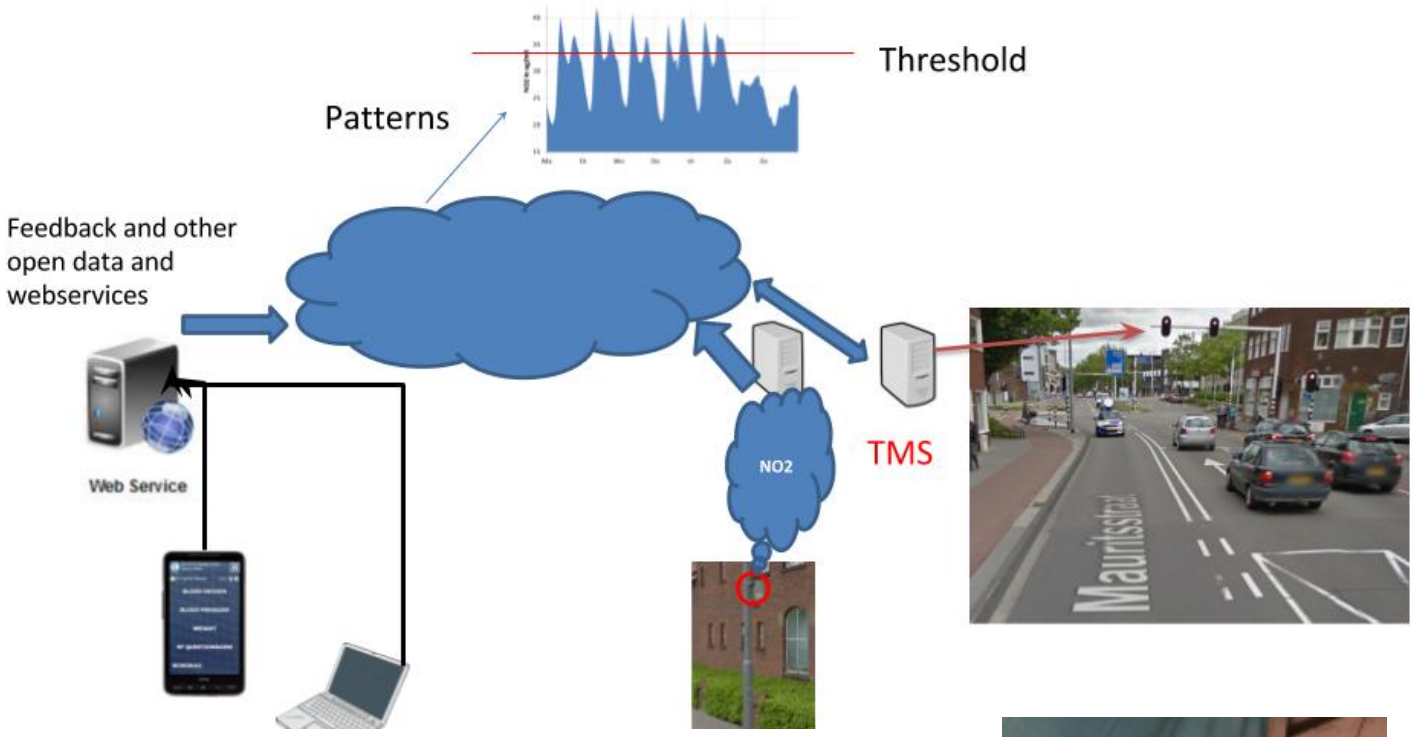
Principle alternative route



Looking for alternatives

The city as place to be

The city has been a place to buy for a long time. Nowadays cities develop into places to be in which the social encounter is as important as the commercial activities. New types of multipurpose entrepreneurship develop in which multiple lines of `profit` are developed at the same time, such as social and ecological benefits, not just economic.

Cars and cities don´t seem to match

Current cars, with fossil fuel combustion and tire wear are not favorable in an urban environment. They pollute not just the air. They need a lot of space for parking and circulation. The amount of vehicles in urban environments is so big that traffic jams are a common burden making a journey within the city not necessarily more comfortable or faster when using a car than other alternatives. In many high density cities people banned the privately owned car and use urban space with a large diversity of individual and shared instruments.

Transforming the city

Mobility is for the city as the bloodstream is for our life support system. Taking this analogy it is deadly for an ecosystem if the stream clots or pollutes. Effective and healthy interaction of mobility with all the functions of a city improves its resilience. A new era has begun in which we experiment with this in a holistic manner taking not just mobility into consideration but also its patterns for the wellness of the entire city.

The car may go into history as the main private transportation system of the 20th century. In the 19th century it was still the horse. The 21st century will show a huge diversity of individual means which are not based on fossil fuels anymore.

2016

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