**Mobility Solution:** Ix3

**Piloting in:** Greater Paris and Helsinki

**Introduction**

Ix3 is an auxiliary optimising system for traffic light management, which simply reduces unnecessary stopping and waiting in red lights. Reducing the amount of stopping and re-accelerating a vehicle in traffic has a surprisingly large impact on emissions. The tests and piloting have proven that city-wide adoption of the IX3-system has a 2% reduction impact on traffic related emissions.

The system combines real-time machine vision sensoring to traffic light controllers and thus enables optimising traffic management logic. With a more precise understanding of the traffic situation, traffic lights can be used more efficiently to increase traffic flows and simultaneously reduce emissions. The system has been developed in collaboration with machine vision expert MarshallAI and Dynniq who has decades long experience in traffic management.

**The challenge**

Vehicles cause the most emissions when they stop and start. Reducing, or even removing unnecessary stops at traffic lights can therefore contribute greatly to the reduction of $CO_2$ emissions in cities. Moreover, traffic management around intersections has for decades been based on time interval based phases. Dynamic inputs have been limited to induction loops giving simple point information at a pre-set distance and push buttons indicating simple presence. Ix3 aims to outperform the accuracy of traditional sensors and increase the amount of data at hand using deep learning based artificial intelligence and visual sensing. This enables traffic prioritisation (removing 'dead seconds' without negative effects) and traffic prioritisation (promoting certain traffic users).

**The solution**

Ix3 provides dynamic information about all objects throughout the intersection to make intelligent traffic optimisation decisions. The system requires no interaction from the traffic users, makes traffic in cities more efficient, increases safety, reduces congestion, reduces wasted time of traffic users and above all reduces emissions. The solution understands the volumes of traffic users including their type and enables the cities to prioritise certain traffic users. As an example the solution can let heavy traffic / public transport through more fluently by extending cycles when there is a vehicle approaching, in order to reduce $CO_2$ emissions. Alternatively the solution can promote green traffic users and e.g. prioritise groups of pedestrians and cyclists. The possibilities are broad and should be planned accordingly with the partner cities in line with their priorities. The system enables easy and efficient ways to test different traffic control schemes in use without compromising traffic safety. Prioritisation is a powerful tool for longer term effects on the choices made by traffic users.

The optimisation of the traffic flows is based on using precise AI based machine vision to detect and follow all traffic users throughout each intersection. This results in a continuous complete understanding of everything happening in the intersection, including the demand from each direction for vehicles and light traffic users (e.g. pedestrians, bicycles and scooters). This information enables the software to know the exact moment, when the last traffic user for the current phase (certain directions having a green light) has crossed the corresponding stop line of the intersection.

The Ix3-system consists of three main parts: the camera sensors, the MarshallAI machine vision platform and the integration to the traffic management systems and controllers. Traffic cameras are

installed in intersections to sense traffic. The visual data is processed by the machine vision platform in real-time to constantly form a complete understanding of the traffic situation in the intersection. This information is transferred to the traffic management system, resulting in an optimised experience for each traffic user.

The added value of using machine vision and AI for traffic management is based on continuous complete understanding of everything happening in the intersection. This allows users to know the exact moment, when the last traffic user for the current phase has crossed the corresponding stop line of the intersection and the simultaneous demand from any of the other phases. The AI part is fully autonomous, without any interaction of any humans. The adaptivity of the AI is based on hundreds of outputs generated by a single traffic user during their journey through the intersection. During this journey the AI provides varying probabilities for the reliability of the detection of the object class of the traffic user in each frame of which the weaker detections can be used for adaptivity and performance increase.

Cities wanting to implement the Ix3 solution should install or allow installation of dedicated cameras that will produce the visual input for Ix3. While this can potentially raise privacy concerns, the system collects only anonymous traffic data with no personal identifiers. The video footage itself is not saved other than for quality assurance purposes. Unless explicitly specified in writing by clients and partner cities no personal data (such as licence number plates) is processed. Data quality is assured by conducting manual audits of randomly selected time-frames when video is recorded for quality assurance purposes. In countries and cities where temporary recording for quality assurance is not permitted, the data quality can be carried out by manual observations in the intersection, that are then compared to the logs of the Ix3-system. By default all collected data and all logs are the property of the client city.

There is also a danger that more effective traffic management may lead to more vehicle use. This could be mitigated by combining traffic optimisation with light traffic prioritisation. Other benefits beyond traffic management include the exceptionally detailed and accurate real-time traffic data that is collected. This data can be used for traffic planning but can also be easily provided for 3rd parties. The advanced machine learning features also promote traffic safety by detecting traffic violations, accidents and even close-calls / near-misses. This enables identifying hazards before the accidents occur.

**Ix3 & AI4Cities**

During the last phase of AI4Cities, Ix3 was succesfully piloted in Meudon (part of the Greater Paris region) and Helsinki. The pilots showed an annualised reduction potential of (at an average) 55.509 vehicle stops and 360 hours of irrational waiting time. That leads to a reduction of about 2% of emissions, though the consortium estimates that a total reduction of 8% is possible. This is based on a study undertaken during Phase 2 of Ai4Cities in which Ix3 was able to increase the efficiency and reduce the emissions also in a green wave cluster of three intersections in Suutarila, Helsinki. Two separate scenarios were implemented:

1. Keeping the green wave as it is, and only optimising based on Ix3 when all three intersections allowed optimisation simultaneously. This resulted in ~1% reduction of the current $CO_2$-equivalent emissions, simulated by Dynniq using the "industry standard" Vissim tool with actual volumes.

2. Disabling the green wave and optimising the three intersections separately. This was calculated by re-running the actual recorded traffic profile and triggering the optimisation always when possible, based on the no negative impact for anyone philosophy. This resulted in ~8% reduction of the current $CO_2$-equivalent emissions.

The AI4Cities-project has provided an excellent framework for continuing R&D over an innovative traffic management product while also giving access to representatives of partner cities. The IX3-consortium has high hopes for the project and aims to optimize traffic all over Europe. The commercial structure of the solution is based on licence fees for the software. The target market is primarily the EU and secondarily the rest of the world. The key customers are the European cities with very ambitious carbon neutrality goals and ever growing traffic amounts.

The market for traffic management globally is estimated to be approx. 62 billion euros during the year 2021. The EU market is approximated as 17,8 billion euros, with an annual growth rate of 13%. It is estimated that ~25% of this market relates to intersections, leading to an addressable market of 4,45 billion euros in the EU. The business plan is to use the outcomes of AI4Cities to enhance existing traffic management systems.

The Ix3-system scales very well from small to large cities, as the basic unit of deployment is a single intersection. Each new intersection does require separate camera devices, as the system is dependent on local situational awareness and video coverage, but there are several categories where consecutive deployments require less resources and thus lower the unit costs. Implementing Ix3 will initially require some effort from city representatives to get familiar with the process and to identify any possible compliance requirements. After the initial work is done and the city specific requirements are taken into account, further Ix3 installations can be deployed with ease.

**The consortium**

Both parties (MarshallAI & Dynniq) of the Ix3-consortium have a proven track record in their respective domains with a deep understanding of the relevant technologies in the field. Together they are developing the Ix3 to take traffic management systems to a totally new autonomous, optimised and advanced level.

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