

**ITS** - INTELLIGENT TRANSPORT SYSTEMS

# 8 NEW INTELLIGENT TRAFFIC SOLUTIONS



# INTELLIGENT TRAFFIC SOLUTIONS FOR THE FUTURE

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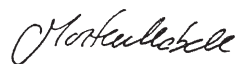
*Buses will be given priority at traffic lights helping them to run on schedule. Cyclists won't need to stop for red lights avoiding endless queues of polluting cars, because traffic lights will be able to adapt to the traffic flow and maintain it at optimal levels. Intelligent traffic lights will provide extended slots of green light after a football match or a concert ensuring a quick exodus from the stadium while keeping noise pollution in the local area as brief as possible. This could shape the future for Copenhagen.*

In the future, the only thing likely to constrain traffic management in Copenhagen is your imagination. This has led us to test a series of innovative solutions at various locations throughout the city in conjunction with 15 Danish and European companies and two knowledge institutions, setting up teams across a wide range of companies and expertise. From the autumn 2013 to the spring 2014, people have scaled lamp posts and traffic signals and have taken up position along roads including Nørrebrogade, H.C. Andersens Boulevard and Østerbrogade. Here, monitoring equipment was installed and tests carried out to find the best possible solution for a smooth and safe flow of traffic.

This resulted in eight very different, surprising, and positive ideas and solutions outlined in this folder. By focusing on specific challenges in Copenhagen, we succeeded in developing technical, creative, and intelligent solutions able to meet both existing and future challenges facing road traffic.

In Copenhagen, funds exceeding DKK 100 m have been earmarked for new traffic signals and intelligent traffic management in the city. This money will be used for financing the best of the ideas. In September 2014, the solutions will be presented to the Technical and Environmental Committee and the first projects are expected to be underway in 2015.

I hope that these solutions will contribute to increasing road safety in Copenhagen as well as improving mobility, especially for cyclists, pedestrians, and bus passengers. This would make it even more attractive to drop the car to and from work. It would not just be the most efficient way to improve mobility in Copenhagen, but also a means to create a city with cleaner air, less noise, and reduced CO<sub>2</sub>-emissions.



Morten Kabell (Red-Green Alliance),  
Mayor, Technical and Environmental  
Administration



## THEME 1

EXTRA LIGHT ON THE CYCLE TRACKS



## THEME 5

BUSES ON TIME



## THEME 2

STREET LIFE IN CAR PARKS



## THEME 6

SMART MOBILITY CHOICE



## THEME 3

BETTER FLOW IN THE STREETS



## THEME 7

PARKEN EMPTIED IN 20 MINUTES



## THEME 4

BOX SENSES THE STREET PULSE



## THEME 8

CYCLISTS RIDING ON THE GREEN WAVE

### WHY ITS SOLUTIONS FOR COPENHAGEN?

ITS (Intelligent Transport Systems) will meet some of the future challenges facing Copenhagen:

- Copenhagen expands at the rate of 1,000 new citizens each month. This creates an added traffic load requiring new solutions to ensure mobility, safety, and sustainability.
- Copenhagen has a goal to be carbon neutral by 2025. We want to be the

world's best city of cyclists and we want to be the European leader within green technology and innovation. These are ambitious goals requiring creative solutions - also with regard to ITS.

- Copenhagen's future growth must go hand in hand with increased quality of life making Copenhagen the best liveable city. ITS can detect and curb air pollution and noise.



## THEME 1

THE COMPANIES BEHIND INTELLIGENT STREET LIGHTING

CITELUM DENMARK

IMTECH TRAFFIC & INFRA

# EXTRA LIGHT ON THE CYCLE TRACKS

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## TRAFFIC ACCIDENTS HAPPEN IN THE DARK

One third of all traffic accidents happen during the hours of darkness despite the fact that there is much less traffic during the evening and night than in the daytime. The vulnerable road users are most at risk. Two thirds of all persons badly injured or dying in road traffic accidents are cyclists and pedestrians.

## INTELLIGENT STREET LIGHTING

Intelligent street lighting means effective synergy between street lighting and traffic signals. Today, these are run as two separate systems without any kind of information exchange. Communication between these two systems would lead to added safety and security for vulnerable road users. It could be used to provide brighter street lighting in dangerous road junctions when needed – for example when sensors detect approaching cyclists or in situations with seriously reduced visibility due to rain, snow, or fog.

## PILOT TEST

In April-June 2014, a pilot test was carried out in one of the busiest road junctions in Copenhagen, namely the H.C. Andersens Boulevard and Tietgensgade intersection. When the lights were green for cyclists, the street lighting became brighter during the evening and night time. In this way, the cycle track approach to the junction was brightly lit when cyclists moved towards the green light. This made motorists more aware of the cyclists while also saving power by not having street lighting running at full power.

Test results showed that communication between street lighting and traffic signals is technically possible and that there is a potential for synergy between the systems. Besides, there was positive feedback from cyclists who were flooded with light on the cycle track forming part of the study.





*It's a dark evening and a cyclist is riding along H.C. Andersens Boulevard. When the cyclist approaches the Tietgensgade intersection, the light becomes brighter making motorists aware of the cyclist*

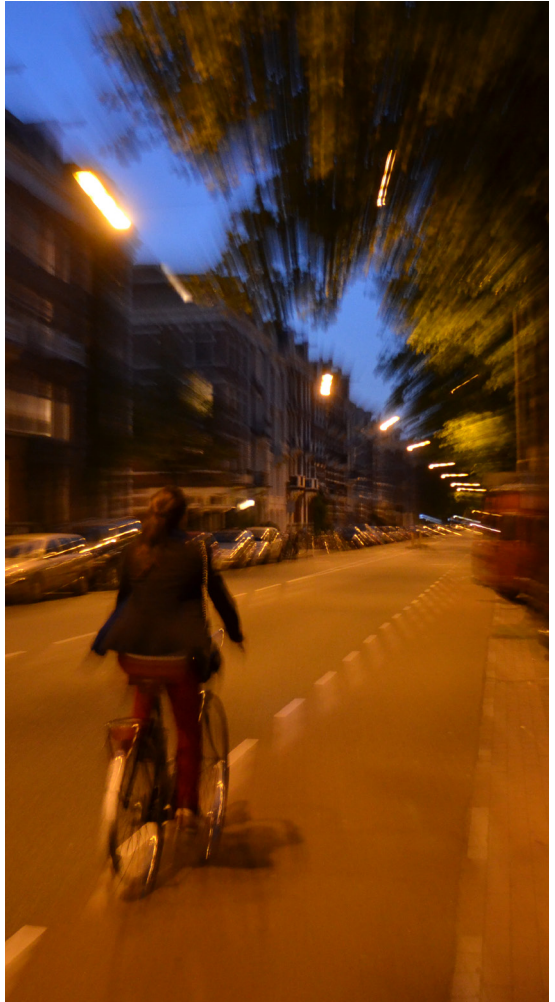
## BENEFITS

Intelligent communication between street lighting and traffic signals may benefit Copenhagen road users by:

- intensifying lighting above cyclists and pedestrians in places that become accident black spots in the dark.
- improving safety and security by increasing motorists' awareness of vulnerable road users.

Intelligent communication may potentially be developed to:

- intensify street lighting when sensors detect the approach of cyclists and pedestrians.
- adapt street lighting to weather conditions such as rain, snow, or fog.
- intensify street lighting in the event of road traffic accidents.
- allow light intensity to vary with traffic conditions.





## THEME 2

THE COMPANIES BEHIND FLEXIBLE URBAN SPACES

OPEN AIR NEIGHBORHOOD

COWI

# STREET LIFE IN CAR PARKS

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## EMPTY CAR PARKS IN THE DAYTIME

In a densely populated city where many people live, work, and move about, the urban spaces need to adapt to a variety of functions that often change in the course of a 24-hour period. In certain areas in Copenhagen, car parks stand empty during the daytime, and these spaces are not utilised.

## FLEXIBLE URBAN SPACES

Flexible use of car parking areas may meet several needs simultaneously. In the daytime, the empty spaces may be used as outdoor serving areas, bicycle parking, shop displays, sport and leisure activities, etc. In the evening, when the cars return, they are once again turned into car parking areas. By establishing flexible parking spaces for car clubbers, it will be possible to free more car parking space for other activities.

## PILOT TEST

The flexible car parking areas were tested in April 2014 at Saxogade and Estlandsgade in the Vesterbro district. In the daytime, car parking spaces were used as outdoor serving areas, for shop display activities, seating, and bicycle parking.

Interviews with residents and users of the area revealed that flexible solutions should reflect the specific needs and rhythm of a locality over a 24-hour period. They also showed that it is important to involve local users in the adaptation plans and that the marking of flexible spaces should be logical and easily understandable. There was some scepticism in relation to car club schemes, but a growing segment was positive if it meant more and better city life in the street.



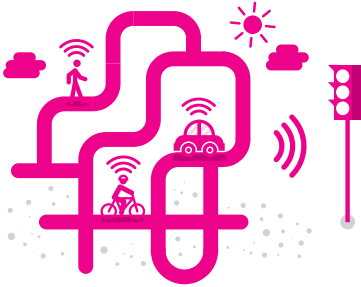
*Early one Monday morning, a man from the Vesterbro district gets into his car and leaves Saxogade to go to work in the town of Køge. Not long after this, the local Café Sonja brings tables and chairs out into the car park, which is now transformed into an outdoor serving area.*

## BENEFITS

Flexible use of car parking space may benefit Copenhageners by:

- using the limited space available in densely populated urban areas smartly and creating more space for activities to benefit city life generally.
- giving citizens ownership of the urban spaces by involving them in the planning and use of flexible car parking areas.
- providing better conditions for car club schemes thereby reducing the number of cars in the city and, ultimately, also noise and pollution.





# BETTER FLOW IN THE STREETS

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## CONGESTION ON THE ROADS OF COPENHAGEN

There is considerable congestion during the rush-hour period on the major roads in Copenhagen where it is a serious challenge to cater for motorists, cyclists, and pedestrians at the same time. This results in traffic jams with the inevitable traffic delays, increased air and noise pollution and considerable irritation on the part of all road users.

## CITS (COPENHAGEN INTELLIGENT TRANSPORT SYSTEMS)

CITS is a system for mapping the position and route of road users in the city. The concept involves placing a number of Wi-Fi access points along Copenhagen streets, anonymously detecting all road users' mobile phones. By triangulating several Wi-Fi access points, it is possible to pinpoint the position of road users' mobile phones. The data collected will then be depersonalised and continuously sent via the

street lighting network to a traffic centre where the data will be analysed according to position, route, and speed and, in this way, various types of road users are identified: pedestrians, cyclists, and motorists.

In this way, the mobility patterns of road users in urban streets may be mapped enabling overall mobility, safety, and CO<sub>2</sub>-emissions to be optimised. This kind of detailed and continuous information about traffic flows will pave the way for more efficient traffic management.

## PILOT TEST

The CITS technology involving the triangulation of mobile units was tested at the Technical University of Denmark. An interface for showing traffic data was tested in workshops. The test showed that CITS is able to map the position and routes of road users and that visualising these may give valuable insight into road user behaviour.



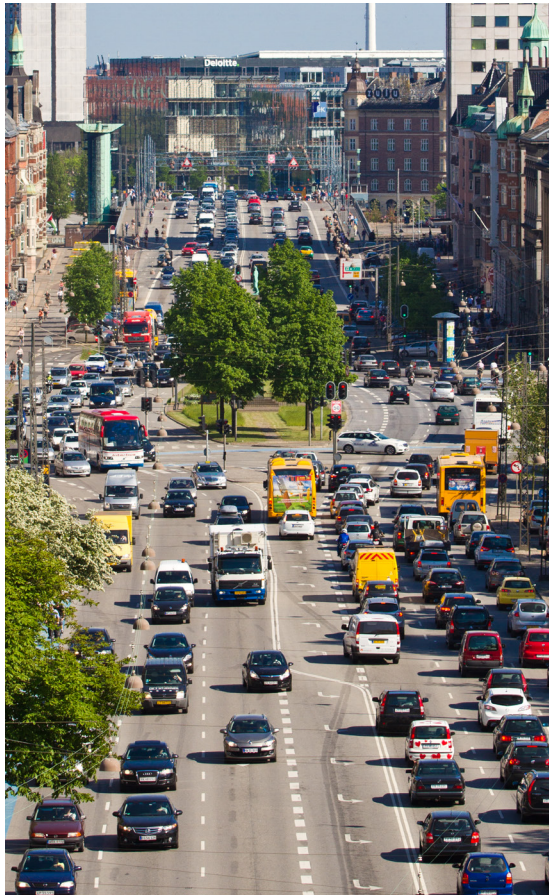


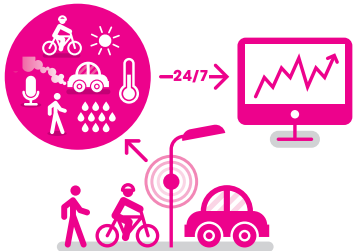
*A traffic jam during rush-hour inner Copenhagen where pedestrians, cyclists, and motorists are clambering to get out of the city resulting in delays for everyone. However, the local traffic lights that normally change according to a pre-determined pattern, now adapt to the specific situation and change to secure the most expedient traffic flow. The jam is dissolved and the traffic moves again.*

## BENEFITS

Current information about the movements of road users will enable the City of Copenhagen to:

- shorten response times in discovering and reacting to specific traffic events.
- optimise traffic lights enabling traffic to flow quickly, easily, and safely.
- adapt traffic lights to dynamically adjust to various situations such as time of day or events involving large crowds of people.
- adjust green waves to specific traffic situations such as reducing the green wave speed in icy conditions.





## THEME 4

THE COMPANIES BEHIND CPH:SENSE

LEAPCRAFT

AALBORG UNIVERSITY COPENHAGEN

# BOX SENSES THE STREET PULSE

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## NOISE AND POLLUTION FROM TRAFFIC

Several stretches of road in Copenhagen exceed the EU pollution threshold values. At the same time, traffic noise is a problem in many places throughout the city. This creates health problems for the citizens.

## CPH:SENSE RECORDS TRAFFIC AND ENVIRONMENTAL CONDITIONS

CPH:SENSE is a sensor box detecting road users as well as weather and environmental conditions. The box can be installed along city streets and will continuously gather information and send it to a traffic centre. Since the box is based on open source and open hard-

ware, it is a comparatively cheap solution. The box can detect motorists, cyclists, and pedestrians anonymously via an infrared visual sensor, and it has also sensors measuring temperature, air humidity, light intensity, noise, and pollution.

## PILOT TEST

CPH:SENSE was tested in Østerbrogade and at Aalborg University Copenhagen in April 2014. Test results showed that the box is able to detect different kinds of road users by means of image analysis and that the large number of sensors in the box work according to schedule.



*A sensor box is installed on a lamp post on a major street in Copenhagen. The box makes recordings and detailed reports on the traffic situation, temperatures, air humidity, light intensity, noise levels, and airborne pollutants. This ongoing information is used to adjust traffic flow: green waves are adapted to weather conditions by e.g. reducing speed in icy road conditions or when there is a headwind for cyclists. Or perhaps by resorting to intelligent traffic management in the event of excessive levels of noise or airborne pollutants.*

## BENEFITS

Current information about traffic, weather, and environmental conditions will give the City of Copenhagen the opportunity to:

- optimise traffic lights so that the traffic will flow quickly, easily, and safely.
- intervene actively with intelligent traffic management if pollution or noise levels exceed acceptable levels.
- adjust green waves to weather conditions by e.g. reducing speed in icy conditions or reducing the speed for green waves for cyclists when there is a headwind.





## THEME 5

### THE COMPANIES BEHIND INTELLIGENT BUS PRIORITISING SOLUTIONS

COWI

IMTECH TRAFFIC & INFRA

INFRATEAM

# BUSES ON TIME

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## SLOW BUSES

The buses move slowly in the rush hour making it less attractive to use public transport. On several routes, the high-frequency bus service tends to result in clusters rather than securing an even spread.

## INTELLIGENT BUS PRIORITISING SOLUTIONS

Buses are given priority in traffic lights and are given an extended green light slot if they are delayed or full. This is done by increasing the data exchange between traffic signals and the Movia buses. The system builds on the existing bus prioritising system where all buses have the same priority at traffic lights. The new system will graduate priorities based on different factors including delay, number of passengers, type of bus route, the specific location in the city or the time of day.

## PILOT TEST

The intelligent prioritising of buses was tested via a simulation of Østerbrogade in April 2014. The simulation indicated that delays could be reduced by up to 25% if the green light slot was prolonged by between 8 and 30 seconds. Furthermore, the simulation showed that the number of delayed buses could be reduced by up to 45% if the traffic build-up in the road junction has disappeared before the arrival of the bus. There were indications that it is feasible to prioritise buses without impacting negatively on other buses travelling across the prioritised bus route.





*A full bus arrives in front of Copenhagen Central Railway Station in the Friday afternoon rush hour. It's running behind schedule. In front and behind, there are other buses loading and off-loading passengers. The full bus proceeds towards traffic lights that immediately change to green enabling the bus to continue and catch up.*

## BENEFITS

Intelligent bus prioritising solutions will benefit Copenhageners by:

- improving mobility for buses resulting in fewer delayed buses.
- reducing the number of buses arriving in clusters.







## THEME 6

### THE COMPANIES BEHIND THE TRAFFIC INFORMATION SYSTEM

THETIS

PARKEON

SYSTRA

IXXI

# SMART MOBILITY CHOICE

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## AWKWARD JOURNEY PLANNING

Today's journey planning does not cater for journeys that combine cars with bikes and public transport. Information about the current traffic situation is sparse, including information on any delays and congestion and this makes journey planning awkward. Besides, traffic officials in Copenhagen do not have systems available enabling them to see and manage traffic broken down into the various modes of transport nor in relation to environmental considerations.

## THE TRAFFIC INFORMATION SYSTEM

The idea behind the traffic information system is to integrate traffic information and journey planning including all modes of transport. For Copenhagen road users, it will be possible to use the system to plan journeys that include all modes of public transport, cars, bicycles, and car club schemes. You will have real-time information about traffic, congestion, and available car parking spaces. The traffic information system can be used via a mobile app and from interactive parking terminals.

The system will also serve to assist municipal traffic officials in gaining an overview of and managing the traffic so that it will flow quickly and safely.

The system will build on existing solutions and draw information directly from all relevant traffic providers and authorities.

## PILOT TEST

The concept for a new and comprehensive traffic information system was tested in two focus groups made up of road users from Copenhagen as well as in a workshop organised for City of Copenhagen traffic officials in March 2014. Test results indicated a positive attitude to the concept. Test participants believed that the concept would prove valuable if your journey involves several changes or if you want to avoid car queues. They emphasised that the system must be flexible and adaptive to the needs of the individual user, and that the most essential information is time, price, real-time, and parking information.



*A young student in Copenhagen wakes with a start and discovers that she's late. Quickly she grabs her mobile phone and inputs her route and priorities. In no time, an itinerary is ready for her with integral traffic info and journey planning including all types of transport showing the quickest way to get to Roskilde University where her lecture begins in one and a half hours.*

#### BENEFITS

The traffic information system will provide Copenhageners with an opportunity to:

- plan journeys involving e.g. cars and public transport.
- find all traffic information using the same portal.
- get real-time information on road congestion and available car parking spaces.

A traffic management system will enable the City of Copenhagen to:

- adjust and manage traffic more intelligently and respond to congestion and pollution.
- spearhead a collective traffic information system that, so far, is unlikely to be matched by the private sector.





## THEME 7

### THE COMPANIES BEHIND TRIGGER FRAMEWORK

IMTECH TRAFFIC & INFRA

BLIP SYSTEMS

HERMES TRAFFIC INTELLIGENCE

# PARKEN EMPTIED IN 20 MINUTES

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## TRAFFIC HOLD-UPS AT EVENTS

When major events including football matches take place at the National Stadium Parken, traffic flow is unable to keep up resulting in traffic hold-ups. Similarly, large crowds of pedestrians are unable to make it across while the lights are green and begin to cross at red lights.

## TRIGGER FRAMEWORK: TRAFFIC MANAGEMENT AT MAJOR EVENTS

Trigger Framework is a system, which through various data sources detects traffic developments early on and is able to assess whether traffic signals need to adjust to a particular situation. The system works by means of street sensors detecting the mobile phones of road users via Wi-Fi and Bluetooth. Additionally, the system gathers information about planned events, road works, etc. Based on various kinds of information, the system will determine whether the situation requires traffic signals to be adjusted to the specific situation.

## PILOT TEST

Trigger Framework was tested in the streets around Parken in April 2014 in connection with two football matches and a concert. 18 Bluetooth/Wi-Fi sensors were set up around Parken, primarily at Øster Allé and Østerbrogade, to detect the public arriving at or leaving Parken. The system detected the increase in road users on their way to or from Parken communicating to the traffic signals that extended slots of green light were required for traffic moving towards or away from Parken.

Test results showed that the congestion period arising immediately following a match at Parken plummeted from approx. 40 to 20 minutes. The test also showed that it is possible to implement intelligent traffic management based on an early analysis of the current traffic situation.



*The top match between Brøndby and FCK has just ended. 40,000 football fans swarm out onto the surrounding streets. Cars, pedestrians, and cyclists approach the traffic signals, which adjust to the thronging crowds by maintaining green light ensuring that the area is cleared as quickly as possible.*



## BENEFITS

Intelligent traffic management of both planned and spontaneous events will:

- ensure traffic flow and mobility in a vibrant city with a rising number of events within culture, sport, politics, etc.
- give increased priority to large groups of pedestrians.



# CYCLISTS RIDING ON THE GREEN WAVE

## MORE PEOPLE NEED TO USE THEIR BIKES

In Copenhagen, 41% use their bikes to work or education. The City of Copenhagen would like to increase this to 50%. ITS solutions can make cycling an attractive proposition and ITS solutions may meet some of the challenges posed by issues of mobility and safety engendered by large numbers of cyclists.

## CYCLIST INFORMATION SYSTEM

A dynamic cyclist sign and a mobile app will give cyclists relevant traffic information. The cyclist signs could be installed along busy cycle tracks and show any relevant information on a screen. The mobile app can be used via a mobile phone mounted on the handlebars, or you could consult the mobile app before leaving home.

The dynamic cyclist sign will be able to show information about e.g. congestion, accidents, and road works ahead and suggest alternative cycle routes that are less congested, greener, or routes that have been cleared of snow. It will

also be able to show the speed necessary in order to benefit from the green wave, supplemented by the cyclist's actual speed. The cyclist sign will also be able to show weather forecasts and encourage considerate cycling habits.

## PILOT TEST

The concept was tested by interviewing cyclists in the street and show them images of the system on a tablet. Furthermore, a prototype of the dynamic cyclist sign has been evaluated at workshops where City of Copenhagen cycling planners participated along with the Danish Cyclists' Federation.

Test results showed that cyclists prefer to cycle further if it means less congestion or a pleasanter route. Cyclists were generally dissatisfied with the behaviour of fellow cyclists and welcomed the corrective feature of the cyclist sign. The fact that the sign would lead to higher priority being given to information for cyclists was welcomed.





*One Monday morning in April, a cyclist is riding along Nørrebrogade. At the Blågårdsgade intersection, the cyclist passes a sign telling him to increase his speed from 15 km/h to 18 km/h in order to benefit from the green wave and avoid having to stop for red lights.*

## BENEFITS

Traffic information aimed at cyclists will benefit Copenhagen by:

- promoting the goal to be the world's best city of cyclists.
- helping to solve congestion and safety challenges on the busiest cycle tracks.
- making it more attractive to use the bike and so reducing CO<sub>2</sub>-emissions from motorised traffic.



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