



# Driving change in Stockholm

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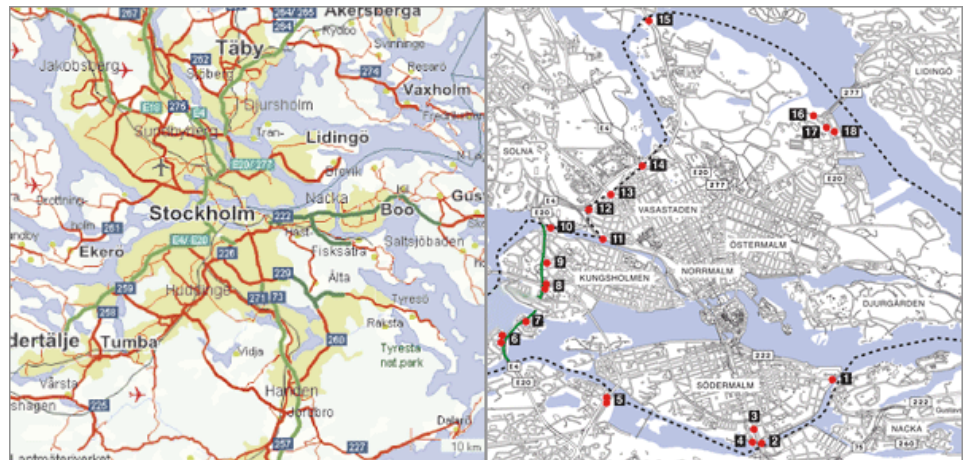
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## A Taxing Problem

It's an issue in cities worldwide: too many cars on too few roads. And Stockholm, Sweden was no exception, with over half a million cars traveling into the city every weekday. By 2005, average commute times were up by 18% from the year before.



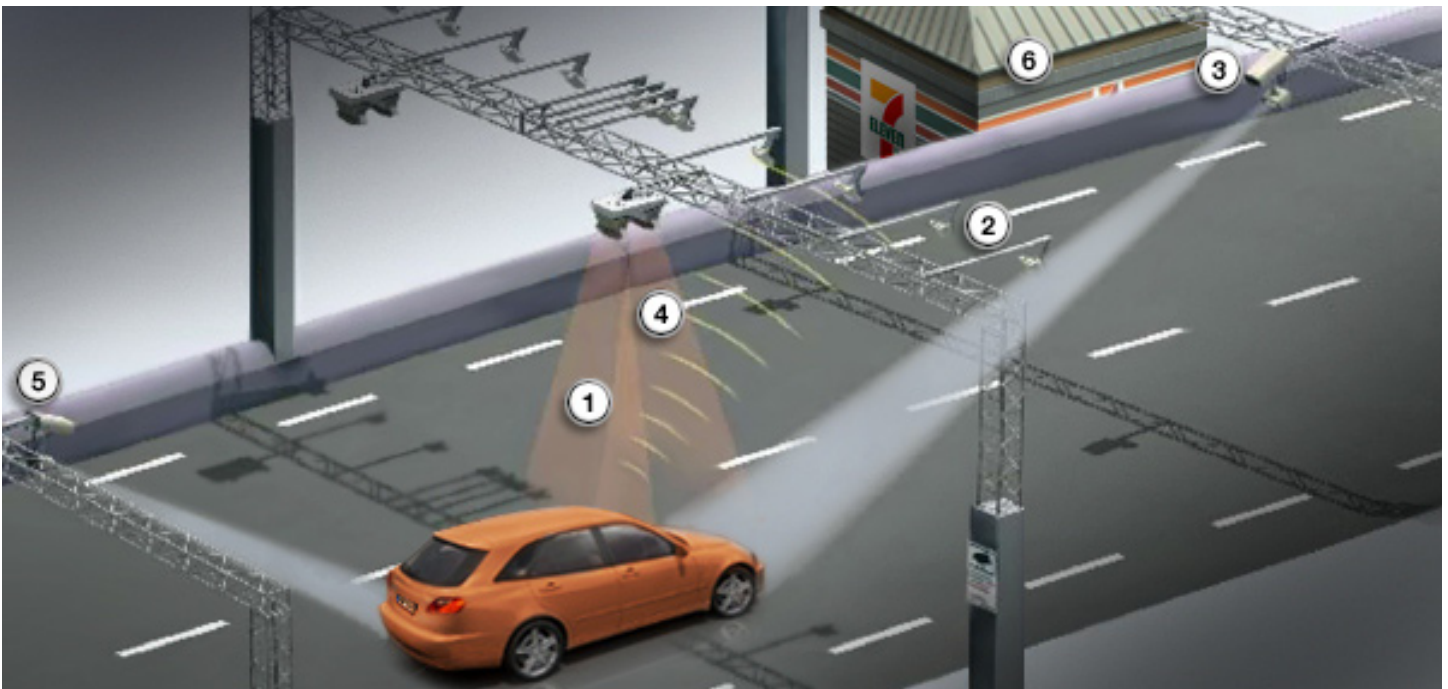
That's why, in the beginning of 2006, the Swedish National Road Administration (SNRA) and the Stockholm City Council announced a trial Congestion Tax, a road charging system similar to those seen in Singapore, London and Oslo. The goal was not only to reduce congestion, but encourage ancillary benefits, such as improving public transport and alleviating environmental damage. The government's plan is to devote revenue from the tax to completing a ring road around the city. The trial period was scheduled to run from January to July 2006, and the newly elected city government has decided to reinstate the tax in 2007. Here's how it works.

## The Design



To make the charging system work, the SNRA and the city had to find a way to recognize, charge and receive payment from vehicles. With help from IBM and its partners, a plan was devised to charge vehicles as they passed control points on the way in or out of the Stockholm city center during weekday, rush hour times. The city implemented a free-flow roadside system using laser, camera and systems technology to seamlessly detect, identify and charge vehicles. In the plan, 18 roadside control points located at Stockholm city entrances and exits identify and charge vehicles depending on the time of the day. The tax per passage was SEK 10, 15 or 20 (about \$1.50 to \$3.00) depending on the time of day. The highest amount charged was during rush hours, from 7:30 to 8:29 a.m. and 4:00 to 5:29 p.m. The maximum amount per vehicle and day was SEK 60, or about \$8.50.

## The Technology



- 1 The vehicle breaks the first laser beam, triggering the transceiver aerials as shown in Step 2.
- 2 The transceiver signals the vehicle's onboard transponder, capturing the time, date and tax amount.
- 3 At the same time as the transceivers, a camera photographs the vehicle's front license plate.

4

The vehicle breaks the second laser beam, triggering the second camera as shown in Step 5.

5

The second camera photographs the rear license plate, all without the vehicle slowing down.

6

Payment is debited from driver's account or paid via Web, a bank or retailers 7-Eleven and Pressbyran.

## The Results

The road charging system has made a real impact in congestion and overall quality of life for the citizens of Stockholm. By the end of the trial, traffic was down nearly 25 percent. Public transport schedules had to be redesigned because of the increase in speed from reduced congestion. And even inner-city retailers saw a six percent boost in business.

But the benefits go beyond fewer cars:

- During the spring of 2006, 40,000 more travelers used Stockholm Transport on an ordinary weekday than the year before—an increase of six percent.
- The reduction in traffic during the Stockholm Trial has led to a drop in emissions from road traffic by eight to 14 percent in the inner-city.
- Greenhouse gasses such as carbon dioxide have fallen by 40 percent in the inner-city and by two to three percent in Stockholm County.

The new Swedish government will reintroduce congestion charging in July 2007. And in the US, the federal government has allocated \$130 million to implement similar congestion pricing systems.



## **How it Works: the Stockholm Road Charging System**

Traffic congestion is a vexing problem felt by residents of most urban areas. But even in the face of high gas prices, rush hour gridlock and pollution, seemingly nothing can interfere with people's love affair with the car.

Stockholm, Sweden is a city of islands. There are 14 small town-sized islands, where citizens can stroll across short car and pedestrian bridges, and boats slowly navigate through the archipelago.

But traffic congestion has been a growing aggravation here for years, with over half a million cars traveling into the city every weekday. And it's not going to get any better on its own. The population of Stockholm County is growing at a rate of around 20,000 people a year, which inevitably means more traffic and an even greater burden on city streets.

Simply building more roads isn't the answer. Road building cannot keep pace with the increased demand, and the environment wouldn't be able to sustain the impact. Authorities in cities across the world have encouraged people to make greater use of public transport, but still the bottlenecks get worse.

And so a few years ago, the Swedish National Road Administration and the Stockholm City Council set out to find another way to reduce both the number of traffic jams in Stockholm and its air pollution levels.

With help from IBM, the solution they came up with was an innovative, high-tech traffic charging system that directly charges drivers who use city center roads during peak business hours. The hope was that this pilot project, which launched in January 2006, would encourage more people to leave their cars behind and use public transportation instead. The charge was also intended to bring about an overall improvement in the urban environment in Stockholm, particularly in air quality.

As part of the project, 18 roadside control points located at Stockholm city entrances and exits were set up to identify and charge vehicles depending on the time of day—higher during peak times, lower during off peak hours.

The way it works, drivers can install simple transponder tags that communicate with receivers at the control points and trigger automatic payment of road use fees. Once a vehicle passes a roadside control point during designated congestion hours, it is recognized by the transponder that is read by sensors.

In addition, cars passing through these control points are photographed, and the license plate numbers are used to identify those vehicles without tags and to provide evidence to support

the enforcement of non-payers. The information is sent to a computer system that matches the vehicle with its registration data, and a fee is charged to the owner. Drivers can pay their bills at local banks, over the Internet and at area convenience stores, like 7-Eleven.

The technologies at work here include RFID tags, which use radio waves to automatically identify objects, and wireless sensors, which are little devices that can detect and measure real-world conditions and convert them into signals that are sent to computers.

Another emerging technology—optical character recognition software—is used to identify license plates from any angle. Because of varying degrees of illumination, bad weather and sometimes-awkward camera angles, not all license plates photographed by cameras at the roadside control points can be automatically identified by standard systems. IBM Research developed a sophisticated recognition system that uses algorithms to make a second attempt at identifying unclear license plate images.

These algorithms use techniques such as image enhancement and comparison of front and back license plates to analyze the entire image and search for predefined patterns. Mimicking the human eye, the algorithms decipher images of often barely legible text by moving the image around until an optimal viewing angle is found, and the expected pattern can be recognized. After recognition, the system automatically records the license plate number, matches it with a vehicle registry database and processes billing.

The road charging system had an immediate impact on congestion and overall quality of life for the citizens of Stockholm. By the end of the trial, traffic was down nearly 25 percent and train and transit passengers increased by 40,000 a day.

What's more, the reduction in traffic led to a drop in emissions from road traffic by eight to 14 percent in the inner city; and greenhouse gasses such as carbon dioxide fell by 40 percent in the city.

In the face of local skepticism about the project, the authorities decided to implement road pricing for one year—on a trial basis—and then allow citizens to decide via a referendum whether to make it permanent. That referendum recently passed, and in a few of months, the program will be up and running again.

Meanwhile, worldwide interest in the economic and environmental challenges of traffic management continues to grow. Governments around the world are struggling to cope with rising traffic levels, rising oil prices, rising congestion and rising environmental concerns; and the solution for Stockholm represents a new benchmark in scale, scope and sophistication.

The success of the project also signals the coming of age of a whole new generation of technologies—more powerful and accessible than ever before.

But as with any complex system like what was developed for the city of Stockholm, you need more than just cutting-edge technology to be successful. You need to analyze how things flow, how people interact, how processes can be more productive and human, and then bring together the abundance of technologies, skills, approaches and capabilities that makes true innovation possible.

And that's how it works.