IoE-Driven Congestion Charging System Enables Stockholm to Reduce Traffic and CO_2 Emissions

EXECUTIVE SUMMARY

Objective

- Reduce traffic congestion and improve the environment in Stockholm

Strategy

- Facilitate cooperation between public and commercial (technology) entities to ensure smooth rollout of system

Solution

- Impose a traffic congestion and environmental tax on vehicles traveling into and out of central Stockholm
- Use cameras mounted along city streets to track individual and aggregated journeys, allowing for road and public transit planning, as well as real-time traffic management
- Improve efficiency of public transportation by using sensors to track locations of buses throughout the city

Impact

- 20 percent reduction in traffic within the congestion charge area
- 2 to 3 percent reduction in carbon dioxide emissions
- 10 to 15 percent reduction in pM10-level particulates
- 2 to 3 percent increase in public transportation usage

Background

In January 2014, Cisco released the results of an in-depth analysis of the economic benefits of the Internet of Everything (IoE) for the public sector. Cisco's model revealed that some $4.6 trillion in "Value at Stake" would result from the adoption of IoE capabilities across 40 key public sector use cases over the next 10 years, including smart water, smart buildings, smart energy, smart parking, and more (http://bit.ly/1aSGlzn).

As a next phase of its analysis, Cisco engaged Cicero Group, a leading data-driven strategy consulting and research firm, to undertake a global study of IoE capabilities across these 40 use cases – how the best public sector organizations are "connecting the unconnected," as Cisco terms it. To that end, Cicero Group conducted interviews with dozens of leading public sector jurisdictions – federal, state, and local governments; healthcare organizations; educational institutions; and non-governmental organizations (NGOs) – to explore how these global leaders are leveraging IoE today.

The research examined real-world projects that are operational today, are being delivered at scale (or through pilots with obvious potential to scale), and that represent the cutting edge of public sector IoE readiness and maturity. The aim of the research was to understand what has changed in terms of the jurisdictions' people, processes, data, and things, and how other public sector organizations can learn from (and replicate) the trail blazed by these global IoE leaders. In many cases, these jurisdictions are Cisco customers; in others, they are not. The focus of these jurisdictional profiles, therefore, is not to tout Cisco's role in these organizations' success, but rather to document IoE excellence, how public sector entities are putting IoE into practice today, and to inform a roadmap for change that will enable the public sector to address pressing challenges on multiple fronts by drawing on best practices from around the globe.

About the Stockholm Traffic Congestion Charging System

The Stockholm congestion charge is a traffic congestion and environmental tax imposed on vehicles traveling into and out of central Stockholm. Its primary purpose is to reduce traffic congestion and improve the environmental situation in Stockholm. There are 18 congestion charge gates around the city. These gates are barrier-free and do not involve stopping; they register and charge cars using pictures taken by traffic-congestion-charge cameras.

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Daniel Firth is the chief strategy officer of the City of Stockholm Traffic Administration. Mr. Firth's education centered on urban planning, and his career has focused on city transport and urban transport planning. He worked on the implementation of London's traffic congestion charging system and its subsequent expansion from 2002 to 2007.

In 2006, Mr. Firth was an informal liaison for Stockholm when it was planning its traffic congestion charge. Shortly after, he accepted a position at the Stockholm City Traffic Administration to implement the congestion tax after a referendum. Mr. Firth now works on a wide range of strategy and planning issues for the city's new urban mobility strategy.

Objectives

According to Mr. Firth, the idea of a congestion charge started a number of years before the trial took place in 2006. The push came from a combination of city government and the Swedish Parliament, primarily from the Green Party. The main drivers of the discussion were traffic congestion and environmental concerns.

"Stockholm is a city built on a series of islands," Mr. Firth explained. "That means almost any journey you make will cross a bridge at some point. There are a limited number of bridges, so around those bridges there is quite a severe congestion problem. The city is divided in two by the system of waterways between the Baltic Sea and Lake Mälaren to the east, and there are a limited number of ways to go from the north to the south of the city. So, congestion problems at these key bottlenecks – but also an environmental concern, largely around the emission of particulates – drove this in the first place."

A trial was conducted in early 2006, and following public support in a referendum in September 2006, the City of Stockholm adopted the congestion charge permanently, and the congestion tax took effect in 2007.

Strategy

The Stockholm traffic congestion charge was first introduced as a trial between January 3, 2006 and July 31, 2006. Following a referendum in September of that year, it was decided to permanently implement the congestion tax. The referendum took place in the city of Stockholm, as well as in surrounding municipalities. The outlying municipalities did not support the congestion tax, but Stockholm voters passed it, and the incoming coalition government decided to impose the charge.

"We did lots of public attitude surveys, both before and after the trial. Before the trial, attitudes and public opposition were quite overwhelming – around 70 percent were opposed and 30 percent were in favor," Mr. Firth explained. "Almost within weeks of the trial beginning, the relationship switched completely, with maybe 60 to 70 percent in favor and 30 percent opposed. The trial was suspended in the summer of 2006, and there was a referendum in September 2006, together with national elections, asking if they would like to retain the congestion tax. In that referendum, which took place in the city of Stockholm and surrounding municipalities, the majority was 52 percent."

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Daniel Firth,
Chief Strategy Officer,
City of Stockholm Traffic Administration

The media coverage in the days leading up to the congestion tax rollout was focused on the expected chaos. However, a successful rollout led to almost immediate positive media coverage focused on the system's efficiency and positive impact. Public support quickly followed. "What has happened since the referendum in 2006 and into 2007 is it has become a non-issue," Mr. Firth said. "Now, when we ask people the same question about the congestion tax, the majority is in favor, and a large number have no opinion. It's gone from being a very divisive issue to something that is kind of accepted."

Stockholm provides data to the public so that it can be used for commercial purposes. "What we have is most people using our parking data to try to provide services to help people park," Mr. Firth said. The journey-time traffic data is currently being made available to commercial services such as Google on a webpage called Traffic Now (www.trafiken.nu). "We make all our data available to anyone who wants it. So at the moment, a lot of data is being made available to a lot of researchers. We would like it to be used by anyone who would like to help with journey planning, software applications, mobile phones, that kind of thing. The city council has a policy of making all non-private or commercially sensitive data available to anyone who wants to use it to develop whatever they like."

While initial funding for the congestion charging system was provided by the national government of Sweden, Mr. Firth stated that the system paid for itself in about four years and has since become a helpful addition to the transportation budget. Additional money received is used in various ways to improve public transportation and the local transport infrastructure. The City of Stockholm is currently planning for an increase in the congestion charge by nearly 75 percent in 2016. The maximum charge will increase from approximately US $3 to US $5.50.

Because the Swedish courts ruled the charge was not a local charge, but in fact a tax, the project is operated by the National Road Administration. “The city council can only tax citizens; we can’t tax citizens of other municipalities,” Mr. Firth said. “So in order to tax cars that aren’t from Stockholm, we need a tax and that goes through the national Parliament, and therefore it is a national authority that actually is taking the tax.”

Parliament works in concert with the local Stockholm government regarding changes to the congestion charge system. “Because it is affecting our streets, the city council has a very large influence over national Parliament,” Mr. Firth explained. “National Parliament cannot make changes without the city council being in agreement.” The city created an initiative to increase the charge, and the new law was passed by Parliament in late March 2014. The charge increase will take effect on January 1, 2016.

Solution

The city of Stockholm implemented a congestion charging scheme in inner Stockholm in 2007, following a successful trial in 2006. This scheme utilizes video cameras that take pictures of the license plates of passing automobiles, and then charges a fee to registered users of those automobiles for driving in downtown Stockholm.

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The system is deployed at 18 charging “gates” that ring the inner city. Cars passing through the gates are not required to stop or slow down, and the cameras are triggered by the vehicles’ movements. A vehicle traveling through a charging gate “breaks” a laser beam that triggers a camera to photograph the vehicle’s front license plate. The vehicle then breaks a second laser beam, triggering a second camera that photographs the rear license plate. The plate information is automatically read using Automated Number Plate Recognition (ANPR) software.

Based on the plate reading and the registration information for the vehicle, the vehicle owner is then charged. Charges vary in cost depending on the time of day (higher traffic times = higher charges). Depending on whether the vehicle owner has established an online account, the owner will either have the payment automatically debited from his or her bank account, or will receive a bill. Bills can be paid via the Internet, a bank, or specified retailers.

“The absolute majority of people pay via debit,” Mr. Firth explained. “So in the same way they pay gas bills or rent, they can have a bill sent to them, but mostly it is done by the bank. Everybody has Internet banking; for most payments, you can set up this automatic billing. It’s only occasionally that users are receiving a bill by post and going online and paying it.”

The use of cameras to record passage of vehicles through the charging gates was, according to Mr. Firth, critical from a legal perspective, as tax charges of this sort need photographic proof to hold up in court. “Initially we were using DSRC (RFID) tags,” Mr. Firth says. The city soon changed to a camera capture system — not because the tags didn’t work, but, according to Mr. Firth, “because the cameras in place are much more accurate than anticipated.”

Swedish law dictates that in order to charge the tax, an appeals process must be in place. The DSRC signal for registration was not sufficient, but a picture meets the proof requirements on the government's behalf. According to Mr. Firth, there is an appeal system that allows drivers to check the passages for which they are charged online, so that drivers can verify the accuracy. If a discrepancy is found, the driver can submit an appeal.

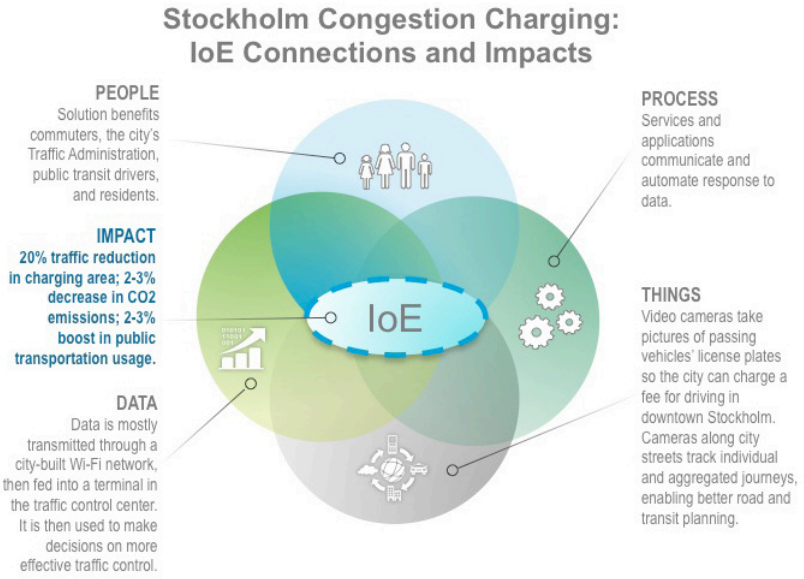
Mr. Firth indicated that because the traffic congestion charge cameras transmit sensitive tax data, the system has a high level of security. The data is transmitted via the city's established fiber network. "It is secure data and needs to have a high level of security and accuracy – it's a closed system," he stated.

Additionally, sensors on public buses track bus location throughout the city .... The system also sends signals to traffic lights so that buses behind schedule are more likely to get a green light.

Mr. Firth indicated that the Stockholm traffic administration maintains a separate system of journey-monitoring cameras that utilize similar license plate detail to calculate how long it is taking vehicles to travel well-established routes across Stockholm. Because a high level of security is unnecessary for data from the journey-time traffic cameras, this data is mostly transmitted through a city-built Wi-Fi network. The data is fed into a terminal in the city traffic control center, where it can be aggregated and used to make decisions on more effective traffic control.

Additionally, sensors on public buses track bus location throughout the city. The bus location data is fed to a central computer via GPS technology. The central control computer then calculates time separation between the buses on a given route and, according to Mr. Firth, sends drivers signals about whether to speed up or slow down, depending on their distance from the bus ahead of them. The system also sends signals to traffic lights so that buses behind schedule are more likely to get a green light. Also, to make the system easier for commuters, bus-location data is fed to each bus stop. The stops have signs communicating when the next bus will arrive, and this information is also made available via mobile phone apps.

Figure 1. Stockholm: New and Better Connections.



Source: Cisco Consulting Services, 2014

Impact

According to Mr. Firth, Stockholm receives unprecedented data from the congestion charge system, and is looking at ways to use the data to provide better, more efficient services. Through its journey-time monitoring system, the Traffic Administration uses cameras to trace vehicles as they pass through the system to see how many through trips are made, which entrances and exits are most utilized, and how long people drive each day.

The data also allows the city to more effectively program traffic signals for traffic flows – both in long-term planning and real-time response. "It's maybe adjusting on a weekly or monthly basis," Mr. Firth says. "Then there is data that is being input into the traffic control center, which then is able to implement a certain traffic signal plan, for example. So if something happened and we see a burden, or there has been an accident, it allows operators on the traffic control system to implement a standard plan such as closing tunnels or closing lanes, or changing speed limits or traffic signal time to cope with that disturbance."

Stockholm has also benefited by having less traffic and increased public transit use – including a 20 percent reduction in traffic within the congestion charge area.

Stockholm has also benefited by having less traffic and increased public transit use – including a 20 percent reduction in traffic within the congestion charge area. "The 20 percent depends on the direction you are looking and the time of day," said Mr. Firth. "So it is between a 20 and 40 percent reduction in journey-time delays, or the measure of congestion that we use. It's not just locally – it's up to maybe 10 kilometers from the congestion tax zone where we are also seeing a reduction in traffic. [This means there has been] no traffic growth, despite very rapid population growth [by nearly 100,000 people since 2006]."

The environment of the city has seen improvement as well. "Carbon dioxide emissions are down 2 to 3 percent and counting," Mr. Firth said. "It sounds like a small number, but for a single measure, it is quite substantial." He added that there has also been a 10 to 15 percent reduction in PM10-level particulates within the city.

The city has also seen a 2 to 3 percent increase in public transportation use since the introduction of the traffic congestion charge.

Lessons Learned / Next Steps

According to Mr. Firth, cooperation between the public and commercial (technology) entities was a key to a smooth rollout of the traffic congestion charge system. "One of the most important lessons learned is that the technology we used was well-tested. We knew it was going to work, and it worked very well from day one and has continued to work. A lot of the reason for that has been very close cooperation between public authorities and the commercial partners who are involved. I can't really stress that enough, how important that was."

Extensive planning and modeling of the system itself was another important lesson. "First, we had really done our homework in terms of modeling the traffic system and what we thought would happen," Mr. Firth explained. "A lot of time went into both developing and refining traffic models and using them to really understand

what the impact would be. You can't introduce this kind of system just by thinking about it or using the experience of traffic engineers, you need to use these models to understand what the effects are. Traffic is like water: it will make its way through unless you know what you are doing, and you need to really understand what the impact is."

This planning led to nearly immediate public approval of the project. "It was a 20 percent reduction in traffic, and you could see it; you didn't need to see the data in nice graphs that we pumped out – you could see it with your own eyes. I think the reason public opinion changed so quickly is that what happened was exactly what we promised would happen, and being able to see that was a very significant part. It's a big change, so the communication around it – explaining that you are trying to make the traffic system work better and that you are trying to improve the city environment – was very important."

According to Mr. Firth, Stockholm will increase the congestion charge in 2016, which modeling indicates will further decrease traffic by 7 to 10 percent.

According to Mr. Firth, Stockholm will increase the congestion charge in 2016, which modeling indicates will further decrease traffic by 7 to 10 percent. "At the moment, the maximum charge in the middle of rush hour is 20 Swedish kroner per passage, which we would increase to 35 Swedish kroner," he said. Mr. Firth says the traffic reductions "will give us more opportunities to bring improvements to the urban environment and to reduce emissions."

One way Stockholm hopes to do this is by using data gathered by the congestion charge system and journey-time cameras, paired with weather and accident data from the past seven or eight years, to make short-term predictions about traffic to stop potential problems before they occur. "We are in the process of trying to use this data and lots of other data and methods for very short-term predictions on what is happening in the traffic system. Instead of waiting until an incident happens and then implementing our traffic management systems, we can force-feed these problems before they happen and start using management tools – the traffic signals, message signs, and such – to make sure the problem doesn't occur, or to reduce the impact of the problem."

Stockholm hopes that individuals or organizations will use the data from the journey-mapping system to develop better travel plans for individuals. "We are opening our data so that people who are much better with this type of thing than the public authority can run these things," Mr.Firth stated.

Separately from the traffic congestion charge, Stockholm wants to implement a parking services program that would assist commuters via a mobile application.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV Amsterdam,
The Netherlands

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