NEW AREAS OF APPLICATION FOR ELECTRONIC FEE COLLECTION.
USING THE AUTOPASS TAG TO PAY FERRY FARES.

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ABSTRACT

As most cars in major urban areas are equipped with the AutoPASS tag, a trial has been undertaken at the Flakk-Rørvik ferry service outside Trondheim where the suitability of using the AutoPASS tag for paying ferry fares has been investigated. The paper focuses on the technology implemented for length measurement of vehicles in a non-stop environment which is very challenging and as far as we know the first worldwide system working in a commercial setting. The paper shows also that that this system could yield substantial economies to both motorists and to the ferry operators.

KEY WORDS

AutoPASS, non-stop length measurement, first worldwide system.

INTRODUCTION

Ferries form an integral part of the road network and the 180 ferries along the Norwegian coastline annually transport more than 18 million vehicles and over 21 million passengers. In ferry services with high traffic levels, capacity constraints are increasingly the results of queues to pay the ferry fares manually. This represents time losses to the motorists and increased operating costs to the ferry companies. Toll financing relies heavily on electronic fee collection (EFC) and today the bulk of the total toll revenues are collected using EFC in several countries, including Norway. This has lead to improved traffic flow and traffic safety as well as reduced operating costs. The Norwegian AutoPASS tag represents an EFC success story with high market penetration and national and Nordic interoperability.

The Norwegian Government aims for cost reduction in operating ferries and one of the issues is the cost for processing ticketing. The Government asked the Norwegian Public Roads Administration (NPRA) to see if it is possible to introduce the AutoPASS tag as a payment means for ticketing and make the ticketing process more cost effective. Building a national payment system using the AutoPASS tag both for road tolling and ferry fare payment is a proclaimed goal for The Norwegian Government. NPRA selected the ferry crossing Flakk-Rørvik, close to the city of
Trondheim. The selection was based on the annual average daily traffic (AADT = 2500) and the percentage of vehicles provided with an AutoPASS tag (approximately 85%).

Figure 1 – Flakk site.

TECHNOLOGY

The complete system consists of the following on road equipment:

Figure 2 – Equipment at site.
Well known technology

Lane sign, traffic lights, video cameras and illumination is standard equipment for traffic control and enforcement handling. 

EFC antenna – communicates with the AutoPASS tag and make it possible to register the vehicle when passing the payment site.

Transponders – AutoPASS tag to identify the car and its owner. The AutoPASS tag has an unique id which identify a contract with a unique vehicle and its owner.

This kind of equipment have been used for several years in many EFC systems in Norway and are well known technology which have proven its functionality.

New technology

The measurement system – Pricing is based on the length of the vehicle. This is because the ferry itself has a limited space for vehicles and the capacity of this space is in some periods not enough. The small vehicles pay less then large vehicles. The vehicles was divided into 3 length classes, less then 6 metre, between 6-12 metre, and more then 12 metre. The AutoPASS system is based on a non-stop concept and because of that we had to test out a non –stop length measurement system.

The requirements for the measurement system was that the accuracy should be inside plus/minus 25 centimetre and that trailers should be a part of the vehicles total length.

Our ambition was to build a dynamic measurement system so that the number of length classes could be reduced or expanded without changing the system configuration at site. But there were no suppliers that could offer such a system and to comply with the requirements for measurement accuracy. Due to that the system ended up with a fixed measurement system based on the 3 length classes needed for this project.

The length measurement system was based on using 3 lasers for both detecting vehicles and measure the length of the vehicles.

The physical properties of the lasers made it possible to measure within the plus/minus 25 centimetres. The cycling period for the lasers are 13 milliseconds which give an accuracy of about 20 centimetres. Mounting height, about 6 metre, make it possible to detect trailer tows wider then 6 centimetre. This will measure vehicles with a trailer as one length object.

Figure 3 – Conceptual model of the lasers configuration.
EVALUATIONS

The system have been used commercial for the last two years and have recently been evaluated both for the technical configuration and cost benefit. Based on the evaluation NPRA have produced a final report to the Government on how to deploy such solutions in the future.

Technical evaluation

Use of AutoPASS technology (AutoPASS tag and EFC antenna) is well-proven technology and is adaptable in a ferry ticketing system. The identification of the vehicle passing at the site is functioning the same way as in a traditional tolling system.

To generate the correct tax the length measurement system must operate accurate and continuous over a long time period. The system proved its quality but there have been some more demanding situations. If there have been a combination of bad weather (heavy rain/snow) and high vehicle speed (above the limit of 60 kilometres/hour) there have been some cases of wrong length measurement. Because of a water/snow tail behind the tires some few cars have been added up until 1 metre to their actual length. The water/snow tail could be filtered away by some software configuration but then we could end up with also filtering away the trailer tow.

Figure 4 – Vehicle with wrong length classification.

The measurement system was based on 3 fixed length groups. To expand the system to handle 4 fixed length groups the system configuration would be significantly more complex. The system has to handle situations like several vehicles simultaneously inside the detection area, vehicles stop and do reverse driving, bicycles/MCs in the area. With only 3 length configuration the different situations is also quite complex.
The conclusions so far is that the length measurement system is well working and its accuracy fulfills our requirements. But to have more flexibility concerning number of length classes we need to look for another configuration. The most simple system could be that the On Board Unit (AutoPASS tag) is the carrier of the needed information, such as vehicle dimensions. April this year Comite Telepeage in Brüssel agreed about a definition of European Electronic Tolling Service – EETS. This agreement could provide such vehicle information inside the On Board Unit within some few years. We are also looking for a system based on image processing to measure vehicle length.

Cost Benefit evaluation.

The project has been motivated by the possibility to reduce costs both for the operator and the users.

Table 1 gives a simple presentation of costs and benefits for different user groups.

<table>
<thead>
<tr>
<th>Car drivers</th>
<th>Ferry company</th>
<th>NPRA</th>
<th>Public</th>
</tr>
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<tbody>
<tr>
<td>Reduced</td>
<td>Reduced</td>
<td>Encreased</td>
<td>Positiv effects</td>
</tr>
<tr>
<td>Queues</td>
<td>Operation costs</td>
<td>Equipment cost</td>
<td>System integration</td>
</tr>
<tr>
<td>Time to do payment</td>
<td></td>
<td></td>
<td>Reduced pollution</td>
</tr>
<tr>
<td>Fuelreduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car expenses</td>
<td>Encreased</td>
<td>Administration</td>
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<td>+/-</td>
<td>-</td>
<td>+/-</td>
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</tbody>
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Tabell 1: Costs and benefits for each group.

Many of these effects could be quantified by a simple cost benefit analyses and to illustrate potentially social economic profit by introducing AutoPASS in this ferry.
crossing. We choose to focus only on the operation costs for the operator and the time saving for the vehicles.

Results of the analyse is presented in table 2.

<table>
<thead>
<tr>
<th></th>
<th>Present value costs NOK</th>
<th>Present value benefits NOK</th>
<th>Net present value NOK</th>
</tr>
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<tbody>
<tr>
<td>Investment costs</td>
<td>5.000.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax costs</td>
<td>1.000.000</td>
<td>26.000.000</td>
<td></td>
</tr>
<tr>
<td>Reduced operating costs</td>
<td></td>
<td>26.000.000</td>
<td></td>
</tr>
<tr>
<td>Reduced time costs</td>
<td>13.000.000</td>
<td></td>
<td>33.000.000</td>
</tr>
<tr>
<td>Net present value</td>
<td>(6.000.000)</td>
<td></td>
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Table 2: Cost benefit analysis  AutoPASS Flakk-Rørvik

Implementing of this system give a cost-benefit value 5.5, each NOK (Norwegian krone) invested gives 5.5 NOK benefit. This is a quite good result and should motivate both the Norwegian ferry companies and the Government to look for further deployment of this system. AutoPASS Flakk-Rørvik is a ITS system and evaluating ITS projects using the principles of cost benefit analysis is desirable and possible [1]. This simple cost benefit analysis shows that the project has been highly profitable and has provided net benefits in excess of what can be found in traditional road projects. The reductions in operating costs provide the operator with high annual benefits.

CONCLUSION

We conclude that this automatic ticketing system is well useful for some ferry connections. Prerequisites are that most of the cars uses an AutoPASS tag (OBU) and that there are a limited numbers of length classes. At this ferry connection ab.85% of the vehicles are equipped with an AutoPASS tag and number of length classes are 3.

As a result of this project we also have made out some conceptual systems for situations were the number of vehicles equipped with a tag is relative low, between 30-50%, and number of length classes are more than 3. There are plans for making some pilot testing for a system like that.

We also conclude that implementing this automatic ticketing system gives great benefit to operator by a significant cost reduction in operating the system.

REFERENCES