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MEMO

MEMO CONCERNS

Simulation of Chicago Avenue

- Adaptive signalling by SPOT/UTOPIA

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FILE CODE	CLASSIFICATION
	Open

ELECTRONIC FILE CODE

Chicago Case,doc

PROJECT NO.	DATE	PERSON RESPONSIBLE / AUTHOR	NUMBER OF PAGES
223050.04	2002-11-15	Ørjan Tveit	9

1 Introduction

1.1 Situation in Chicago

Regional Transportation Authority (RTA) is in the process of evaluating different techniques to give priority to public transport in Chicago. This is done by a large project that consists of 17 different cases (corridors) evaluated by simulation (VISSIM). SINTEF have been following the work being done in Chicago by attending lectures by RTA representatives at both the 7th and 8th ITS Would Congress.

According to the 2001 Urban Mobility Report, by the Texas Transportation Institute, Chicago ranked fourth among the most congested urban areas in the United States. Transit Signal Priority (TSP) is a tool that can improve bus service and operating efficiency while complementing the region's ongoing efforts to relieve traffic congestion. The basic TSP operation is accomplished by either granting the transit vehicle an extended green or an early green signal when approaching a signalized intersection. In order to ensure regional coordination for this promising technology, the RTA is leading a comprehensive plan known as the Regional Transit Signal Priority Integration Plan for the Chicago area. The goal of the plan, which is being undertaken in conjunction with Service Board (Chicago Transit Authority and Pace Suburban Bus) is to provide a regional framework for the implementation of TSP systems.

The evaluation methodology is designed to answer where and when TSP should be implemented. After an initial feasibility study, 17 corridors were selected to be evaluated by simulations.

Intersection improvement scenarios will also be considered for the selected locations then tested on a "before" and "after" basis to evaluate which are most effective in maximizing TSP performance. For each of the 17 corridors, four scenarios will be evaluated.

- Existing signal timings
- Optimized timings
- Existing signal timings with TSP capability
- Optimized timings with TSP capability

1.2 SINTEF involvement

In Europe there is a tendency to co-ordinate the traffic signals when we are providing priority to Public Transport. This approach secures that the benefits that are achieved in one intersection are maintained in the next intersection. SINTEF has been responsible for evaluations of adaptive signal control (SPOT/UTOPIA) in several Scandinavian areas.

SINTEF is currently in the process of assisting and evaluating PEEK Traffic's further development of SPOT/UTOPIA, which is the Italian optimisation system for signalised areas. As an extension of our involvement, SINTEF is involved in making simulations cases with adaptive signal control. As a stage in this work, SINTEF has supplemented the simulation study undertaken in Chicago by a case study of SPOT/UTOPIA in one of the areas investigated. The work was done in cooperation with Peek Traffic Norway.

Thereby SINTEF got a case study with American driving conditions, and RTA got a supplement to their study. The aim of the project was both to give the Public Authority in Chicago answers about the effects of adaptive signal control as well as gaining experience for our further development of the tools.

2 Evaluation method

Traffic responsive signal systems can, compered to fixed signalling, achieve better traffic flow and at the same time give special priority to selected groups. In Norway the Public Authority are implementing the Italian SPOT/UTOPIA signal system in several cities. The aim of the installations is to give priority to the public transport. Therefore the installations are founded by grants reserved for public transport.

When the sites consist of more than 8-10 intersections with signals, it becomes too complex to optimise from a local level. By combining SPOT/UTOPIA with the American NETSIM simulation model we have a powerful tool to assist the traffic engineer. We have used this combination to improve the progression for public transport.

Simulations in Norwegian towns show that this approach is a valuable tool for the traffic engineer. The results from the sites in Oslo, Bergen and Trondheim demonstrate how flexible the traffic responsive signal systems can be with regard to give priory to the public transport without disturbing the other traffic.

Another goal of using simulation before installations is that this gives us the possibility to evaluate several different settings. It is seldom possible to do these tests in real life because it's too costly. By testing different setting in advance, the Public Roads Authority can determine if it is possible to use heavy priority schemes for the public transport or if this will lead to breakdown in the traffic flow.

The American NETSIM model is used together with SPOT/UTOPIA to simulate the traffic flow that will occur with SPOT/UTOPIA. Also European simulation models are possible to integrate with SPOT/UTOPIA. This is already done with HUTSIM and NEMIS.

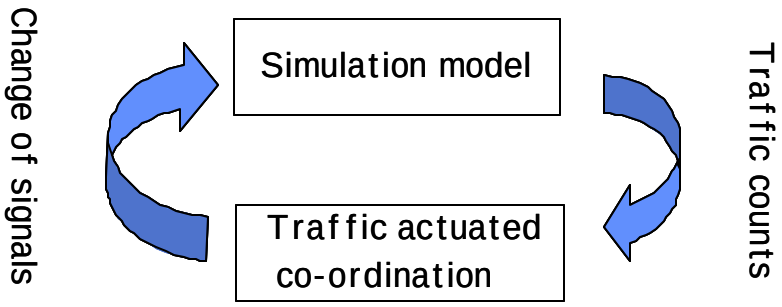

Figure 1 – Data flow in simulation set-up

In the simulation model the vehicles are generated and shipped through the network. When a vehicle is passing a detector a message is generated towards SPOT/UTOPIA. SPOT/UTOPIA is treating the traffic information to set-up the best signal setting according to the present traffic situation. The chosen strategy is shifted back towards the simulation model that is changing its signals according to the SPOT/UTOPIA strategy. This exchange of information between the simulation model and SPOT/UTOPIA is a continuous process with several message interchanges each second.

3 Chicago case

SINTEF and Peek Traffic Norway have done a brief survey of the 17 simulation cases. Two areas meet our “demands” to an ideal area for a simulation setting. The demands are mainly referring to intersection spacing as well as area factor like bus frequency, pavement quality and so on. Also the other areas can utilise SPOT/UTOPIA.

The two chosen areas are Washington Street, in a suburb outside Chicago, and Chicago Avenue in the centre of Chicago. The difference between the areas is mainly that Washington Street is a commuter area while Chicago Avenue is a downtown area. In our simulations the road anatomy, the traffic flows as well as the pedestrian volume are quite similar. All data are available at an equivalent level. One area is representing a typical suburban where SPOT/UTOPIA is solving problems similar to many small town areas. The other is a typical downtown area with normal traffic problems like many other American cities.

SINTEF has been fortunate to get access to the data from both sites. Based on a discussion with RTA, Chicago Avenue was chosen. The selection was partly based on the availability of the data at the start of the simulation build up.

Figure 2 – Picture from Chicago Avenue

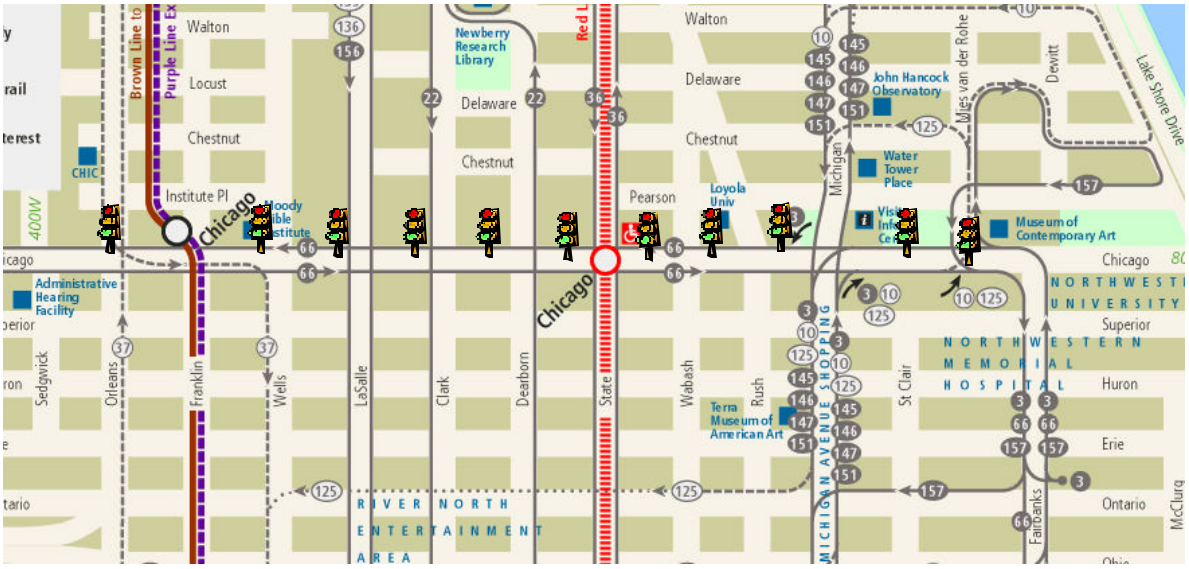

Figure 3 - Simulation area in Chicago Avenue

12 intersections in Chicago Avenue were selected to test adaptive signalling by the SPOT/UTOPIA system. The goal of the simulations was different in the morning rush and in the afternoon rush.

- Morning rush – optimise traffic flow for all traffic categories
- Afternoon rush – improve traffic flow for public transport without giving advantages to the ordinary traffic.

The first approach is the normal setting in Europe. We usually also give special attention to the public transport by selective loops or automatic vehicle monitoring systems. This is the basis for selective priority of the public transport.

The second approach is based on some criticism from bus companies in Norway. The Norwegian adaptive systems are built by public founds focusing on giving better progression and more equal travel time for the public transport. When also the other traffic gets advantages from the signalling system, the set-up is regarded as negative. However, it is difficult to give advantages to only the public transport without reserved lanes. The second approach sets high demands to the priority system.

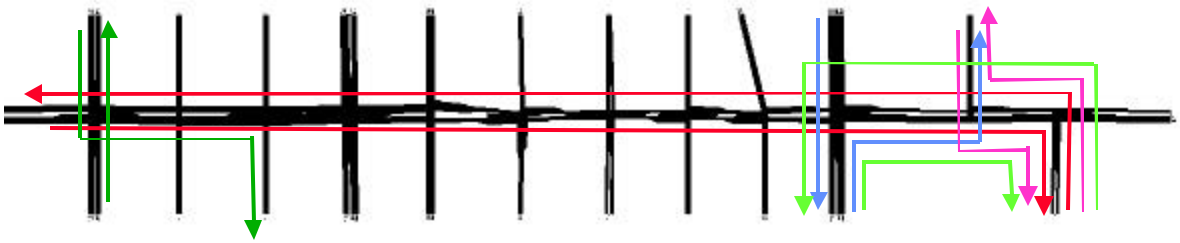

Figure 4 – Bus routes used in the simulation

4 Results

The simulations are done for both current conditions as well as for SPOT/UTOPIA. The current conditions use fixed signal timings. This case forms a basis that is used to compare how well SPOT/UTOPIA performs in Chicago Avenue.

One of the special features of SPOT/UTOPIA is that the green time in each direction is set according to the actual platoon size. This gives fluctuations in the cycle time for each intersection. The key to a good progression is that the intersections are pulsating together.

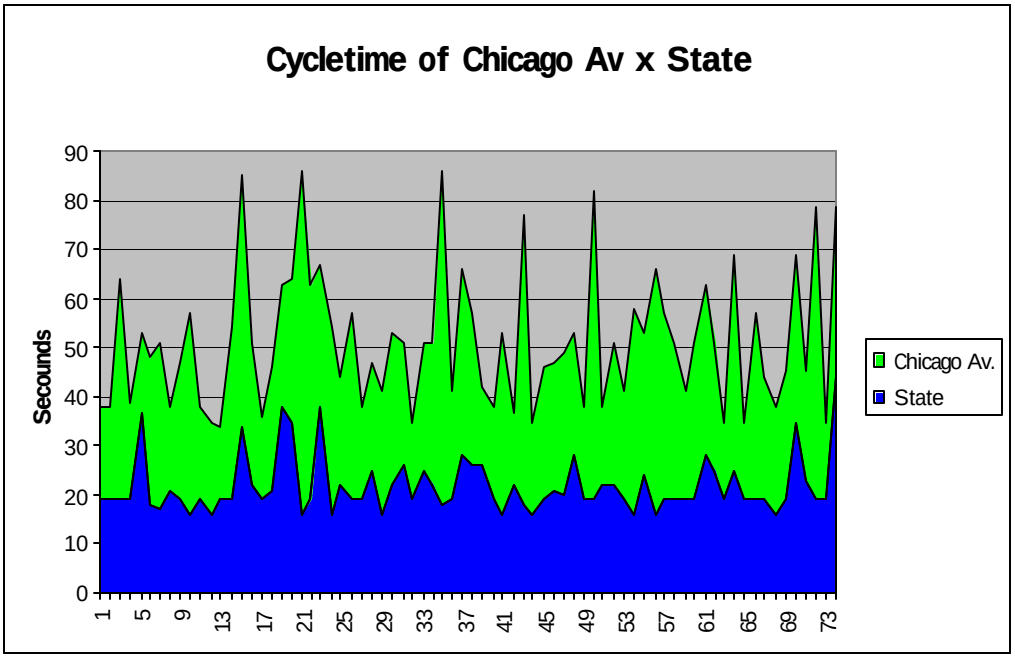

Figure 5 – Variations in cycle time

Comparison of adaptive signalling with original signalling	Changes in travel time - morning rush		Changes in travel time - afternoon rush	
	Public transport	Other traffic	Public transport	Other traffic
Benefits with SPOT	- 13 %	- 15 %	- 15 %	- 3 %

Figure 6 – First simulation results

The simulations show that SPOT/UTOPIA has a potential for reducing the travel time in the area around Chicago Avenue. Although the original traffic signalling is functioning well, the potential for improvements should be regarded as high.

The results from the simulations in the afternoon rush are nearly as good as expected. The enforced restrictions to only give advantages to the public transport, is setting a boundary on how much reductions in the travel time that can be achieved. However, the irregularities in the travel time due to the stop time at the bus stops, makes it hard to give a good prognoses on when the bus needs green signal at the stop line. Some priority efforts are therefore not utilised.

In the morning rush the progression for the public transport is bellow what we expected. This is mainly due to the irregularities in the travel time for the public transport when it is approaching the stop line. Sometime the bus stops at the bus stop just before the stop line, and sometimes they passes the bus stop. This make a large window of needed green time to ensure that all buses passes inhibited. Since such a large green time is not possible to combine with optimisation of the traffic flow, only some of the buses get priority.

In an attempt to give higher priority to the public transport we have tried to relocate the bus stops from the near side to the far side of the intersections. We have also reduced the number of bus stops.

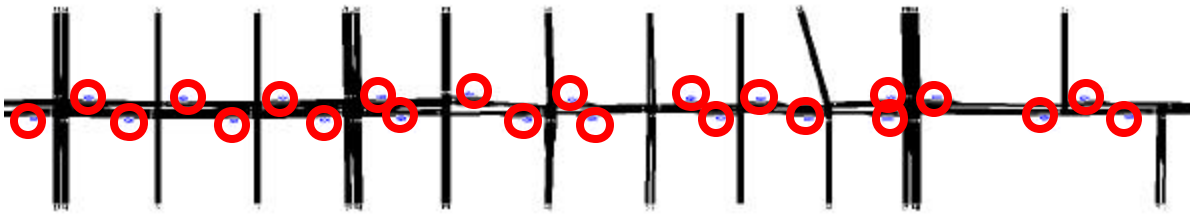

Figure 7 – Original number and location of bus stops

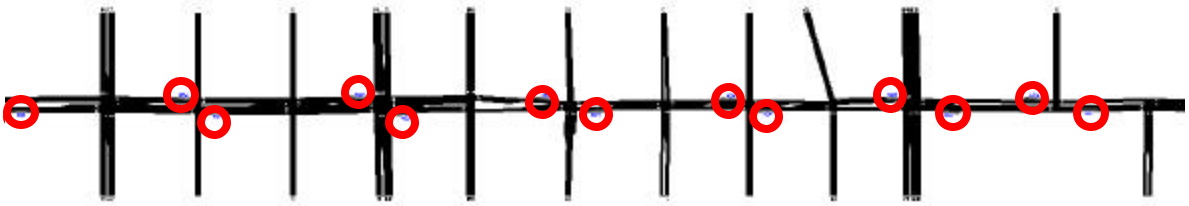

Figure 8 – Proposed relocations of bus stops

The proposed new setting in figure 8 is not well funded in the utilisation of the different bus stops. It is just an example on how one could relocate the bus stops to make a system that is more predictive with regards to the travel time towards the stop lines.

The proposed system gives no changes when we simulate it with fixed signal timings. In this case it is the signalling and not the bus stops that determine how the progression for the public transport should be.

When we simulate the area with SPOT/UTOPIA settings, we get results more in line with our previous European experiences.

Comparison of adaptive signalling with original signalling	**Changes in travel time - morning rush**	
	Public transport	**Other traffic**
Benefits with SPOT	- 22 %	- 14 %

Figure 9 – Second simulation results

With SPOT/UTOPIA the average cycle time is reduced by 15 %. This gives benefits to the pedestrians.

In all the figures we have used the term *Changes in travel time*. It is worth mentioning that this concept includes both the delay and move time. In Chicago the delay time is more or less equal to the move time.

A 22 % reduction in the travel time for the public transport is therefore equal to a 44 % reduction in the delay time. This is quite significant.

5 Conclusions

The Italian signal optimisation system SPOT/UTOPIA has showed to be highly successful in Europe. When we use the payback time to evaluate the economic effects of the installations, we get a payback time of 2 to 3 months in all the cities.

The simulations have showed that an adaptive signalling system like SPOT/UTOPIA can give large benefits for the public transport in Chicago. SPOT/UTOPIA should be regarded as one of several different techniques that can give advantages to the public transport.

The selection of technique to be utilised in the different areas should be based on a local traffic evaluation in each case.

SINTEF is ready to assist if there are any desire to progress further with SPOT/UTPOIA.