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Cooperative systems roll-out in Austria and Middle-Germany: key impacts on environment - first calculations

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Abstract

This paper presents climate-related target impacts from simulation studies in two complementary large-scale regional initiatives on cooperative systems (I2V) within the currently emerging European context. The innovative value-added is to share early results and approaches from rather complementary regional initiatives – in a level of detail that we have not seen anywhere else – for cross-fertilization and harmonization with other teams. In Austria the driving element for setting-up a large-scale cooperative services field test has been the newly emerging opportunity to directly communicate with car drivers in contexts when public transport offers an attractive alternative (thus reducing CO2 emission). Rather soon – while setting-up the field test – it became clear that cooperative services (EASYWAY set) have not only a significant potential in terms of increasing efficiency but also in terms of effectively coping with severe weather conditions. MOSAIQUE has been Germany's flagship cooperative systems activity within what is known as Middle-Germany (with some 14MEuro budget spent). Regional governments' driving rationale has been to better prepare for handling traffic-related challenges as being a main cause for facing bottlenecks in meeting ambitious German environmental and climate targets and agendas. For some mid-size towns the target is to reduce the number of days per year with critically high particulate matter levels by 5 or 10.

Keywords:

Co-operative services; I2V; co-modal routing; green urban mobility; low-carbon mobility; environmental-conscious mobility, ITS deployment; impact assessment; FESTA-methodology.

Emerging situation in Middle-Germany[1]

In Middle-Germany co-operative services investment has been driven by three threads:

(1) MOSAIQUE – one of the five large-scale German ITS research projects into future traffic management approaches at Halle/Leipzig.

(2) German society repeatedly watching on TV during prime time the unanticipated consequences of millions of drivers trying to escape from severe winter conditions on German highways – heavily aggravated by unanticipated consequences from thousands of car drivers using Google's routing services (in January 2010, in December 2010).

(3) Strict and very ambitious targets in terms of legal C02 emissions and air pollution in Germany.

In MOSAIQUE (Halle/Leipzig) the guiding study question was: What can be gained from intelligent traffic management for this region? Where MOSAIQUE's approach differs from Google's free-rider approach is (1) in delivering dynamic infrastructure-related traffic information into the cockpit as well as (2) using information from participating drivers to improve the overall picture and traffic status information as input for improved traffic management. Purpose is not to provide services for individually outsmarting traffic jams but generating routing information that is in line with a town's environmental targets – however, without establishing heavily restricted traffic areas. As a consequence of this new form of traffic management and route guidance traffic jams, necessary stops and resulting acceleration and deceleration should be significantly reduced. An outstanding feature in the MOSAIQUE

[1] The region of Middle Germany consists of the three states Saxony, Saxony-Anhalt and Thuringia, which were the former German Democratic Republic's industrial core. Meanwhile the region's industry production outperforms Germany's nation-wide 20 per cent benchmark. Therefore efficient traffic infrastructure is a key factor in keeping and attracting industrial manufacturers. Additionally the region hosts two strategic European transit corridors (from East to West and from North to South). In the last two decades (after the German unification) the investment to rebuild and brush-up this infrastructure has almost been completed and now ITS-investment takes an increasingly important role. Environmental and traffic-related challenges in this region come from high traffic load on the highways (A2, A4, A9, A14), the environmental challenges in bigger towns (e.g. Erfurt, Leipzig, Halle, Magdeburg, Dresden), accident rates above national average and declining population numbers in rural areas (difficult financing of public transport).

approach – especially for Halle/Saxony Anhalt – has been the joint optimization for public transport and individual mobility – both integrating real-time traffic information (7), (9), (11). Erfurt (Thüringen) has been rather ambitious when it comes to reducing air pollution by means of intelligent traffic management. For Erfurt an additional focus is on intelligent traffic management for some of those days when particulate matter levels is anticipated to be beyond target values. A third element in monitoring traffic status is NOX (average per year).

Emerging situation for co-operative systems' environment impact in Austria

In Austria a large-scale field operational test on co-operative systems started in March 2011 - funded by the Austrian Climate and Energy Funds. In this national funding program co-operative systems were picked because they offer the missing link towards those mobility consumers who do not yet use public transport to its full potential (e. g. when there are traffic jams).

The FOT "Testfeld Telematik" was selected by the funding agency because it nicely integrates all results from preparatory projects (transport capacity, information layer, maps, routing information) and provides the strongest leverage for climate policy. Users in the Vienna metropolitan area can now plan and adapt individual trips on the fly – all based on real-time traffic information and infrastructure bottlenecks. The multitude of on-board units and smartphone apps are anticipated to significantly contribute to a more conscious form of ecomobility.

From a historical perspective this large-scale FOT builds on four strong elements in Austrian co-operative services.

(1) A strong telematics industry cluster whose members were the backbone of EC's three integrated projects on I2C co-operative services. (1)
(2) ASFINAG – the national motorway operator – has played a leadership role in European telematics and especially co-operative systems agenda for more than a decade. Marko Jandrisits from ASFiNAG – the Austrian FOT's project coordinator – has also chaired the working group on co-operative services in EASYWAY.
(3) A study team from TU Vienna (3) investigated the potential reduction from using co-operative services during the COOPERS demonstration test (Innsbruck, Brennerautobahn, EC's IP on I2C co-operative services).
(4) Finally all favourable preconditions in Austria have profited from the opportunity window that ITS world congress 2012 will take place in Vienna, Austria. The key

ambition is to demonstrate that co-operative services (fully compliant with EASYWAY's shortlist) are highly accepted when presented in a state-of-the-art user interface into the cockpit.

First calculation for Austrian co-operative systems FOT's environment impact

A study commissioned in COOPERS revealed that providing I2C co-operative services into the cockpit reduces CO2 by three per cent on average with reductions up to nine per cent at sections where ghost driver warnings are displayed (Pucher et al 2010). Results from a simulator study in Linköpping VTI (2) point towards similar results in the long run. It is anticipated that drivers experiencing the superior validity of accurate real-time location-based recommendations and warnings will come rather close to these nine per cent expected reduction. A first grasp of what can be expected from introducing this type of co-operative services in the southern part of the Vienna region is shown in table 1. The identical overall calculation design was successfully used in the Hamburg area by Plank-Wiedenbeck et al (2010) when estimating impacts for the entire Hamburg metropolitan area. Particulate matters and NOX have not been at the focus of this calculation. Figures presented are actual traffic figures for the Austrian FOT.

Assessing Testfeld Telematic environmental impacts: The 5 MEURO Austrian FOT will soon be evaluated by means of an independent study team – where environmental impacts will be assessed on the traffic system level. Table 1 shows the status quo of cars on the corridor A23/A04/S01 (covering all incoming traffic from the south and the east of the Vienna metropolitan region) - totaling 328.000 cars per day. The rest of the table illustrates CO2 quantities involved, when using standard figures how in Germany CO2 emissions for cars are calculated. Three key elements in our first approximation are: (1) currently traffic jams do not impact 55 per cent of cars on this corridor, (2) there is significant idle capacity in terms of park & ride facilities in the south of Vienna and (3) public transport has sufficient capacity to quickly transport additional passengers from these park & ride facilities.

Scenario	Current traffic situaion (Vienna, Motorway Corridor A04, A23, S01)			
Radial Motorway Vienna	Count location (km)			
A04	11,693	Schwechat	Vehicle	95.069
A04	11,693	Schwechat	Vehicle > 3,5t GVW*	10.405
A04	11,693	Schwechat	Vehicle <= 3,5t GVW*	84.664
A23	9,068	St.Marx	Vehicle	198.124
A23	9,068	St.Marx	Vehicle > 3,5t GVW*	14.008
A23	9,068	St.Marx	Vehicle <= 3,5t GVW*	184.116
S01	6,16	Rustenfeld	Vehicle	72.091
S01	6,16	Rustenfeld	Vehicle > 3,5t GVW*	12.404
S01	6,16	Rustenfeld	Vehicle <= 3,5t GVW*	59.687
*GVW=Gross Vehicle Weight				
Number of vehicles entering target area in total	328.467	Vehicles/day		
Share of heavy goods vehicles	11%	%		
Number of heavy goods vehicles	36.817	Vehicles/day		
Number of vehicles entering target area (before)	291.650	Vehicles/day		
Long-term modal shift to public transport	-	%		
Number of vehicles entering target area (after)	291.650	Vehicles/day		

Criteria	Not concerned of traffic jams		Concerned of traffic jams				In total	
			Additional users of park&ride		Direct drivers			
Share	55%							
			-	%	100	%		%
Traffic entering target area	160.408	Vehicles/day	-	Vehicles/day	131.243	Vehicles/day	291.650	Vehicles/day
Average driving distance	35	km	12	km	35	km	35	km
Number of trips	2	Trips/day	2	Trips/day	2	Trips/day	2	Trips/day
Average fuel consumption	7,0	litre/100 km	7,0	litre/100 km	8,4	litre/100 km	7,6	litre/100 km
Share of diesel vehicles	23	%	23	%	23	%	23	%
C02 emmission diesel vehicles	2,7	kg CO2/litre	2,7	kg CO2/litre	2,7	kg CO2/litre	2,7	kg CO2/litre
C02 emmission petrol vehicles	2,3	kg CO2/litre	2,3	kg CO2/litre	2,3	kg CO2/litre	2,3	kg CO2/litre
CO2 emmission fleet of vehicles	2,4	kg CO2/litre	2,4	kg CO2/litre	2,4	kg CO2/litre	2,4	kg CO2/litre
Fuel consumption	785.997	litre	-	litre	771.706	litre	1.557.703	litre
CO2 consumption vehicle/day	1.880	tons	-	tons	1.846	tons	3.726	tons
Number of heavy goods vehicles	20.249	Vehicles/day			16.568	Vehicles/day	36.817	Vehicles/day
Average driving distance	42	km			42	km	42	km
Number of trips	2	Trips/day			2	Trips/day	2	Trips/day
Average fuel consumption	12,5	litre/100 km			15,0	litre/100 km	13,6	litre/100 km
Share of diesel vehicles	100	%			100	%	100	%
C02 emmission diesel vehicles	2,7	kg CO2/litre			2,7	kg CO2/litre	2,7	kg CO2/litre
Fuel consumption	212.618	litre			208.752	litre	421.371	litre
CO2 consumption heavy goods vehicle/day	574	tons			564	tons	1.138	tons
CO2 consumption/day	2.454	tons	-	tons	2.410	tons	4.864	tons
CO2 consumption/year	716.619	tons	-	tons	703.589	tons	1.420.208	tons

Table 1: Status quo at corridor A04/A23/S01 Vienna / "Testfeld Telematik"

However in the impact scenario for Vienna (see Table 2) we used rather conservative estimates (as compared to Hamburg). For the "Testfeld Telematik" we used the rather low figure of 1 per cent car drivers switching to park & ride facilities. In the long run 1 per cent is anticipated to permanently switch to public transport. Improved real-time traffic information in the "Testfeld Telematik" is estimated to increase the number of cars not impacted by traffic jams or traffic jam-related deceleration and acceleration from 55 to 60 per cent. From these two input variations we calculate a reduction of CO2 emissions in the order of 27 tons CO2 per year or

roughly some 2 per cent (from 1.420208 million tons CO2/year down to 1.393010 million tons/year – last line column to the right).

Within the political discourse and in other teams' preparatory studies significantly higher figures were communicated – e.g. 6 to 30 per cent are said to be ready for modal shift. We need to add 3 to 9 per cent from the TU Vienna study (Pucher et al 2010) to our conservative estimate of 2 per cent. Overall co-operative services in Vienna could reduce CO2 emissions by some 5 per cent – even from a rather conservative point of view. In this model any increase of traffic jams – either from increases in traffic, from construction work, severe weather conditions or imposed legal restrictions – would probably make modal shift even more attractive - thus reducing CO2 emissions even further.

Scenario (conservative)	Impact of co-operative services at the corridor Vienna: Motorways A04, A23, S01							
Number of vehicles entering target area in total	328.467	Vehicles/day						
Share of heavy goods vehicles	11%	%						
Number of heavy goods vehicles	36.817	Vehicles/day						
Number of vehicles entering target area (before)	291.650	Vehicles/day						
Long-term modal shift to public transport	1	%						
Number of vehicles entering target area (after)	288.734	Vehicles/day						
Criteria	**Not concerned of traffic jams**		**Concerned of traffic jams**				**In total**	
			Additional users of park&ride		**Direct drivers**			
Share	60%							
			1	%	99	%		%
Traffic entering target area	173.240	Vehicles/day	1.155	Vehicles/day	114.338	Vehicles/day	288.734	Vehicles/day
Average driving distance	35	km	12	km	35	km	35	km
Number of trips	2	Trips/day	2	Trips/day	2	Trips/day	2	Trips/day
Average fuel consumption	7,0	litre/100 km	7,0	litre/100 km	8,4	litre/100 km	7,6	litre/100 km
Share of diesel vehicles	23	%	23	%	23	%	23	%
C02 emmission diesel vehicles	2,7	kg CO2/litre	2,7	kg CO2/litre	2,7	kg CO2/litre	2,7	kg CO2/litre
C02 emmission petrol vehicles	2,3	kg CO2/litre	2,3	kg CO2/litre	2,3	kg CO2/litre	2,3	kg CO2/litre
CO2 emmission fleet of vehicles	2,4	kg CO2/litre	2,4	kg CO2/litre	2,4	kg CO2/litre	2,4	kg CO2/litre
Fuel consumption	848.876	litre	1.940	litre	672.310	litre	1.523.127	litre
CO2 consumption vehicle/day	2.031	tons	5	tons	1.608	tons	3.643	tons
Number of heavy goods vehicles	22.090	Vehicles/day			14.727	Vehicles/day	36.817	Vehicles/day
Average driving distance	42	km			42	km	42	km
Number of trips	2	Trips/day			2	Trips/day	2	Trips/day
Average fuel consumption	12,5	litre/100 km			15,0	litre/100 km	13,5	litre/100 km
Share of diesel vehicles	100	%			100	%	100	%
C02 emmission diesel vehicles	2,7	kg CO2/litre			2,7	kg CO2/litre	2,7	kg CO2/litre
Fuel consumption	231.947	litre			185.558	litre	417.505	litre
CO2 consumption heavy goods vehicle/day	626	tons			501	tons	1.127	tons
CO2 consumption/day	2.657	tons	5	tons	2.109	tons	4.771	tons
CO2 consumption/year	775.777	tons	1.355	tons	615.878	tons	1.393.010	tons

Table 2: CO2 impact scenario from co-operative services at the corridor A04/A23/S01 (conservative scenario)

First impact calculations for Middle Germany

To illustrate the guiding rationale for Middle German mid-size towns (100,000 to 500,000 inhabitants) we here present elements from preparatory work on Erfurt/Thüringen. In this town Erfurt significant efficiency gains have been due to improved traffic infrastructure and public transport. Environmental impact assessment from this type of investment can be measured ex-post – however rather in the long run.

However, all success has not been sufficient: on a significant number of days per year particulate matter levels are critically above thresholds. This is due to typical 'continental climate'. Figure 1 shows results from the measurement installation Erfurt-Bergstraße: on 326 days the particulate matter level was sufficiently below the threshold of 50 micrograms per square meter (324 measurements and 2 special cases) (8), (10). The high level on 39 days is beyond the legal limit of 35 days per year. As a consequence penalties will have to be paid by the municipality for the years to come – thus adding to the business model for rolling-out cooperative services in cities.

Improved traffic management by means of co-operative services therefore faces the short-term bottom-line target of reducing critical particulate matter levels on at least 4 days per year. 4 days amounts to some 1 per cent of a year, however typically under challenging climate-related conditions. Such a reduction of 1 per cent per year will have its immediate financial benefit for the municipality.

This approach was selected as a result after a feasibility-study in 2010 (done by University of Weimar in co-operation with pwp-systems). As a result a pilot test in the area of Bergstraße started in February 2012. Two modules were set up: a traffic-management-system and an environmental-monitoring-system. First results – after six months operation – have confirmed the expected outcome and impacts. The pilot is expected to be continued and extended in 2013.

In more technical terms the purpose is to significantly reduce stops, frequent acceleration and deceleration from approaching traffic lights and dense traffic. Three significant constraints contribute to this bottleneck-approach: (1) shifting traffic to other areas of Erfurt is considered inappropriate, (2) individual traffic can never be prioritized towards public transport and (3) mobility in its role for economic prosperity and quality of life cannot possibly be restricted.

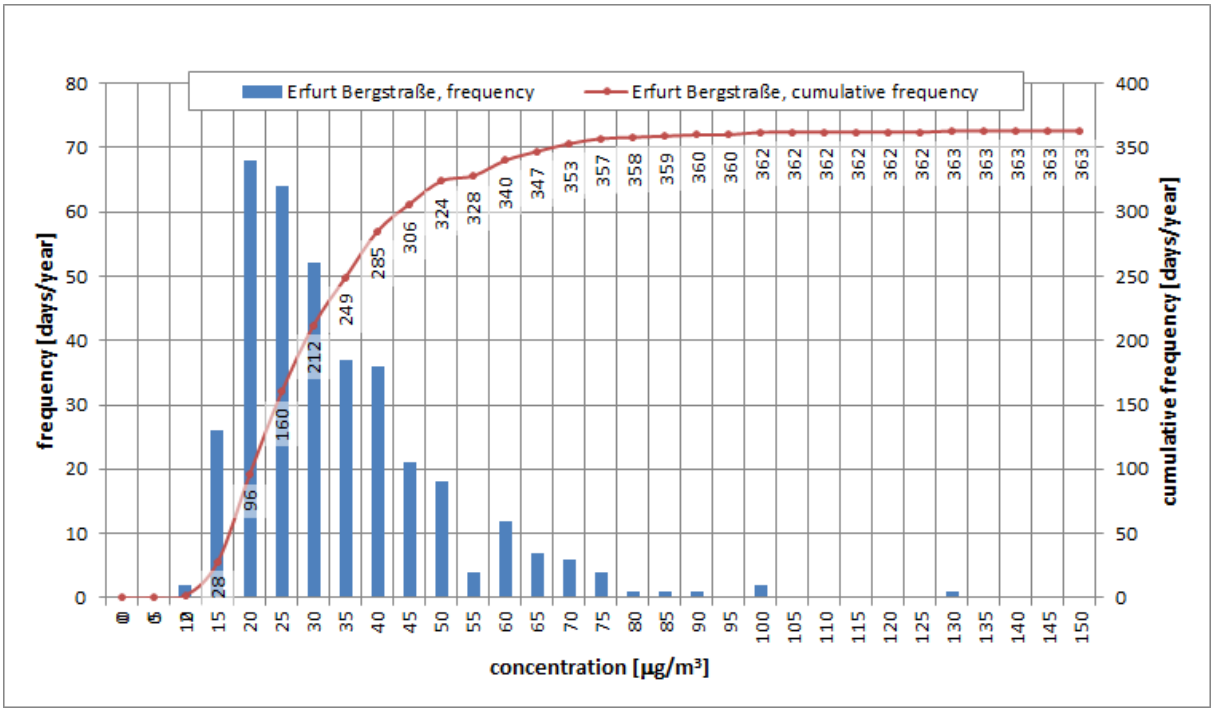

Figure 1: particulate matter level (PM10-concentrationen) at Erfurt-Bergstraße in 2009 [source: TLUG; cumulative number of days plotted against PM thresholds]

Outlook into a European Dimension

From a European dimension we here have two pioneering groups. The Austrian "Testfeld Telematik" follows a service quality-oriented road map while rolling-out co-operative services. The climate aspect comes in mainly in situations when mobility behavior change offers immediate advantages to the driver. In Middle-Germany the climate-related rationale rather leads to a soft form of interventions; - soft as compared to static bans for individual car traffic. Both approaches capitalize on results and lessons learnt in EC's infrastructure-to-car flag ship project COOPERS. Climate-related improvement presented in our paper might be less than expected in ambitious political agendas. However, co-operative systems demonstrate how elegantly intelligent infrastructure-to-car investment can be used to successfully cope with societal challenges and bottlenecks. It is anticipated that extreme weather conditions will become more frequent – another opportunity window for marketing co-operative services. The authors are looking forward to joining forces with other European pioneers in the field of infrastructure-to-car co-operative services and to discussing and forging on our measurement approaches in Vienna.

Conclusions

From the short description of what has been going on in two different pioneering regions in Europe we tend to draw the following conclusions:

- EC's initiatives (ITS Action Plan, ITS Directive (4), (5), (6)) have successfully fuelled local authorities' and their preferred partners' preparatory bottom-up exercises for coping with key safety, efficiency and climate-related bottlenecks by means of cooperative-systems and next generation traffic management.
- Some transport-policy stakeholders pushing for rapid deployment of cooperative-systems (requested shift from research to technology deployment) tend to neglect the knowledge-related challenges for sound local traffic management as a basis for adequate recommendations to car drivers.
- (Even after) large-scale lighthouse projects (COOPERS, MOSAIQUE) there seems to rather exist different qualified options for different cultural and economic contexts. However the common ground seems to be (1) Sharpen strategic focus among various local authorities and partners (2) Need for significant public spending (3) Importance of key-individuals.
- The Austrian model might qualify for pioneering industrial road operators in climate-conscious forerunner regions (money from national climate funds), while the Saxony-Anhalt model (EFRE / ERDF: European Regional Development Funds) might qualify for pioneering regions with state-owned road infrastructure in economically weaker European regions with heavy transit traffic.
- An informal open exchange between key stakeholders from regional initiatives has proven fruitful and highly complementary to what has been on the agenda of official network activities (FOT-Net, large-scale European FOTs' dissemination and networking events EuroFOT, TeleFOT, FOTSIS).
- Even pioneers tend to draw different conclusions from standardization-related risks. While key stakeholders in Saxony-Anhalt maintain that the risk and cost from waiting for sufficient European or international standardization is high and therefore proceed

with their implementation, Austrian nation-wide highway operator ASFINAG (with plenty of cross-border tourists and transiting traffic) now reaches out for joint activities on the level of European pioneering countries. Having at least a harmonized technological subset is here considered a pre-requisite for a commercially viable national roll-out investment decision.

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