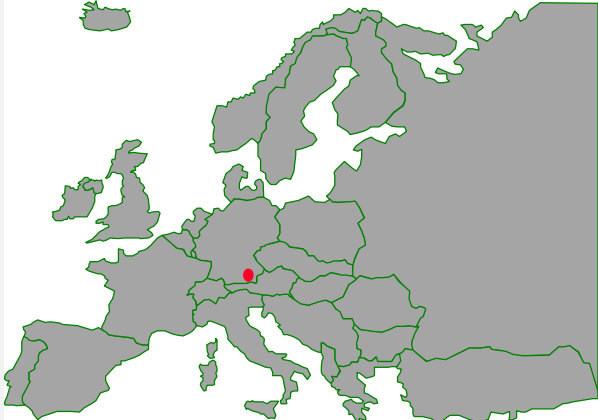


<p>DEMONSTRATION SITE:</p>	<p>(FROTTMANING P+R STATION, MUNICH ON THE A9 MOTORWAY) MUNICH/GERMANY</p> 
<p>NAME OF THE DEMONSTRATION PROJECT (CASE STUDY):</p>	<p>DYNAMIC VMS FOR P+R INFORMATION SYSTEM</p>
<p>DURATION OF THE PROJECT:</p>	<p>1994 - THE P+R SYSTEM WITH VMS INFORMATION ON SPACE AVAILABILITY WAS IMPLEMENTED. 1996 – SYSTEM EXPANDED TO DISPLAY A WIDER RANGE OF INFORMATION ON SPECIAL EVENTS ETC.</p>
<p>NAME OF THE TAP PROJECT:</p>	<p>TABASCO</p>

URBAN PROFILE

Munich has a population of 1.296.710 million inhabitants and is the capital and major centre of Bavaria. The city is home to industrial manufactures like BMW, Siemens, MAN and is a centre for banking, high technology development and services.

ABSTRACT

The dynamic VMS for P+R Information System at the P+R station of Munich-Frottmaning on the A9 motorway was chosen in the framework of the TABASCO project as a demonstrator for examining the effectiveness of VMS in conjunction with P+R sites on the periphery of regional centres. The P+R station has 1270 car spaces and 80 spaces for tourist buses. It is linked to a new underground station of the Underground Line U6.

The flexible VMS signs inform drivers about available capacity in the car park (number of free spaces for cars and buses) and public transport (e.g. present frequency of service, destination, closure, breakdowns). Additionally, messages can be displayed on events or the traffic situation in the city centre and motorway. The system is now in continuous daily operation and working to a reliability level of 96%.

Evaluation of the system shows high user satisfaction and a strong impact of the signs both in raising awareness of the P+R and shifting car drivers to P+R during special events. Even without consideration of considerable potential socio-economic benefits, hard economic analysis shows the system to pay back comfortably in Munich with consideration of reduced PT operating costs. It is estimated that 2% of the overall traffic in the relevant part of the network is being captured by the P+R system of which 23% can be directly attributed to the VMS information system.

The highly flexible, freely programmable dynamic information signs used in this demonstrator are relatively expensive (300,000 EUR for the three signs) and therefore they are suitable only for

high capacity P+R (500+ spaces) with a high quality PT connection. In smaller cases and places with lower PT revenues where hard economic justification cannot be made, it may be worth considering a less flexible but cheaper VMS solution.

BACKGROUND AND OBJECTIVES

The TABASCO project has a dual aim : the user-orientated validation of transport telematics systems implemented in cities and in their surrounding regions, and the integration of these systems to produce a more efficient transport system as a whole. The Munich VMS / P+R project was defined as an ideal demonstrator within the framework of TABASCO for examining the effectiveness of VMS in conjunction with P+R sites on the periphery of regional centres.

The mission of the project was to build up an information system with the aim to provide information to drivers on the A9 motorway to improve the acceptance of P+R, encourage modal shift from car to public transport and to improve safety and comfort of drivers.

Measurable targets were defined as following for the different players in the project:

Player	Target
Traffic authorities	Efficient and effective operation of the system. Reduced overall congestion on approach to the city.
P+R users	Improved journey times, journey reliability, reduced journey cost.
Non P+R users	Reduced congestion/improved journey times/ journey reliability
P+R company	Increased capacity utilisation of the P+R facility

PRESENT STAGE OF IMPLEMENTATION

The system is now in continuous daily operation and working to a reliability level of 96%, which can be considered very satisfactory.

Data on the status of the car park is now being sent to the traffic management centre TIP/SSC in the city district administration. There it can be used for strategic planning purposes.

In the framework of the new traffic management project MOBINET in Munich, discussions are running to extend the Fröttmaning P+R information system by installing an additional VMS in the North of the adjacent motorway intersection Munich North and thus providing the drivers with route recommendations concerning the new Munich Trade Fair Centre (recommendation of public transport under defined traffic conditions).

Financing and Resources Used

The following overall costs for the P+R information system are available

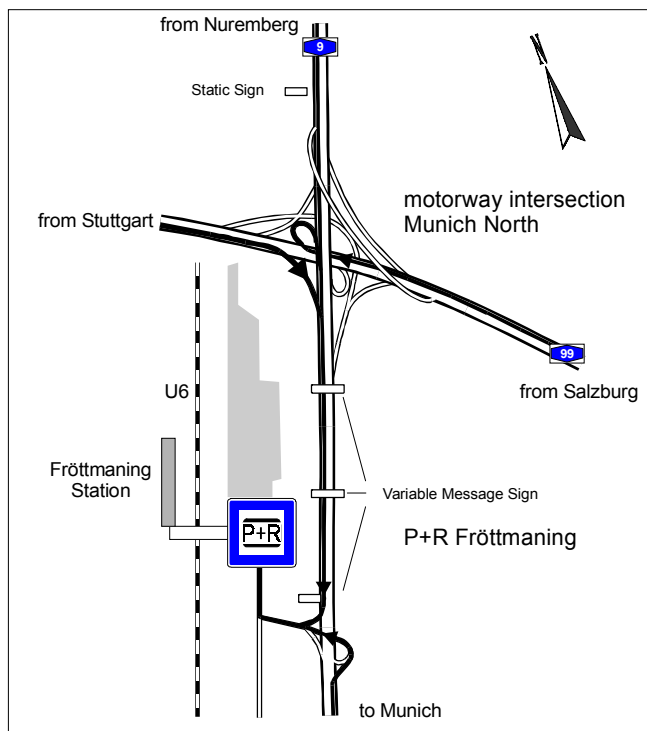
Cost categories	EUR / year
Depreciation based on the investment and service life.	45.000
Operating costs	10.000
Costs for preventive and corrective maintenance	10.000
Total	65.000

The new underground station and the new car park were completely financed by the City of Munich. The costs for the motorway infrastructure (VMS, wires, computers) were covered by the Free State of Bavaria while the laser scanner detectors in the car park were financed by Signalbau Huber (electronic industry). The work on research and development was funded to a small amount in the framework of LLAMD and TABASCO. Additional money was provided by the City of Munich for extensive interviews and evaluation studies.

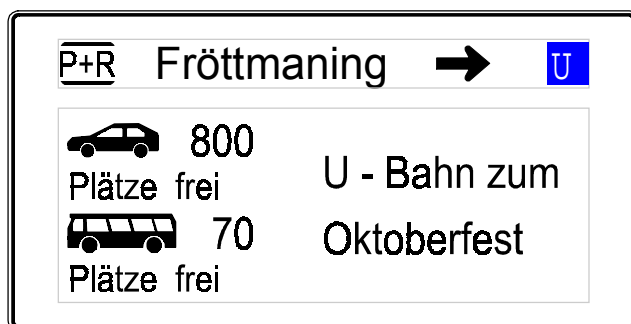
TECHNICAL PROFILE OF PROJECT

Dynamic P+R and traffic information is presented on two large-scale matrix display units placed on the motorway, 950m and 280m before the exit for Fröttmaning. They inform drivers about available capacity in the car park (number of free spaces for cars and buses) and public

transport (e.g. present frequency of service, destination, closure, breakdowns). Additionally, it is possible to display messages about events or the traffic situation in the city centre and motorway, thus underlining the advice to use P+R. A third display unit next to the exit currently repeats the information "free/complete/closed" for cars and buses. Parking space monitoring is made at the entrance and exit to the P+R with ultrasonic and laser detectors. Furthermore, in the case of a hazardous situation on the motorway the display shows a warning with very big letters. In this case no P+R information will be given.



The capacity of the P+R centre is 1270 car spaces and 80 spaces for tourist buses. It is linked to a new underground station of the Line U6 which has a service frequency of five minutes in peak hours and ten minutes during normal times. The travel time to the city centre (Marienplatz) is 17 minutes.



Laser detectors at the exits and entries count the number of vehicles arriving and leaving, thus providing the system with the necessary data to monitor free capacity (See Figure 2.3.4). As both cars and buses are admitted to the P+R-Terminal, these detectors distinguish between different classes of vehicles.

P+R information system Fröttmaning – VMS Display

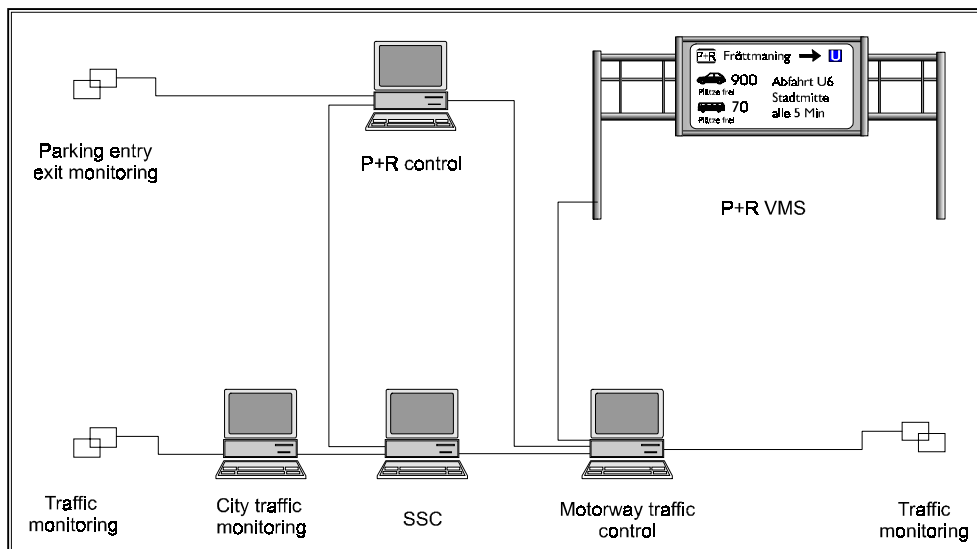
The first and second VMS display have a net display area width of 5.5 m and a height of 2.4 m. The third has a net display area width of 3 m and a height of 1,92 m. The whole display area is

freely programmable and the layout and character sizes can be modified at any time. Magnetic flip elements were chosen as display technology for the information signs. These are widely used in small-sized displays, for example within parking guidance systems, and therefore have a proven record of reliability.

The information system on the motorway A9 is operated by the Motorway Traffic Control Authority and the P+R company. The system can also be operated by the Strategy and Service Centre which is under the control of the City of Munich and the Free State of Bavaria. The three parties can all communicate with each other and all have the possibility of manual or automatic update of the displays with information relevant to their sphere of authority.

The main control of the P+R VMS is, however, via the motorway control computer, although the main user of the VMS is the P+R company. About 95% of the information shown is demanded by the P+R company. This line-up has been chosen because the motorway authority is the only institution allowed to operate signs at motorways.

The use of P+R is free of charge. A cafeteria and a dynamic public transport information system called „EFA“ (Electronic time-table information) complete the service offer. Some spaces are reserved for women and disabled people to park their cars. The facility is video monitored and 24 hours per day operating and security personnel are in the facility.



Control of the information system A9 - computer structure

RESULTS & IMPACTS

Various validation data and information about the performance of the system and the impact on its users was collected using the following channels on a before and after comparison basis :

- Survey of decision makers
- Survey of traffic authorities
- Survey of operators
- Survey of P+R and non P+R users
- Automatic and manual traffic data collection
- Automatic and manual data collection concerning the system performance

The increase of revenue by the MVV (Munich PT authority) is 370 KECU / year, while the DB (train operator) is losing 120 KECU / year due to the P+R system; and of this 90 KECU / year, respectively 25 KECU / year are attributed to the information system.

The annual cost for the Munich P+R information system lies around 65 KECU/a, and this includes depreciation of the installation costs (assuming a service life of 10 years) as well as operating and maintenance costs. The benefits through the reduction of vehicle operating costs alone, attributed to the information system is 82 KECU/ year, i.e. 26 % higher than the system costs. This ratio would clearly be increased further, if benefits from reduced travel times could be taken into account as well; but although P+R users experience a substantial travel time reduction at least during peak hours, the data was not conclusive enough to allow a reliable estimate of these additional benefits.

The modal shift that resulted from the introduction of the P+R system in Munich was estimated to have reduced the number of private vehicle kilometres by 2.4 million veh*km/year, which equates to 2% of overall traffic in the relevant part of the network. It was further estimated that 23% of this shift would not have been achievable without the dynamic P+R information. Journey times for P+R users are roughly the same as with car use during off-peak hours, while in times of high traffic volume P+R users can gain around 25 to 30%.

Environmental impacts are summarised in the following table :

Reduction of pollution	by the P+R facility Fröttmaning	by the VMS information system
CO ₂	- 860 t/year	- 200 t/year
CO	- 6,8 t/year	- 28 t/year
Nox	- 0,4 t/year	- 1,6 t/year
HC	- 0,9 t/year	- 3,8 t/year
Fuel (petrol and diesel)	- 210.000 litre/year	- 50.000 litre/year

The information provided by the signs was found to be generally very useful by drivers, especially the additional information on road conditions, special events etc. In fact in the period of special events (such as the October Fest) the use of the P+R facility was seen to double. 90 % of those questioned considered the content of the signs to be good and useful.

The P+R company as the operating authority of all P+R facilities in Munich is very satisfied with the dynamic P+R information system Fröttmaning and the results of the demonstration. With the system, the P+R company could increase the use of the P+R facility by about 20 % to 50 % (during special events). Because the facility is often used only to 50%-70% of its capacity the information system leads to a considerable and necessary improvement.

On the question 'How did you get knowledge of the P+R centre Fröttmaning' about 47 % of P+R users answered that the P+R information system was their only source of information and a similar percentage were convinced to use P+R by this system. This is clear evidence that the information system is fulfilling its mission to improve the acceptance of P+R.

BARRIERS & CONFLICTS

The different and sometimes conflicting responsibilities and demands of different users of the system and integration of different systems proved the most difficult problems to overcome in the duration of the project.

One problem with dynamic information on motorways is the current uncertain legal situation concerning information systems on motorways in Germany. In the Fröttmaning field trial a P+R information system has been installed on a motorway for the first time in Germany. At the moment, strictly only traffic and direction information systems are allowed on motorways but no systems which give information on other subjects like P+R, public transport or special events.

All problems were overcome for the realisation of the project.

TRANSFERABILITY

Dynamic P+R information with freely programmable, large scale VMS is recommended for large car parks with reliable data collection. The link to a public transport facility with a high capacity and frequency is required for a good acceptance.

Adaptation costs (adaptation of existing parking monitoring systems for example) and planning costs, depending on the scale of implementation will all be required in the process of transferring the system.

Due to the high investment costs for the dynamic information displays (300,000 EUR) the implementation is only recommended for P+R centres with a capacity of more than 500 spaces. In order to reduce the investment costs there is also the possibility to apply cheaper displays, e.g. displays which combine static information with a dynamic display. In places with lower PT revenues per passenger where implementation can be achieved only with hard economic justification, it may be worth considering a less flexible but cheaper VMS solution.

The city can provide advice, detailed reports on the system and extensive evaluation results.

LESSONS LEARNED

A shift from car traffic to public transport is possible to an extent. The benefit of such systems can be higher than their costs, if the basic conditions are right and the user needs have been taken into account. The display of information on the cost and availability of the P+R is essential to uptake of such a system, which is highly utilised by occasional visitors (business trips, adverse traffic conditions and special events)

Travellers, both car drivers and public transport users, need more information. They want to know which options they have and which are the conditions for their use:

- road: traffic situation, shortest and/ or fastest routes
- public transport: lines, frequencies, fares
- P+R: free capacities, fees
- events: location, duration, effects on traffic

For traffic authorities, information and guidance systems provide a very good tool to influence the traffic in general and the modal choice in particular.

On the strategy level, it is essential that user needs and conditions set by the existing infrastructure are analysed for every single application. There is no system that satisfies all requirements, but careful planning will help to achieve the highest possible benefit for a wide range of user groups.

For the detailed planning, the early integration of all affected authorities is essential to avoid co-ordination and organisation problems during the realisation and operation. Usually, a wide variety of institutions, such as city and motorway traffic authorities, P+R and parking operators as well as representatives of interest groups like automobile clubs are affected by the implementation of new traffic systems. If they are all integrated in the planning, realisation and operating process at the earliest possible stage, then this will help to ensure widespread acceptance of the system.

With regard to user acceptance and in addition to taking appropriate account of the expected user needs, it is very important that any information and guidance given to travellers is useful, comprehensible and reliable.

If travellers receive wrong information only on a small number of occasions, the acceptance of any information and guidance system will decrease rapidly during operation. One major point in this context is the data collection. Only a comprehensive and reliable input ensures a reliable output! And finally it should be noted that in many cases it is possible to increase the acceptance of new traffic systems further with appropriate public relations and public awareness campaigns.

ADDITIONAL INFORMATION

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Bibliography and pictures :

1. Kempter, Signalbau Huber, Hardt, SSP, LLAMD Deliverable No. 4006, System Design of P+R Information System, 1993, Munich
2. Hardt, SSP, Kempter, Signalbau Huber, LLAMD Deliverable No. 4007, Impact Analysis of P+R Information , 1995, Munich
3. Kempter, Signalbau Huber, Hardt, SSP, Dynamic P+R-Information, Proceedings for the European Conference on Advanced Telematics, 1995, Munich
4. Hardt, SSP, Kempter, Signalbau Huber, Dynamic P+R-Information, The Second World Congress on Intelligent Transport Systems, 1995, Yokohama
5. TABASCO, Deliverable 04.1, P+R Information: user needs and functional specification, 1997
6. TABASCO, Deliverable 04.2, P+R Information: tests, demonstrations and first results, 1998
7. TABASCO, Deliverable 04.3, P+R Information in TABASCO: results of demonstrations and evaluation, 1998