Down to the

last penny

State budgets are tight, yet new roads and infrastructure cost money. One possibility is a comprehensive vehicle tolling charge. Proven technology for a number of solutions is available today.

Tolling charges can be a divisive issue. Just a few months ago a project for a complex, extensive tolling system in Holland, though already well underway, was put on hold for an indefinite period following massive protest. Yet transport researchers and tax experts have long been convinced that, since many countries are struggling with empty state coffers, there may soon be no way of getting around a universal road-use toll for all vehicles. But how can such a toll be calculated to make it both fair and effective, and which system offers the best options for the future?

The vignette toll sticker used in countries like Austria, Slovenia and Switzerland requires no corresponding infrastructure yet ensure regular public revenue. With this prepaid method, drivers are granted use of certain roads for a fixed period of time on payment of a flat sum. The sticker is placed on the windshield as a sort of visible voucher. But when it comes to detecting toll evaders, efficient systems have their price tag. Siemens was commissioned to install a video camera system for electronic toll monitoring in London's low-emission zone. The camera system records the license plates of passing vehicles, transfers the information via data cable to a data bank, and checks whether the driver has paid the compulsory congestion charge.

Prepaid solutions like this are able to respond to environmental and economical demands by using specially adapted tariff bands depending on vehicle weight or pollutant emissions. After all, hybrid sedans, 40-ton trucks and electric cars affect the environment to very different extents. The system clearly benefits those who drive a lot, as the flat charge means it does not matter how high the mileage is within a defined zone and time frame.

DSRC systems: short ranges

This is not the case with tolling systems that calculates the toll amount on site, depending on distances. On freeways and highways in Austria and the Czech Republic, truck tolling systems operate with microwave technology using microwave transponders – a system know as Dedicated Short Range Communication (DSRC). These transponders are installed on toll gates spanning the driving lanes and toll-paying vehicles are provided with an on-board unit (OBU) that communicates with the microwave transponders.

Christoph Wondracek, head of Global Tolling Systems at Siemens Mobility in Austria, explains the advantages and disadvantages of this type of system: "Microwave systems with their short ranges are best suited to situations where the operator wants to cover road sections with few entrances, such as bridges, tunnels, a clearly defined road network or individual highway sections belonging to private concession holders."

Tolling systems provided by Siemens that are based on the existing infrastructure have been operating successfully for years on the Brenner Highway and on the Arlberg and Felbertauern roads. "Yet for national projects aiming to implement general road-user charges, the cost of the technological infrastructure required would be enormous," adds Wondracek. For each section of the network where tolls are to be charged, whole new cable connections would have to be laid, toll gates built and transponders mounted. Every subsequent road widening would also involve a costly conversion of the tolling technology in place.

This is where satellite-supported methods differ, such as the truck tolling system in Germany operated by TollCollect. In this method, the position of the individual vehicles is determined by

Christoph Wondracek, Siemens Mobility, Tolling Systems

a global navigation satellite system (GNSS), therefore avoiding the need for stationary infrastructure for toll charging. The infrared toll gates on German roadways only have a control function in the system. "There is some highly intelligent technology in the on-board units for satellite systems," assures Wondracek. "The OBU determines the vehicle's position with GNSS data and compares it with the geo data saved internally. The device then detects whether the route is subject to tolling charges, calculates the charges during the journey, and transfers this information in code via mobile radio to a computer center."

> "Satellite systems offer all the technology we need for fair toll regulations in Europe.

It has been clearly demonstrated that GNSS systems can operate not only on individual sections of road but also on entire regional networks. As part of a large-scale model test in 2005, Siemens engineers used this technique to record over 400 vehicles on more than 5,500 kilometers of road in 6,000 toll sections around Seattle, in northwest of the United States – the world's first regional tolling system. Perhaps the most interesting result from this, however, was that the central management system developed by Siemens proved to be highly flexible, even in the test phase, as the tariff structure changed or as the toll region was extended.

In practice, this means that higher tariffs can be set during rush hours, for example, on route sections and entrances in metropolitan areas where there is a good public transport service. This would mean that public transport would offer commuters an even more economical alternative and would therefore also help to reduce congestion. On the other hand, car owners in poorly served rural areas who are very dependant on their cars could benefit from very low charges per kilometer all day. The really special advantage of the solution is that the operator can adjust the toll area or tariff structure overnight with a simple software update. This method offers even further advantages in terms of data protection, explains Wondracek: "For billing, all that needs to be transferred is a user ID, the time and the tolling charge."

Satellite solutions: tried and tested

The most modern version of this type of GNSS-supported method is the SkyToll system for vehicles with a total weight of over 3.5 tons in operation in Slovakia since January 2010. For this, Siemens provided not only the on-board units for the vehicles but also the detection software. This project replaces the previous sticker solution and also brings a unique new advantage: electronic toll charging covers highways as well as a network covering 2,400 kilometers of roads across the country, including secondary roads. It became evident how easily a complete tolling system can be installed. Only one month after the contract was issued, Siemens engineers tested the entire system, clocking up some 19,000 kilometers on more than 7,500 toll sections.

One of the main advantages of the on-board units used is their user-friendliness. Like mobile navigation devices, they can be connected simply to the vehicle's power supply. There is no need for a fixed connection to a tachometer, etc. Nonetheless, all toll-paying road sections are saved in these efficient OBUs as geo data. The toll-recognition software from Siemens regulates reliable communication via GSM to the accounting center's main computer and sends encoded information on the sections traveled, the vehicle category and the time of detection. A distinct electronic signature assigns the information transferred to the relevant user.

"As far as the technical design is concerned, the satellite-supported OBUs in use in Slovakia are capable of a great deal more," informs Wondracek. "They can work together internationally with other tolling systems in Europe, including the microwave version in the Czech Republic and Austria. All that is need is a software update." Even city-toll projects in Europe's densest cities can be integrated without problems into this satellite-supported solution from Siemens – after all, Slovakia's tolling system already operates today with a detection accuracy of 99.85 percent. If the European Galileo Project is launched soon with its extra 27 navigation satellites, further special telematic applications may also be possible, such as for registering the transport of hazardous materials or signaling an alarm for accidents. Wondracek is convinced "that satellite systems offer all the technology we need for fair toll regulations in Europe. The technology is definitely there." Implementing it however, is not the job of the engineers, but of the politicians. □

Tolling systems: Pros and cons

- **Vignette stickers:** Prepaid voucher system
+ Simple, can be implemented without technical infrastructure
– Monitoring is expensive
– Does not really enable traffic control
– Frequent drivers benefit, intermodal mobility is disadvantaged

- **Video control:** Video-supported detection for access control and toll surveillance
+ No on-board devices required
+ High license-plate recognition rate
– Stationary infrastructure required (gates, cameras)
– Detection only possible in a limited area

- **Microwave systems:** Detection and toll calculation for short distances (DSRC)
+ Charging according to use is possible
– Section-dependent rather than usage-dependent detection
– Expensive stationary infrastructure (gates, transponders, long-distance cables)
– Changes are costly

- **Satellite-supported systems:** Positioning via satellites, toll calculation in the vehicle
+ Can be used over large areas
+ No stationary infrastructure required
+ Charging based on precise sections and times, flexible tariffs
+ Easily adaptable with software updates via mobile radio