Remedy and the cause

by PJ Ware

Road tolling is in danger of adding to the congestion problem rather than helping in its solution. As the volume of traffic rises, the need for its control grows, but current systems designed to reduce demand, particularly on the inter-urban roads network, stand accused of creating a raft of additional problems. So what is the answer? Can technology help?

If traffic flows are to be improved or even maintained at their present levels, there is no question that greater attention will need to be paid to road traffic management systems throughout the world. And while advances in in-vehicle and road-side technologies have certainly had an impact on improved levels of road-safety and its corollary, reduced congestion, there is a generally held perception that, ultimately, demand-management, in transport terms, is about road-pricing.

Plaza problems

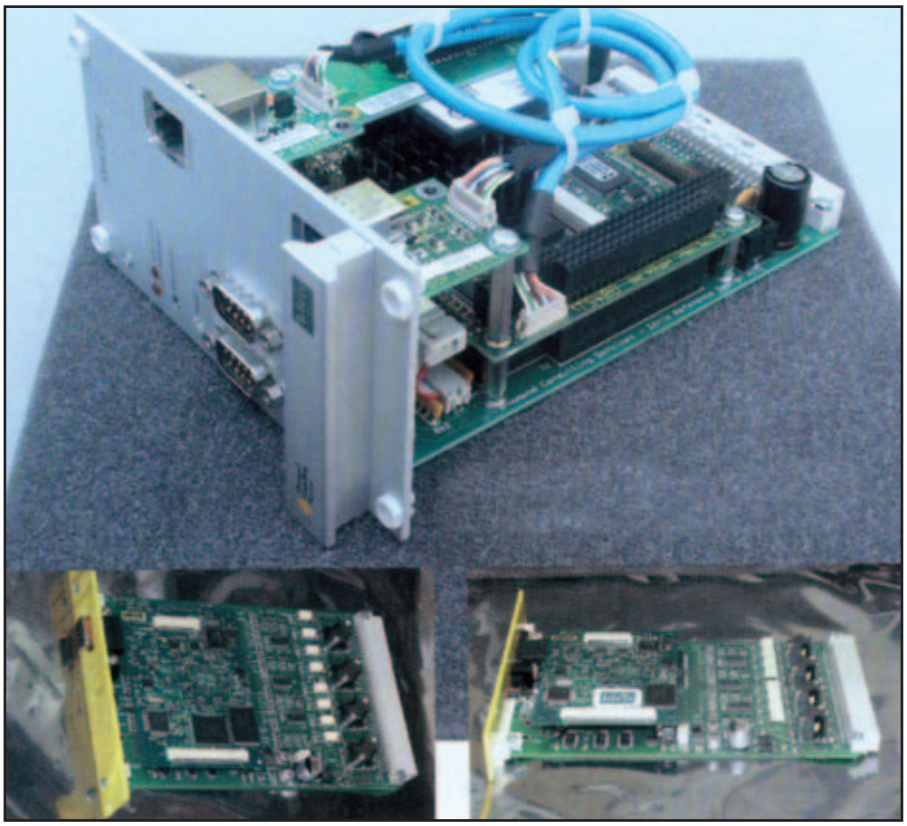
Yet herein lies a problem. Current systems of road-user charging in inter-urban areas are almost exclusively based on the idea of the tolling plaza, an environmentally damaging, highly expensive and land-hungry piece of infrastructure. On busy routes, they are responsible for delays, congested traffic, increased levels of pollution and accidents. But, in the absence of other, more rapid and more efficient means of collecting tolls, there is little alternative but to accept their continued presence. Or is there?

Over the past eight years, a British company has been researching and developing a multi-lane tolling system capable of use in both the open-road and toll plaza environments. The system that eventually emerged, fulfilled this basic criteria and added a few more along the way, including highly accurate (>99.9 per cent) data-collection through the development of sophisticated algorithms and an ability to work under all weather conditions, including fog and snow.

Advantages

Based on advanced induction loop and computer technologies, the Idris® system, developed by Diamond Consulting Services (DCS), a small research and development company in the south of England, is capable, accurate and robust. Already installed in tolling facilities in both Europe and the United States, it deals with the complete range of tolling related problems, including lane-straddling, stop-go conditions and tailgating, at all traffic speeds. It will count the number of axles on the vehicle, measure its length and trigger an enforcement camera in cases of non-payment of the toll charge.

"If Idris has three advantages over competing ETC technologies," said Fiona Lees, marketing director for DCS, "it is that it will deal with all the problems associated with electronic tolling, without the need for additional sensor technologies. Secondly, it is virtually maintenance free and totally unaffected by weather conditions including low visibility and thirdly, it will handle multi-lane, open road tolling. This has been achieved through our development on enhancing the output of loop detectors through advanced signal processing techniques."



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Multi-lane tolling

It is this last advantage that is crucial. The limitations of tolling plazas are rapidly becoming more obvious and in addition to the congestion they cause, have a high financial and environmental cost that toll operators and the wider community are reluctant to continue supporting. There is now wide-spread recognition within transport engineering circles of the need for a system of open-road tolling that would both allow the free movement of traffic while, at the same time, imposing a sanction on the use of the road.

Future specifications for ETC systems are likely to demand the ability to handle high-speed, multi-lane fee collection and enforcement systems. The technology will need to be robust enough to accurately handle lane-straddling/changing, poor visibility, tailgating and a host of other problems associated with multi-lane highways, without deploying a range of additional and expensive sensor technologies that are the hallmark of current above-ground systems.

"Idris software was designed, from the out-set, to cope with express, open-road tolling," says Lees. "The highly complex configuration of the patented induction loops, coupled with the Idris software means that it doesn't matter whereabouts on the road surface a vehicle is, the system is able to detect, identify, classify and enforce tolls, even for vehicles passing through the system at high speed."

Without this range of functionality, no tolling system could hope to handle the reality of genuine open road tolling.

"In designing and developing the Idris technology," says Bob Lees, a systems engineer with over 20 years experience in traffic and one of the founders of Diamond Consulting Services, "what we had to bear in mind was driver-behaviour and, in traffic terms, the worst case scenario. There is no point designing a system for open road tolling that takes no account of drivers changing lanes, or of the possibility of a vehicle tailgating or being hidden in the shadow of a larger vehicle or of coming to a halt over the sensors. Nor is there any point in a system that degrades over time, causing a loss of accuracy.

"We already knew that overhead light curtains were subject to high maintenance costs, could not, on its own, deal with multi-lane tolling or count the number of axles a vehicle had. We also knew that treadles and peizos were subject to degradation over time and couldn't deal with fast-moving traffic. The inductive loop seemed to us to offer advantages that could not be matched by other technologies. It is why we chose it as our starting point."

Induction loop technology

One of the major considerations of the work undertaken by the company was the need to achieve very high levels of accuracy in the data-collection process. "Given the very high volumes of traffic that pass through the average tolling facility it is important for the tolling operator that any system he has in place should be accurate," says Fiona. "This doesn't just mean taking a toll charge from vehicles that the system identifies, but should also include the ability to detect the difference between separate vehicles and those with trailers. It should also be able to tell the difference between a single vehicle which is lane-straddling and two vehicles side-by-side or the difference between signal over-spill from a large vehicle and the presence of a second, smaller vehicle. These are all things that Idris has already achieved in the multi-lane, open road tolling environment, even in situations of heavily congested and stationary traffic."

Several years into the research and development process and the company

had produced a set of algorithms that, it claims, achieved the results that it was looking for. These algorithms are now routinely yielding vastly improved levels of accuracy in loop technology.

"It represented," says Bob Lees, "a quantum leap in the count accuracy levels hitherto associated with loops; typically error rates better than 1 in 10,000 compared to 1 in 100."

As vehicles pass over the loops, buried in the road surface at precise distances apart, streams of high-speed data are fed to the Idris system. Here, the specially written software that lies at the heart of the Idris system analyses the data in real time and provides all the relevant and required information on individual vehicles in what are known as PVRs (per vehicle records). These are then passed to the lane controller.

And while the exact details of how Idris identifies and classifies each vehicle, is commercially sensitive, the general engineering principles involved are not. What Bob Lees and his co-founder brother Andy, have done is to take those basic principles and turn them into a highly robust and sophisticated tool of tolling management. Software driven, the number of loops that can be laid side by side across the carriageway is limited only by the number of lanes in the road.

And being software driven, data from all the loops is immediately available to the lane controller for payment and enforcement procedures. By analysing all loops simultaneously and comparing the vehicle's unique data-pattern or 'signature', the algorithms can then determine exactly what has transpired on each loop in the array, calculating the relational effects of each. This provides precise and consistent outputs, regardless of traffic flow and environmental conditions, including queuing or slow moving traffic, individual slow or stationary vehicles and vehicles travelling in the wrong direction.

A continuous stream of signal pulses, reads the changes in the inductance registered on each buried loop, as a vehicle passes overhead. The exact pattern of changes is then processed and converted into a unique line-graph that becomes, in effect, the vehicle's signature, capable of being precisely linked to a specific lorry or car. When read in conjunction with an in-vehicle tag, the system either allows the vehicle to go on its way or triggers an optional VES (vehicle enforcement system) camera and supporting procedure.

It is no longer a question of whether or not inductive-loop technology has a future within ETC but rather how long it will be before the competition catches up with the engineering principles being demonstrated by this small, yet highly innovative, company. Throughout the United States, Europe, Asia and the Far East, electronic tolling systems have been and continue to be introduced as a means of controlling access to an increasingly overcrowded resource.

It is important both for the travelling public and for the tolling operators themselves that if drivers are to be expected to pay for the use of the roads network, they should be allowed to do so with the least amount of delay and with absolute confidence that the system is fair and accurate. On that score, the Idris system seems more than capable of fitting the bill. ■