



Electronic tolling schemes – integrated platform for toll collection and value added services

U. LEINBERGER

Satellitic Traffic Management GmbH, Dachauer Str 665, 80995 Munich. Germany,

ABSTRACT

Complex intelligent systems based on GNSS and GSM can be operated with very high security, reliability and availability even in very large fleets. This is clearly demonstrated by Toll Collect since its start. Even now they are economical and competitive.

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1. Satellite tolling systems are new and complex, but work well, are manageable and competitive

For a long time private concessionaires have been operating special small parts of the road infrastructure in many countries, e.g. tunnels, bridges or some motorways. In such cases, their investments will be rewarded by levying a toll on the users of these infrastructures. However, such ventures so far cover only very small parts of the total road infrastructure – only single buildings or roads with very limited number of junctions with large distances between them. Collection of toll in these cases usually is done manually at toll booths or for registered users via specially equipped toll lanes that can read microwave-tags at the vehicle's wind-screen. Such installations with special

toll lanes, beacons and barriers require huge investments in road-side infrastructure. Opening barriers only after correct payment has been made leads to major obstruction of traffic flow. These legacy tolling schemes are limited to single tunnels and bridges and to specific motorways or closed networks or areas. They are definitely not applicable for large and complex existing public road networks.

For a new toll on Germany's very large, open and very complex network of Autobahn with its large number of junctions and slip roads the legacy tolling schemes were obviously not an option. The installation of special technical infrastructure like toll booths or gantries or barriers at every junction and slip road is simply out of question.

For these reasons, the first Tolling System relying on satellite navigation (GNSS) was developed and put in operation. Levying toll in this system does not require road side equipment and infrastructure at every junction or segment. Rather it relies on autonomous On-Board Units (OBU) allowing the user to pay his charges automatically in the most convenient way.

This technology is a quantum leap allowing true usage-based tolling for the first time also for very large and complex road networks. This quantum leap is evident when taking into account, that the tolled roads in Europe increased overnight by 50% from 24,000km to more than 36,000km while the number of toll operators increased less than 1% from 126 to 127.

However, this new technology with its clear advantages involves also a new scale of complexity, e.g. with the management of a large fleet of more than 600,000 intelligent On-Board Computers. All their states need to be monitored and all their functions operated and their software and data must be updated and kept current – a totally new challenge with quite a few surprises and its own learning curve.

But since the start on Jan 1 2005 the satellite based Toll Collect System has been smoothly levying toll for HGVs on Germany's extensive Autobahn network flawlessly – demonstrating that this new technology is fully under control despite its complexity. And the cost per tolled vehicle-km seems to be lower than e.g. in Austria or Switzerland.

Especially for large and complex road networks of nation-wide scale the satellite based tolling is the best and future-proof solution – and will certainly benefit from GALILEO to become even better.

2. Standardisation in Europe goes forward and will establish a common platform

While the road infrastructure in Europe does comply with common standards already allowing every vehicle registered and licensed in any European country and every driver to use any road, tolling systems have still a long way to go. There is a multitude of tolling regimes with incompatible technologies. The user is confronted with a multitude of different toll operators, rules, ways of payments and technologies – and his journey is halted at many points.

To improve this unacceptable situation, the introduction of an interoperable European Electronic Tolling Service (EETS) is already a legal obligation within the EU under Directive 2004/52/EC and has been adopted in national legislation in most EU countries. On this basis, users shall get a tolling service following the principle “one contract, one device, one payment” everywhere, starting with HGV and later for all vehicles. For this, a combination of legacy microwave technologies and the new tolling technology based on satellite location and GSM communication shall be used. This new technologies also open a range of new

possibilities, e.g. road user charging schemes not possible with legacy technologies, getting rid of traffic obstacles like toll booths and barriers. In addition, this new technology can be the platform for other services for the user. Due to this potential, even a range of non-EU countries like Switzerland, Sweden and Norway take an active part in all the activities.

Not all aspects and details of EETS are described and defined in the Directive. On technological, contractual, procedural and other levels additional standardisation and regulations are required. These standards and regulations are actively pursued on a European scale. The European Commission has initiated a range of expert groups looking into all aspects. In the 6th Framework Programme the projects CESARE III are dealing with commercial and contractual aspects and RCI (Road Charging Interoperability) is focussing on technological aspects including development of two pilot OBUs and testing their interoperability. All these activities will lead to a set of detailed CEN/ISO standards and a legal framework for EETS – and all these activities also take into account that on this platform also other new services based on satellite navigation, GSM and DSRC communications should be enabled. These new standards will be the basis for implementation of EETS and its components and their certification against these standards. Certification procedures will of course be a central part of the standards themselves.

A lot of progress has been achieved in all these matters and the foundations of a new technological platform for tolling & telematic services on the basis of common, open standards is being laid. For a possible impact of European standards GSM is a good example. This mainly technological standard has been defined in the 1980s and first implemented in the 1990s – and has seen worldwide adoption and is omnipresent today. A huge range of new services and applications for mobile telephony has been built on top of GSM, enabling new industries in most sectors of the economy worldwide. In analogy to GSM we believe that the new satellite based technology will thrive on the basis of the newly created standards and develop into a mass market technology, where ever more functions will be implemented in ever smaller and cheaper devices, building the foundations for a range of new applications and services.

3. Problems of society and politics can only be solved with satellite technology

Policy-makers are facing some harsh problems concerning society and budgets that require new concepts. Let us name just a few.

3.1. Even more accelerated growth of hgv traffic due to extension of the common eu market

The already very high growth rates of HGV traffic and displacement of other modes of transport by HGVs have accelerated even more since extension of the EU to the east. Current forecasts imply that the existing infrastructure will not be able to cope with traffic in the near future – impending collapse of traffic in many regions. Even today many roads have reached the limits of their capacity and are at peaks time far over their limits. Environmental damages are ever increasing – even more so since HGVs replace environment-friendly other modes of transport like rail and ship.

To make more intelligent use of existing transport infrastructure possible, usage-based road charging is a means that policymakers are discussing more and more. It is a means to help achieving better transport efficiency and to shift transports to preferable modes of transportation. It is also driving efforts for better integration of inter-modal transport chains and to reduce growth of transportation through more intelligent production and logistics. The first implementation of usage-based road charging for HGV as a political steering instrument in Austria and Germany show first promising results: The German Ministry of Transport reports a significant reduction of empty HGV trips as well as an increase in very environment-friendly new HGV registrations since introduction of Lkw-Maut.

To really achieve these political objectives, very high reliability, coverage of large road networks and in the near future whole nations with good differentiation of charges, e.g. according to environmental or safety and load criteria are requirements for future road charging solutions.

3.2. Changing the flag after opening of european transportation markets¹

In the past, national transportation markets were quite isolated due to strict rules of cabotage, but today they are wide open – leading to a new competition between national and foreign carriers. As a consequence, operators have taken the same step as ship-owners – they started to change the flag of their fleet to foreign countries with lower taxes and cost. This makes survival hard for national carriers on the one hand – and results in huge losses of tax revenue for the government. Not only VAT on vehicles and annual vehicle tax are lost, but also taxes

¹ Several studies give numbers for cost inferred due to congestion in the range of 100Bln€/year in Germany alone

on insurance, on fuel and on profits of companies and on income of employees. In addition, the social security system suffers with reduced revenue and an increase in unemployment.

The natural conclusion is to start shifting taxation of transport & mobility to means that can not be evaded, thus levelling the competition between national and foreign carriers on the one hand and preventing or at least limiting the losses of tax revenue and social insurance contributions – as has happened with road charging for HGVs in Austria and Germany. Of course, governments in other countries are coming to the same conclusion and are considering or actively pursuing road charging plans.

Solutions based on a common standard ensuring full interoperability are thus required to guarantee free access to all road networks in Europe without barriers. They are also required to allow competition between solution providers ensuring economical efficiency.

3.3. Daily collapse of traffic in metropolitan areas

Not only in the transportation sector, but also in the individual mobility sector we see a wide spectrum of ever increasing problems. Especially in metropolitan areas we observe daily collapse of traffic due to increasing commuting traffic coupled with decreasing share of public transport. In many areas extensions of infrastructure would be required to address at least the most urgent bottlenecks. But extending the infrastructure can not be the only solution. Science as well as politics is accepting more and more, that this will not really solve the issues, but that just extending the infrastructure will lead to a re-shuffling of traffic patterns and to changes in the housing and work structures creating ever more traffic².

As a result, political objectives are focusing on more intelligent concepts aiming at better utilization of existing infrastructure. This leads to fundamentally new concepts and governments are looking for new steering instruments. Examples for such new instruments are Congestion Charging Schemes in London and Stockholm – and policymakers of other metropolitan areas in Europe and the world are closely observing their results. Some countries e.g. the Netherlands are even developing concepts to shift taxation of mobility from legacy instruments like car tax and fuel tax to road charging schemes that take internal and external costs as well as environmental and safety aspects into consideration and that can be tailored to have strong effects on behavioural and traffic patterns. Such concepts require road charging systems that are able

² See for example Technology Review July 2006

to charge every mile driven according to traffic situation, type of road, environmental criteria etc on every road in a country. The focus lies on gaining new steering instruments to avoid collapse of traffic with its massive economical and environmental impacts. Such steering is impossible with vignettes or legacy beacon systems - satellite based systems seem to be the only choice.

3.4. Insufficient budgets for maintenance and improvement of infrastructure

In most countries the very tense budgetary situation prevents the execution of plans for infrastructure improvements – or at least their execution in a timely manner. Even worse, many countries can not even cope with maintenance and repair costs for their infrastructure any more, while the needs are ever increasing due to the growth of traffic and aging and due to additional follow-up cost caused by insufficient maintenance in the past. Insufficient investment in maintenance and repair will trigger an avalanche of cost later. In many cases, bridges and tunnels are in urgent need of refurbishment or even replacement since their static and safety are endangered – causing additional budgetary problems without a visible solution. For €-zone countries these financial needs make it even harder to meet the Maastricht criteria of balanced public budgets – an important issue for governments.

In most countries the amount of tax levied from the traffic & mobility sector is far more than what is required for infrastructure purposes – but these taxes are simply vanishing in general budgets for other needs. In many countries plans to improve this situation have been considered, and some have been implemented. Let's look at just a few examples. In many countries, motorways have been financed, built maintained and operated by private concessionaires who refinance their investment and cost with road user charges. The Austrian government transferred the public motorway network into a private company which again is operating on user charges – getting this block out of government budgets³

In some countries e.g. Poland Infrastructure Funds have been established that will be filled from both government's budget, EU-Funding and from user charges and in many countries new concepts for public private partnerships for infrastructure investment and operation have been implemented.

In all these examples it can be hardly envisaged that the existing complex road networks could be charged

using toll booths and barriers – this would be far too expensive with disastrous effects on traffic flow. Not even setting up gantries & beacons is viable for larger public road networks. These legacy tolling systems were beyond their limits even in the case of Germany's Autobahn network and are even less usable for lower level road networks – not to mention that they have no potential for additional services and applications. This is the domain of satellite technology.

4. Desires of society and economy can be fulfilled by satellite technology only

Besides governments also the society in general and the commercial world desire better, more efficient and more effective use of transportation. They all want to be able to plan better and to make use of a combination of several modes of transport easier. They all want to be informed faster and more reliable about exceptional situations and traffic jams – including scope, duration, impact and alternatives – and of course about the situation on the alternatives. Travellers want to find out, how and where they can switch from car to public transport – and when and where this makes sense. Companies want to monitor their transport fleets and to integrate detailed planning, monitoring and control of multi-modal transport chains and a lot more. In all these fields satellite technology has been introduced for quite some time – isolated individually designed fleet management systems allowing single operators detailed monitoring & control. In cars and trucks satellite navigation systems are normal and now even hand-helds for cyclers and pedestrians are gaining ground.

But all outlined additional benefits can be utilized only, if all these different information and applications can work together – with increasing needs for data protection and privacy. The emerging common open standards for GNSS/GSM based platforms with Toll Collect as an early adoption will enable to move from individual islands to a widely accepted and widely available infrastructure of high-volume low-cost devices that are “already there” (just like PCs or Mobile Phones) that supports a whole world of new applications and services and new markets for many providers. This will also be a platform to implement services relevant to the public like traffic monitoring, analysis and prognosis or accident and safety alarms with a hitherto unknown quality at much lower cost.

³ It would be interesting to investigate the impact of this measure on Austria's ability to fulfil the Maastricht criteria...

5. Conclusion

Complex intelligent systems based on GNSS and GSM can be operated with very high security, reliability and availability even in very large fleets. This is clearly demonstrated by Toll Collect since its start. Even now they are economical and competitive.

Only intelligent GNSS/GSM platforms have the technical versatility to contribute to the solution of a wide spectrum of issues in society, economy and politics. Fast progress of standardization on a European scale will initiate a self-accelerating propagation leading to massively

lower prices for ever better and smaller devices. This open but secure platform will enable a wealth of new services and applications and for new providers in other fields than road charging. This might finally open a way into the telematics world envisaged for so long – just as the GSM standard has helped to open the way into a new and unforeseen new world after the start of the first GSM networks just 15 years ago.

Satellite Traffic Management GmbH is ideally positioned to play a significant role in this game.

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