

Fiammetta Diani and Norbert Schindler present the case for satellite-based tolling in Europe and beyond

The Soyuz launcher will take two Galileo satellites at a time into Medium Earth Orbit. Deployment will be accelerated by the use of higher-capacity Ariane launchers



The future is now

A few decades ago, before high speed trains were operating in Europe, the impression of a European travelling in Japan must have looked rather futuristic: the *Shinkansen* or “Bullet Train” with its extraordinary aerodynamic design operates at speeds over 300km per hour. One decade into the new century, the ITS World Congress in Tokyo provided the authors with their first opportunity to visit Japan. Although visitors from Europe may no longer be overwhelmed by the speed of public transportation, the sheer volume of people making their local commutes in the Tokyo region is almost impossible to imagine unless you have seen it yourself. A typical station in Tokyo (of which there are dozens) typically processes more than a million passengers per day.

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The public transportation system in Japan is, by anyone’s standards, hyper-efficient with very frequent intervals and minimal delays, even during challenging weather conditions such as typhoons - as we experienced during the Congress. In one of the opening speeches, a senior manager at Toyota asserted that there are still many situations in Japan in which a passenger car is the optimal transportation choice between two given places. According to the world’s largest auto manufacturer, Intelligent Transport Systems facilitate more safe, efficient and comfortable travel by car. In Japan, as in Europe, road infrastructure still forms a central element of transportation. Around the world, countries are faced with the need to maintain and improve their road networks, despite the constraints of national budgets.

In Tokyo, we had the opportunity to learn about how innovative ITS solutions in Asia can improve traffic management and emergency services, contribute to a more resilient transport system during natural disasters, and support today's navigation demands by using augmented reality.

However, in the field of Electronic Toll Collection, Asia has yet to demonstrate the emergence of truly innovative schemes and technologies – with the exception of the ground-breaking but isolated case of Electronic Road Pricing (ERP) in Singapore. At the “ETC Technology” sessions of the ITS World Congress, a majority of the panelists represented Asian ITS companies. Several of the Japanese speakers described optimizations for handling the large volumes of traffic at toll plazas. Presentations made by speakers from France and Austria, on the other hand, focused on the implementation of free-flow tolling systems.

One delegate at the final session pointed out that free-flow systems around the world are increasingly replacing toll barriers and asked why Japan has not yet begun to do the same, particularly in light of the enormous operational costs and the significant delays cause by toll plazas. The Japanese panelists, however, chose not to express their opinion on potential changes to the legacy toll plazas in the future. This may come as a surprise to visitors arriving to Japan for the first time, impressed by the otherwise highly advanced technological aspects of modern life there.

The contrast of Japan to Europe with respect to tolling technology is indeed astounding, especially in light of the developments being undertaken in Europe in recent years. Tolling has been traditionally linked to motorway concessionaires and their respective business models, typically requiring payments for road usage according to the distance travelled. Initially requiring manual toll plazas, toll collection has become increasingly automated. A major step was taken in Central European states a decade ago, when nationwide electronic free-flow truck

Rural roads in Eastern Europe are being targeted for tolling



tolling schemes were introduced. These systems now operate in Switzerland, Austria, Germany, the Czech Republic, Slovakia, Poland, and most recently Hungary. Those countries which took advantage of satellite positioning technology are now reaping the benefits of the innate flexibility of GNSS, as we will illustrate.

STATE OF PLAY

This past year has been an extraordinarily busy one in Europe with respect to the planning and introduction of truck tolling schemes. The long-awaited tenders in Belgium and Russia have finally been issued, both mandating the use of satellite-based technology as the basis for calculating the distance-based fees. The introduction of the new French “*écotaxe*” system was also scheduled for 2013, with the deployment of the new GNSS-based tolling scheme in France being subject to some exceptional difficulties and becoming part of a larger public debate for fiscal revision. Consequently, the Ministry of Ecology announced that the launch will be postponed for another year¹. Hungary, after having launched and cancelled truck tolling tenders in the past, finally started its nationwide scheme in July after less than three months of implementation time, surely a new record!

In Hungary, tolls are now charged on designated sections of the 6,500km public road network. Within the first months of operation, more than 100,000 trucks were registered in the new scheme. Tolls can be

paid either by manual ticketing (one ticket per trip, with at most four points) or through the purchase of a satellite-based On Board Unit at one of the registered OBU Service Providers. With an OBU, of course, all the travelled routes liable for tolling can be recorded automatically. By the end of 2013, more than a third of all toll revenues were collected through the use of OBUs. After the first six months of operation, €250m in toll revenues have already been generated. With their unique tolling system, already one of the largest

in Europe, the Hungarians have demonstrated how quickly and easily a nationwide tolling scheme can be implemented.

This past year, the European tolling community also witnessed a sudden change of plans for two countries that intended to launch new national systems of their own. The satellite-based truck tolling scheme intended for Denmark was abandoned only moments before the tender was issued, while in Slovenia the tender procedure was cancelled after only one offer was made.

BELGIUM AND RUSSIA PREPARE FOR GNSS

Although originally anticipated a year earlier, the public tenders for the new truck tolling systems in Belgium and Russia were launched in 2013. In both countries, the prequalification phase is complete and final offers are under preparation as this is being written. In Russia, GPS will be used in combination with GLONASS to charge up to two million vehicles on 50,000 km of federal roads, which will make this national tolling scheme the largest of its kind. New technical challenges are being faced in Russia due to the vast size of the country: the varying density of mobile network coverage, the extreme climatic conditions, and the need for reliable and accurate satellite positioning in higher latitudes are placing new demands on the robustness of a GNSS-based solution.

The Belgian project is similar to the French one in that the system is being

designed based on the concept of the European Electronic Toll Service (EETS). A Toll Charger is either operated directly by the state, or subcontracted by the state, and enables private Toll Service Providers to offer tolling services directly to their clients - with their own OBUs. The Belgian Truck Tolling scheme thus requires full compliance to the decisions and directives of EETS, and will manage up to 1m trucks on a road network of 3500 km – with the potential to include up to 50,000km of roads. The system is certain to reach a high level of complexity, especially with the implementation of 100,000 unique tolling zones throughout the nation's three regions.

GNSS HEADLINE NEWS

Also in the news at the end of 2013 was the announcement of plans by the newly formed coalition government in Germany to execute the “call option” in its contract with Toll Collect, thus taking over the system ownership completely. Once this step has been taken, the German Government could extend the truck tolling system beyond the 13,000 km network of Motorways (“Autobahnen”) to include all 40,000 km of national roads (“Bundesstrassen”) by 2017².

The most exciting news, though, comes from Slovakia where the current tolled road network of 2,500 km has been extended by an additional 15,000 km to include roads of the first, second, and third class categories. This unprecedented extension of the tolled road network by seven times its original size has been implemented within three months – a new world record. From the beginning of 2014, the Slovak toll system has clearly become the largest in the EU. If ever a single argument were needed to demonstrate how advantageous the use of GNSS technology is for tolling, this would probably be it.

DETOUR DE FRANCE

Although the latest news from France is not overly heartening, the French *écotaxe* system is clearly one of the most significant innovations in the tolling domain that has emerged in Europe in recent years.

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In the framework of environmental and transportation policies, French authorities decided that trucks should pay a fee when travelling on 15,000 km of national roads which until now were without charge.

The *écotaxe* is intended to contribute to the optimization of truck transportation by reducing the amount of empty cargo trips, much in the way that this was accomplished with Germany's GNSS-based tolling for trucks. This would encourage a shift to intermodal solutions – or simply to move heavy goods vehicles to the tolled concession-based motorway network. The goal of developing of a unique solution in response to the challenges of charg-

ing a large and complex road network, with a seamless integration to the existing tolled road network, has been successfully accomplished. The GNSS-based system is compliant with European Commission's EETS Decision and is therefore open to European Tolling Service Providers. Even if the deployment has been delayed for political reasons, the technology is ready. A significant step towards EETS has been made and the experience gained in France is of great value to the European community in general.

THE LATEST DEVELOPMENTS IN SATELLITE POSITIONING SYSTEMS

When discussing the use of GNSS for tolling, we should clarify what is actually behind the general term of GNSS. Until a few years ago, the choice of GNSS was very limited, and the GPS system was synonymous to satellite navigation. This has now changed: Russian GLONASS has been modernized, and combined GPS and GLONASS receivers are now commonly used in smartphones - and are beginning to spread to automotive devices as well.

In 2014, European GNSS will make significant progress as additional Galileo satellites are scheduled for launch and, as European Commission Vice President Antonio Tajani recently announced, early operational services will be made available towards the end of the year. In fact four satellites have already been launched in orbit and since March 2013 have started transmitting the open signal. Since then, the “position fix” has been evaluated by many GNSS experts from the industry, and from research intuitions around the world, who have confirmed the excellent quality of the Galileo signal.

An additional 22 Galileo satellites have been contracted and are currently in advanced production stage. The Galileo constellation places the satellites in three orbital planes in Medium Earth Orbit at 23,000 km above the Earth. These satellites will be launched two at a time, using the Soyuz launcher next year. The European Ariane launcher will carry four satellites at once, accelerating the deployment.

Since it was designed, Galileo was conceived as being interoperable with GPS satellites. This contributed to facilitate the use of Galileo together with GPS in the mass market for satellite receivers, without implying additional costs. It's a significant advantage when you have more satellites in view and better signal availability, especially in demanding environments such as urban canyons. It is not necessary to wait for the full constellation to be deployed to have these benefits. By the end of 2014 "early services" will be made available, including the Open Service which is free to the public. We will thus witness improved positioning accuracy and performance. Additionally, Galileo is also expected to provide an authentication service to ensure that the signal is genuine and therefore immune to spoofing attacks. This will become of growing importance as more payments are increasingly made on tolling systems and smartphone applications that are based on GNSS, thus requiring a high level of robustness and accuracy.

In addition to America, Russia and Europe, other regions are joining the GNSS club: China is building its navigation system known as Compass, and the Japanese have demonstrated their capacity to launch navigation satellites that will provide a regional service with the QZSS system. The project "GNSS for Asia", co-funded in the European Union's 7th Framework Program for Research and Development, is actively working on cooperation between Europe and Japan in GNSS applications in several domains including Intelligent Transport Systems. Thanks to multi-constellation Global Satellite Positioning Systems, we will soon enjoy a virtual satellite constellation that will permit much greater accuracy, availability and robustness of the positioning, thus contributing to further improvement to system performance as well as cost reduction for GNSS tolling systems.



European GNSS also includes EGNOS, a satellite-based augmentation system of GPS that delivers corrections of typical ionosphere and system errors, improving position accuracy, and gives information about reliability of GPS signal. The French *écotaxe* system took advantage of the European GNSS opportunity by including EGNOS-enabled and Galileo-ready positioning capability. The Belgian tolling system architecture also requires multi-constellation (GPS, Glonass and Galileo readiness) and EGNOS augmentation.

BEYOND EUROPE

Beyond Europe, there are two interesting developments in the use of satellite technology that are worth mentioning. Singapore's ERP system, in operation since 1999, has been one of the earliest and most innovative electronic schemes in the world. In 2012, extensive trials were completed in which a variety of new technologies were evaluated, including the use of satellite technologies to enhance the already complex urban tolling system.

In 2014, a tender is anticipated for the introduction of satellite-based technology for the tolling of up to 1m vehi-

cles. In Oregon, an ambitious plan is currently underway for the introduction of a distance-based charge on electric vehicles (since these cars don't pay any fuel tax). One of the options given to these vehicle owners is the measurement of "vehicle miles travelled" using GPS, thus becoming the first case of a permanent deployment of a satellite-based tolling solution in the United States. Extensive trials for this novel approach were completed in Oregon at the beginning of 2013, and in July the Oregon State legislature passed the necessary laws enabling this new approach of road user charging to be implemented. A tender for the new scheme should be announced in the beginning of 2014.

RETURN TO TENDER

GNSS-based systems are spreading with an increasing tempo throughout Europe, becoming the de facto standard for comprehensive nationwide tolling schemes.

Although the rest of the world still embraces more traditional tolling approaches, first steps towards the implementation of satellite-based tolling schemes have already been taken. With the upcoming tender in Singapore and the implementation of the world's largest tolling system on 50,000 km of Russian roads, satellite-based technology is also spreading to Asia. In the coming months, North America will take witness to the first public tender for a mandatory toll system that will make use of satellite-based technology. Without a doubt, we are very optimistic that GNSS will eventually become a logical choice for tolling systems around the world. 

 

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Footnotes

- 1 http://www.lemonde.fr/economie/article/2013/11/19/l-ecotaxe-suspendue-jusqu-a-une-remise-a-plat-de-la-fiscalite_3516066_3234.html
- 2 <http://www.zeit.de/politik/deutschland/2013-11/lkw-maut-ausweitung-spd>