Figure 1: GPS only on the left. GPS and GLONASS used on the right.

Using GLONASS to improve accuracy in GNSS tolling

Norbert Schindler, global sales manager, Siemens Electronic Tolling.

GPS-based positioning technology is being used for Truck Tolling in Switzerland, Germany, Slovakia, and – most recently – Hungary. By the end of 2013, France will also introduce a nationwide truck tolling based on satellite technology, for 15,000 km of national and regional roads that have not yet been subject to tolls. Belgium and Russia are launching tenders for GNSS-based truck tolling systems in 2013 as well, and a number of European countries are currently preparing for the launch of their own nationwide satellite-based schemes.

The Russian tolling project is particularly ambitious, since two million trucks will be subject to paying distance-based fees on 50,000 km of Federal Roads. This will clearly be the largest free-flow electronic tolling system operating in the world. Russia's state-of-the-art GLONASS (GLObal NAvigation Satellite System) will be the centrepiece of its tolling system technology, and this is sure to have an impact on satellite-based tolling in Europe as well.

GLONASS has already begun taking a prominent place alongside GPS for commercial positioning applications. Since October 2011, the full orbital constellation of 24 GLONASS satellites enables complete global coverage. Some of the latest smart phones now use a combination of GPS and GLONASS to improve position accuracy, since the number of potential satellite signals that can be received are basically doubled. The same principle obviously applies to GNSS On Board Units (OBUs) as well. As extensive field tests at Siemens have shown, an OBU using both GPS and GLONASS signals works exceptionally well in demanding environments (such as urban canyons) – even without the use of special algorithms which have been developed to improve position accuracy when GPS signals are feeble.

For example, on an overcast November evening, a trip was taken through the narrowest streets of Vienna's historical old town using both a conventional GPS OBU and an OBU having a combined GPS-GLONASS chipset. Figure 1 illustrates the typical problems of GNSS-based systems passing through urban environments when using only GPS (on the left). Yet, when both GPS and GLONASS are used simultaneously, the OBU has drawn a nearly flawless path through those narrow streets (as is shown on the right). Such accuracy will become essential when GNSS is used for charging vehicles based on the distance travelled in city centres.

GLONASS also offers improved accuracy in regions having high latitudes. Although GNSS-based tolling systems have not yet been implemented in regions of higher latitudes, this will obviously change once the Russian Federation launches its system.

Sweden and Finland have also been exploring the use of GNSS-based technology for tolling and can clearly benefit from the use of GLONASS in the far north. At very high latitudes, the level of GPS position accuracy drops significantly – at levels which would most likely compromise the performance of a distance-based tolling scheme. GPS consists of 24 satellites in 6 planes inclined at 55 degrees to the equator – thus providing less coverage at the poles. GLONASS, on the other hand, comprises a constellation of 24 satellites placed on 3 planes, inclined at 63 degrees to the equator.

Siemens has now integrated a new state-of-the-art GNSS chipset into its Sensus Unit. This new generation OBU can receive GPS, GLONASS, and GALILEO satellite signals – and can be configured to use one or any combination of these three systems. The new unit will become commercially available by the end of 2013 and will be able to determine a reliable position even when only two GPS satellites and two GLONASS satellites are in view. To further improve position accuracy, satellite-based augmentation systems (SBAS), such as EGNOS, are used by the new OBU as well. By October 2014, GALILEO's "early operational services" will also start, which will further improve position performance. Since the latest Sensus Unit is already GALILEO-enabled, even higher position accuracy will be possible in challenging environments, such as urban canyons.

In the coming years several countries will be implementing new – and very large – satellite-based schemes. The number of installed GNSS-based OBUs will soon multiply from a few hundreds of thousands to several million OBUs. Thus, the demand for higher position accuracy in increasingly demanding tolling environments will continue to grow. By using

both GPS and GLONASS (and later GALILEO), satellite-based tolling solutions can overcome many of the limitations that are currently faced in demanding environments. Thanks to the increased position accuracy demonstrated by the combined GPS-GLONASS module described above, we can already anticipate a significant reduction in the implementation cost of future GNSS schemes that take advantage of multiple satellite signals; in many circumstances, the need for installing supporting roadside infrastructure to improve position accuracy will become obsolete.

Legacy tolls to open road tolling

Mahesha Suriarachchi, associate, IBI Group, asks is inter-operability next for the UK?

In the United Kingdom, those who access roads, bridges and certain towns have been exposed to tolling for as long as tolling has been in existence.

Although the UK was once an early adopter, over the last few decades other parts of Europe, North America and Australasia have left us behind, with a distinct shift towards modern forms of tolling such as tolling of motorways and/or regions, and the use of a mix of tolling regimes and/or applications.

Here in the UK, the levy of a toll charge has remained primarily limited to tolled crossings or to a small number of specific charging schemes, mostly based around toll plazas (with the London Congestion Charging scheme as a notable exception).

While the UK lags behind much of the developed world in its approach to and acceptability of Road Pricing, for those of us who are involved in tolling in the UK, with the impending introduction of Open Road Tolling (ORT) at the Humber Bridge (c.2014), the Dartford River Crossing (c.2014) and the Mersey Gateway (c.2018), it seems we have finally begun to move in the right direction. Rightly or wrongly, the "stop, pay and go" concepts are no longer acceptable to even the road users. Most consider it to be old-fashioned and a cause of congestion and pollution.

Therefore, the current shift by a number of tolling authorities to move from legacy toll plazas to ORT will be welcomed by all those who pay their respective tolls.

Mahesha Suriarachchi,

We must recognise that these changes have not come easily. The UK's toll operators have had many fears around the operation of an ORT scheme.

One area that concerns most operators is the possibility of revenue leakage. Nevertheless, taking on board the lessons learnt from other parts of the world, as well as our own London Congestion Charging scheme, the UK operators have moved forward with the confidence that most of these operational issues can be overcome, thereby paving the way for the UK's road users to benefit from these new operational regimes. For that we must commend those toll operators who have led the way amid operational uncertainties.

Along with these positive developments in the UK's tolling landscape, in time, we hope to see a renewed interest by local authorities and the UK Government in implementing Road User Charging (RUC) schemes as revenue generators and/or for congestion management.

With the transformation of the Highways Agency (HA) into a publicly owned corporation and the need to 'sweat the asset' even more, the HA would be able to consider some form of managed lanes (eg. time of day pricing related HOT/HOV type schemes) as a natural progression of managed motorways.

With that said, it begs the question if the time is right for a meaningful discussion on whether implementing Toll Interoperability is the next step for us here in the UK. It is clearly a development that has brought significant benefits to nations or regions and therefore, if we are to move with the times, we must begin to lay the foundations upon which a UK centric Toll Interoperability scheme can be rolled out.

As with the operational concerns around ORT, there will be, and there are, concerns around the viability or the necessity for Toll Interoperability. There is a wide perception that the road user will not value toll interoperability and that the UK toll operators do not see a benefit of it. There is also the uncertainty over the European Electronic Toll Service (EETS) and if and when it will come to fruition.

In much the same way toll operators have decided to tackle the operational concerns around Open Road Tolling, the tolling community should look to move past the misconceptions and uncertainties around toll interoperability.

The Department for Transport (DfT) or the transformed HA should step in and look to develop a National Toll Interoperability scheme.

Connecting the tolling points spread across the UK via a national interoperability scheme would ensure that those who enter road pricing in the future could benefit from the tags in circulation and the existing tag issuers (ie. toll service providers) rather than having to set up new customer service centres.

This would lead to significant cost savings and efficiencies to a new toll authority.

Once a national interoperability scheme is achieved, there would be scope to include Value Added Services (eg. parking, drive-through payments etc) and Regional Toll Interoperability, making it commercially viable for the private sector.

Just as we have moved from legacy toll schemes to Open Road Tolling, we should consider Toll Interoperability as a next crucial step towards gaining further momentum for Road Pricing in the UK.