Satellite-based tolling system
Sitraffic Sensus

The ideal solution for modern free-flow applications.
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The Siemens portfolio for satellite-based tolling:

Siemens offers a full range of products, systems and services needed for satellite-based toll collection systems. Thanks to the modular concept, you have the choice: from individual components to complete solution, exactly adapted to your needs.

Sitraffic Sensus front-end systems

- Hybrid on-board units: Sitraffic Sensus Unit
- Universal back-office system: Sitraffic Sensus Server
- Intelligent enforcement solution: Sitraffic Sensus Monitor
- Installation
- Maintenance
- Operation

Back-end solutions

In collaboration with our partners, we can also take over the implementation and operation of the central management system on behalf of the toll operator, including tariff management, toll calculation and invoicing, customer management etc.
What is satellite-based tolling and what are the advantages?

As a satellite-based tolling system, Sitraffic Sensus requires neither toll gantries nor toll plazas. Instead, an on-board unit uses GPS satellite signals to continually determine the vehicle’s position, and mobile radio technology to pass the data on to the control center. The software checks if the vehicle is driving on a tolled road section and if so, calculates and invoices the applicable toll fee on the basis of the pre-defined tariff. This makes the technology especially cost-effective on extensive and complicated tolled road networks because it requires no roadside infrastructure for toll data collection.

Microwave- and satellite-based tolling systems – the main differences

<table>
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<th>Microwave (DSRC)</th>
<th>Satellite system (GNSS) Sitraffic Sensus</th>
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<tr>
<td>• Complex roadside infrastructure (toll gantries) required for toll data collection</td>
<td>• No toll gantries needed for toll data collection</td>
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<td>• High operating costs</td>
<td>• Low operating costs</td>
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<td>• The on-board units’ only function is to allow vehicle detection at toll gantries</td>
<td>• The on-board units (OBU’s) take over all data collection functions for toll calculation</td>
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<td>• The addition of new route sections to the system is time-consuming and expensive (additional toll gantries)</td>
<td>• The addition of new route sections requires only a software update</td>
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<td>• Cost-effective if the toll system covers nothing but a limited number of motorways</td>
<td>• Cost-effective in extensive tolling systems covering motorways and other roads</td>
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<td>• Examples: Norway, Austria, Poland, Czech Republic</td>
<td>• Examples: Germany, France, Slovakia, Switzerland</td>
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Europe discovers satellite-based tolling. And its many advantages.

Europe keeps growing together. While basically this is a very positive development, it also involves challenges like a steep rise in transport volumes, resulting in higher emission levels and a heavy strain on the existing transport infrastructure. This is why more and more countries have decided to introduce tolling systems in order to steer and ease traffic loads on the road network and raise the funds for road maintenance and upgrading.

There is more than one method of collecting toll, however. Some years ago, the prevailing toll collection technology was microwave-based and required expensive roadside infrastructure. Today, satellite-based systems are gaining ground because of their high degree of reliability and cost-efficiency. They require neither toll gantries nor toll plazas and allow easy extension of the tolled road network at any time – through a simple software update of the on-board unit.

Sitraffic® Sensus by Siemens is a mature satellite-based toll collection system and an ideal solution for all of today’s requirements. What makes Sitraffic Sensus especially attractive is its hybrid technology and hence suitability for any toll collection scheme that combines microwave and satellite technologies.

Thanks to this flexibility, Sitraffic Sensus lays the optimum foundation for the development of a pan-European toll scheme. The system is perfectly equipped for supporting the future European standard EETS.
Sittraffic Sensus adapts to any application. And leaves you the freedom of choice!
Up to now, a toll operator’s decision in favor of a specific technology entailed an exclusive long-term commitment. Today, our hybrid Sitraffic Sensus technology opens up convincing ways of combining advanced satellite-based toll collection solutions with legacy systems based on DSRC technology. The trick: Sitraffic Sensus fully supports microwave-based toll collection on the existing tolled road network while using cost-effective and flexible GNSS technology on those road sections that are newly integrated into the tolling scheme. This makes it especially easy to add also national and regional roads to the tolled road network.

Such a hybrid solution has been developed for France, for instance, while Slovakia has decided to implement a purely satellite-based toll collection system, with plans calling for an extension of the tolled network by another 15,000 km in the future. In both cases, Sitraffic Sensus has proven its capability to meet all requirements. A key component is our Sitraffic Sensus Unit, an on-board unit that reliably collects all travel data relevant for toll calculation.
Different countries, different road types, different technologies. And a single toll solution.

About a dozen different toll collection systems are currently deployed on Europe’s roads alone. Besides satellite-based GNSS systems, the responsible authorities use microwave-based DSRC communication for vehicle identification on tolled road sections and for the collection of all data needed for toll enforcement. This makes it easy to recognize those vehicles that are regularly travelling on tolled roads in several European countries — their windshield is equipped with a whole range of on-board units, each with a specific user interface that the driver must know how to operate.

The use of Sitraffic Sensus Unit as an on-board unit (OBU) makes things a lot more manageable for operators and users alike because it is compatible with all tolling technologies and supports the CEN standard suite for DSRC — and Uni-DSRC as an option — as well as the ISO/CEN standard suite for autonomous tolling systems. It goes without saying that our Sensus Unit complies with the European EETS standard.

Different countries, different road classes — only one OBU
Sitraffic Sensus facilitates not only cross-border tolling, but the technology supports also hybrid tolling schemes that use different tolling technologies for different classes of road. France, for example, already uses microwave-based DSRC tolling technology on some motorways while planning to deploy satellite-based GNSS technology on other road sections (national roads and motorways). To collect the data relevant for toll calculation, Sitraffic Sensus Unit automatically connects with the technology installed on the currently travelled road section. No manual intervention is required so that the driver can focus fully on the traffic.

Reliable toll collection in all kinds of tolling landscapes
The Siemens back-office system is EETS-compliant and thus suitable for deployment in many European countries. It adapts to the widest range of tolling landscapes and system architectures. Sitraffic Sensus works just as well with smart-client solutions (the OBU stores geo-data, toll domains etc.) as with thin-client solutions (the back-office system holds those data). Neither does it matter if data collection relies solely on satellite signals or if it also integrates microwave-based sensor solutions. Sitraffic Sensus is absolutely flexible and compatible with a wide variety of technologies and any tolling scenario up to area-wide toll schemes covering all road classes. The back-office system Sitraffic Sensus Server can be integrated smoothly into existing technical system landscapes and easily adapted to new OBU models.

Flexible combination of modules for a custom-tailored solution
A toll collection system consists of numerous components and the corresponding interfaces. With Sitraffic Sensus, Siemens offers a flexible system of modular components for electronic toll recognition, toll enforcement, central system and system integration. This modularity allows the definition of a custom-tailored system solution perfectly adapted to the structure and needs of your specific system. Open interfaces facilitate interoperability with third-party systems. When it comes to satellite-based toll collection, toll operators in Switzerland, Germany, Slovakia and France rely on the extensive experience and the technical expertise that only Siemens can offer.
For the Slovakian toll collection system, cross-border travel is no problem: The OBU is able to record toll-relevant data also in the microwave-based toll collection systems deployed in neighboring countries.
Tolling systems are an important source of revenue for the upkeep and expansion of our road infrastructure. In many countries, toll income provides a substantial percentage of the road maintenance budget. Hence it is all the more important that the toll collection system can be deployed without heavy investment – and that it includes tools for effective enforcement. In this respect too, the performance of Sitraffic Sensus is more than convincing.

Already in its first year of operation, Slovakia’s Sitraffic Sensus system generated more than €140 million in toll revenues. And the proceeds continue to rise. The system requires no roadside toll data collection infrastructure, detects every attempt at dodging the toll and reliably records every yard driven on tolled roads. And whenever new road sections are to be incorporated in the tolled road network, a simple software update does the job. That’s cost-effective operation at its best!
Sitraffic Sensus stands for dependable toll revenues. From the start!
Our toll enforcement solution Sitraffic Sensus Monitor uses highly innovative sensor technology to detect and document toll fraud, complete with court-admissible evidence.
Reliable revenues, minimum operational costs. A highly successful principle.

Purchasing a satellite-based toll collection system from Siemens is a highly profitable investment decision. The more complex and finely branched a tolled road network, the higher the savings compared to conventional tolling technology. In operation, the system ensures reliable and cost-effective toll collection and invoicing while a fully integrated enforcement module supports the effective detection and prosecution of toll dodging attempts.

**More satellites, higher accuracy, higher toll revenues**

The Sitraffic Sensus system includes multi-satellite OBUs, i.e. on-board units that can use three different satellite navigation systems to determine their position: the US-American GPS, the Russian GLONASS and the European GALILEO. This enables the unit to provide reliable positioning data even in areas with limited signal quality. As test drives through Vienna’s historic city center confirmed, a combination of GPS/GLONASS delivers significantly more accurate data than purely GPS-based positioning. As a result, the system reliably distinguishes between closely-spaced neighboring streets, and very rarely encounters problems with signal reception even in areas where high-rise buildings obscure the satellite signals.

**Effective toll enforcement**

In the case of satellite-based tolling systems, vehicles are equipped with an on-board unit (OBU) that uses satellite navigation technology to track and record every mile traveled on tolled road sections. But what happens if the OBU is turned off? Or if it has been fed with incorrect data on vehicle size and the number of axles? One possibility to uncover these – or other – cases of toll cheating is the installation of monitoring solutions on toll gantries. Sitraffic Sensus operates with fully integrated vehicle detection and toll monitoring devices and offers an enforcement solution that sets new standards.

**World-class sensor technologies enable effective toll monitoring**

Sitraffic Sensus uses first-rate sensor technology for detection and monitoring purposes. From devices for automated number plate recognition at vehicles speeds of up to 200 km/h, or laser scanners for automated three-dimensional vehicle classification, right up to cameras that provide legal evidence in the form of razor-sharp pictures – every single one of the sensors used is among the best in its class. In combination, these devices ensure thorough and effective toll monitoring because they are able to determine positively if a vehicle subject to the toll is actually equipped with a fully functional OBU, and if so, whether the OBU has been fed with the correct data (number of axles, emission class) and is operating properly. Thus the system can reliably identify and document any attempt at toll cheating – complete with court-admissible evidence.
Sitraffic Sensus is a success. Deployed in several countries already!
In toll systems in Germany, Switzerland and Slovakia, Sitraffic Sensus demonstrates every single day the advantages it offers in terms of efficiency and profitability. And not only that. France is currently setting up the first truly hybrid system, providing regional proof that EETS has already arrived in the real world. The French solution is mastering even the complicated task of bringing together several toll operators and their assorted technical systems and equipment under one common toll roof. For vehicles crossing the border to Spain, the advantages of a uniform European tolling standard become immediately apparent: The Sitraffic Sensus OBU works just as well with Spain's toll collection system as with the French one.
“Hybrid” stands for diversity. And Sitraffic Sensus for the art of supporting diversity.

Around a dozen countries in Europe have already implemented a nation-wide toll system for trucks. These systems rely either on microwave or satellite technology or on both; in some countries the tolled road network includes only motorways, in others a combination of motorways and national or regional roads; the toll applies to trucks of more than 3.5 t, or 12 t, or to trucks and passenger cars alike; the toll collection system may be operated by a public body or a private company or a mixed organization; some countries have only one toll operator, others count as many as 20....

As these examples show, the world of tolling is far from uniform. Hence the increasing importance of hybrid concepts that work reliably in a wide variety of system landscapes. Sitraffic Sensus is such a hybrid system. The four projects implemented up to now in Germany, Slovakia, Switzerland and France are perfect showcases of the flexibility that allows the Siemens solution to adapt to any task.

Slovakia: Very short project run time for a satellite-based system for toll collection on motorways and first-class roads
Within only 11 months, Siemens implemented a fully operational satellite-based toll collection system in Slovakia – without erecting a single toll gantry or building a single toll booth. Besides 500 kilometers of motorways, the system covers a total of 1,900 kilometers of first-class roads. As Slovakia is a geographically relatively small state surrounded by five neighboring states, cross-border interoperability is also an important aspect. With the Siemens solution, borders cease to be a problem because the hybrid OBU Sitraffic Sensus Unit operates across Europe. Already in the first year of operation, transit traffic generated € 4.5 million in revenues for Slovakia. And the incorporation of first-class roads into the toll system makes sense too, because this part of the road network contributed a hefty € 50 million to the overall earnings of € 141 million.

What is more, operating costs are far lower than for a typical microwave-based system.

Switzerland: Satellite-based truck toll on all roads
In Switzerland, our Sitraffic Sensus system is the basis for a truck tolling system covering the entire road network. Satellite navigation technology is used to record the miles driven on Swiss territory while the toll monitoring component is based on microwave technology. For Swiss trucks weighing more than 3.5 t, installing an OBU is obligatory. Foreign trucks can log into a manual booking system. For cross-border transport, the Sitraffic Sensus OBU is very convenient because it also works in Austria and Italy. With revenues of € 750 million, the system makes a valuable contribution to financing the huge investments needed for the upkeep and extension of the Swiss road network.

France: GNSS truck toll routes totaling 15,000 km are added to the existing DSRC-based general toll system on motorways
The French system is one of Europe’s most extensive satellite-based tolling systems and a “doubly” hybrid system to boot: On the technical level, because it uses both DSRC and GNSS data collection technologies; on the organizational level, because it enables the integration of the new, country-wide truck toll system with the existing toll solutions, which are run by five different private toll operators and their roughly 20 licensees. The hybrid Sitraffic Sensus Unit OBUs serve a purpose in both parts of the system: On the 8,000 km of tolled motorways, they enable automated payment, while on the additional 15,000 km of tolled road they serve to precisely record the distances travelled by every truck. It goes without saying that the OBUs work just as well in Spain.
With Sitraffic Sensus, national and regional roads, too, can easily be integrated in a tolling solutions where needed. The Slovakian system is an excellent example of this flexibility.
Siemens is among the most successful global suppliers of innovative transport technologies. Around the globe, people are using systems and facilities for which we have supplied equipment or even taken over the leading role in the project consortium: airports, rail systems, traffic information systems and increasingly also tolled road networks, tunnels, bridges and inner city areas.

From the start, our Electronic Tolling headquarters in Vienna, Austria, have been involved in the development of satellite-based toll collection systems, making innovative contributions. Our on-board units developed in Vienna keep setting new standards, from the first generation to what is now the fourth. Starting with the first satellite-based area toll scheme covering around 16,000 square kilometers in the Seattle region in the USA, via major pilot projects for testing our hybrid technology in Sydney (Australia) and other cities, our system has been developed, tested and perfected over many years – up to today’s mature level.

So if you want to play it safe with your future toll collection system, rely on Siemens. With Siemens as your partner, you are sure to get an excellent solution – on both the technical and financial level.

Across the world, suitable tolling schemes are increasingly advocated as sources of revenue for extensive and costly infrastructure projects. Siemens is the partner of choice when it comes to implementing efficient toll solutions.
Satellite-based tolling is our area of expertise. And that not only since yesterday!
This is the home of satellite-based tolling: The Siemens Competence Center for Satellite-Based Tolling in Vienna, Austria
Siemens is one of the world’s leading transport technology providers. To the benefit of your project!

From consulting to service, from roadside equipment to software integration in traffic centers – Siemens offers a truly comprehensive portfolio of products, systems and services for transport technology. In conjunction with the wealth of expertise and experience available within one of the world’s technology giants, this means one thing in particular: the certainty that your toll project is in the best of hands with us, in technical and economic terms.

Innovative technologies and top quality are our hallmarks
Products and systems provided by Siemens always meet the highest technical and quality standards. That comes as no surprise in the light of the fact that every year, we spend close to € 4 billion on research and development and apply for about 53,000 patents. As many as 28,000 of our 360,000 employees worldwide are working in research and development. Extra security for your important traffic infrastructure projects!

We know what the automotive and transport industries need
Siemens has close links with the automotive and transport industries. So our customers can be sure that all our tolling components, from the on-board units for vehicles right up to add-on applications for fleet management etc., are fully in line with market requirements.

Toll tariffs that reflect current traffic load? Implemented at any time!
With satellite-based toll systems, it becomes easy to control and steer traffic volumes – for a more balanced traffic distribution and less congestion. So-called road-pricing schemes, for instance, allow the application of higher toll tariffs during peak hours than during normal or low-load times. And since it is not possible to predict traffic volumes with 100 percent accuracy, there are no fixed time-based tariff schedules, but the toll fee is adapted dynamically in function of the current traffic volumes. Still a vision? Not at all: Using standard components from the Siemens tolling portfolio, such a solution can be implemented at any time.

A valuable partnership – and as inclusive as you want
If you like, we will implement all technical and administrative components for your tolling solution across the entire value chain. Siemens has the extensive experience and resources to lead even huge projects to a successful and timely completion. And we have the innovative ideas and flexibility to take new and unusual technical paths whenever your needs require us to.

In short, we offer you outstanding electronic tolling solutions that will help you reach your goals quickly and efficiently. As your partner, we will do more than simply meet the “usual” requirements: We can realize additional intelligent telematics solutions that will provide added value.

Keeping traffic flowing, ensuring mobility also in densely populated areas, raising funds for the upkeep and upgrading of the transport infrastructure, minimizing particulate and nitrogen oxide emissions … the tasks in transport policy are many. The satellite-based Sitraffic Sensus tolling system from Siemens can make a valuable contribution to their solution.
The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The desired performance characteristics are therefore to be specified on a case-by-case basis when the contract is agreed.