GNSS ON ROAD

STUDENT CONTEST 2019

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INTRODUCCION

In this research we will talk about the different applications that GNSS technology can have in the road sector.

Although this sector of the GNSS is quite developed and there are multiple applications and sectors in which we can find this technology we wanted to find and explain technologies that are novel. To this end, we will point out several applications and developments that can be used by vehicles and which are of great interest to the user due to the ease they can offer, whether prevention, safety, time saving and / or money.

Finally we wanted to make a special mention to the application that can have this technology for people and we wanted to refer to several projects that are currently under development and we have found very interesting.

GALILEO SPEED WARNING (GSW)

BACKGROUND

Nowadays road safety is very important task and when road rules are not enough to guarantee the passengers security, then there is a need for creating and monitoring what is happening on the road network. A lot of researches have shown that every year more and more people were killed by inappropriate speed. And as we can see on diagram 1 most of the incidents happen on open roads. Twenty-one percent of all fatal crashes are on open roads (over speed limits 80km/h). A further 9 percent are urban (speed limits 70km/h) crashes in which speeding is a contributing factor. Speeding was a contributing factor in 34 percent of urban fatal crashes and 30 percent of open road fatal crashes.

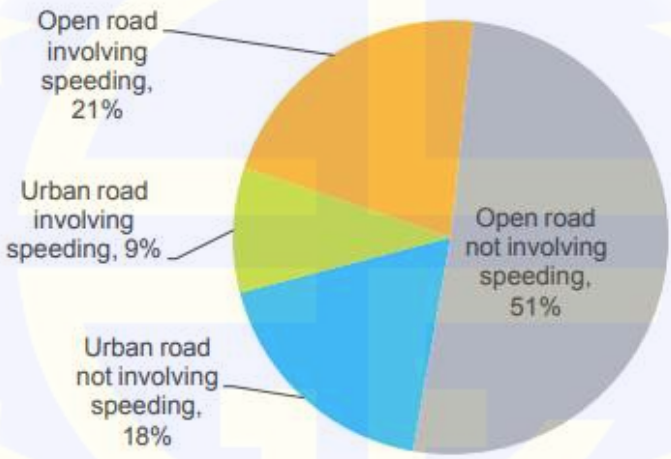

DIAGRAM 1. DISTRIBUTION OF ROAD INCIDENTS /2016/

HTTP://WWW.TRANSPORT.GOVT.NZ/ASSETS/UPLOADS/RESEARCH/DOCUMENTS/SPEED-2016.PDF

DEVELOPMENT OF GSW/ CARAT

Galileo is an European global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. By offering dual frequencies as standard, Galileo is set to deliver real-time positioning accuracy down to the metre range. As a result of this constellation of satellites, there are a lot of applications in the transport sector.

In January 2009 the European GNSS Agency has decided to develop a new product innovation - GSW CARAT (Galileo Speed Warning/ Continuous Assessment of Road Attidude Counter). GSW is an intelligent speed system that is based on emerging satellite navigation technology /Fig.1/.

FIG.1. GSW SYSTEM APPLICATION

HTTPS://WWW.GSA.EUROPA.EU/GALILEO-SPEED-WARNING-GSW-0

The newly made system not only observe drivers attention on the road, but warm them about speed restrictions. Moreover the CARAT Counter rewards good drivers' behavior on the road by collecting points. Still collecting points means saving people lives on the road with appropriate speed driving. The CARAT Counter increases when the driver keeps specified speed limit thresholds, but if they break the thresholds while driving they stop receiving CARATs. The driver can review how many CARATs they have collected and also how many they could have collected through safer driving.

The new product is intended to integrate with existing Intelligent Speed Adaptation devices, and make use of the data collected during driving, such as speed limit, location, etc.

CARAT SYSTEM

To communicate the principles of the CARAT Counter to users, a simulator was created and made available for the public to trial. The simulator allows the user to select a driving speed and then monitor the CARATs they have collected.

In the figure 2 on the left below, the driver is driving within the defined ‘acceptable’ driving band and the status is indicated as green.

In the middle, the driver has accelerated beyond the speed limit and the status turns red.

On completion of the simulated trip, the driver gets a count of their CARATs.

In the near future maybe for good behavior on the road drivers can receive fuel discount, for instance.

FIG.2. SYSTEM SIMULATION

HTTPS://WWW.GSA.EUROPA.EU/SITES/DEFAULT/FILES/VIRTUAL_LIBRARY/2009_-_CARATS_FOR_SAFER_DRIVERS.PDF

GSW TECHNOLOGY

The key to the technology is the use of global navigation satellite system (GNSS) signals, as will be provided by Europe's Galileo system, which will provide greater accuracy and have a high availability.

"Drivers need to trust the application," says the agency. "ISA is an autonomous system which uses the satellite data to accurately position the vehicle and calculate its speed independently of the vehicle's instruments. Really accurate positioning for the vehicle on the road is essential. Galileo will provide a higher accuracy and signal availability than the current GPS. This will also help reduce the cost of the system."

The GSW team had developed a system that is independent of the ISA hardware and allowed deployment across a range of different units. *"The architecture of CARAT counter software is designed to be independent of the ISA device,"* announced the company.

PRIVACY CONCERNS

Privacy concerns are the most important potential obstacle to the successful deployment of GALILEO services because many useful applications rely on monitoring the location of each vehicle at all times.

Privacy concerns mean that the general public is very unlikely to accept the use of such a system without having credible guarantees that it will be used only for very specific applications. A first step toward gaining acceptance for the system should be the introduction of transparent data-protection policies at European level aimed at avoiding the misuse of data.

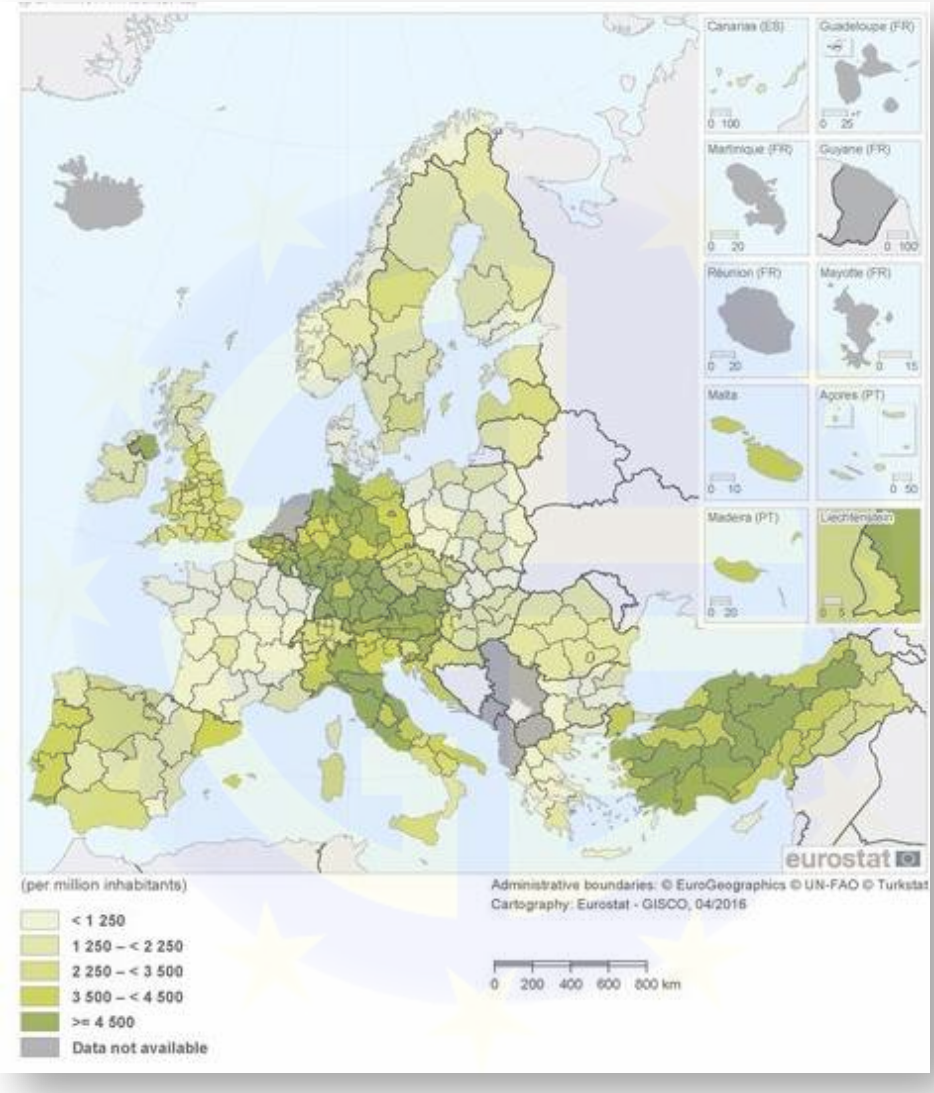

FIG.3. INJURED PEOPLE IN EUROPEAN COUNTRIES /2014/

HTTPS://I.PINIMG.COM/564X/78/6D/D6/786DD639729CBBB4F3955C6DA8F62EC6.JPG

On the map in figure 3 there is a horrible statistic made by Eurostat, that shows how many people are being injured due to high incongruous speed. The hot-spots of high speed accidents is central Europe.

In conclusion, in the near future there are expectations that the accidents caused by speed will be minimized thanks to GNSS technology and useful applications.

ECALL

INTRODUCTUON

Vehicles positioning is important about observing road traffic, road network, hazard warming and preventing accidents. It is extreme advantage providing accurate vehicle location about warning the right services at the exact time in case of collisions. Global navigation satellite system and digital maps have become major part for cars positioning providing not only location information, but also geometry preview of the road. Advances in wireless communication have made it possible for a vehicle to share its location information with other vehicles and traffic services which greatly increases the opportunities to apply vehicle positioning technologies for improving road safety.

FIG.4. PERCENTAGE OF ROAD INCIDENTS

HTTP://EUROPA.EU/RAPID/PRESS-RELEASE_MEMO-17-675_EN.HTM

ECALL DEVELOPMENT

In 1999 the European Commission /EC/ services presented the concept of eCall at the start of the Galileo project. Ten years later the eCall project was introduced at the European Commission and after that released step by step all around European countries.

The European Commission first proposed the eCall type-approval regulation in June 2013, estimating that, once the system is fully implemented, it could save hundreds of lives every year and help injured people get a quicker recovery.

ECall is a product developed to provide quick emergency response in case of a road accident, anywhere in the European union. Its aim is to advance Europeans' protection and safety, and moreover to reduce crashes caused by road accidents, as well as related injuries. The product was developed to address the problem that drivers involved in accidents often have inaccurate awareness of their location, especially on dangerous roads. In the most crucial cases, victims may not be able to call because of a lot obstacles.

The eCall system can provide the car's exact location to emergency services, the time of incident, speed and another useful information. It is improved that fully implemented system eCall could save thousands of lives and help injured people as quick as possible.

The 112 eCall automatically dials Europe's single emergency number 112 in the event of a road incident and sends the car location to the nearest emergency service.

Every year around 25 000 people all over Europe were killed and more than 1 million people injured in every day traffic accidents according to Eurostat agency.

ECALL WORKING SYSTEM

The essential part of the system is that eCall can automatically be activated when in-vehicle sensors detect a crash hazard.

Once set off, the system dials the European emergency number 112, establishes a telephone link to the appropriate emergency call centre /PSAP/ and sends details of the accident to the rescue services, including the time of incident, the accurate position of the crashed vehicle and the direction of travel. A PSAP is a physical facility where emergency calls are first received under the responsibility of a public authority or of a private organization recognized by a specific EU member state. Once the sensors detect hazard and the information is send, the emergency serviced can provide fast and accurate care of the people in need.

The PSAP operator can receive both the voice call from the accident point and a message including the exact geographic location of the vehicle, the direction of travel and another important data. During an accident event, the message transmits the triggering location in WGS84 coordinates.

A benefit of this system is that eCall is not expensive. The cost is around € 100 per car at the date of entry into force of the proposed regulation. The future plans in the following years consist of installing an eCall system in every single made car in Europe.

PEOPLE CONCERNS

At first drivers and passengers were afraid of that by having an eCall equipment installed in their cars, they will be non-stop tracked, monitored and traced everywhere they go. But PSAPs are used to dealing with personal data, respecting people' privacy in the course of their normal operations (i.e., when citizens call to the single European emergency number, 112). Moreover, the system and the in-vehicle equipment should guarantee that vehicles equipped with eCall are not traceable and are not subject to any constant tracking.

The eCall developers assumed that data sent by the in-vehicle equipment should be limited to the minimum information required to appropriately emergency calls. The in-vehicle system will continuously erase data on previous locations of the vehicle.

ADVANTAGES OF THE SYSTEM

The major pros of the system is provided by use of multiple constellations - at least three GNSS, including Galileo, GPS and GLONASS, along with satellite-based augmentation systems (SBAS) should be supported by vehicles' navigation modules.

Thanks to this effort, GNSS testing requirements can be simplified, together with the fact that the eCall cannot be considered a safety-critical part of the vehicle, as the GNSS navigation information does not affect the driving process. Indeed, in the majority of cases the eCall functionality will never be activated.

The ability of eCall to deploy emergency assistance save lives and reduce the social burden of road accidents. The service will improve the notification of such accidents, speed up the emergency service response and address the resulting issues of fatalities, injuries and traffic flows.

MAIN WORKING MODELS

There are three main models that portray the possible functioning of eCall.

1) eCalls routed as 112 calls: The most appropriate Public Safety Answering Point (PSAP) receives 112 calls and eCalls.

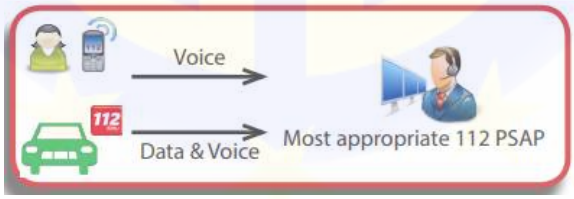

FIG.5. FIRST MAIN MODEL

HTTP://WWW.EENA.ORG/DOWNLOAD.ASP?ITEM_ID=111

2) Calls routed to a PSAP dedicated only to eCalls: 112 calls continue to be routed to the 112 PSAP. An eCall is identified in the network thanks to the "eCall flag", which indicates that the call is not a usual emergency call but rather an "eCall". That way, it can be routed accordingly by mobile network operators. Please note that the eCall flag is a recommendation made by the European Commission. So far, Mobile Network Operators are not obliged to implement it and very few have done so, despite the fact that it is of crucial importance in order to distinguish between 112 calls and 112 eCalls. A Member State can choose to outsource the reception of an eCall to a third party instead of a public authority.

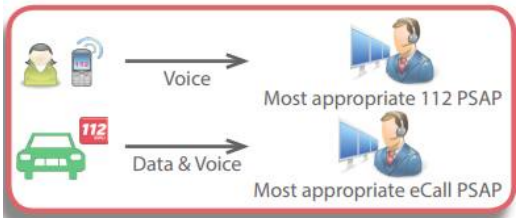

FIG.6. SECOND MAIN MODEL

HTTP://WWW.EENA.ORG/DOWNLOAD.ASP?ITEM_ID=111

3) Manually triggered eCalls and automatically triggered eCalls are routed to different PSAPs: It is possible that it can be the same PSAP as for 112 calls. A PSAP that receives the manually triggered eCall can also be the same PSAP receiving traditional 112 calls.

FIG.7. THIRD MAIN MODEL

HTTP://WWW.EENA.ORG/DOWNLOAD.ASP?ITEM_ID=111

1) A 112 emergency call is made automatically (airbag sensors) or manually when there is a accident.
2) Thanks to satellite positioning and mobile location, the accurate position of the accident is received and after a while transmitted by eCall to the nearest emergency centre.
3) The eCall's urgency is recognized and PSAP have all the useful information.
4) With the exact knowledge of the crash, the emergency services can arrive much qiucker.

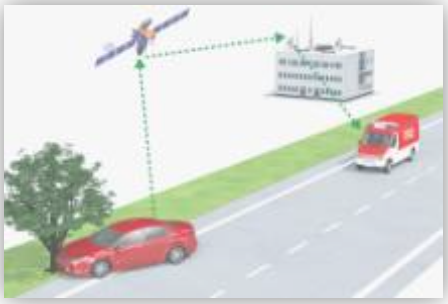

FIG.8. ECALL SYSTEM

HTTPS://WWW.AUTOBILD.ES/SITES/AUTOBILD.ES/PUBLIC/MEDIA/IMAGE/2015/04/412001-ASI-FUNCIONA-ECALL-LLAMADA-SALVAVIDAS.JPG

SATELLITE FREE-FLOW TOLLING

INTRODUCTUON

At present there is a high movement on the road, nationally and internationally. Whether for freight transport or for passenger transport or autonomously we travel between different cities and countries finding us along the road with payment roads which means having to go through a toll. Sometimes the mere fact of stopping the vehicle to pay the corresponding fee can cause jams and long queues. The use of most European highways or roads is a quota and in spite of that, until today there is no standard of uniformity on the amounts or method of payment on these, because in some countries the payment method is different

DIFFERENT FORMS OF PAYMENT

In this section we will explain the different forms of payment that can be found in the European Union. For this we are going to help us with the following image /Fig.9/

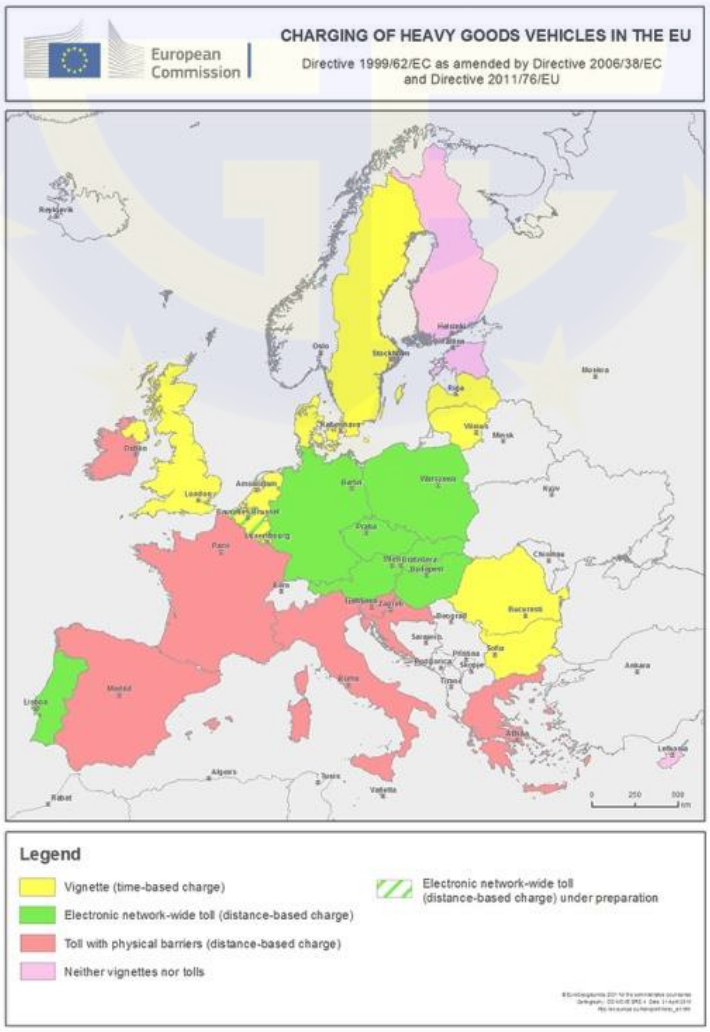

FIG.9.: EUROPEAN UNION TOLL RATES.
SOURCE: WORLD ROAD ASSOCIATION GUIDE

As we can see in figure 9 in the European Union there are different types of rates on privete roads:

- In areas higlighted in red: These are physical barriers that measure the distance traveled on the payment road. The amount must be paid at the exits or entrances to highways or highways.
- Green areas: In these countries a small electronic device must be installed inside the car, which automatically registers, when passing through control points, the distance traveled and the corresponding toll. These devices are recharged with money or linked to a bank account.
- Countries marked in yellow: Use toll labels (vignette), this is a sticker that adheres to the vehicle's windshield (depending the country, the position can change) and both the vignette and thepurchase receipt can be checked by the police to see if they are valid. Such vignettes may involve a weekly, monthly or annual payment. This way, all road networks can be traversed without physical barriers or control points, since it is the police officers who can verify that the vehicle carries this tag.
- Finally, the pink areas do not have any paymet for the roads.

Because many vehicles, of goods and passengers mainly, cross different countries repeatedly and to avoid jams and problems with the forms of payment has been developed the technology: Satellite Free-Flow Tolling.

It is an automatic payment procedure that avoids the formation of jams and retentions in the accesses and exits of the highways. And that also adapts to the different countries in which the vehicle is located.

It consists of an on-board unit (OBU) composed by a GNSS receiver that allows to mark at all times the route followed by the vehicle in question, a module DSRC (Dedicated Short Range Communication) that by means of microwaves, will be able to interoperate with other European systems, it transmits information of localization of bridges and control vehicles, and the support of GSM / GPRS mobile telephony for the transmission of data to the control center, which automatically performs the calculations for charging the entire network of federal highways according to the kilometers traveled, the number of axles and category according to pollutant emissions.

BREAKDOWN OF FUNCTIONING

The vehicles must have an on-board unit that can be obtained via the Internet or physically in authorized establishments. We can indicate the form of payment, pre-paid or post-paid. In addition you can select the regions by which the vehicle is expected to be moved.

Once the unit is available we must place it in the inner central part of the windshield at an approximate height of 1.5 meters. The device is powered by connecting it to the cigarette lighter socket. To activate the unit we enter the data of the vehicle, such as weight, axes, etc.

Thanks to GNSS technology, the on-board device detects the vehicle's situation autonomously. As the vehicle advances, the different toll zones are identified. The device stores the sections through which it has passed and sends them to the appropriate office using GPRS technology. Once the information is transmitted to the office there is checked with the help of a digital map the sections through which the vehicle has passed. Using the data

entered at the beginning of the characteristics of the vehicle and with the information sent by the device, the cost of driving on those roads is calculated for that vehicle.

Depending on the legislation in force in each country to calculate the cost of road traffic, the following parameters can be taken into account: distance traveled, vehicle weight, vehicle size, vehicle emissions, number of axles, day band, type of road or amount of traffic.

To notify the user of the amount an invoice is sent via email or by ordinary mail indicating the sections that have traveled and any of the above mentioned parameters plus, clearly, the cost of the trip.

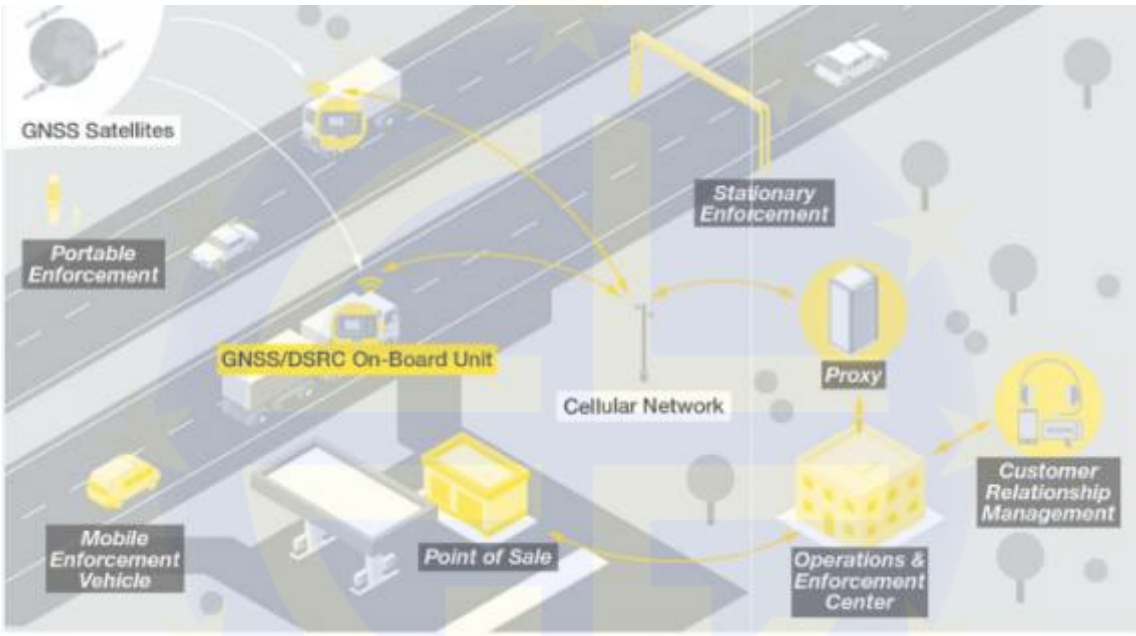

FIG 10: SATELITE TOLLING.
SOURCE: KAPSCH

In figure 10 we can see an outline of the operation explained above.

This system, at present, results of great utility for the heavy vehicles and of transport of goods, as the trucks.

GNSS FOR PEOPLE

INTRODUCTUON

As we have seen there are different applications of GNSS technology for roads, but nevertheless, we must not forget that roads have not only been created for vehicles but also for pedestrians. Within this group we can put special emphasis on people with some type of disability.

GNSS FOR BLIND PEOPLE

In this case we are going to talk about an application for mobile devices in particular, ARGUS. It is an application developed by Vicomtech-IK4, a Basque company based in San Sebastián.

This application combines information of the different satellites obtaining the information of position of the user and generating a suitable route for its disability. This route arrives acoustically to the user through stereo headphones of the open type to allow the user not to isolate himself from the rest of sounds and thus not to run other kind of hazards.

The application also allows to generate routes of previous form, either to share the routes that friends or relatives have followed or to publish in social networks those made by the own user.

The difference of this application with other existing ones is that it has been developed entirely taking into account the needs of the visually impaired. For this, a large repositories of special sounds have been created, using 3D sounds (binaural sounds) for the user to indicate the routes that facilitate the positioning system.

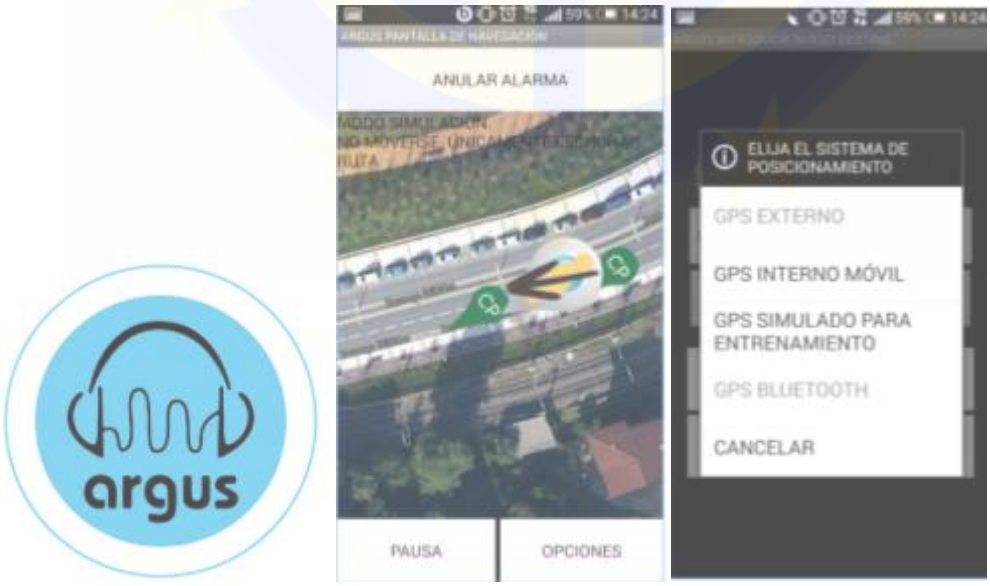

FIG. 11. APP ARGUS

GOOGLE PLAYSTORE

GNSS FOR PEOPLE WITH FUNCTIONAL DIVERSITY

In this section we are going to talk about a project that is currently under development. Adapt the information provided by GNSS devices with useful contents for people with disabilities: for both drivers and pedestrians, and incorporate adapted public service information.

According to data from the National Statistics Institute of 2013, around 8% of the Spanish population suffers from a disability, among which we can also find disabled drivers.

It's interesting to note that mobility limitations can be divided into different categories:

- 37.5% of the total use manual wheelchair.
- 20.6% use an electric wheelchair.
- 13.1% use crutches and canes.
- 23.6% do not need technical assistance.

In order to create this technology, the existing information must be adapted in the current devices. For this purpose, maps of accessibility to cities should be developed, including information on easily accessible roads and other useful information, such as the availability of parking spaces for the disabled in real time, access to public or private buildings or data practical in real time on public services like the bus and the metro.

FIG. 12. GNNS DEVICE WITH ADAPTED INFORMATION

HTTP://WWW.EMPRENDEDORES.ES/IDEAS-DE-NEGOCIO/GPS-PARA-DISCAPACITADOS/CONTENIDOS-ADAPTADOS

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