European Space Policy Institute

Views on Public Perception and International Aspects of the European Space Flagship Programmes Galileo/EGNOS and GMES

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Foreword

by Vladimír Remek

Dear Friends,

The European Space Policy Institute (ESPI) is conducting a Study on Europe´s Flagship Projects: Galileo and GMES. You have in your hands a brochure which covers the Galileo – GMES Workshop: "Lesser Known Elements of the Space Flagship Programs: Public Perception and International Aspects". This workshop has been organized by ESPI in order to provide the opportunity of debate amongst the stake holders, and the need for action in the areas of public perception and international cooperation.

It turns out that the theme and content of this Workshop has led to a strong response and they are still topical. For this reason it is without doubt a good idea that ESPI has decided to collate the participants contributions, presentations and conclusions from this Workshop, as well as to undertake a Study. I would therefore like to once again thank the authors for all the presentations and speeches made at the Workshop. The study addresses a very important and highly topical issue, which the development of satellite navigation definitely is. It is not my intention to repeat the speech I made at the Workshop, nevertheless I would like to highlight some of the points once again.

Firstly I consider conducting the study concentrating on the Public Perception of Satellite Projects and their International Aspects was very good idea. For it is long proven, and not only in this field, that public opinion and perception is a very important factor for the majority of activities in both politics and economics. It is true that if the public disagrees with something or does not feel connected to something it will not support any good intention at the end and as a result the final benefits and contribution of such activities will not be as great as it could have been with the support of the public. Moreover, it is well-known truth that public opinion is linked to the behavior of political representatives and decision-makers. You can't have one without the other.

In our particular case we are able to say that the European public generally supports satellite projects. The general public also supports the independence of Europe in this direction. Details can be found in the study. However, in relation to specific activities around building a system - such as Galileo - the responses are already not so clear. Therefore it is important to understand all the factors that operate here, and based on this findings there will be a better chance to set the right policies and procedures.

One of the other aspects which I consider very beneficial is the fact that the debate took place - and hopefully will continue - under the auspices and responsibility of ESPI. It brings to our work in the European Parliament, as well as to other institutions an element of detachment, independence, the opinion of "outsiders". Yes, people from ESPI as well as those they cooperate with know a lot about satellite navigation. But they are not directly related to the preparation of projects, work on legislation and decision making.

Therefore, I welcome similar activities, so I have participated in them and will support them in the future because I am convinced that Europe needs projects like Galileo and others in order to have a future.

I believe that the text you hold in your hands not only tells you many things and signals many issues, but may also provide direction or provoke questions as well as being useful in your occupation whether it is in the European institutions, industry or elsewhere.

Vladimír Remek
Member of European Parliament
Member of Galileo Interinstitucional Panel
Vice-president of Sky&Space Intergroup
Cosmonaut

Foreword

by Norbert Glante

Dear readers,

The present brochure will give you a detailed overview of the European space flagship programmes Galileo/ EGNOS and GMES. The European Space Policy is continuously developing and influencing more and more our daily life. Applications of global satellite navigation systems go far beyond finding your way easily through an unknown city: We speak about precise management aspects in fields like agriculture, electricity supply, financial transactions or aviation safety - space technology applications are various and concern most of our everyday life's situations.

The European Geostationary Navigation Overlay Service (EGNOS) has now been operational for one and a half years. After its start with an open service we recently got operational with the safety-of-life-service in March this year. This new service will increase flight safety, reduce delays and open up new flight destinations thanks to better evaluation methods. Regarding Galileo we are making progress too. For the moment we are working out the legal provisions concerning the access to the public regulated service of Galileo. This service will be used by public authorities for security related applications. The next good news from the Galileo project is that now the first two satellites are ready for being launched in September from spaceport Kourou in French Guiana.

Regarding GMES as the other space flagship programme progress has also been made since the workshop has taken place. The governance structure of GMES is now set and its work programme for 2012 is now being prepared. In June the GMES security board will meet for the first time. That GMES is already working to the benefit of all has been demonstrated once again after the earthquake in Fukushima. Shortly after the incident high-resolution maps were provided by the system in order to support the emergency services.

In order to develop a comprehensive approach of all space activities in the EU the European Commission has recently published a space strategy concept called "Communication towards a space strategy for the European Union that benefits its citizens". Besides the completion of the Galileo/ EGNOS and Galileo programme this communication aims at reinforcing Europe's space infrastructure and calls for increasing support for research to increase European technological non-dependence, foster cross-fertilisation between the space sector and other industry sectors, and boost innovation as a driver of European competitiveness. Finally partnerships with EU Member States and the European Space Agency should be strengthened.

Within this framework for a European Space Policy we will have to bundle all stakeholder's efforts to make our economy and citizens benefit from all new technologies arising in this field.

Norbert Glante
Member of European Parliament

1. Introduction

by Christina Giannopapa and Gai Oren

Europe is at a stage where the successful realisation of the European space flagship programmes, Galileo/EGNOS and GMES is at stake. The focus of the political debate has so far been on governance, finance and technology. Two crucial elements have been neglected which are of utmost importance for the implementation of the flagships: the public perception and the international relations.

To help address these issues the European Space Policy Institute in close cooperation with the ITRE Committee organised a workshop at the European Parliament on 7 December 2010, entitled "Less Known Elements of the Space Flagship Programmes: Public Perception and International Aspects". Building upon existing analysis and discussion on governance and structure of the two flagships, it focused on public perception and international aspects. The figure represents a schematic perception of the focus of the ESPI workshop (doted lines) with A covering the aspect of public perception and B the international cooperation.

These two specific issues have not been investigated thoroughly and neither in a comparative approach. These issues can be regarded as framing elements of the two flagships in that they look into the foundations of the programmes vis-à-vis the general public and decision makers; and for the second part, relate to the interaction on the global scale with other actors conducting activities with a global approach in the two fields. The structure of the workshop was in two parts: public perception and international aspects. Each part was comprised of presentations of the relevant main points for Galileo and GMES and followed by round table discussions amongst the stake holders and the needs for action in the two areas. It addressed decision makers in particular Members of Parliament at European and National level. It analysed the whether a comparative approach between the two flagships could be useful defining concrete activities and policies. The present document represents the compilation of the contribution of the relevant stakeholders on these issues.

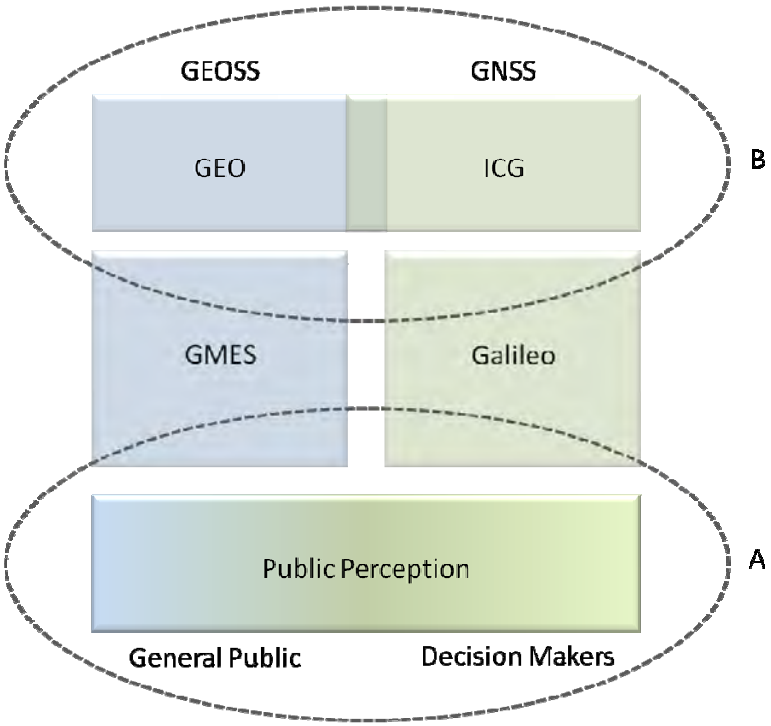

Figure 1: Conceptual schematic on public perception (A) and international aspects (B) for Galileo and GMES.

2. Contributions to the ESPI Workshop of 07 December 2010

2.1 Galileo status and future challenges

by Vladimír Remek

Dear Ladies and Gentlemen, dear Guests,

I would like to thank you for giving me the opportunity to share my views about public perception of the European Satellite Navigation System. I welcome every opportunity to support discussion about an important project like Galileo.

Since the time of my cosmic flight one of my life mottos has been per aspera ad astra (over obstacles to the stars). This is also due to the fact that I also had to - together with other astronauts - overcome a number of obstacles before - my space mission took place. It seems now that this motto would be quite fitting also for the development of the Galileo project. We are trying to overcome obstacles in order to send a set of satellites closer to the stars; and to benefit the whole of Europe and all mankind.

Those obstacles are not small. One of the main obstacles is the project financing. The financing is complicated - even more complicated and even less feasible when people do not understand the advantages and values of the project. Understanding is lacking not only amongst the general public, but also amongst politicians and decision makers.

The head of ESA, Mr. Dordain is saying that we need a political dimension to the Galileo project and it is true because what we miss is a clear agreement between the top leaders of European politics in order to clearly support this important, necessary and ambitious infrastructure project. This brings me to the very important aspect of Galileo which according to my opinion can influence both the perception by the public and the politicians; and mainly those who takes decisions about the financing.

As you know very well from your own countries politicians like to stay in their posts, and in order to stay there they need the support of the public; at least for the elections. But when people hear about the crisis all the time and about a need to make cuts and austerity, and then they are forced to do it themselves on one hand; and in the other hand they don't have a very large awareness of the project, or they just hear how expensive it is, or that is running behind schedule; and they have no idea what use it has, then of course they have no need to support or to be in favour of the project.

Just by way of illustration, Eurobarometer together with the Gallup Institute have made their own review about the awareness of Galileo, with 25,000 respondents, and only 40% of those asked confirmed that they have heard about the satellite navigation project; 59% of Europeans considered it something completely unheard of or completely new, even though we have been speaking about Galileo since 1999. This particular poll took place in 2007. Now we are in 2010 and it does not seem that the situation has changed dramatically. A public hearing organised by Transport Committee last week confirmed this when one of the speakers there was forced to admit that half the representatives of the companies who need location services are not aware of what GMES is.

Ladies and Gentlemen, politicians are very well aware of this. Some of them might not be fully aware of the advantages of the project for European Union and for their own country; some of them maybe yes, but they are afraid to support the project more intensively because there is a crisis. Why aren´t we able to present and state clearly at the right place and time, that it is precisely in the time of crisis, when we should invest in projects which will keep Europe competitive, independent and equipped with advanced technology for the future. Why do we hear or read so little about the potential of thousands of job opportunities to be created? Instead of that the public is fed with all this information about "how much Galileo costs", "how it has been delayed", and "how maybe we do not need it, because we have GPS already" etc.

But you all know that we have arguments. A recent British study of Oxford Economists shows that the British Space Industry is valued at about 7.5 Billion Pounds, and despite the recession it has been growing on average by 3% in last two years. Employment in this sphere is growing by 15% a year. And this in a situation of a crisis. Have you read about

this in the mainstream media? Yes, this is a good example of how we are unable, incapable of persuading the public and through the public to persuade politicians – or the other way round – about the benefits of investment into space policies and projects like Galileo.

I remember that in the times of my space flight, which is already 30 years ago, and even before hand; money has always been a problem. There is never enough money, but that's another thing I want to mention. I would like to use the example of Christopher Columbus. If he didn't manage to get the trust and the large support of the Spanish court, mainly financially, he could hardly have tried to discover a new route to India. It matters very little now if it was him or not who discovered America but it's obvious that without a certain measure of trust and a certain measure of risk no big projects can take place. The Galileo project is an infrastructure projects something like railway or internet and we can not build infrastructure half heartedly.

We can not just allocate a little bit of money and build a track from Town A to Town B and then wait until we get money for the rest of it. If you do not have the whole system functioning from the beginning, it has no merit. Mr. Verhoef from the Commission recently stated that if we only allocate money for a limited number of satellites - the figure usually quoted is 18 - Galileo will not be functional throughout the whole year as for 3 weeks of the year we will not have adequate signal; which means we will be without guarantee of the service. Who can then rely on our system? Who will then invest in its applications?

So it is not very surprising that people in the business community write various memoranda asking for Galileo to be launched as soon as possible, and some of them are already looking for opportunities to collaborate with China before the EU decides. Time is money and our delay is getting even greater because we are unable to set priorities. If we are to use the full potential of the market, created by the satellite market, we have to get to this market with our Galileo as soon as possible. Because this market is already profitable for a number of subjects, a number of players. Does the public know this? Not that much. Why is the majority of the information about Galileo only focusing on using navigation in cars? Then it is obvious that people will be asking "Why we spend money on Galileo when we already have GPS? I already have it". But who knows about applications for agriculture, security, safety of life, the financial and banking sector, the energy sector, and so on?

And when talking about finance and the costs of Galileo, yes of course we should not just waste money and all cost has to be transparent. On the other hand, when talking about Galileo, we are talking about something like 3.5 Billion Euro. Of course for a regular citizen this is an astronomical sum. Of course the public is then open to be persuaded by the critics and that it is very expensive and maybe we don't need it. But what if people realise that this sum represents the sum of debts of 20 Spanish football clubs or that for this kind of money we could build about 500 or maybe 600 km of highways?

Yes, people have became quickly used to the fact that satellites serve them very well and they are not really aware of it; they take it for granted. But only when our satellite TV does not work, when our internet banking using satellite does not work, or when we don't have a forecast of the hurricane, or when we don't have the necessary data on the situation of energy networks, then suddenly we remember how it all works. So, satellite technologies are basically victims of their own success and of our inability to remind people of their usefulness for everyday life.

Just for inspiration let's look somewhere else. Why are all the enemies of nuclear energy so successful in affecting a public opinion although it is a source of energy which is without emissions? Well because they use people's emotions, their insecurities, their fears. So to say it clearly to threaten people and to awaken their fear is always more efficient then trying to underscore the usefulness of something and the quality of something. Why shouldn't we show people how would a day be without satellites and without navigation system? What would that day look like?

When I talk to children at school about my space flight and say it took place 30 years ago, well they just nod their heads but when I add that there were no mobile phones, no computers, no notebooks and let alone internet they are suddenly taken by surprise.

I do not have time to discuss international aspects of the acceptance of Galileo in detail but we might have space for it in further discussion. Now I will confine myself to saying that I have always taken cosmonautics, research and space exploration as a classical example of international cooperation. This is the same today as it was then. It is even more so in a globalised world. We could also talk about the need to connect space policies and satellite policies with all other European policies about various campaigns in support of Galileo and how to bring more information to the hesitating public and politicians rather

than just discuss it among those who are already convinced supporters of these prospective projects and do not need to be convinced anymore.

Now let me finish my contribution with a statement that I believe that in the end Europe will manage to use its good starting position that it will not be in vain. It is something that we are deciding now and it is not just a question of space it is a question of our every day life in the future.

2.2 GMES, current status and future Challenges

by Norbert Glante

Dear colleagues, dear Ladies and Gentlemen,

As a member of the Progressive Alliance of Socialists and Democrats within the Industry Committee of the European Parliament I deal with space issues. Besides from Galileo GMES is one of the main projects in this field. Lately, I have been rapporteur of the Parliament for the regulation on the European Earth observation programme GMES and its initial operations until 2013.

All parliamentary groups in the European Parliament supported my report on the proposal of the European Commission from September 2009. The Members of Parliament have always been aware of the significance of that project for our environment and society and see great potentials for the environment and security in many applications, but also mainly for small and medium-sized businesses in the field of earth observation and relating industries.

The main points during parliamentary debate have been the budget, access to data, certification of the data and how to include users and other stakeholders. The legislation was dealt by trilogue-procedure between European Parliament, Council and Commission and finished in single reading. We voted in Plenary on June 16th 2010 and confirmed the results of the trilogue with broad majority. This was a great success.

In detail we fixed the following points: A budget increase to 316 million Euros for 2011 to 2013 is accepted by all Member states. Also a free and open access to data is assured. Sentinel data are provided free of charge at the beginning (2011 to 2013) in order to promote the development of new businesses in this field and to establish the market. Furthermore the scope of the regulation is extended to the field of application for atmosphere monitoring and marine environment monitoring. The prevention of data duplication is confirmed; as a consequence the collection and provision of new data should only be done if the adjustment of existing data is technically not possibly or will cause unjustifiable costs. A GMES Committee is created which is responsible for dealing with issues related to security to make allowance for security concerns of the Member states. Finally beside the GMES Committee a User Forum is additionally introduced to secure the user orientation of the project.

2.2.1 What is the current status of GMES?

The act was published in the Official Journal of the European Union on 20th October and entered into force 20 days later. So, since November 9th 2010 we have our first valid legislation on GMES. This is a historical step for earth monitoring in Europe. Despite a relatively small budget the regulation is of utmost importance for stable and sustainable earth monitoring services. The European Commission has now to implement the law, prepare the call for tenders, take care of the acquisition etc.

Therewith we enter in a new work phase for the Commission, and also for the industry and companies it will be important. Now the Commission will ask the Member states to nominate representatives for the GMES programme committee. A first formal meeting will take place in January 2011. Furthermore the implementation of a steering mechanism is planned. On December 10th there will be the first discussion about how to establish/ build up the User Forum. Therefore the Member states are asked to ensure the contact to user forums at national level in order to involve the user needs.

Another question will be how to organise the work regarding security issues. A Security Committee will meet on regularly basis to analyse scenarios concerning threats and risks and to evaluate them.

2.2.2What are the next steps?

For 2011 a legislative proposal of the Commission concerning the further approach at GMES is expected. This proposal will cover financial and program aspects for infrastructure and services of GMES. Regarding the budget we know that until 2013 we have to cope with the amount of 316 million Euros as fixed in the latest regulation.

Other important points of the upcoming new regulation are the establishment of a legal and regulatory framework for the fields of ownership, data politics, governance and

international cooperation. I am looking forward to this proposal of the Commission and will continue being active in the behalves of GMES.

2.2.3 What are the challenges?

GMES is a complex project that can only succeed by close cooperation with all involved stakeholders in the European institutions and the Member states as well as the European Space Agency. First of all financing has to be guaranteed on a long term basis. Necessary funds need to be at disposal on time.

The Parliament called on the Commission to present a financial strategy for GMES in the context of the Midterm review of the current Multiannual Financial Framework. Furthermore the Commission was requested to develop a long term financial strategy for the next Multiannual Financial Framework. From 2014 on European space policy should have its own budget outline and GMES should not be financed exclusively out of the Research Framework Programme any more.

As a second challenge an intelligent data and information policy needs to be developed to make sure that data will be provided continuously and reliably. This is the only way users and processors have guarantees for planning and can develop stable business models.

And thirdly a good organisation and structure of the project has to be guaranteed in order to make GMES a success. I am very committed to this project of high importance for our European industry and SMEs and will do my best to promote it. I am happy to count on the support of my colleagues here in the European Parliament.

2.3 The decade belongs to GNSS[1]

by European GNSS Agency

The global market for GNSS will grow significantly over the next decade, reaching some €244 billion for the enabled GNSS market in 2020

GNSS market forecasting is of great interest to private and public GNSS stakeholders, for business and strategic planning and policy-making. According to the 2010 GNSS Market Monitoring report[2] published by The European GNSS Agency (GSA), the global market for GNSS will grow significantly over the next decade, reaching some €244 billion for the enabled GNSS market in 2020. Delivery of GNSS devices will exceed one billion per year by 2020. Mobile location based services (LBS) and Road will be the market sectors with the highest revenue generation.

The report covers four market segments: Road, Agriculture, Aviation and LBS that represent the largest volume of users and/or public benefits.

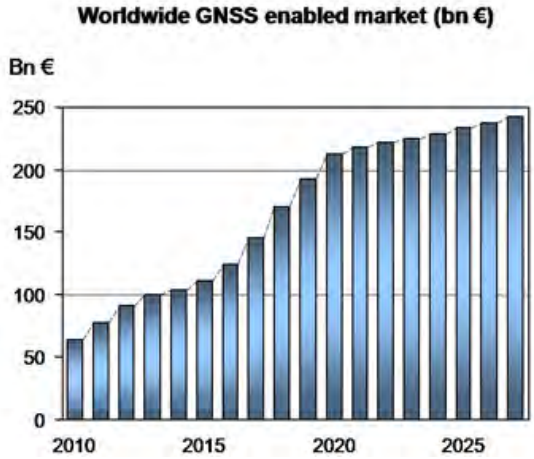

Figure 2 Worldwide GNSS enabled market (bn €)

2.3.1 Road leads the way

The road transport sector is facing major challenges, such as the demand for increasing safety and for reduced congestion and pollution. These problems are particularly acute in highly populated zones, including big cities and suburban areas. GNSS represents a powerful tool for improving road transport. Not only does it help get drivers where they want to go more quickly and efficiently, but it also promises fairer road-pricing schemes, for example, to automatically charge drivers for the use of road infrastructure.

The report shows that the road transport sector is still the main GNSS market segment, accounting for a share of more than 50%.

[1] previously published in mycoordinates, jan. 2011
[2] the report may be downloaded free here: http://www.gsa.europa.eu/go/download_the_gsa_gnss_market-report

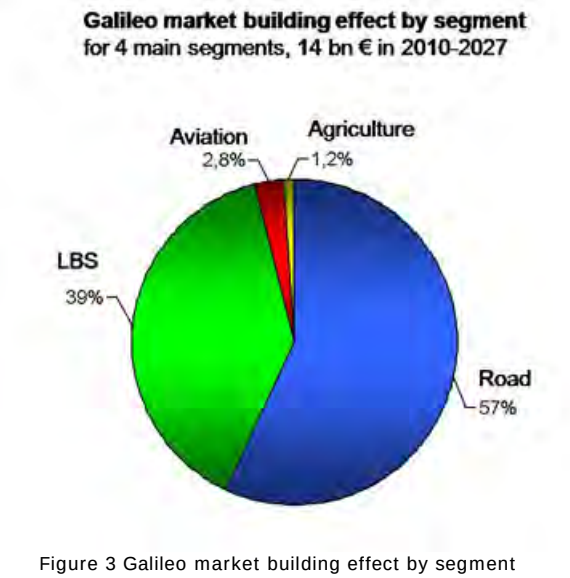

Figure 3 Galileo market building effect by segment

The penetration of receivers in road vehicles, today at 30%, will exceed 80% over the next decade. The Japanese and North American market would reach almost 100% penetrations in next decade whereas penetration in European Union would be around 90%. However, after a period of fast growth, market saturation and competition in the form of 'smartphones', often equipped with free navigation capabilities, have resulted in a slowdown in the car-based navigation market. The estimated global device revenues in road sector by the end of 2020 are €87 bln.

Erosion of device prices has been high, driven by declining costs and strong competition. Vendors are using innovation as a differentiator resulting in 'converged' products with both communication and multimedia functionalities. Some Personal Navigation Device (PND) vendors are also tapping into new distribution channels, including car dealerships and smartphone application stores.

2.3.2 LBS- GNSS in your hands

Mobile location-based services (LBS) are taking off as progress is being made in different areas and innovation is fast in the very competitive mobile industry. More and more mobile phones now have built-in GNSS capabilities and the awareness of consumers and developers is increasing. The hardware, software and content needed for navigation has become cheaper while the user experience has improved tremendously.

All major mobile phone operating system vendors now provide application programming interfaces (API) with location functions. Some of the most popular applications on the various applications stores are based on navigation.

The integration of accurate hand-held positioning signal receivers, within mobile telephones, personal digital assistants (PDAs), mp3 players, portable computers, even digital cameras and video devices, brings GNSS services directly to individuals, making possible a fundamental transformation of the way we work and play. The penetration of GNSS in mobile phones is therefore expected to increase very quickly, from some 20% today to above 50% within the next five years.

Geographically, as of now penetration of GNSS-enabled phones is much higher in North America and Japan compared to the European Union. However, by 2020, the penetration of GNSS in mobile phones will reach 97% in North America and the European Union, almost 100% in Japan and 82% in China. Total annual core GNSS revenues in LBS are expected to grow between 2010 and 2020 from €12 bln to €96bn.

2.3.3 Aviation- high and robust

The aviation market requires the highest possible robustness and integrity. GNSS-based navigation has the potential to greatly complement the traditional systems to locate and track the planes. Moreover, SBAS systems improve the accuracy and integrity of GNSS via a network of ground stations that take measurements of GNSS and broadcast information messages to users via satellite.

According to the report, the penetration of GNSS in aviation in the European Union will grow to 97% and in North America and the penetration of GNSS in aircraft will reach 78% by 2020. Total cumulated revenues from GNSS in the aviation sector for the period 2010-2020 will be €4.2 bln.

2.3.4 Agriculture – drive on tractors

The report also assesses the market potential in agriculture segment. It has been observed that in agriculture the low technology GNSS solutions are used for low-value crop cultivation, low accuracy operations and for agro-logistic applications. However, high technology GNSS solutions are also used for high-value crop cultivation or precision operations where levels of accuracy achieved are in the range of 2 to 10 cm.

The report says that the annual shipments of GNSS devices in the agriculture sector are expected to grow in all regions to reach 75,000 units by 2020 in the European Union, 110,000 units in North America and 350,000 units in the rest of the world. It is important to mention that the increased sales are mainly driven by the growth of the fleet and

the higher penetration of GNSS in new tractors. Worldwide agriculture revenues will increase over the next decade driven by the increase in device sales from €198 mln in 2010 to €486 mln in 2020.

2.3.5 Galileo and EGNOS

The GSA says Galileo in the future and EGNOS today open up new and exciting prospects for economic growth, benefiting citizens, businesses and governments throughout the EU and beyond.

The road segment has the potential to reap the largest benefits from Galileo. These benefits derive mainly from a reduction in travel time (a result of better navigation), reduced fuel consumption, better congestion management and the development of intelligent services.

The development of LBS, such as GNSS-assisted medical monitoring and other emergency services, will lead to significant benefits due to the reduction of injuries. In agriculture, the use of more accurate positioning technologies will allow rationalisation and increased efficiency in the use of fertilisers and pesticides. In aviation, the integrity information will increase flight safety and reduce fuel consumption.

In 2009, the GSA developed and implemented a GNSS market monitoring and forecasting process which resulted in first issue of the report in question. This process was developed with the support of VVA and LECG, two consulting companies expert in market analysis and forecasting. The Market Monitoring Model takes as input the data from GSA market studies and reliable industry sources. Moreover, the model is based on a tailor-made selection of econometric techniques. An extensive set of variables are defined by key assumptions on the adoption of GNSS and Galileo. This process allows the simulation of different market scenarios. Additionally, a consistency check was performed for each segment by comparing the model's results with the most recent reports from independent GNSS market research companies.

2.4 EGNOS has landed: How it will benefit Aviation[3]

by European GNSS Agency

Helicopters, regional airlines and business aircraft, along with the European small and medium-sized airports they fly into, will benefit most from the greater accuracy provided by EGNOS, which allows more efficient approaches and lowers the decision height for landing.

In seeking a more efficient use of resources and air space, the aviation sector is looking at a number of technological innovations to better manage congestion, cut costs through improved operating efficiency, and reduce its impact on the environment.

One of the areas of innovation is Performance Based Navigation (PBN), as defined by the ICAO, which will reduce fuel consumption, CO_2 emissions and noise levels. Improved or augmented satellite navigation signals make PBN possible. Whereas GPS is a great tool for en-route navigation, satellite-based augmentation systems (SBAS) enhance the performance of GPS according to four parameters: accuracy, availability, continuity and integrity.

By itself, the US GPS is not accurate enough in the vertical plane to provide pilots with usable glide slope information for precision approaches when landing. EGNOS, the European SBAS, and WAAS, the North American version, guarantee the level of vertical precision required for PBN. The vertical precision of SBAS is 2-3 meters on average, and within 4 meters 95% of the time, compared to 20-30 meters for GPS. This improved accuracy for landing approaches using SBAS brings a pilot's decision height down to 200 feet (about 60 meters).

2.4.1 Benefits for aviation

Helicopters, business aviation, regional airlines and the large general aviation aircraft flying into small and medium-sized airports – where the traffic does not justify expensive investment into ground-based navigation infrastructure – will benefit from the considerable reduction in the decision height provided by EGNOS.

When the decision height is lowered, the uncertainty of landing in adverse weather conditions is equally reduced. This translates into a substantial drop in delays, diversions and flight cancellations, allowing operators to achieve reductions in unnecessary flying hours (and thus cuts in costs for staff, fuel and CO_2 emissions), and lost passenger hours.

Safety is also improved. By being able to fly the same approach procedure regardless of the weather, the pilot has more situational awareness, resulting in an estimated reduction by 74% of so-called controlled flight into

[3] previously published in airport, dec. 2011

terrain (CFIT), when a fully serviceable aircraft hits the ground due to loss of pilot situational awareness.

Airports can also achieve cost savings. Once more aircraft start using SBAS, navigation beacons can be phased out, leading to a substantial cost reduction for the airport. The United Kingdom, for example, is investigating phasing out half of its VORs over the next decade, while France's ANSP is looking into phasing out ILS (Instrument Landing System) CAT I installations. The investment in SBAS landing procedures will be recovered many times over by the savings realized on not having to make costly ILS maintenance and replacement investments.

Olle Sundin, the Chairman of ACI Europe's Small & Medium Size Airports Action Group (SMAG), said members of the organisation would benefit from the lower investment needed to use EGNOS compared to paying for ILS Cat I infrastructure.

"I can see a huge possibility for savings at small and medium-sized airports," he said. "Once it is certified by the regulator there will be a big interest from our group if it can deliver regularity and reduce the number of diversions."

2.4.2 Small and medium-sized airports

The corporate aviation sector is not only the fastest growing segment in European aviation, but also one of the biggest beneficiaries of EGNOS, in terms of increased safety, cost reductions and access to airports.

Business aircraft often use small and medium-sized airports that are less frequented by commercial traffic: Eurocontrol calculated that 66% of business aircraft traffic occurs between city pairs where no daily commercial direct flight is available.

Using small and medium sized airports implies new types of constraints. First, such airports may be located in demanding environments. Airports in mountainous areas usually require complex approach trajectories. Airports located in the immediate vicinity of, or even inside cities are also often obliged to develop approaches with complex trajectories, in order to avoid populated areas for safety and noise abatement reasons.

Second, such airports are often less equipped. ILS navigation aids are usually nonexistent or limited to a single runway end. The result is an increased risk of flight diversion.

SBAS is a very promising navigation means for smaller and medium-sized airports as it:

- Improves accuracy and integrity compared to stand-alone GPS
- Covers wide areas
- Does not need a specific ground installation.

APV approaches based on SBAS – so-called LPV approaches (Localizer Performance with Vertical guidance) – could enable developing near-precision approaches for any kind of airport since no ground equipment is needed, increasing the real operational capability of an aircraft.

Indeed, more precise approach trajectories enable landing in demanding environments with a reduced decision height. LPV approaches are designed with a 250 ft decision height in Europe, but that figure can go down to 200 ft in the future as the FAA already publishes LPV200 approaches today. By comparison, the average decision height for NPAs is 470 ft in the United States.

Moreover, as the final approach segment is purely virtual and not linked to a ground-based guidance system, it is possible to imagine different approaches on a same runway end taking into account the aircraft category.

Light aircraft, like those used in business aviation, could take advantage of their better performances in terms of steep descent and landing distance in order not to follow the same approach trajectories as transport aircraft. Approaches on a steeper slope or with a shifted threshold combine several advantages:

- Protection of light aircraft against wake turbulence from heavier aircraft
- Higher traffic flow thanks to a reduced separation
- Noise nuisance reduction.

With these benefits, it is no wonder that the business aircraft sector and small and medium-sized airports are behind EGNOS. For example, in a recent interview European Business Aviation Association (EBAA) President and Chief Executive Brian Humphries called for the quick take up of EGNOS once it is certified for use by the aviation sector in November this year.

"The certification of EGNOS will be the most exciting thing to hit European aviation in a long time – we are great fans," he said. "In addition to increasing efficiency at airports, there are also huge safety and environmental benefits for aviation."

The use of EGNOS for near-precision landings would open up large and small airports to more aviation business.

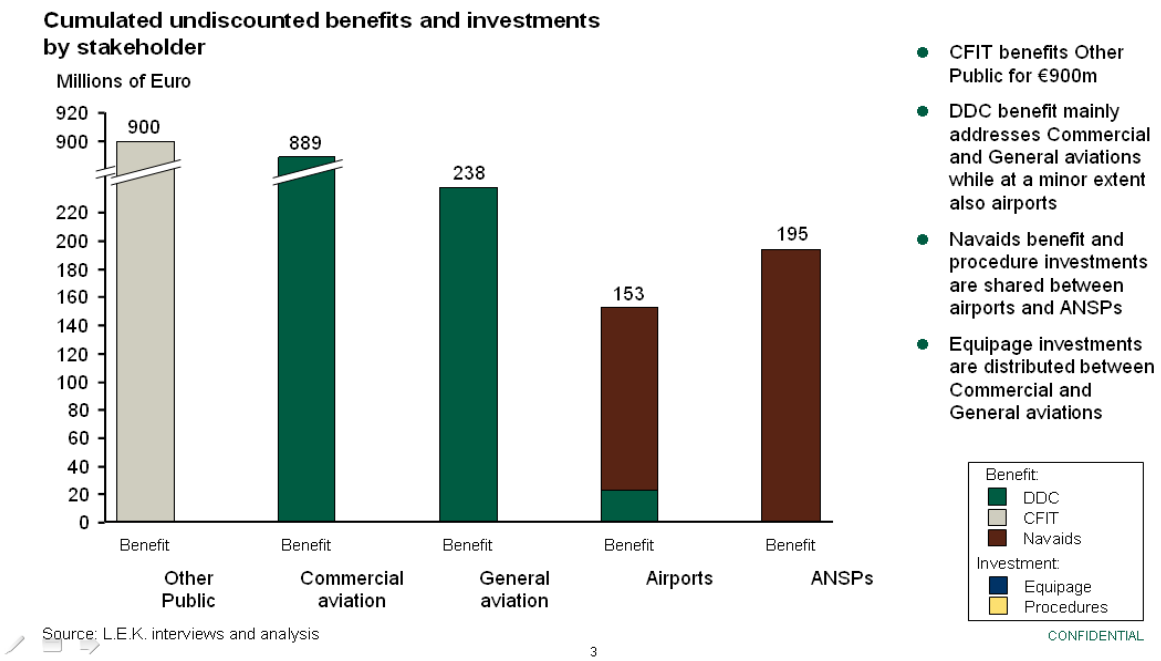

Figure 4 Cumulated undiscounted benefits and investments by stakeholder

2.4.3 Towards global SBAS coverage

In order to implement PBN, ICAO strongly recommends that states develop APV procedures for each IFR runway end by 2016. In Europe, EGNOS is a free SBAS signal provided by the European Union to make PBN possible. One reason Europe decided to invest in the system was to reap the public benefit expected from a reduction in CFIT accidents.

European Commission Vice-President Antonio Tajani declared in October 2009 that "the Safety-of-Life Service *is* provided free of charge, and the European Union is committed to supporting EGNOS for the long term, even after Galileo has become operational. This includes extending its geographical scope within the coverage of the three satellites involved."

The EGNOS “MT0 code”, which warned a receiver the signal should not be used for safety-of-life applications, was switched off in December 2010 and the signal was certified for civil aviation in March 2011. Airlines and pilots are now able to perform EGNOS-based approaches everywhere in the European and North African coverage area where a procedure is available.

Other SBAS are also coming into operation, opening up the possibility that aircraft will be able to use SBAS-enabled landings around the world.

In the US, WAAS has been operational for aviation over the continental United States since 2003 and over Alaska, Canada and Mexico since 2007. More than 2,000 WAAS procedures have been published to date, outnumbering ILS CAT I procedures in the US.

Japan is also launching an SBAS service called MSAS. India is launching their version called GAGAN. Russia’s SBAS is called SDCM. All these systems use the same technical specification to guarantee interoperability for the users: a business jet flying a New York-London route will be able to process both the WAAS and EGNOS signals on the same receiver.

High-level coordination is happening intensively between the US and Europe to ensure this interoperability. The EU regularly meets with the Russian and Indian authorities to ensure truly interoperable systems.

The future SBAS coverage area could become truly global once all systems become operational, when a second frequency is adopted and when additional ground stations are implemented in the Southern hemisphere.

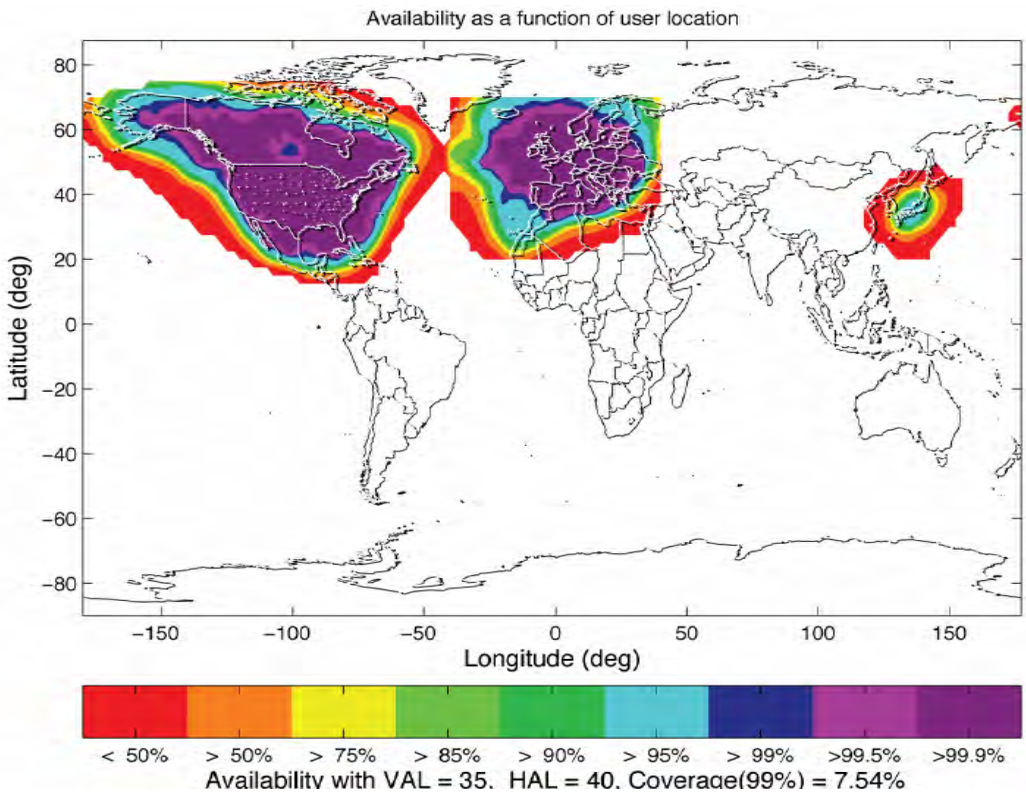

Figure 5 Current coverage area

2.4.4 EGNOS. It's there, use it!

EGNOS, Europe's SBAS, provides very clear benefits for the aviation sector, especially for business and helicopter operations, whose aircraft/rotorcraft performance is not specifically catered for by the current Air Traffic Management system.

The use of EGNOS will allow APV everywhere in Europe and will:

- Improve flexibility and enabling advanced arrival, approach and departure procedures;
- Improve accessibility by providing lower approach minima at non-ILS-equipped runways;
- Improve operational capability by providing a back-up for ILS approaches;
- Reduce environmental impacts and costs by enabling more efficient routes, time and fuel savings, and lower CO_2 emissions;
- Increase safety by allowing IFR approaches at difficult locations or under meteorological conditions where previously such approaches were not possible due to safety concerns.

EGNOS also benefits from an international effort to have full interoperability among the SBAS systems already operational and those about to come into operation. The development of new systems (GAGAN and SDCM) adds to the overall network. The scheduled upgrade of existing systems (WAAS, EGNOS, MSAS) creates a coverage area that can very well become global – with the exception of Antartica.

Acknowledgements

We'd like to acknowledge the work done by Todd Walter of Stanford University in mapping the coverage area in current and future scenarios. Also, the feedback from Eurocontrol has been most useful in double checking and validating the quantitative benefits of aviation, as pointed out in the L.E.K. Cost Benefit Analysis.

References

(1) Cost Benefit Analysis for EGNOS in aviation, by L.E.K for the GSA, 2009.

(2) David March, head of forecasting, Eurocontrol in Reuters article, 3 May 2010.

(3) GIANT 2 Technical and economical feasibility study, Dassault Aviation and Ineco, 2009

2.5 Road: EGNOS and Galileo for efficient road network management[4]

by Fiammetta Diani, Philippe Hamet and Gian Gherardo Calini

2.5.1 Abstract

Ten per cent of Europe's roads are congested on a daily basis and mobility demands continue to grow together with the pressure on national budgets to build or scale up roads. In addition, road transport is a significant source of CO2 emissions. A new strategy is needed to pass from "road saturation" to "network fluidity": balancing traffic to eliminate congestion, increasing the net value of externalities (e.g., socioeconomic benefits), improving the fairness of cost-sharing (e.g., new pay-per-use road pricing initiatives).

While Electronic Fee Collection solutions have traditionally been implemented using manned or partially automated toll gates, free flow options are now available to cities, regions, countries and road operators. In this context, Satellite Navigation solutions play a key role, since they do not require an infrastructure, are flexible, and have proven to be the enabling technology for new nationwide road pricing schemes.

When road pricing strategies are applied to specific vehicle types (e.g. Heavy Goods Vehicles "HGVs") in large road networks, or when tolling systems are extended to different road classes (e.g. first class roads or all roads), the advantages of Satellite Navigation solutions in terms of cost-benefit ratio are maximised.

The EU is committed to GNSS and is building a European GNSS, comprising EGNOS and Galileo that are expected to add further value to the GNSS solutions as they are improving availability and accuracy of GPS-only solutions and are adding the integrity feature, much needed for RUC schemes.

EGNOS provides *increased accuracy over GPS* (e.g., a meter-level accuracy could solve disambiguation among parallel roads or, under certain conditions, also among parallel lanes) and could offer a "*guaranteed position*" (obtained as exploitation for the EGNOS integrity information). This means that EGNOS can help reducing incorrect charging, increase trust in the system, while reducing GNSS investments (it will partly make location augmentation infrastructure obsolete). Moreover, thanks to EDAS, EGNOS corrections are available also in difficult environments, such as urban canyons.

Galileo OS and CS can offer several advantages over GPS to a "liability critical" service like road pricing:

- *increased availability* (a new constellation interoperable with GPS will improve visibility in urban canyons);
- *increased accuracy* (allowing lane detection),
- *stronger resistance against interference and reflections*
- *faster Time To First Fix;*
- *service guarantees and liability acceptance* due to authentication and to the "subscription" nature of the service (Galileo CS).

Growth of GNSS road applications has been driven by a very wide range of applications, encompassing e.g.:

- Road pricing/ Road User Charging (RUC);
- Navigation and guidance;
- Traffic management ;
- Vehicle management.

The EC and the GNSS Supervisory Authority (GSA) are supporting the full exploitation of EGNOS and Galileo potential, especially in the road pricing domain to accelerate in Europe the passage from "road saturation" to the "network fluidity" paradigm by means of:

- Awareness campaign, at different decision levels (e.g., national authorities, road operators) to increase knowledge of the Satellite Navigation potential and of the European GNSS' (EGNOS and Galileo) value added;
- Cost-Benefit Analysis to demonstrate the cost-efficiency advantage;
- Field trials (with EGNOS) to increase the perception of maturity;
- R&D projects to fill the gaps and leverage on the EGNOS/Galileo's differentiators (e.g., integrity, authentication);
- Policy developments in the frame of the EC strategy to fight climate change and provide better mobility conditions to citizens.

Moreover, the EC and the GSA are focusing also on other road applications, especially those aimed at improving safety on European roads.

[4] previously published during its Europe 2010

2.5.2 An overview on mass market applications for GNSS systems[5]

The past few years have seen a rapid expansion of the downstream market for GNSS, including American GPS, Russian GLONASS and upcoming European Galileo.

Awareness among consumers is increasing. In Europe, 68% of recent survey respondents reported being familiar with satellite-based navigation, while 35% expects to use it in the near future[6].

Currently the market trend is driven by the development of LBS solutions (available on telephones and PDAs) and of road solutions (driven by the huge success of Personal Navigation Devices, PND). In the coming years the growth of the LBS and road segments will be even more significant especially with the deployment of new GNSS constellations.

The worldwide GNSS market is 58 m€ in 2010 and growing at a 11% compound annual growth rate over the next decade, it will reach by 2020 a minimum of €165 bln. In the EU, the GNSS market is expected to reach €32 bln in 2020.

Location Based Services on mobile handsets and Road Transport will remain the main market sectors, summing up to 95 % of the all downstream market for GNSS.

On top of this, GNSS should generate €850 bln of public benefits (e.g., creation of jobs, export of technologies, reduction of travel time and fuel consumption, increase in safety in the European Union between 2010 and 2030.

In particular, GNSS worldwide consumer market for road applications has exploded in the past 5 years adding over 63% per year in *volumes*.

As a result, in 2009 more than 20% of road vehicles have a GNSS device on board (including smartphones used as PND, Personal Navigation Devices). This high penetration resulting from navigation systems can represent an opportunity for other applications (e.g. road tolling, Advanced Driver Assistance Systems). This penetration will surpass 80% by 2020.

Significant *price* erosion has taken place in the past, especially for PNDs where the average price of a device declined from over €600 to under €200 in 5 years. Their price is expected to go below €100 in the next few years. The same happened for road charging onboard units: from 800 € in 2000 to 100 € in 2010

Total GNSS *revenues* in the road segment will increase rapidly from €45 bln in 2010 to €67 bln in 2020 driven by the increase in device sales offsetting price decline.

Services based on cooperative systems such as advanced services for safety, assistance to the driver and active traffic management - as well as new and innovative information and entertainment services – will provide an important additional source of growth.

2.5.3 Road pricing for a better mobility

Mobility is an important element of European citizen's daily life. Over the last 30 years, the number of cars per 1,000 persons has doubled and the distance travelled by road vehicles has tripled[7]. As a result, 10% of European roads are congested daily[8].

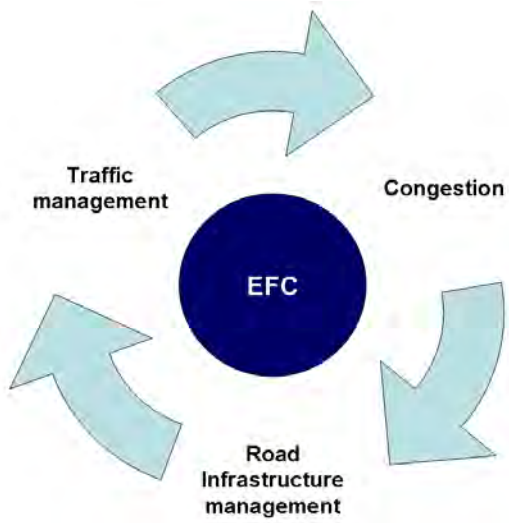

Figure 6: Electronic Fee Collection: a virtuous loop

Commercial transport is also developing and relying upon just-in-time operations, which depend on reliable and predictable delivery times. Finally environmental pressures are affecting the way Europe perceives mobility – in particular on the road. Road usage imposes external effects on others and on the environment, including noise, accidents, congestion, pollution and visual intrusion on the landscape. Charging a vehicle without requiring it to stop or slow down reduces not only congestion and travelling time, it also diminishes traffic noise and related emissions; it is an important benefit that should be taken into account by public authorities when proposing a road pricing scheme.

[5] GSA. <http://www.gsa.europa.eu/>.
[6] Eurobarometer <http://ec.europa.eu/public_opinion/index_en.htm>.

[7] ertico
[8] European Commission. "Raising awareness of ict for smarter, safer and cleaner vehicles", COM (2006) 59 final

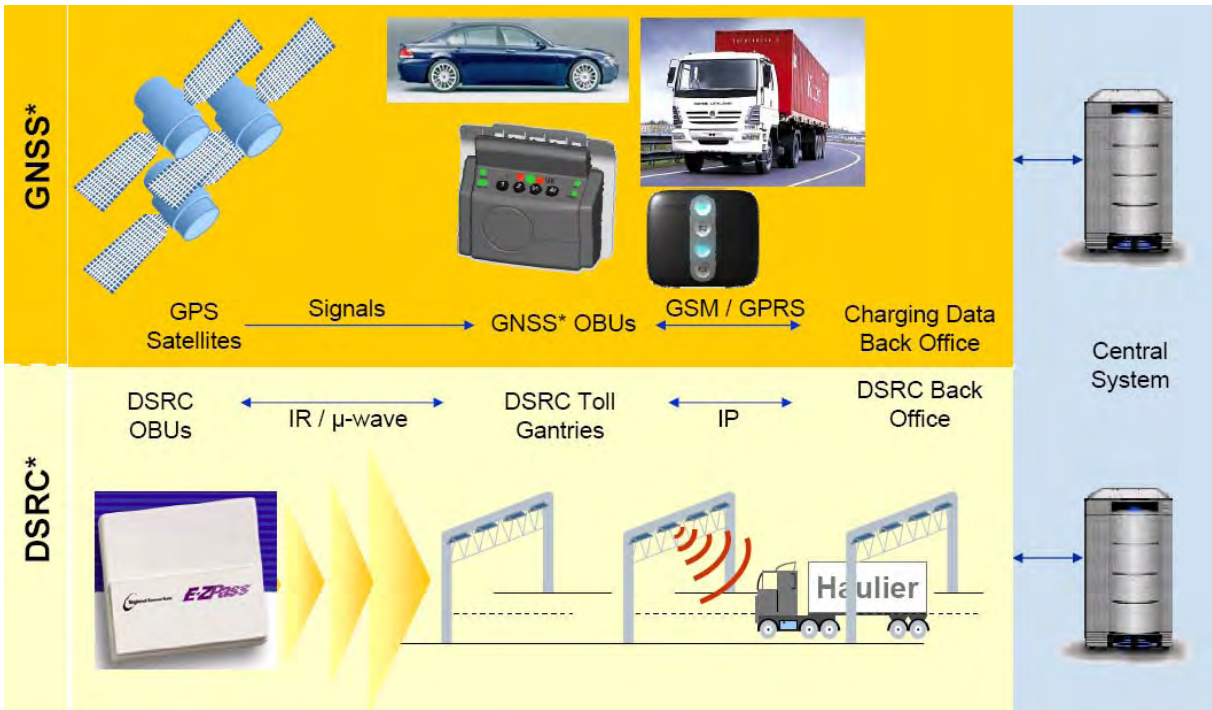

Figure 7: Road tolling technological alternatives

In this context, road pricing is an effective instrument for Europe to build, exploit and maintain a sustainable road network of high quality. It is expected to be one of the key instruments for policy makers and operators to help improve the efficiency, safety and sustainability of transport.

One of the main question upon which politicians should reflect is the sustainability of personal cars in urban environment: 50 % of the trips of a car in a city are less than 2 kms, and 80 % less than 5 kms. If most people using their cars for a 2 kms drive would let it home, there would not be congestion anymore in our cities. GNSS road pricing schemes with decreasing fees according to the kilometres driven would be the perfect tool to discourage drivers in small trips, helping to sustain personal mobility in the city of the future.

Different technologies for road pricing

The approaches to road pricing have recently moved from the usual motorway tolling to more innovative schemes:

- Area tolling depends on the area where the car is driving, no matter how often it enters this area within a certain period of time;
- Cordon tolling proposes to toll a vehicle each time it enters or leaves a zone;
- Time-based toll scheme charges a vehicle on the basis of the time it spent in a zone or on a network;
- Measured distance toll is based on the exact distance travelled within a defined area.

To implement such tolling schemes, diverse technologies are available: GNSS, DSRC[9], ANPR[10] or tachymetry. The two most common systems are DSRC (with toll gantries or free flow) or GNSS (see Figure 7).

The DSRC based solution is the most common and proven technology, but it has limitations, mainly infrastructure requirements and flexibility to extend the network and to implement innovative charging schemes.

GNSS value added in road pricing

GNSS is an upcoming solution which can offer:

1. Cost efficiency: no capital-intensive toll gate infrastructure;
2. Flexibility to adapt over time as road networks/ traffic evolve;
3. Holistic approach to traffic management (adapting the scheme to all roads or to specific roads, to all vehicles or only specific vehicle types, e.g. HGVs);
4. Interoperability in a pan-European network;

[9] Dedicated short range communication
[10] Automatic number plate recognition

Figure 8: GNSS offers a multi-purpose solution for VAS

5. New business opportunity for Value Added Services (see
6. Figure 8).

Germany has successfully introduced a road charging system based on GNSS. It constitutes the first nationwide toll system for trucks based on GNSS. The system started its operations in January 2005. It applies for trucks over 12 tons and covers about 12.000km of motorways.

- Over 650,000 OBUs have been installed;
- About 26 billion vehicles/ per km/ per year have been tolled – of which 35% were foreign trucks from more than 20 different countries;
- The system has generated over €3billion revenue per year (90% of the collected through the automatic system);
- The system has proven very reliable with a 99.75% successful OBUs tolling transactions;
- The violation rate is under 2%;
- In addition it is possible to easily expand the tolling road network (as it happened in 2007 when 42km have been added to the scheme to stop diversion from the motorway).

The results of the use of GNSS in Germany indicated a change in driving behaviour:

- The number of loaded runs due to higher cost awareness increased to a total of 82% and empty runs fell under 10%;
- Share of cleaner vehicles rose substantially;

Hence, GNSS proves to be the right mean to tackle congestion, guide traffic and to improve the effectiveness of freight shipments. It is the best system for urban charging schemes where no toll plazas or gantries are possible.

Also for this reason, apart from Germany, Road User Charging schemes based on GNSS are gaining momentum in Europe: *Slovakia* has just implemented a nation wide GNSS tolling system for 2010, while *Switzerland* complements its system via a satellite technology, although as a security enhancement. France is currently preparing the implementation of a large GNSS tolling scheme for trucks on first class roads, covering 13,000 km.

Some other European Countries (e.g., *Belgium*) are evaluating the introduction of distance based national tolling schemes for trucks, where GNSS could be the most suitable solution.

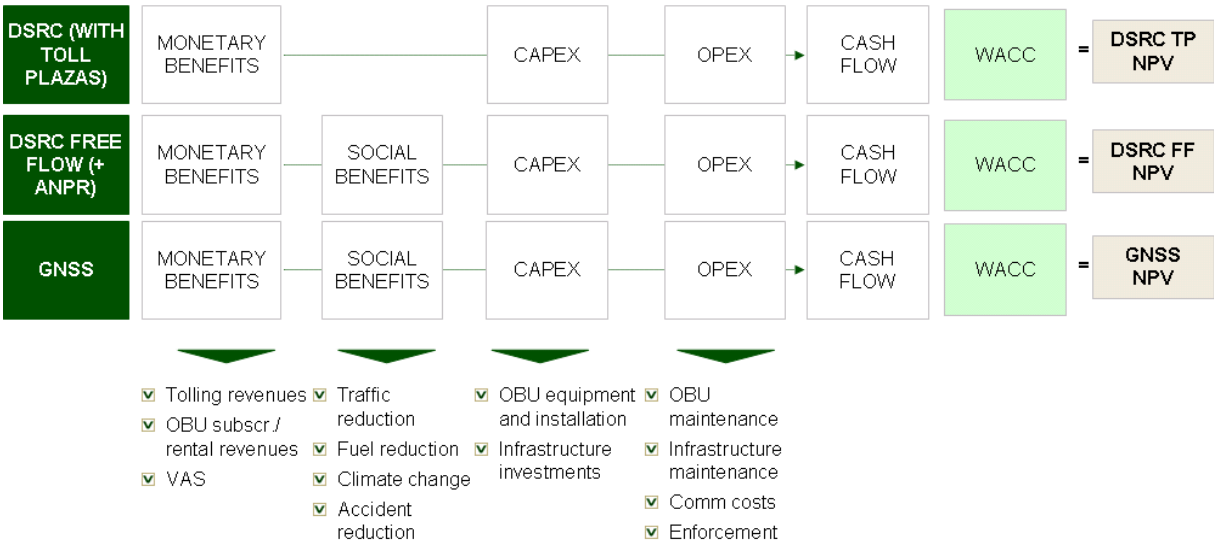

Figure 9: CBA methodology

A CBA analysis to prove GNSS benefits

To compare different solutions, it is important to address key benefits brought by each of them:

- Monetary benefits: e.g., tolls, service fee, OBU rental, VAS (GNSS only);
- Social benefits: traffic, congestion, pollution and accident reduction (Mainly free flow technologies[11]).

To evaluate the cost of the different solutions, it is important to take into account all the components of the systems e.g. not only the OBU but also infrastructure cost, back-office expenses and enforcement costs. These elements could be summarized as follow[12]:

The main cost drivers for GNSS and DSRC are:

- GNSS: (cost of OBU x number of vehicles) + communication costs + enforcement costs;
- DSRC: roadside infrastructure + number of road segments (points of entry/exit) that need to be covered + enforcement costs (if a free flow solution is adopted).

The analysis performed shows that GNSS is the most efficient solution when road pricing is applied to large road networks or to specific vehicles types. In fact GNSS strongly reduces the infrastructure investment required and ensures flexibility, enabling innovative road pricing schemes aimed at improving mobility and reducing the pollution effects.

[11] gnss and dsrc free flow
[12] t-systems

EGNOS/ Galileo trials and EDAS role

Several projects were run by the EU/ by private entities to prove EGNOS/ Galileo benefits for road charging:

- Both the EU funded Gauss, Giroads, GINA and GSC projects and TfL, Sanef and Satellic trials have recently tested EGNOS OS;
- M-TRADE, MENTORE, SCUTUM (and to some extent GINA) FP projects run/ are running trials EGNOS CS/ EDAS;
- Some studies (e.g., GAC and CATS) analysed authentication issues for Galileo.

Nevertheless some uncertainties over EGNOS and Galileo performances still exist. For this reason, the EC has recently launched a call for tenders to perform further EGNOS trials, with two objectives:

- Identify a “yes or no” position of road transport operators concerning the use of EGNOS OS and EGNOS CS/EDAS in their operations, opportunely argumented through a technical evaluation and a market assessment;
- How to use of these features in road charging as evidence in judicial procedures, on the basis of the outputs of a study considering technical, market and legal aspects.

Results will be available in the second half of 2011.

EDAS provides EGNOS corrections through terrestrial communication means, enhancing the EGNOS availability in ruban environments. Ithas been beta tested until March 2010.The tests have demonstrated the interest of EDAS for the urban road activities.

The EDAS service is now continuing and will be improved in order to help starting up the market during the next three years. .

Interoperable road tolling across the EU

Irrespective of the technology chosen, it is crucial that all the solutions selected in the different European countries are interoperable. An individual travelling around Europe cannot have 27 different OBUs installed in his vehicle. This is why the interoperability Directive of 2004 recommends dual mode onboard units: GNSS + DSRC.

Contractual interoperability between the different service providers is also essential for a smooth flow within European countries.

The interoperability of road charging solutions is an objective of the European Commission. The Interoperability Directive creates the European Electronic Tolling Service (EETS), which should start offering by 2012 (for vehicles above 3.5 tonnes) and by 2014 (for all vehicles) one contract and a single OBU for its customers for all the tolled networks in Europe.

With the new EETS decision adopted in 2009 after intensive discussions with the toll chargers and service providers, satellite navigation can become the preferred technology to realise a unique Europe-wide tolling service.

2.5.4 Navigation and guidance

PNDs makes navigation and ITS available for the mass market. Independent research proved that PNDs:

- Improve road safety;
- Make drivers more alert, less stressed, less distracted, more in control and feel safer.

Drivers with navigation systems on board in fact submit 12% less claims for accidents and claimed 5% less costs.

Additional safety benefits of PNDs include:

- Speed warning, school warning;
- Accident warning if the application provides real-time data

Furthermore, use of PNDs allows:

- 16% less km driven (less CO2 emissions)

18% less travel time

Car navigation is currently the main application of GNSS. GNSS data combined with electronic maps allow positioning and guidance of the road user. PND sales have enjoyed fast growth (76% per year) over the last 4 years.

2.5.5 Traffic management

GNSS traffic management solutions are used to locate vehicles in order to optimise resource management, reduce travel time, increase security and reduce fuel consumption.

Not only private fleets (e.g., trucks, buses and police) are interested in this area, but the growing demand for higher quality of service has motivated *motorway operators to improve safety levels* as well as *to provide additional travel and traffic information on the road network.*

As an example, a coordinated approach among service providers and traffic control centres can allow for an *active guidance,* i.e., route guidance is provided cooperating and in accordance with traffic authority' orientations, knowing real traffic conditions.

- This will avoid that users are directed to low capacity traffic road networks in days of abnormal traffic levels potentially creating to local road networks severe traffic problems, therefore further emphasizing the "network optimisation" paradigm.

More, an *improved traffic management* system based on satellite systems may allow control centres to have a better and/ or faster understanding of traffic conditions to react faster/ with better information to what is happening in the field, the road or motorway.

- This way it may contribute to less congested roads, with less CO2 emissions and providing a higher level of comfort to the drivers.

The usage of *meteorological services* by control centres allows the forecasting of weather conditions assisting the preparation of required resources in advance of adverse weather events.

e-Call aims to reduce the number of fatalities in the roads. Its efficiency can be further improved if prompt information of emergency calls and breakdown calls is sent not only to the emergency service, but also to the related road control centre.

This will make possible to reach faster the target point, to deviate timely the traffic and to guarantee to sanitary assistance the minimum safety conditions to assist the injured people in safe conditions.

To unveil GNSS benefits in traffic management application, the *EC* is investigating the expediency of some regulations: one on GNSS-based monitoring of the transport of dangerous goods, another on GNSS-based

monitoring of long-range coaches, and one on GNSS-based multimodal logistics

Moreover, the EC will propose amending the Directive on digital tachographs, to take advantage of authenticated GNSS-based positioning, timing and speed information

2.5.6 Vehicle management

Advanced Driver Assistance Systems (ADAS) are all Its systems embedded in the vehicle, eventually communicating with the infrastructure, which allows a certain part of automatism in the driving of the vehicle. They range from Intelligent Speed Adaptation (ISA) to truck platooning for instance, with different degrees of complexity and automation.

ADAS can impact on driving habits of end users:

- Reducing the response time in case of intervention;
- Assisting them during the guidance, imposing e.g. a compulsory distance between cars.
- Providing informative support via cooperative Car2X systems.

For ADAS systems, position determination is a critical variable, especially when safety critical applications are concerned. GNSS based systems have a role in those critical systems, offering:

- Accuracy of positioning signal;
- Reliability of the system.

GPS provides navigation and positioning data imprecise for high safety applications (e.g., Intelligent Speed Adaptation Systems, ISA or, Lane change assistance, LCA/ Lane departure warning, LDW).

The exact level of accuracy needed in the applications considered is being with the support of various R&D and testing projects carried on around Europe (e.g., COVEL).

The adoption of EGNOS in ADAS could lead to several technological advantages:

- EGNOS could enable some ADAS applications (both safety- critical and not) not currently on the market because of lack of a proper technology;
- EGNOS could support the development of existing ADAS applications (e.g., LDW/LCA).

In short, road safety and innovation are improved thanks to EGNOS' reliability and accuracy.

Given that some future Intelligent Transport Systems (ITS) for road transport, including ADAS, might use the integrity and authentication functions offered by Galileo, the EC is promoting chips and handsets incorporating Galileo and EGNOS through industrial cooperation with GNSS-owner countries and with receiver manufacturers and the certification of Galileo for ADAS will be looked into. This certification is required as for every safety critical application. The main difficulty encountered in this process in comparison to other modes of transport like aviation is that it does not exist a legitimate body mandated to certify Europe wide or worldwide any type of equipment or source of data for road transport. EC will launch reflections on this issue in 2011.

The European Commission GNSS Action Plan addresses the promotion of GNSS services within specific ITS applications (eCall, tolling, parking for trucks, etc.), while the ITS and Logistics Action Plans are another opportunity to develop GNSS applications for instance for real-time tracking of containers, or to prevent cargo theft. There is, however, very little awareness of EGNOS in the ITS community.

For this reason, the EC will undertake an awareness campaign, to include a series of tests to demonstrate the benefits of EGNOS and a marketing campaign targeting the road transport community.

Some future ITS systems for road transport (including ADAS, anti-theft protection, accident data recorders and reconstruction systems) will require transmission of the electronic identification and the location of vehicles.

Therefore, the EC will investigate the expediency of equipping vehicles with a GNSS and Radio Frequency Identification (RFID) enabled on-board functional unit to provide both the exact authenticated position and the electronic identification of the vehicle and be the first element of a future accident data recorder.

2.5.7 GNSS/ EGNOS market entry plan

EC and the GSA believe GNSS solutions can contribute to reduce accidents, congestion and pollution by an optimal usage of the road network.

To stimulate the penetration of GNSS-based solutions, an *active market development* has been developed:

- Proving GNSS/ EGNOS benefits by Cost Benefit Analysis and by EGNOS on field trials;
- Reaching real adopters/ Accelerating market development via co-marketing

with key players and by Market awareness/ dissemination.

R&D to fill market gaps is also a pillar of the strategy**:**

- Identification of gaps to adoption after an assessment of clients' needs and having highlighted market trends;
- Closing of the gaps by investing in projects close to the market and by engaging downstream players.

A market entry plan to maximise GNSS/ EGNOS penetration in the road segment has been implemented since early 2009 and concrete results are already visible.

With regards to *road pricing applications*, this strategy has been tailored to specific targets in relation to their maturity towards GNSS:

- Convincing those that have already chosen a GNSS infrastructure to improve their infrastructure with EGNOS (also via support to trials);
- Convincing to adopt GNSS demonstrated benefits versus other solutions and. showing EGNOS value added versus GPS-only solution to those countries that are evaluating GNSS. Key actions in this area are CBAs, EGNOS trials, presentations, and participation to conferences
- Identifying key opportunities (and promoting GNSS solutions, also via real cases) in other countries

With regards to *other applications*, the GSA the effort is focused on ADAS systems that are enhancing safety, with priority actions mainly targeted at supporting industry players towards EGNOS adoption:

- Industry-wide awareness campaign towards key decision makers to promote new ADAS systems enabled by EGNOS and to win new "EGNOS champions";
- Identifying most promising companies developing EGNOS-based ADAS solutions and partner with them/ propose them EGNOS for trials in their major ADAS projects;
- Proposing EGNOS as a platform for advanced ADAS trials to promote innovative solutions.

2.5.8 Conclusions

Finally, to conclude this paper, let us introduce the new EGNOS webportal (www.egnos-portal.eu), which intends to develop awareness of EGNOS for all communities of users, and provide support to application developers and end clients. The weportal contains also user *fora* for the different communities, intended to let everyone share his experience, his concerns, and his know-how with others. The results of the EGNOS test campaigns will be available on the portal.

2.6 EGNOS and Precision Applications: Early Adopters in Mapping and Precision Agriculture[13]

by Gian Gherardo Calini, Fiammetta Diani and Reinhard Blasi

2.6.1 Abstract

Within the High Precision segment, EGNOS is already being employed by a growing number of farmers. Other sub-segments, such as the Mapping segment, are evaluating the increasing opportunities of this technology.

GIS-mapping

The world wide market for GNSS handset devices employed in Geographic Information Systems, GIS/ Mapping applications is experiencing a significant growth mainly due to the growth of applications fostered by new clients' needs and to a general trend towards digitalization.

Whereas in other surveying disciplines a sub-meter or even centimetre accuracy is needed, meter accuracy applications can play a role in Mapping.

EGNOS is currently present in most of GIS/ Mapping devices, but not fully used. However, in the close future, it is expected that EGNOS will unveil its potential and provice also for this sub-segment a meter accuracy at low cost.

Precision agriculture

Precision agriculture is a highly effective farming strategy that increases yield and productivity, while lowering costs and minimising environmental impact.

With costs perpetually on the rise and environmental demands gaining ground by the day, efficient and sustainable farming solutions are needed more than ever.

Traditionally, the main barrier to precision agriculture has been a substantial investment in equipments and services to obtain concrete

[13] "International Symposium on Global Navigation Satellite Systems, Space-Based and Ground-Based Augmentation Systems and Applications". Dec. 2010. Previously published.

results. EGNOS has fundamentally changed the equation by offering high precision at low cost, and addressing a part of the market not completely covered by existing Satellite Navigation solutions.

- EGNOS increases the accuracy of existing satellite positioning signal to about 1-2m. In precision agriculture, this permits a pass-to-pass accuracy of around 20 cm, allowing a wide range of applications, e.g.:
- Tractor guidance with improved precision;
- Automated variable ploughing, seeding and spraying;
- Virtual fencing and livestock positioning;
- Easy and accurate field measurement and boundary mapping.

Precision Agriculture can be considered an early EGNOS adopter: 8% of new tractor sold in Europe is equipped with GNSS devices and, today, out of c. 150,000 tractors with GNSS positioning systems on board, more than 50% are using EGNOS. And there is growing potential.

2.6.2 Introduction: EGNOS and EDAS in high precision markets

Standalone GPS positioning relies only on the receiver range measurements and is limited to an accuracy of a few meters. EGNOS improves the accuracy of position measurements by sending out signals that correct GPS data and provide information on its reliability.

The EGNOS network includes more than 30 reference stations in 20 countries. Ranging and Integrity Monitoring Stations (RIMS) on the ground pick up signals from GPS satellites, which are processed in Master Control Centres (MCC). The accuracy of the original signals is determined and confounding factors, such as electrical disturbances in the atmosphere, are corrected.

These data are incorporated into EGNOS signals and sent to its three geostationary satellites. The satellites then relay the signals back to users on the ground, thus providing far greater positioning accuracy than would be achieved through GPS alone.

EDAS -the EGNOS Data Access Service- allows you to plug into EGNOS to receive the data collected, generated and delivered by Europe's first satellite navigation system. EDAS is part of EGNOS and therefore provides the opportunity for service providers to deliver EGNOS data to users who cannot always view the EGNOS satellites (such as in urban canyons) or to support a variety of other value added services, applications and research programs.

2.6.3 GIS Mapping

GIS-Mapping: an emerging GNSS downstream market

Mapping, as it is considered here, is the study and practice of making geographical maps. There are two main maps' categories, general maps and thematic maps. General reference maps show where things are located "in space" and thematic maps depict patterns "about space" (e.g. population density, life expectancy, demographic trends).

Geographic Information Systems (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

The world wide market for GPS and GNSS handset devices employed in GIS/ Mapping applications is experiencing a significant growth due to more and more applications of GIS in more and more industries, satisfying growing client needs.

Until 2008 the market has been growing at a 10% pace until the economic downturn: in the last 2 years due to the economic crisis the market of GNSS professional devices addressed to GIS/ Mapping solutions has slowed down

However, for the next years (2010-2013) the market of GNSS devices in GIS/ Mapping solution is expected to grow at around 6% (CAGR). It is expected to reach around EUR 700 bn by 2013.

The market is expected to grow quicker after the launch of additional GNSS systems such as Galileo and GLONASS, which will increase the availability and reliability of satellite-positioning signals.

GIS/ Mapping has been identified as an area where EGNOS can play a role by adding value.

Companies and users are considered as a secondary market for EGNOS. Whereas the GNSS device industry is considered as the primary reference market for the EGNOS market entry plan, as GNSS device and software providers are the "carriers" of EGNOS in the secondary market.

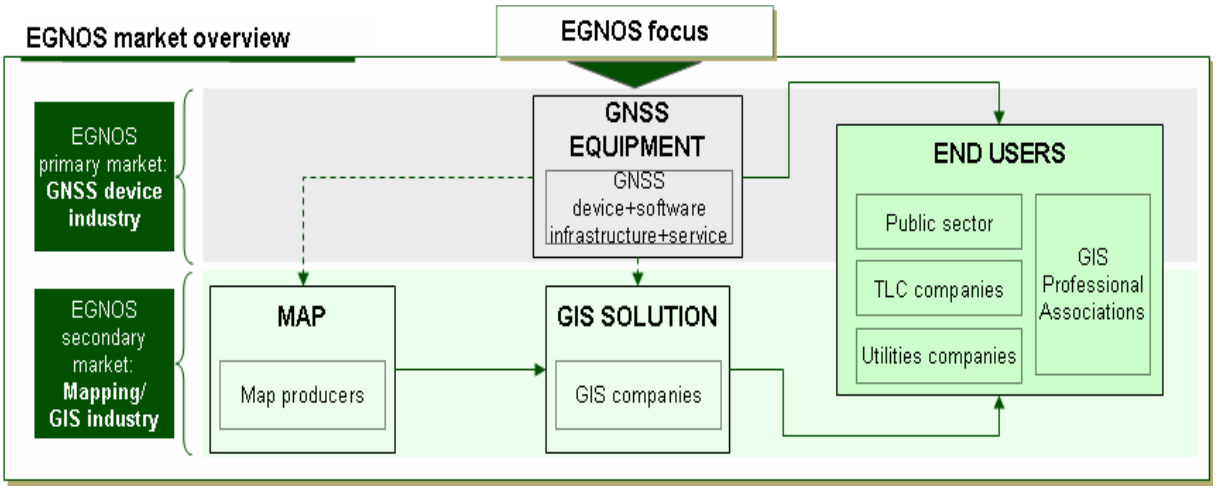

Figure 10: Overview over the GIS-mapping sector

	GPS	SBAS (EGNOS and WAAS)	Global DGPS (SBAS-Omnistar / Navcom)	Other DGPS (GBAS)	Real Time Kinematic
Coverage	Global	Regional	Global	Local	Local *(10 km around base station)*
Level of accuracy	2 m	Meter – Sub meter	10 cm	Sub meter	<5 cm
Time required for initializing	< 10 minutes	1 minute	20 to 40 minutes	1 minute	1 minute
Equipments	Receiver only	Receiver only	Receiver only	Radio beacon + receiver	Base station + receiver
Cost of receivers	Low	Low	High	Low	High
Cost of service	Free	Free	High	Depending	None or limited

Figure 11: Comparison between the different GNSS systems

EGNOS role in Mapping

The GIS/ Mapping segment is comparable to geodesy, cadastre and surveying. The technical criteria are settled in terms of accuracy required for the segments. Whereas in general the latter areas require submeter accuracy, meter accuracy applications can play a role. The sector is currently dominated by RTK as well as DGPS applications.

EGNOS provides a meter accuracy (under specific conditions, it can also be higher). The surveying discipline that is suitable with 1m level of accuracy thus is GIS/ Mapping.

Benefits from the application of GNSS in GIS-mapping

The device producers and subsequently the users can lever on key success factors to compete and success in the Mapping/ GIS segment.

Market dynamics and opportunities for EGNOS:

1. Market dynamic diversification - leverage GNSS experience across adjacent market segments: in an increasingly competitive GNSS market, it is important to increase the scale of the operations by entering adjacent segments using existing skills and assets.

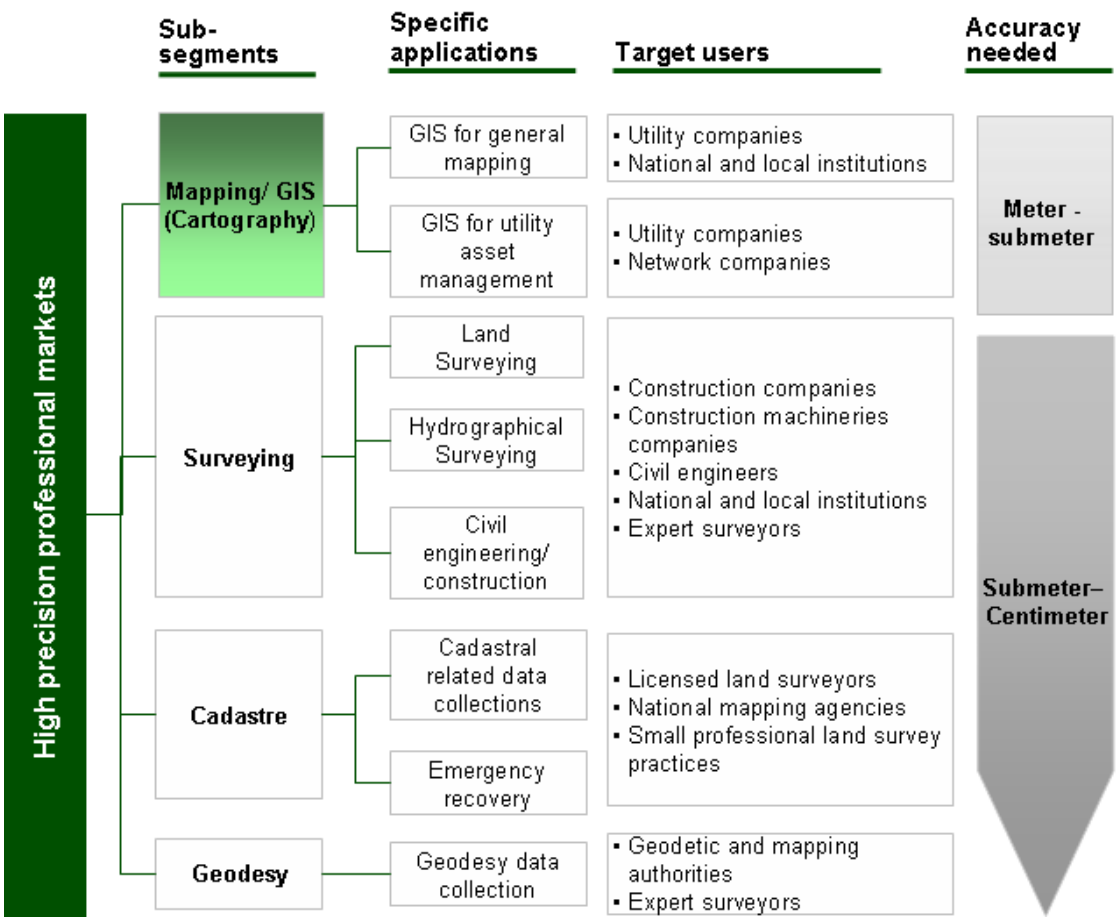

Figure 12: Accuracy requested for GIS-mapping in comparison with comparable segments

> Opportunity for EGNOS
> EGNOS can represent the opportunity to further diversify the offer, integrating a positioning technology that can allow to target new market segments and to exploit the needs of new clients target in the same industry.

2. Market dynamic convergence - explore the integration of GPS with other positioning technologies: though GPS technology has a lot of benefits as a standalone solution, often it only reaches its full potential when combined with other technologies. The weak indoor coverage of GPS can be solved by adding Wi-Fi or cellular-based positioning capabilities. In order to achieve this, companies should explore partnerships or acquisitions

> Opportunity for EGNOS
> EDAS can be exploited as an add-on to the present positioning technology to supply availability, integrity and EGNOS accuracy performance.

3. Market dynamic need for ease of usage. It is very important to design simple and intuitive user interfaces, especially as the complexity of devices and solutions is constantly increasing.

> Opportunity for EGNOS
> EGNOS can be considered a “ready to use” (with no training needed) positioning technology as the agriculture experience has demonstrated.

4. Market dynamic high service – low price

   The expenditure for an end user for complete GNSS high precision equipment can reach sizeable dimensions,

also considering the cost of the yearly fee for the DGPS services

At the same time, there are some market segments that would need the GNSS technology, but are not willing to pay for higher accuracy solution, even if it could bring advantages.

> Opportunity for EGNOS
> EGNOS offers meter level accuracy (can be even better under certain conditions), reliability and integrity for free (no fee for the Signal in space service).

5. Market dynamic densification - the global players invest in their own worldwide reference station network to provide the signal with a global coverage. The local players´ reference network, was originated to provide post-processing services, but nowadays are upgrading to provide real-time services.

> Opportunity for EGNOS
> The opportunity for EGNOS (EDAS) is to be integrated by the service providers in their reference network to increase coverage in some European areas: instead of installing new reference stations the service provider can leverage on EGNOS to provide the signal in the not-covered zones.
> Additionally, EGNOS could represent a technological upgrade as a real time augmentation service for free.

2.6.4 Precision agriculture

Agriculture: a growing downstream GNSS market

The application of GNSS technologies to agricultural activities brings several advantages to the user community. The source of the advantages brought by a GNSS technology is in terms of accuracy (higher than human precision) and repeatability of the same action (due to the recording of data) year after year.

These two fundamental features are the main sources for the following benefits from the farmer perspective:

- Reduction of waste and over-application of fertilisers and herbicides;
- Seeds consumption reduction;
- Fuel saving;
- Time saving;
- Reduced fatigue;
- Extended equipment lifetime due to an optimised usage;
- Optimisation of crop yields.

In Australia, the application of GNSS for machine guidance has shown clear benefits such as:

- Increased annual yields by 10%;
- Fuel and oil costs reduced by 52%;
- Labour costs reduced by 67%;
- Crop gross margin up.

An estimated 10-15% of grain growers in Australia already use GNSS for machine guidance.

Traditionally, precision agriculture have been characterised by significant equipment investment and costs related to usage. Now, EGNOS can offer an affordable precision solution.

A rapid expansion of the downstream market for global navigation satellite systems (GNSS) has occurred in recent years.

Although relatively small, *agriculture* is one of the market's most interesting segments, due to the fact that the penetration of GNSS applications is increasing at a fast pace. In 2009, about 8% of new tractors sold in Europe were equipped with GNSS-enabled receivers and this percentage is expected to increase to 13% by 2012. Moreover, the retrofitting of old tractors with GNSS receivers involves about 4% of the European fleet, with an expected annual growth of 12%. As a result, in 2012 about 240,000 tractors across Europe are likely to be equipped with a GNSS-enabled receiver.

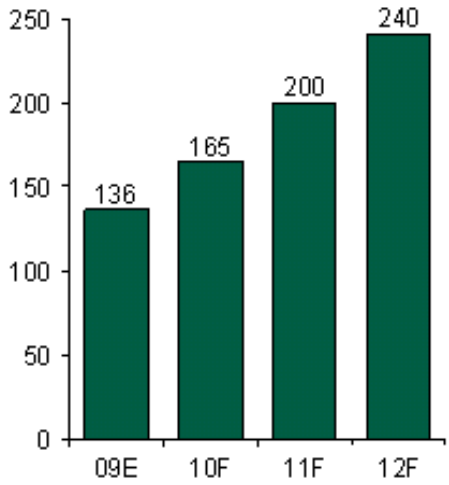

Figure 13: Cumulated GNSS-equipped tractors forecast (2009 E- 2012 F)

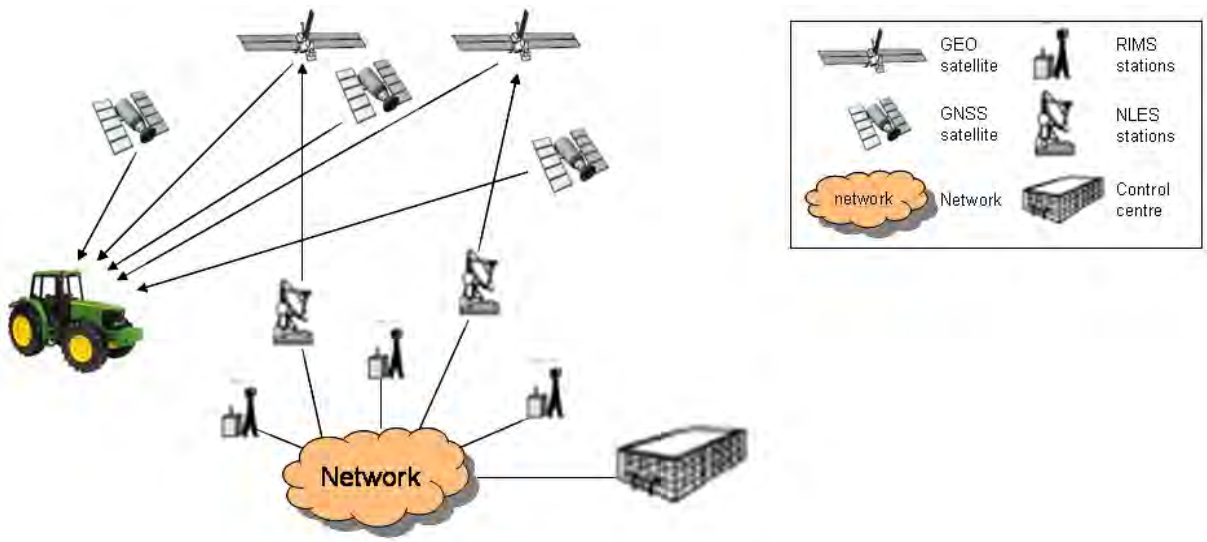

Figure 14: EGNOS system architecture

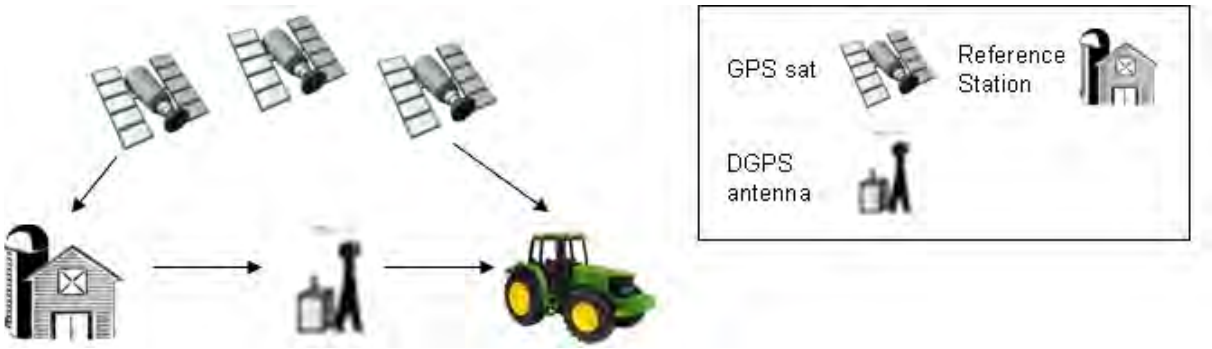

Figure 15: DGPS system architecture

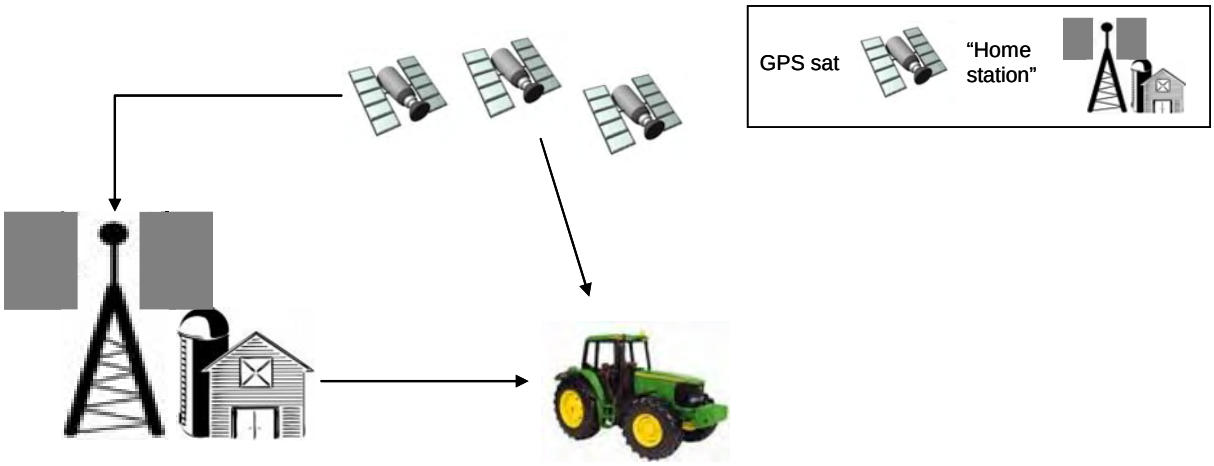

Figure 16: RTK system architecture

Until recent years, the two main technologies have been used for agriculture applications: DGPS and RTK.

Differential GPS (DGPS) employs a variety of different processes: the most used in agriculture (and normally addressed as "DGPS") is derived from signal travel time delay measurement (Pseudorange corrections, achievable accuracy approx. 1 m): a GPS reference station is located at a known point. The GPS reference station determines its GPS position. Given that the position of the GPS reference

Application category	Application field	Required accuracy level
Arable	High-value crop cultivation (e.g. potatoes and vegetables) and/ or precision operations (sowing and transplanting)	c.2cm
	Low-value crop cultivation (e.g. cereals) and low-accuracy operations (fertilising and reaping)	c.1m
Agro-logistic	Land parcel identification/ geo-traceability, post harvest pick-up and supervised tracking of livestock, manure, etc.	c.2.5m
Legislation/ management	Field measurement and boundary mapping and updating	c.2.5m

EGNOS application domain

Figure 17: Main EGNOS applications in agriculture

station is exactly known, the deviation of the measured position to the actual position and the measured pseudorange to each of the individual satellites can be calculated. These variations are valid for all the GPS receivers around the GPS reference station in a range of up to 200 km. Real-time DGPS solutions require data communication between the base station and the mobile receiver.

Real Time Kinematic (RTK) is a DGPS technique based on the use of carrier phase measurements of GPS signals and can arrive down to a centimetre level of accuracy. RTK solutions applied in agriculture normally require a reference station installed in the farm.

There are two kinds of position service providers:

- Global players, delivering a worldwide DGPS service;
- Local players, delivering DGPS corrections with a local/ regional coverage (up to several hundreds km in post-processing).

EGNOS role in agriculture

EGNOS can be used for a wide range of applications in agriculture. These can be grouped into arable, dairy, agro-logistic and legislative/management uses.

In the *arable farming sector*, EGNOS can be used to *support machine guidance,* thus helping to reduce a farmer's fatigue and allowing him to operate for longer. It can also be used for the *variable rate application* (VRA) of fertiliser and pesticides. VRA allows farmers to determine the optimum herbicide and fertiliser doses for their fields, adjusting them to the observed variability of the field. For example, only sections of a field with weeds will be treated with herbicides.

For *agro-logistic applications* an EGNOS-enabled receiver can be used to locate and identify an agricultural parcel. Information on the location and the size of the parcel can be used to generate a Unique Area ID (UAID) code: a global standard for identifying it. The code can be converted into a barcode or printed on labels to allow authorities to trace food back to the field where it was produced if there is a problem.

EGNOS' higher accuracy can also be used to help farmers managing their fields and *comply with legislation*. EGNOS receivers can be used to measure the area and perimeter of a parcel or to measure changed parts of its boundary, with an accuracy complying with Europe's Common Agriculture Policy (CAP) requirements. Landscape features can be documented as facts related to requirements on the environment, public and animal health, animal welfare and plant protection products.

EGNOS can also be used to make the *verification of farmers' declarations of land parcel size* more efficient. Under the CAP, GNSS is routinely used to verify the declarations.

Thanks to its advantages and its affordability, EGNOS (which has already 50% of market share), is expected to reach 70% by 2012 with targeted marketing actions. Leading industry players and precision agriculture experts confirm this view.

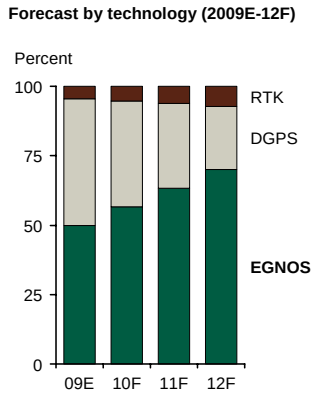

Figure 18: Agriculture technologies, market share evolution forecast

A CBA analysis to prove EGNOS benefits

EGNOS, DGPS and RTK, with different investments and operating costs bring different benefits to the farmers. A Cost Benefits Analysis (CBA) to show the benefit of the three GNSS technologies by cultivation and by field size has been therefore prepared.

	Accuracy	Initial Investment	Operative costs	Ease of usage
EGNOS	MEDIUM Meter level	Very Low	None	Elementary
DGPS	MEDIUM/HIGH Decimeter level	Medium	Annual fee	Elementary
RTK	HIGH Centimeter level	High	Annual fee Initial investment	Training needed

Figure 19: Main characteristics of each technology:

The CBA focuses on the application of GNSS as a support in machine guidance and its value added in terms of accuracy and of reduction of overlapping or gaps in the different phases.

This economic benefit varies by cultivation addressed. Target cultivations for the CBA have therefore been chosen considering only cultivations in which GNSS technology can be applied. Among them, main European cultivations in terms of hectares have been chosen.

Cultivation	Cultivated Area (Million Hectares 2008)
Soft and Durum wheat	24.7
Barley	13.8
Corn	8.4
TOT EU27 cultivated area	95.3

Figure 20: Main European Target Cultivations

Afterwards, phases where GNSS could add value (i.e.., soil preparation, fertilizer application, seeding, treatments after planting, harvesting) have been identified.

The last step has been to identify and quantify:

- benefits brought by each technology per cultivation, per phase per hectare;

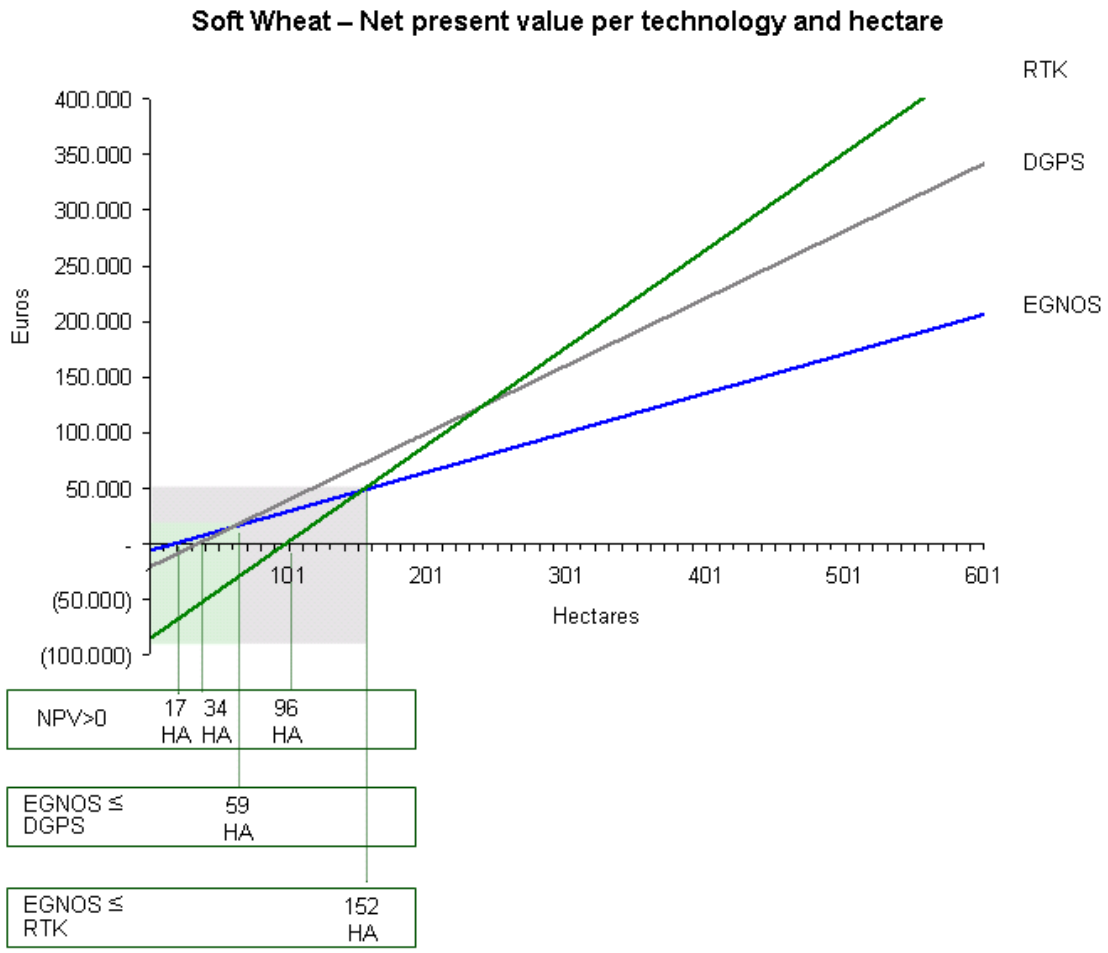

Figure 21: One of the results from the CBA (the soft wheat example)

- Investments and costs by technology.

The CBA resulted with an encouraging scenario for EGNOS. In fact for the cultivations considered (soft and durum wheat, corn and barley), EGNOS had positive results already starting from less than 20 hectares of cultivation and due to its low cost, was the best technology for *small-medium sized farms (i.e. with cultivated fields below 60 or 30 hectares*). In Europe the average farm size is 16 hectares, EGNOS could therefore represent the best technology for European Farmers.

2.6.5 Conclusion

EGNOS affordable precision is changing the accessibility to GIS/ Mapping and Precision Agriculture solutions. As for Mapping, promising applications show potential in this segment. EGNOS is expected to play an increasing role. In order to foster market awareness and adoption further analysis such as Cost Benefit Analysis (CBA) and awareness efforts will be undertaken.

For Agriculture, EGNOS is already the preferred technology in many applications and has the potential to reach 70% market shares in few years, contributing, at the same time, to the increase the overall GNSS market in agriculture. To exploit this potential, the EC and the GSA are implementing tangible and focused market development actions, and this paper has presented the first achievements.

Finally, the new EGNOS webportal is now available: www.egnos-portal.eu. It intends to develop awareness of EGNOS for all communities of users, and provide support to application developers and to end users. The EGNOS portal contains also user fora for the different communities, intending to share developers and users experience, concerns and know-how. The results of market research and of the EGNOS test campaigns will be available on the portal.

References

(1) EGNOS, the European Geostationary Navigation Overlay Service, is Europe's first venture into the field of satellite navigation and paves the way for Galileo, Europe's independent global satellite navigation system currently under development. EGNOS Open Service is now since October 1st 2009 officially operational and available for use.

(2) Economic Benefits of Precise Positioning, Matt Higgins, Principal Survey Advisor, Queensland Government, Australia, Vice President, International Federation of Surveyors (FIG), President IGNSS Society, Australia

(3) Cultivations like wineyards or fruit trees have been for instance excluded from the analysis

(4) C. 60 hectares for wheat, c. 40 hectares for corn, c. 30 hectares for barley

(5) FieldFact "Critical Analysis Report"

2.7 How can satellites serve European information needs?

by Josef Aschbacher and Maria Pilar Milagro-Pérez

2.7.1 Introduction

Global Monitoring for Environment and Security (GMES) is the most ambitious operational Earth Observation programme to date and will provide global, timely and easily accessible information in domains such as land, marine, atmosphere, emergency response, climate change and security.

To accomplish this, the European Union (EU)-led GMES initiative has been divided into three main components: Space, In-situ and Services. The Space Component, led by ESA, is in its pre-operational stage, serving users with satellite data already available today at European, national and international level, so called "GMES Contributing Missions". It will become operational once the dedicated space infrastructure, the "Sentinel" satellites, and their corresponding ground segment, are operational. The first of these satellites will be launched in 2013. They will provide a unique set of observations using SAR, multispectral, altimeter and atmospheric chemistry sensors.

This data will be then turned into services for monitoring the environment and for security related issues.

The GMES Space Component (GSC) is organised in two overlapping phases: the development and the operational phase, the latter starting in 2014. The challenge will be now to ensure the programme's long-term sustainability.

2.7.2 The services component

GMES Services are designed to provide a complete and ongoing picture of Earth's condition. They will help public and private authorities make decisions on a wide range of important environmental and security related

Figure 22: Map showing extent of the flooding in Hungary in March 2010.
Credits: GMES SAFER/DLR (data source: Envisat/ASAR, JAXA/AVNIR-2 and CNES/SPOT-5)

issues. They will also help to grow new and existing businesses, expanding the European economy and providing jobs for European citizens.

The European Commission is implementing GMES services in five main areas:

- Marine environment: marine safety and transport, oil spill monitoring, water quality, weather forecasting and the polar environment
- Land environment: water management, agriculture and food security, land-use change, forest monitoring, soil quality, urban planning and natural protection services
- Atmospheric conditions: air quality, ultraviolet radiation forecasting, climate change
- Emergency response: help mitigating the effects of natural and manmade disasters, flood, forest fire, earthquakes and humanitarian aid
- Security: support for peace-keeping efforts, maritime surveillance and border control.

Climate change has been added as a new GMES service and cross-cuts all these domains.

Depending on their users and scopes, GMES distinguishes between GMES Services and downstream services.

GMES Services provide standardised multi-purpose information common to a broad range of EU policy-relevant application areas, many of which are implemented at national or regional level, with perspective of sustainability.

Downstream services generally serve specific national (or trans-national), regional or local information needs. The corresponding information products may be derived from products of the GMES Services or be based on data directly provided through the observation infrastructure.

Figure 22 shows a map of the flooding in Hungary of March 2010, in the frame of the SAFER project, the GMES Emergency Management Service.

Figure 23 shows an example of downstream atmosphere services: the reduction (in months) in life expectancy due to concentration of particulate matter (i.e. particle pollution in the air with diameters that are 2.5 µm and smaller) in central Europe.

The evolution of these services from research to operations is continuing steadily. In each of the service areas, the range of products designed to meet the needs of identifiable groups of users is growing.

2.7.3 The space component

The Space Component comprises two types of Earth observation missions: Sentinel and Contributing Missions. Integration of these into a data stream to users is a major challenge and is carried out as part of a distributed ground segment design allowing interoperability with these missions.

There are around 30 existing or planned Contributing Missions from ESA or their Member States, EUMETSAT and other third party (European and international) mission operators which make part of their data available for GMES. They do not replace nor duplicate the capacities of the dedicated Sentinel missions but rather complement them.

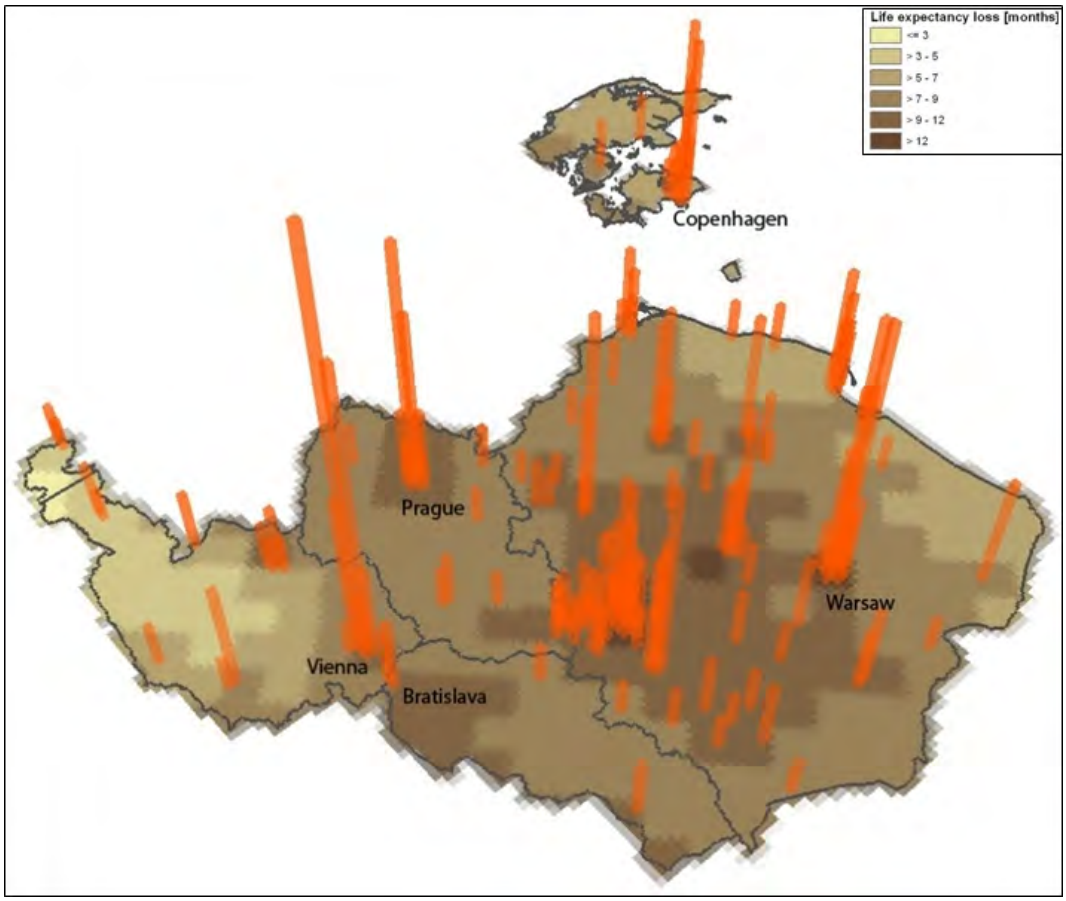

Figure 23: Loss in statistical life expectancy attributed to man-made emissions of PM2.5.
Credits: Geoville GmbH (data source: EEA)

The Sentinels have been specifically developed by ESA to meet GMES user needs and are the backbone of the Space Component Programme.

- Sentinel-1

The Sentinel-1 constellation is a pair of C-band synthetic aperture radar (SAR) imaging satellites, providing all-weather, day-and-night imagery, with improved revisit frequency and coverage. It also ensures continuity of C-band SAR data and builds upon heritage and experience with the ERS and Envisat satellites. The radar operates in four modes, with the interferometric mode as the default mode with a swath width of 250 km which enables global coverage every five days with the nominal two-satellite configuration. The instrument operates at ground resolutions of 5 m and higher. Its applications cover ice/ocean observations, land monitoring/management, hydrology, disaster management, oil spill monitoring, ship detection for maritime security, etc. With two satellites the global revisit time of Sentinel-1 will be 6 days, with 1-3 days coverage of areas like Europe, Canada and main Northern shipping routes. The first satellite will be launched in 2013.

- Sentinel-2

A pair of Sentinel-2 satellites will routinely provide high resolution optical images globally, ensuring continuity of SPOT and LANDSAT type data, but with major improvements. Sentinel-2 will carry an optical payload with visible, near infrared and short-wave infrared sensors comprising 13 spectral bands: 4 spectral bands at 10 m, 6 bands at 20 m and 3 bands at 60 m spatial resolution (the latter dedicated to atmospheric corrections and cloud screening), and a swath width of 290 km. The 13 spectral bands will guarantee consistent time series, showing actual variability in land surface conditions minimising the artefacts introduced by atmospheric variability.

The revisit time, with 2 satellites in orbit, will be 5 days (at Equator) and 2-3 days (at mid-latitudes). Data from Sentinel-2 will benefit services in areas such as land management by European and national public institutes, the agricultural industry and forestry as well as disaster control and humanitarian relief operations. Images of extreme events such as floods, volcanic eruptions and landslides will also be acquired by Sentinel-2. The first satellite will be launched in 2013.

- Sentinel-3

The Sentinel-3 mission's main objective is to determine parameters such as sea-surface topography, sea- and land-surface temperature as well as ocean- and land-surface colour with high-end accuracy and reliability.

Benefiting from a proven heritage on ERS-2 and Envisat, Sentinel-3 carries several instruments:

a) A Sea and Land Surface Temperature Radiometer (SLSTR), that uses a dual viewing technique and operates across nine wavelength bands (plus 2 additional fire channels) supporting atmospheric correction. It provides a swath width of 750 km in dual and 1420 km in single view. The SLSTR has a spatial resolution in the visible bands of 500 m.

b) An Ocean and Land Colour Instrument (OLCI), with improved wavelength bands with respect to Envisat's MERIS instrument (21 compared to 15) and sun-glint effects reduction.

c) A topography system, which includes a dual-band Ku- and C-band altimeter based on technologies used on ESA's Earth Explorer CryoSat mission, a microwave radiometer for atmospheric correction and a DORIS receiver for orbit positioning. It features an advanced discrimination of ocean and sea ice and of the transitions from land to sea in coastal or inland water areas. It will measure the topography over all types of surfaces such as sea, coastal areas, sea ice, ice sheets, ice margins and in-land waters with high coverage and accuracy.

Sentinel-3 instruments revisit times are very short, even with only 1 satellite in orbit: less than 3 days for OLCI, less than 2 days for SLSTR and 27 days for the topography package. Combining the OLCI and SLSTR instruments global daily coverage is provided with the nominal 2 spacecraft configuration.

Sentinel-3 is primarily a mission to support services relating to the marine environment, with capability to serve numerous land-, atmospheric- and cryospheric-based application areas. The first Sentinel-3 satellite is expected to launch in 2013.

- Sentinel-4 & Sentinel-5

The Sentinel-4/5 and Sentinel-5 precursor missions will be devoted to atmospheric composition monitoring and will be carried on meteorological satellites operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

The Sentinel-4 payload (an Ultraviolet-Visible-Near-Infrared Spectrometer) will be embarked on the two Meteosat Third Generation–Sounder (MTG-S) satellites in geostationary orbit (planned to launch in 2018 and 2024).

In addition, Thermal Infrared (TIR) sounder data on the same platform, and a cloud imager on the MTG-Imager platform will be exploited by the Sentinel-4 services.

The Sentinel-5 payload will be carried on the MetOp Second Generation spacecraft (planned to launch starting in 2020) in a sun-synchronous low Earth orbit (at about 800 km mean altitude). The Sentinel-5 mission will consist of an UV-VIS-NIR and Shortwave Infrared spectrometer which will also house a TIR sounder and imager.

According to this concept, a Sentinel-5 precursor mission is planned to launch in 2014, to avoid data gaps between Envisat (SCIAMACHY instrument data in particular) and Sentinel-5. It will provide data continuity and support the transition into an operational scheme. Services proposed will cover air quality, climate change and stratospheric ozone and solar radiation.

The integrated ground segment architecture operates and provides access to Sentinel data, as well as interfaces with Contributing Missions in order to obtain a coordinated data stream to satisfy observation requirements of GMES services.

2.7.4 Conclusions

Once ready, GMES will be the most comprehensive space-based data collection system in the world. European scientists will have a more comprehensive capacity to assess climate and environmental pressures and drivers, and will therefore better advise policy makers on requirements for new and more effective policies. Also public sector organisations will benefit from GMES as they require access to reliable, timely and cost-effective information on environment and security issues to manage their policy implementation (e.g. agriculture, fisheries, forest management, civil protection agencies, and humanitarian aid coordination).

The societal benefits will also translate into economic benefits. The public investment will create new opportunities in the private sector and will facilitate market uptake and competitiveness by value-adding service providers in innovative services.

2.8 Public perception of the European satellite navigation programmes EGNOS and Galileo

by Isabelle Maës and Ingrid Godkin

2.8.1 Introduction

In order to let European citizens and other relevant stakeholders know about the European satellite navigation programmes EGNOS and Galileo, understand why Europe needs them and follow how they are progressing, the European Commission has put in place a process for developing, implementing and evaluating a yearly communication plan for those programmes. It does so in close coordination with the other players involved (e.g. Member States, the GSA, ESA) in order to ensure consistency, leverage synergies and avoid duplication of efforts. Roles and responsibilities are clearly assigned; the EC is in charge of the overall coordination and the institutional communication; the GSA is responsible for the sector-specific, market oriented communication as well as the communication on research projects under the Research Framework Programme; ESA is entrusted with the communication on technical aspects and with several specific communication activities.

2.8.2 2011

In many ways, 2011 promises to be a very exciting year for EGNOS and Galileo.

The EGNOS Safety-of-Life Service declaration will mark the start of the use of EGNOS for Aviation. EGNOS was developed for Aviation and this is where it adds the highest value for European citizens. EGNOS significantly increases the safety of air traffic in Europe. The European Commission has the opportunity to let the general public know about the existence of EGNOS and how it was born out of a successful cooperation between the EC, ESA and Eurocontrol. How it is already bringing value to economic sectors such as Agriculture, Road transport or Construction. How it will soon benefit Air transport. How it will soon bring increased precision to location-based services. In 2011, the European Commission will give EGNOS visibility in the print media to increase the general public's awareness of EGNOS and of its benefits. In parallel, the communication efforts started in 2009 towards professional sectors will continue, through websites, publications, videos, conferences and exhibitions.

The launch of the first two operational Galileo satellites in the latter half of 2011 will mark the start of the concrete deployment phase of the programme. Galileo will become physically visible in the eye of the general public. It will be a key opportunity for the Commission to explain or remind European citizens of why Europe needs Galileo. To communicate the importance of satellite navigation for European businesses and citizens in their daily lives; to show that Europe cannot afford to stay dependent on other nations in a field that has become so critical for both its economy and the well-being of its citizens; and to demonstrate that Galileo can play an important role in generating economic growth in these times of economic crisis.

To that end, the European Commission will also give Galileo visibility in the print media, organise an EU-wide competition for children where the winners, one child in each member state, will have his or her name given to a Galileo satellite, develop a video for seeding on the web and that people will want to share amongst themselves and produce stock shots to encourage TV producers to develop programmes about this major European endeavour. The communication efforts to professional audiences will also continue in parallel, with the primary objective of supporting and facilitating the development of receivers and applications.

2.8.3 Strategy

How can the European Commission play a key role in improving public perception of the European satellite navigation programmes EGNOS and Galileo?

Not only in increasing communication activities in quantity but also in continuing to communicate the right messages in the right way at the right time.

The European Commission is placing greater emphasis on the importance of satellite navigation for Europe's citizens and its economy - already 6 to 7% of the EU's GDP, or about €800 billions, relies on satnav applications. A majority of citizens already use one or several satellite navigation applications, typically in-car navigation while almost all of them already benefit from public services that use satellite navigation applications, like emergency medical services, fire brigades, the police etc.

As mentioned above, the European Commission is demonstrating the reasons for Galileo. Strategic independence from any other global

navigation satellite system is key for both the economy and social welfare in Europe. Having our own satellite navigation system in place will create both business and job opportunities for Europe.

The European Commission has learned from the lessons of communicating over-optimistic time-schedules when dealing with such an enormous project. Building your very own global navigation satellite system is a very complex process, Galileo is no exception. In fact, Galileo is the largest and most complex programme ever undertaken by the EU. It is managed by the EU because no single member state or even group of member states or group of industries could do it alone. Galileo does not simply require the launching of satellites. A complete ground and space infrastructure needs to be constructed, open tenders launched, procurement activities managed, consultations with industry, this all takes time. Complexity means risks and when risks materialise timings do slip. This is a simple fact inherent to the project itself. It is unfortunate but very hard to avoid, irrespective of efforts and competency. The European Commission will provide and communicate timing taking into account possible and sometimes inevitable slippage in schedules. This will demonstrate the necessary openness in communication and help build credibility.

Last but certainly not least, the European Commission is endeavouring to create involvement with Galileo. The competition for children is written in that context. Galileo is not a programme for engineers only. It is not an abstract system without impact on each and every European citizen in their daily lives. It is a programme for the European citizens who are the key beneficiaries, managed through political institutions who strive to answer to citizens' needs and expectations.

2.8.4 Conclusions

The European Commission is well aware of the public perception challenges surrounding the European satellite navigation programmes EGNOS and Galileo.

A process is in place in which a yearly communication strategy and plan is developed, implemented and evaluated in a coordinated way between itself, the European Space Agency and the GNSS Agency.

The European Commission will increase EGNOS and Galileo visibility to the general public in 2011 in the context of, one the one hand, the EGNOS Safety-of-Life Service declaration for Aviation and, on the other hand, the launch of the first two operational Galileo satellites. Those efforts should help address a number of the public perception challenges.

A strategic approach based on raising awareness amongst the general public on the increasing importance of satellite navigation in their daily lives and of the reasons for being of the programme, on creating realistic expectations and on creating involvement should also help address those challenges.

2.9 Earth Observation in the Global Context: GEOSS (the Global Earth Observation System of Systems)

by Gilles Ollier

2.9.1 Introduction

The Global Earth Observation System of Systems (GEOSS) interconnects the Earth observation systems (spaced-based, ground-based, and water or airborne) that are owned and maintained by the member governments and participating organizations of the Group on Earth Observations (GEO), with the vision to providing a full range of new resources for the monitoring of the Planet Earth by 2015. As specified in its strategic targets by 2015 GEOSS is expected to achieve effective and sustained operation of the global climate observing system, establish a worldwide biodiversity observation network, and enable the global coordination of observing and information systems to support all phases of the risk management cycle associated with hazards. In order to achieve these strategic targets, the 85 GEO members have committed to cooperate at a global level, bringing their information together, making it interoperable, and creating global datasets available to everybody at minimum cost. This is now becoming a reality following the decision made by the GEO members at the GEO Ministerial summit in November 2010 to create the GEOSS Data Collection of Open Resources for Everyone (GEOSS Data CORE). This is a distributed pool of documented datasets with full, open and unrestricted access at no more than the cost of reproduction and distribution.

2.9.2 International dimension

Earth Observation and Earth Monitoring are becoming increasingly international activities .as our understanding and prediction of an environmental situation at a particular geographical site depends largely on the under-

standing of the functioning of the global earth system. This is typically the case for climate issues. The GEOSS added-value with respect to existing Observing Systems lies principally in its capacity to combine national and regional Earth Observation Datasets and information and to build global datasets and resources necessary to understand and predict the functioning of the earth systems. This objective is emphasized in the GEOSS strategic target document which states: "*GEOSS will meet the need for timely, quality long-term global information as a basis for sound decision making etc...*Europe adheres to this objective because it is essential for the implementation of a number of the European Union policies. Therefore a real effort is now taking place in Europe to "*globalise"* several of the European initiatives relevant to GEOSS. The European Commission encourages and assists the owners of European datasets and Earth Observation resources to contribute to substantial GEO added-value achievements. Many of these have been showcased at the GEO 2010 Ministerial Meeting in Beijing. GEO flagship initiatives to which Europe contributes include: 1) The Global Carbon Monitoring System which integrates several models and datasets (atmospheric, in-situ and space data from European projects such as ICOS, MACC or MOZAIC 2) The GEO Biodiversity Observation Network GEO BON to which the European projects EBONE, Lifewatch and LTER Europe project contribute 3) GEO Capacity Building actions, such as the 'GEONETCast' data and information broadcasting system to which the 'DevCoCast' European project contributes. This serves a broad range of user communities from the developing world who otherwise would have little access to information.

2.9.3 The GEOSS difference

GEOSS intends to develop along two main avenues: 1) Establish the *full and open exchange* of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation 2) Create a GEOSS *Common Infrastructure (GCI)* to ensure that end-users of Earth Observation data have, effective access to the full suite of Earth observation content provided through GEOSS and to facilitate interoperability among all content contributed to GEOSS.

Full and open exchange of data

The GEO data sharing principles which advocate the full and open exchange of data are not intended as a binding data policy but rather as an incentive to share good practice at international level in making Earth Observation Data Sets freely available. Although not binding, the data sharing principles are now recognised by 85 governments, and they have become powerful instruments in constituting global observations datasets and resources. This approach, promoted through GEO, has started bearing fruit. For example, the removal of imagery charges by the China Brazil Earth Resources Satellite (CBERS) resulted in increased access from1,000 images/year to 10,000 images/month with more than 10,000 new users registered in the first year alone. Likewise, the U.S. Geological Survey has achieved similarly impressive results following removal of Landsat's charges for internet users which resulted in more Landsat data (more than 1.1 million images) being processed and distributed in 2009 compared with the whole 38 year mission history combined. This trend should accelerate in the years to come. Building on the current momentum, on the occasion of the recent GEO Beijing Ministerial Summit, many countries announced, full and open access (at no more than the cost of reproduction) to previously hard-to-find national data from either in-situ or remote sensing. The GEO Data Sharing approach for full and open exchange of data has been adopted in Europe by GMES (Global Monitoring for Environment and Security) as a general principle for the implementation of the GMES Data Policy. In particular, it is planned to apply it to the future GMES space infrastructure - the Sentinels space missions. The European Space Agency (ESA) also started to implement the GEO Data sharing principles which already apply to ESA's new GOCE, SMOS and CryoSat Earth observation missions and offers open and free access to data. ESA's Climate Change Initiative, through which world-leading international science teams are co-operating to provide long-term high-quality datasets on 'Essential Climate Variables' (ECV) will also release the data on the basis of GEO full and open access .

The GEOSS Common Infrastructure (GCI)

The GCI is a unique information system designed to permit upload and download of Global Earth Observation data and resources across the 9 GEO Societal Benefit areas. It will allow users of Earth observations to access, search and use the data, information, and tools available through GEOSS. The infrastructure consists of three main elements: 1) The GEO Portal provides the direct web interface through which the user accesses GEOSS and searches for information and services. 2) The GEOSS Clearinghouse connects directly to the various GEOSS components and services and 3) The GEOSS Regis-

try provides services similar to a library catalogue. The GCI is currently being tested but is not yet in operational mode. This is expected when the current GEO implementation phase is completed in 2015. On the occasion of the GEO Plenary meeting in November 2010, the GEO community formalized the arrangements by which leading institutions will operate and sustain the GEO Portal and its underlying clearinghouse and registry. The US Geological Survey (USGS) was designated as the single provider for the GEOSS Clearinghouse, and registry while the European Space Agency (ESA) and the UN Food and Agriculture Organisation (FAO) was designated as the single provider for the GEO Web Portal. The GEO Web Portal, currently being tested, can be accessed at the following internet address: http://www.geoportal.org/web/guest/geo_home.

Europe is active in providing operational options for the GCI. In particular, the FP7 project EuroGEOSS has implemented a brokering service that allows finding and accessing data from a wide range of standards and domain-specific practices including the use of a semantically-rich querying capability which may be incorporated in the GCI. Further development should take place in future projects supported through FP7 in particular under the 2011 call of the Environment Theme of the FP7 cooperation programme through the topic: "*Interoperable integration of shared Earth Observations in the Global Context".* A project funded under this topic should enable further global access to Earth Observation data and resources through the GCI by supporting the development of new tools, processes, procedures and protocols to remove obstacles to the sharing of Earth observation (EO) data at a global level and to address data/product providers' identified concerns.

2.9.4 Public perception

The public perception of Earth Observation in general is largely dominated by a spectacular vision of the Planet provided by remote-sensing and space observation. Because there is often a complex modelling process between the acquisition of satellite data and the delivery of information (temperature, salinity, vegetation etc…) which is difficult to explain, it appears to the public that satellites are measuring those parameters directly. Nonetheless, the final delivery of information from remote-sensing depends in many respects on the assimilation of in-situ data that are collected by ground stations. This perception raises a number of expectations among both the public and decision-makers who, not having access to the full picture, tend to overestimate the capacity of remote-sensing alone to monitor our planet. The European GMES initiative clearly indicates that its service component depends on Earth observation data collected from space (satellites), air (airborne instruments, balloons recording stratospheric data, etc..), water (floats, shipboard instruments, etc.) or land (measuring stations, seismographs, etc.). As indicated in its 10 year implementation plan funding document, GEOSS aspires to encompass all areas of the world and to cover *in-situ*, airborne, and space-based observation. GEOSS and the current global initiatives are currently contributing to propose a more balanced approach for the monitoring of our planet in terms of data source. In particular the integration of space data and in-situ data is very high on the agenda of several initiatives promoted through GEO such as GEO BON (GEO Biodiversity Observation Network), the Global Carbon Monitoring System, the Forest Carbon Tracking System, and the Natural Hazards Supersite initiative. Meanwhile, the overall perception of GEOSS still remains modest beyond the circle of specialists contributing to develop it. This was raised in the GEO mid-term evaluation report presented to the GEO Ministerial in 2010: "*GEO has not adequately communicated evidence of progress to show added-value results unique to the implementation of GEOSS and to unequivocally prove a positive return on investment".* This statement is balanced by the following: *Stakeholders are generally positive about the foundation that has been established and optimistic that appropriate outcomes are being realised".* Finally, the evaluation and monitoring group recognised that GEOSS is a recent endeavour (started in 2005) that has put the proper foundations in place but which needs to improve communication the added value of its results.

2.9.5 Conclusion

Three years before the completion of its 2005-2015 Implementation Plan, GEO is reaching a critical time. It has laid the foundations for the implementation of GEOSS with the GEO Data Sharing Principles being broadly accepted, the GCI currently being tested, and progress made to reach the strategic targets in the 9 GEO SBA's. The development of the new GEO 2012-15 work plan in 2011 is the opportunity to rearrange the current diverse and numerous GEO tasks that were proposed initially through a bottom-up approach in a simpler and more visible manner so that the perception of GEOSS increases in the public and among decision makers. For the longer term, beyond 2015, the GEO governments have decided in adopting the Beijing Declaration to "*meet before the end of*

2013 to review the recommendations for the governance, role and future work of GEO beyond 2015 and to take the necessary decisions". Those decisions will be made when the EU will be deciding its new programmes beyond 2013, in particular those related to the Innovation Union strategy against the background of the new EU financial perspectives.

2.10 Elements for discussion on public perception and international aspects

by Jérôme Béquignon

2.10.1 Public perception

Galileo and GMES are infrastructures. The benefits of infrastructures are not always easily perceived and this is not specific to Space; let us consider the main trans European highways or railways. They represent heavy investments, not always popular (think of the highways in the Alps) but everybody enjoys their guaranteed level of service (first priority snow cleaning; 24/7 service areas; etc). Likewise, GMES will be a guaranteed flow of geospatial information and its benefits will become apparent when data flows freely.

Space serves other policies. Letting aside exploration of the Universe, the European space policy is mostly geared towards other policy areas of the EU rather than a policy *per se*. The public perception of the flagship programmes Galileo and GMES should therefore be measured by the level of acceptance of such programmes by the stakeholders of these other policy areas. Let me take the case of the EU Disaster Response capability. GMES is actually quoted in the recent communication of the European Commission, which decided to merge humanitarian aid (ECHO) and Civil Protection in a single Directorate General. This shows how this well identified community takes over the Emergency service of GMES.

All EU institutions must seize Space. The Space council recently reaffirmed that a European Space Policy relies on a triangle: the EU, the European Space Agency and their Member States. At ESA we do our utmost to deliver the satellite systems on time. The Member states and the EU institutions have a key role to play. By the EU, one should understand the European Commission indeed, but also the European Parliament who has been quite supportive - thanks to Messrs Remek and Glante - the EU Council, the Committee of the Regions, the European Economic and Social Committee, etc. These last two institutions have a very important role to play in establishing and maintaining communication with the civil society and the many "stakeholders" of Galileo and GMES. Likewise, public perception of Galileo and GMES should also be measured by the level of discussion, commitment and ownership of these institutions and their constituencies.

2.10.2 International aspects

GMES contributes to the Global Earth Observation System of Systems in many ways.

Data democracy. It is first and foremost a coherent and sustained source of important data sets well recognised by the world community. The proposed GMES data policy is aligned with the GEOSS data sharing principles. It fits nicely with the Data Democracy concept being advocated worldwide: to provide timely access to key data sets, sharing of software tools, increased training, and technology transfer to end users, all these free of charge to build capacity worldwide, especially with respect to developing countries.

GMES is consistent with the EU approach relying on effective multilateralism, belief in international law and negotiated solutions. This is particularly the case of climate change policies, both for assessment and adaptation

REDD. Let me pick the case of the UN REDD+ programme (Reducing Emission from Deforestation and Degradation). A central element to this policy is the ability to measure, report and verify. – as objectively as possible of their forest carbon stocks.

The key to the success of the initiative is based on accurate observations from satellites, which are validated by measurements taken in situ, and an operational framework that allows for a range of national forest assessment systems for measurement, reporting and verification (MRV). The Sentinels –in particular S1 and S2 – allow to map the world's land use every month. It allows Europe to participate to some activities of the GEOSS such as the Forest Carbon Initiative Through the first global monitoring system for producing assessments of forest carbon, changes in forest cover will be accurately monitored to ensure that assessments of stocks are credible, transparent and comparable from one country to another.

The Arctic. The EU Arctic policy is another example : a report by MEP Gahler promoting an EU policy for the high North spots the role of EGNOS and Galileo to support EU assets in the Arctic. Again the Sentinel-1 and Sentinel-3 series are particularly well suited to provide valuable information on sea ice cover and thickness and Galileo will provide a much better coverage of the poles.

3. Summary of the Roundtable and General Workshop Discussion

by Christina Giannopapa and Gai Oren

3.1 Public perception

The main challenge faced today regarding Galileo/EGNOS and GMES is the financing. This needs to be guarantied on a long term basis and to be available on time. This is necessary to ensure that the investments made until now on these two programmes are not jeopardised; to avoid additional costs and delays; and to avoid policy discontinuities. The second challenge is the communication mechanisms regarding the two programmes vis-à-vis the public, (general and decision makers) and the international community. The third challenge is related to providing adequate answers in issues related to governance and data policies.

The support from the general public as well as the decision makers is essential for the success of the programmes. Currently, the European citizens support the two flagships with large numbers; in particular they support by 91% the development of Europe earth observation systems to monitor our environment including natural disasters, 67% to improve citizen's security and 67% the development of an independent "European GPS" system[14]. Even thought the public is aware of the space activities and their importance, when it comes to budget, they are reluctant to support an increase. However, the general public is often reluctant when it comes to budgetary increase in areas where the effect is not direct like pensions, healthcare, education, taxation, etc. Therefore, the political dimension for such programmes needs to be very strong and continuously reinforced.

The decision makers and in particular the politicians, have supported the flagship programmes and safeguarded their continuation in times of uncertainty. In order for the politicians to continue to support the flagship programmes two main factors need to be continuously fulfilled. They need the support of the general public which is necessary to justify the investment in terms of return in competitiveness, job creations and benefits to the citizens. In particular in times of economic crisis, programmes such as Galileo/EGNOS and GMES which contribute to the European non dependence, competitiveness and development is of great importance. Emphasis on the applications and success stories can significantly support such initiatives. The second factor is that the politicians themselves need to be more informed and convinced of the benefits these programmes can bring to Europe and its Member States in the implementation of their policies. There are a number of politicians that are aware but the outreach should be expanded to those who see the benefits indirectly and where these programmes are a tool to assist them bring added value and improve the policies they are concerned with e.g. agriculture, transport security, financial and banking, energy. Seminars and workshop which encompass the transverse nature of space can bring an important contribution.

The media is instrumental in creating positive and negative opinions. To safeguard that the appropriate information is transmitted to them and that they have the right capacity to interpret it correctly, the communication strategy implemented is an essential element. Information days and the establishment of effective official communication channels can assist the media receive immediate, reliable and appropriate information to further distribute to the public. Specialist publications are necessary but in order to achieve a more effective communication, information needs to be transmitted though more popular forms and though more popular channels (e.g. popular magazines, TV programmes). Reference to budgetary numbers related to the cost of Galileo/EGNOS and GMES and delays of the programmes are always popular topics to the public. Such references are often misleading as delays in technology development are often occurring and in budgetary terms, such numbers appear large to the general public as there is typically no reference to the cost of other infrastructure in the Union and Member States (e.g. the cost of Galileo is equivalent to 500km of highway). Therefore, there is a

[14] Flash EuroBarometer. Space Activities of the European Union. Flash EB series N 272. <http://ec.europa.eu/public_opinion/flash/fl_272_en.pdf>.

need for a more creative ways to introduce these programmes to the public other than the budgetary aspects, time delays, etc, but also on the benefits and the effects that lack of them would have the citizen's economic and social prosperity.

The European Space Agency, the Member States, and the European Union institutions, including European Commission, European Parliament, Council, Committee of Regions, European Economic and Social Committee, play a key role in communication. In particular, the last two have a very important role to play in establishing and maintaining communication with the civil society and the main stakeholders for Galileo/EGNOS and GMES. At the same time the public perception of Galileo and GMES should be measured by the level of discussion, commitment and ownership of these institutions and their constituencies. The Commission is currently working closer together with the Member States, regions and company associations to support such awareness for the general public. This awareness can be further supported by closer collaboration between the Parliament and the Commission to enhance the public awareness. Additionally, the companies developing these services have to be involved in bringing awareness about the huge potential the applications stemming from the flagships have.

One of the best ways to showcase the value of these programmes is to demonstrate the return of investment by social and economic benefits bought to the actors in the value chain, the end user. The use of navigation, positioning and earth observation applications is constantly expanding world wide. The GNSS market is a fast growing market expected to reach up to 244 billion Euros, according to the GNSS market report recently published by GSA. Since Galileo and GMES are not present yet, this can be done by showcasing EGNOS. EGNOS can be used in different segments like agriculture, mapping, aviation and road. Today EGNOS is used by more than 80.000 farmers and soon 20.000 will be using it for mapping. In 2011 it will be used in aviation and later in road transport. These results are showing already the usefulness of EGNOS though various applications. These benefits need to be constantly showcased as much as possible to the public in an understandable way. These should be complemented by communicating the benefits Galileo will additionally bring once completed. One needs to go beyond just press communication, but needs to enter into well thought communication and marketing strategies. GMES is a more difficult case regarding communication as it is still in building phase and it is very technical. Amongst other, the services of such a system in emergency response, is one of the top priorities where the Union has significant progress and were GMES is quoted as a tool that will contribute in prevention and mitigation. The international recognition of the European research team in the field is a significant step for the European visibility internationally. Additionally, the use of navigation, positioning and earth observation, are complementary. Therefore, an integrated application from synergies between Galileo/EGNOS and GMES will provide additional market development and social benefits. Organisation of events such as "applications days", seminars and workshops for the flagship programmes, significantly contribute in a positive public perception.

Overall even though there as some examples, there is a gap between what the public wants today and what you can convince them to pay today for, with the promises that they will benefit from it in the future. Therefore, the political support of such programmes needs to be strong to back up such decisions for investment with benefits further in the future.

3.2 International aspects

The political ambition to develop Galileo and GMES have put Europe at the spotlight vis-à-vis the international community. The importance of these systems is focused around three main aspects: international cooperation, the global dimension of systems of systems and European autonomy. Such instruments provide the basis for international partnerships and cooperation in many areas (energy, agriculture, transport, environment, space, research, etc). The provision of systems of systems approach gives the possibility to guarantee services of high standards. Additionally, currently Europe relies on foreign assets for critical information which is essential for day to day operations and decision making. European ambition to develop the flagship programmes has resulted in raising internationally the expectations of Europe's involvement in fulfilling its international obligations towards climate change (e.g. Kyoto), Millennium Development Goals (e.g Africa), etc. and in providing global infrastructures. Europe has committed its Galileo to be the first GNSS civilian infrastructure operating globally with guaranteed operation. GMES will be the most compensative space-based data collection system in the world and the European contribution to GEOSS.

The EC GNSS international strategy has seven elements: access to global GNSS-

related resources and setting word wide standards; ensuring security of the space segment and ground networks of the systems; ensuring acquisition of required space technologies word wide (e.g. use of non-EU technologies in non-sensitive areas); developing jointly innovative applications and space technologies; developing specialised applications of supra-regional interest (e.g civil aviation, maritime transport, banking); enhancing the global business environment, worldwide for European GNSS technologies and applications industries; discussing the development of Galileo globally (e.g international agreement, forums). One of the primary ones is to establish partnerships with countries like China, India, Japan, Russia and US, to ensure compatibility and interoperability of the GNSS systems. The number of international agreements between the EU and other countries regarding Galileo is large and reflects the changes in the governance of Galileo over the years. Another element of importance is to ensure that European industries have access to markets in these countries (e.g. additional taxation if not local systems are used) and protect technology transfer and intellectual properties (e.g. IP EU China help desk). Additionally, the increase of the GNSS systems provides more reliable and enhanced services (e.g. Arctic).

The primary benefit of the international cooperation though GMES and GEO/GEOSS is the impact on policies. Data sets build globally for areas which are not critical, like security, provides confidence for the development of policies which need information across the globe e.g. environmental pollution of Oceans. Additional confidents would be provided by the fact that such data sets would be commonly agreed by the international community. Added values services are provided for policy makers as well as for other users on an operational sustainable basis. Furthermore, the voluntary nature of GEO/GEOSS and the successful agreement of the international community on data sharing principles is an example of successful international cooperation towards common goals and serving common needs.

The use of positioning, navigation and earth observation infrastructure have become today indispensable tools on a global scale, needed to fulfil daily operation related to economic development and services for the citizens. Thus, the flagships are a strategic asset for Europe and demonstrate like no other asset the strategic nature of space. Dependence on strategic infrastructures leads amongst others, to limitations in acquiring knowledge, which results in restrictions in freedom of action. Therefore, such strategic infrastructures are essential in achieving autonomy though non-dependence; in being able to make strategic decisions related to European and Members States goals. In this context it is understood that cooperation with other international partners is necessary but at the same time core autonomy for Europe is essential.

Additionally the resent strategy of the Europe 2020 provides an opportunity though the innovation union strategy to take advantage of the full potential of novel technologies and applications. The research agenda of the Union includes focus on challenges such as energy, security, transport, climate change, resource efficiency, health and ageing, environmentally friendly production methods, and land management. The space flagship programmes can be used as tools for contributing in tackling such challenges and promoting international cooperation.

The United Nations in particular UNCOPUOS provides the possibility of exchange on developments across the nations and a platform for discussion for GNSS and GEOSS and their applications. Hardships in accomplishing these programmes will have a negative impact on the political arena. On the other hand the success of the Union to showcase its flagship programmes will be an opportunity to show internationally how well Europe and its Members States can works together, promote European values and inspire for a closer international cooperation of issues of common interest.

List of Acronyms

Acronym	Explanation
ADAS	Advanced Driver Assistance Systems
API	Application Programming Interfaces
CBA	Cost Benefits Analysis
CBERS	China Brazil Earth Resources Satellite
CFIT	Controlled Flight Into Terrain
DGPS	Differential Global Positioning System
EC	European Commission
ECV	Essential Climate Variables
EETS	European Electronic Tolling Service
ESA	European Space Agency
ESPI	European Space Policy Institute
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FP	Framework Programme
GEO	Group on Earth Observation
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information Systems
GCI	GEOSS Common Infrastructure
GLONASS	Russian Federation´s Global Navigation Satellite System
GMES	Global Monitoring Environmental and Security
GNSS	Global Navigation Satellite System
GSA	Galileo Supervisor Agency
GPS	Global Positioning System
ICG	International Committee on GNSS
ITRE	Institute for Transportation Research and Education
ITS	Intelligent Transport System
LBS	Location Based Services
LCA	Lane Change Assistance
LDW	Lane Departure Warning
LPV	Localizer Performance with Vertical guidance
MPE	Member of the European Parliament
MRV	Measurement, Reporting and Verification
OLCI	Ocean and Land Colour Instrument
PBN	Performance Based Navigation
PDA	Personal Digital Assistants

Acronym	Explanation
RTK	Real Time Kinematic
SAR	Synthetic Aperture Radar
SBAS	Space Based Augmentation System
SLSTR	Sea and Land Surface Temperature Radiometer

Workshop Programme

Background

The European Space Policy Institute (ESPI) is conducting a study on Europe's Flagship Projects: Galileo and GMES. This study touches two specific issues which have not been investigated thoroughly and neither in a comparative approach. Building on existing analysis, on governance and structure of the two flagships, this study will approach issues of public perception and international cooperation. These two areas can be regarded as framing elements of the two flagships in that they look into the foundations of the programmes vis-à-vis the general public and decision makers; and for the second part, relate to the interaction on the global scale with other actors conducting activities with a global approach in the two fields.

The workshop shall provide the opportunity to debate amongst the stake holders, and the needs for action in the two areas of public perception and international cooperation. It will address decision makers in particular Members of Parliament at European and National level. It shall also analyze whether a comparative approach between the two flagships could be useful defining concrete activities and policies.

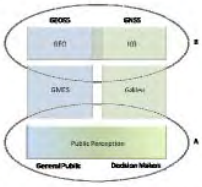

Figure: European and International setting regarding Galileo and GMES.

The figure represents a schematic perception of the focus of the ESPI study (doted lines) with A covering the aspect of public perception and B the international cooperation.

The participants in the workshop are expected to actively contribute to the discussions to tackle the issues from the perspectives of all stake holders.

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European Space Policy Institute

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Participation upon invitation

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December 2010

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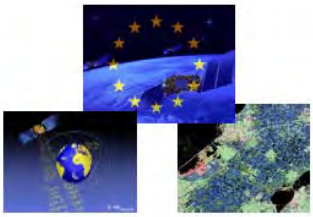
Galileo – GMES Workshop

Less Known Elements of the Space Flagship Programmes: Public Perception and International Aspects

Programme



7 December 2010
09.00 - 13.15
Room ASP 3E2
European Parliament
Brussels, Belgium

ESPI
European Space Policy Institute

09.00-09.45 Welcome and Introduction

Welcome
Kai-Uwe Schrogl, Director, ESPI

Presentation of the project
Christina Giannopapa,
Resident Fellow, ESPI

GMES, current status and future challenges
Norbert Glante, MEP

Galileo status and future challenges
Vladimir Remek, MEP

09.45-10.45 Part A: Public Perception (General Public and Decision Makers)

09.45-10.15 Presentations

The European GNSS Programmes: messages beyond the general perception
Gian Gherardo Calini, Head of Market Development, European GNSS Agency

GMES - How can satellites serve European information needs?
Josef Aschbacher, Head of GMES Space Office, European Space Agency

GMES and European policy-making – need to have or nice to have?
Marie Menard-Caër, GMES Bureau, DG Enterprise and Industry, European Com mission

10.15-10.45 Round Table Discussion on Public Perception

Moderated by Kai-Uwe Schrogl and Gai Oren, Secretariat ITRE Committee, EP
Panelists: Speakers and Jérôme Béquignon, Brussels Office, European Space Agency

11.00-12.00 Part B: International Aspects (European Perception in the Global Effort and Bilateral Relations)

11.00-11.30 Presentations

International Aspects of the Galileo/EGNOS programmes
Jean-Yves Roger, Policy Officer, EU Satellite Navigation Programmes, Applications, Security, International Aspects, DG Enterprise and Industry, European Commission

Earth Observation in the Global Context: GEOSS (the Global Earth Observation System of Systems)
Gilles Ollier, Head of Sector, Earth Observation, DG Research, European Commission

11.30 -12.00 Round Table Discussion on International Aspects

Moderated by Kai-Uwe Schrogl and Gai Oren, Secretariat ITRE Committee, EP
Panelists: Speakers and Jérôme Béquignon, Brussels Office, European Space Agency

12.00-12.15 Conclusions

12.15-13.15 Buffet Lunch

gmes
Observing our planet for a safer world

GALILEO

About the Contributors

Josef Aschbacher

Josef Aschbacher is Head of the GMES Space Office at the European Space Agency. His main task is to coordinate programmatic aspects of GMES including the cooperation with the EC and the establishment of the programme's long term funding. From 2001-2006 he was Programme Coordinator in the Directorate of Earth Observation Programmes at ESA's HQ in Paris. From 1993-2000 he worked at the EC Joint Research Centre in Ispra, Italy, where he was the Scientific Assistant to the Director. Through his work at the EC and ESA he gained profound knowledge of Earth Observation activities in Europe and has actively contributed to the advancement of European space programmes, most notably GMES. Josef Aschbacher has a PhD and Masters degree in Natural Sciences from the University of Innsbruck, Austria. He has 25 years of working experience in the domain of satellite Earth observation and has published more than 100 articles, many in peer-reviewed journals. He has been a lecturer at University Innsbruck, Austria, the Asian Institute of Technology in Bangkok, Thailand, the Politecnico Milano, Italy, and the University of Wuerzburg, Germany.

Jérôme Béquignon

Jérôme Béquignon, 52, started his career as geophysicist at the Euro-Mediterranean seismological centre. He joined the European Space Agency (ESA) in 1991 and specialised in space technology applications to disaster management.

From 2002 to 2007 he was seconded as Advisor on space and new technologies to the Director of Civil Protection with the French Ministry of Interior,. He steered several projects for the European Commission on civil protection matters.

He has been Executive Secretary of the International Charter "Space and Major Disasters" from 2000 to 2007. This international agreement aims at providing satellite imagery to emergency managers during major incidents.

He is currently Senior Coordinator at the Brussels office of ESA, he liaises with the European Institutions on major space programmes such as Galileo and GMES. He is a regular lecturer on space technology for emergency management at various academic institutions.

Christina Giannopapa

Christina Giannopapa has been Resident Fellow at the European Space Policy Institute (ESPI) since January 2010. Prior to joining ESPI, she had ten years experience in engineering. From 2007-2009, she served as Technical Officer for the European Space Agency (ESA), where she was responsible for overseeing projects in the field of life and physical science instrumentation. Previously, she held positions in academia in Eindhoven University of Technology, the Netherlands, where she currently holds an Assistant Professor position. She has worked as a consultant to various high-tech industries in research and technology development. In policy she worked briefly in DG Research, European Commission. In her academic years she has received various academic scholarships and has numerous publications in peer reviewed journals. She holds a PhD in Engineering and Applied Mathematics from the University of London, UK and an MEng in Manufacturing Systems Engineering and Mechatronics, University of London, UK. Additionally, she has attended professional education in Law and International Management.

Norbert Glante

Norbert Glante has been Member of the European Parliament since 1994. Prior to his political career he has studied automation technology in Leipzig and worked as an electrical engineer. Furthermore he has ten years experience in design engineering and in computer science.

Norbert Glante joined politics in 1989 and became a member of the Social Democratic Party of Germany (SPD). From 1990 to 1994 he served as Chairman of Potsdam district council and was then nominated as SPD-candidate of Brandenburg for the European elections. Since 2000 he is Board member of the German delegation within the Socialist group in the European Parliament.

Being a member of the Committee on Industry, Research and Energy (ITRE) he deals

with space policy, energy and research topics. Beyond this technical approach he is member of the Delegation to the EU-Mexico Joint Parliamentary Committee and Vice President of the Delegation to the EU-Latin American Parliamentary Assembly (EUROLAT).

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Ingrid Godkin

Ingrid Godkin is Communication Officer for the EU satellite navigation programmes EGNOS and Galileo at the European Commission. Ingrid has held various positions in the EU institutions (European Commission and European Parliament) since 1994.

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Isabelle Maës is Communication Officer for the EU satellite navigation programmes EGNOS and Galileo at the European Commission. Prior to joining the Commission, Isabelle held various communication and marketing positions in the private sector, primarily at Procter & Gamble. Isabelle holds a Master in Business Administration from INSEAD, France and a university degree in Commercial Engineering from ICHEC, Belgium.

Gai Oren

Gai Oren has been working since 2004 in the Secretariat of the Committee on Industry, Research and Energy (ITRE Committee) of the European Parliament. During that time, he has been closely involved and in charge of diverse legislative proposals and policy frameworks in the field of industry, environmental protection, research, innovation and space. Some of the files include: European industrial policy, the future of manufacturing industry, automotive, nanotechnologies, SMEs, chemical legislation, CO2 emissions of cars, Emissions Trading Scheme, energy efficiency of buildings, the European Institute of Innovation and Technology and Galileo. Previously, he worked with the Ministry of Economic Affairs in the Netherlands, advising political decision-makers on economic and financial issues (fiscal policy, infrastructure, pensions and budgetary affairs) and drafting parliamentary interventions for the Ministers on economic issues such as innovation policy, entrepreneurship, and energy He is an economist by profession, holding a Master degree from the Erasmus University of Rotterdam.

Maria Pilar Milagro-Pérez

M. P. Milagro-Pérez works in the GMES Space Office of the European Space Agency, which is located at ESA/ESRIN in Frascati, Italy. Before, from 1999 to 2007 she was working for Radar Altimetry applications at ESRIN, verifying algorithms and validating products mainly for ESA's Envisat satellite. Through her work at ESA she earned a profound knowledge of the Earth Observation landscape in Europe, most notably the Global Monitoring for Environment and Security (GMES) initiative. M. P. Milagro-Pérez has a University degree in Physics from the University of Zaragoza, Spain, and a PhD in Plasma Physics from the University of Tor Vergata, Rome (Italy). He has more than 12 years of working experience in the domain of satellite Earth observation.

Vladimir Remek

Vladimír Remek, born in 1948 in České Budějovice, former Czechoslovakia. Former military pilot, 87th cosmonaut in the space, first Czech in the space and first non-soviet and non-american cosmonaut. Space flight 2.-10. March 1978, spaceship Sojuz 28 and space complex Saljut 6. Later on i.a. worked as a Director of Military Museum of Aviation and Astronautics in Prague and Czech diplomat in Moscow. Since 2004 he is a member of the Czech delegation within the Confederal Group of the European United Left - Nordic Green Left (GUE/NGL) in the European Parliament. He is a member of Committee on Budgets (BUDG) and substitute of the Committee on Industy, Reasearch and Energy (ITRE) as well as a member of Gallileo Inter-Institutional Panel. Beyond this technical approach he is a member of Delegation to the EU-Russia Parliamentary Cooperation Committee and Vice-president of Sky&Space Intergroup. In 2004 elected as the Member of European Parliament and re-elected again in 2009.

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First workshop panel with (from left): Jérôme Béquignon (ESA), Christina Giannopapa (ESPI), Petr Voldan (representing MEP Vladimir Remek), MEP Norbert Glante, Kai-Uwe Schrogl (ESPI), Gai Oren (Secretariat ITRE Committee), Gian Gherardo Calini (GSA), Josef Aschbacher (ESA), Marie Ménard-Caër (EC)

Second workshop panel with (from left): Jérôme Béquignon (ESA), Christina Giannopapa (ESPI), Petr Voldan (representing MEP Vladimir Remek), Henning Schuechner (representing MEP Norbert Glante), Kai-Uwe Schrogl (ESPI), Jean-Yves Roger (EC), Gilles Ollier (EC)

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