

An independent satellite navigation system for Europe

# Why we need Galileo



## GNSS and aviation

*Helicopters play a key role in today's rapid-response services, undertaking emergency transport and delivery operations in life or death situations. They are also crucial tools in the field of aerial firefighting.*

Through the hot summer months in the Catalanian Pyrenees, fires have been spreading. Firefighters have so far managed to keep them under control, but homes and businesses are now under threat.

Elio Salazar is a decorated pilot who flew missions in the first Gulf War. Today, he operates a private helicopter service, transporting important passengers and equipment, working on construction jobs, search and rescue operations, and fire-fighting missions.

Helicopters are especially useful in fighting wildfires in areas like the Pyrenees mountains, where terrain can make it difficult for ground-based crews to respond rapidly. Pilots must rely on satellite navigation technologies to locate fires and, crucially, to land at small airports and other sites for servicing, loading and refuelling.

Today, Elio is flying a large water-dropping helicopter in a bid to extinguish an area of burning scrub that is threatening a nearby village. As inhabitants are evacuated, the unthinkable happens. The GPS signal disappears. "I can't explain it," Elio tells his co-pilot. "We're going to have to land soon, but with the reduced visibility due to all this smoke and without our satnavs we'll never find that mobile refuelling station. We're going to have to abort the mission. I just hope those people on the ground can get out in time."

## Air transport needs GNSS

Many modern commercial aircraft are now equipped with GNSS units that feed location information into flight-management systems, a primary means of navigation during all stages of flight except the approach phase.

Since March 2011, the European EGNOS augmentation system is also enabling approach and landing operations in conditions of reduced visibility, thereby increasing safety and helping to avoid delays and cancellations.



## A critical moment for road transport

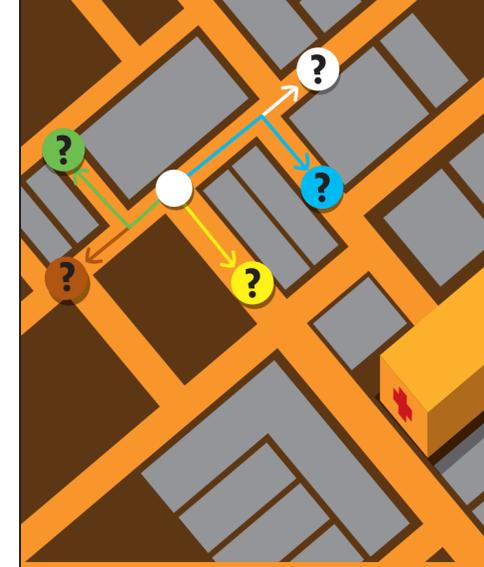
*On any given day in any number of European cities, road-based delivery services shuttle documents, parcels and even life-saving equipment and supplies between offices, emergency facilities and homes.*

For the past three months, Danny Leclercq has delivered medical supplies to local clinics in Brussels. Recently relocated from Lyon, in France, Danny is a competent driver but still needs help navigating the winding streets of the European capital.

Today, Danny is on an important mission: an emergency clinic has received a man suffering from anaphylactic shock due to a bee sting. The treating physician has discovered to his great surprise that his supply of epinephrine is exhausted. If the patient does not receive treatment soon he could die. The doctor considers calling an ambulance but knows the supply service Danny works for is not far away.

Danny grabs the medicine, types the clinic's address into his GPS device and gets under way. About halfway there, the unexpected happens – the GPS readout says 'no signal'. He retypes the address, then taps the receiver to see if it is working. He pulls out his cell phone and rings his dispatcher. "Where are you now?" she asks. "I'm not sure," he admits. "I was following my GPS' instructions."

Meanwhile, all around him, traffic is getting worse. What should he do?



## GNSS for road transport

Car navigation is currently the main GNSS application, with device sales having increased rapidly over the last four years: 76% per year worldwide, 55% in the EU.

Simultaneously, significant price erosion has taken place, especially for personal navigation devices, where the average price per device fell from over €600 to under €200 in five years.

In 2009, more than 30% of all road vehicles had GNSS receivers, and 80% will have them in ten years. Of course, many drivers still carry street maps or simply know where they are going, and many of them will assume they would not be affected if satellite navigation signals were cut off, but other drivers would be, and that would have an impact on everyone.

## Why do we need a European global satellite navigation programme?

*A lot of people would like to know why we are investing public money in the European satellite navigation programme Galileo, when we already have the Global Positioning System (GPS). One of the key reasons is precisely that Galileo is European.*

In the European Union, and around the world, satellite navigation applications are now numerous and varied and are playing key roles both in business and in the daily lives of citizens and communities.

The most recent available figures show that in 2009, 6-7% of EU GDP, or about €800 billion, depended either directly or indirectly on satellite navigation applications. Most EU citizens have some experience with such applications, especially in-car guidance. But our reliance on satellite navigation signals goes much farther. Applications affect local community services, such as the police and emergency services, and touch areas of the economy that most of us are unaware of.

The examples given in this brochure are part of the reason why I believe that the EU must have an independent satellite navigation infrastructure to guarantee the provision of services that have become so central to our economy and jobs and on which our quality of life, health and safety depend.

## GNSS for precision agriculture

*With the advent of satellite-based positioning systems, Europe has seen a revolution in the way farmers plant, map, sample, scout, measure and harvest crops. Combined with satellite and aerial imagery, satellite positioning is now the basis for a new wave of agricultural technology.*

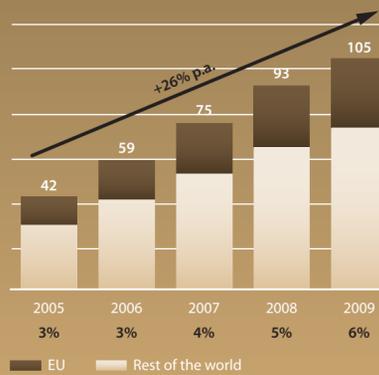
Marcel Imbert runs a 350-hectare farm north of Paris, 75 hectares of which he sows with wheat. Having grown up on a farm himself and now well into his sixth decade in the agriculture business, Marcel has seen a lot of changes, including the GPS-based revolution that has swept across the sector.

French farmers set specific goals for wheat production, realistic targets when the principles of precision agriculture are applied. But without satellite navigation aids, farmers can miss their targets by as much as 30%.

This year, Imbert has hit a major obstacle. The GPS signal he depends on has been suspended. When they work, GPS-based tools can automatically steer farm equipment, so operators do not have to hold a straight line manually. They can work longer while paying closer attention to crop conditions, their machines, and ground obstacles.

With the suspension of GPS, Imbert's combine harvester drivers have been forced to return to manual steering, an inefficient way to cover the vast area of his farm. Now, examining his books, Imbert realises profits are down.

## Shipments of GNSS devices in agriculture sector ('000 units)



## GNSS now prominent in agriculture

Within the last five years, the GNSS market in agriculture has grown – from 42 000 to 105 000 GNSS units shipped annually.

While high-technology devices, such as Real Time Kinematics (RTK) systems or commercial satellite augmentation services, will cost users about €12 000 to purchase, low-technology devices, i.e. standard GNSS receivers complemented by free augmentation services such as EGNOS, only cost around €1 800.

EU figures now estimate GNSS penetration in tractors will reach 33% in Europe by 2020, with EGNOS-based systems accounting for a significant part of them. Revenues from sales of GNSS devices in the sector are expected to hit almost €500 million worldwide by 2020.

## How secure is your security?

*From the beginning, the American GPS system has been aimed at providing a key strategic advantage to US and allied military troops on the battlefield. Today, the free GPS signal is also used around the world by security forces such as the police.*

Stieg Hansen is a retired military officer from Malmö now representing a large producer of security systems. Today, he is speaking to a group of people at an important trade show. Behind him, a bold sign reads 'GPS for Security'. His audience includes a number of stern men and women, and one person who looks like a journalist.

"The 'STRYKER', as we like to call it in the field, is the hand-held GPS receiver for domestic security." Brandishing a notebook-sized electronic device, he continues, "This little baby has all the hardware you will ever need to locate, mobilise and coordinate your security team, wherever they may be."

Someone in the audience calls out: "What if GPS gets cut off?" Hansen hesitates, does not look at the person asking the question, then continues: "Most European governments have placed restrictions on the sale and use of this little baby, due to the powerful electronics inside. Very robust, very difficult to jam."

"What if the little baby can't get GPS?"

"This little bab..." Hansen stops short before finishing the word. "This device's primary mission is to provide positioning support, velocity, navigation and timing to all land-based security operations, including police forces in pursuit of criminals or transporting dangerous prisoners, border guards in anti-smuggling operations and..."

"He's not answering the question," someone murmurs. Other members of the audience are now looking at each other. One person says to his neighbour, "That's right. What if GPS stops working?" Hansen takes a step backwards.

## Selling GNSS-based security and defence

GPS-based technologies have become increasingly prevalent tools for law enforcement, with important functions in solving crime and keeping citizens safe. But these tools can never be more reliable than the GPS signal itself. Today, a more robust and security-encrypted version of the GPS signal exists but it continues to be reserved for the US military and its allies.



This brochure is intended to serve as a reminder of just how important satellite navigation applications have become in the European Union. The stories are fictitious, the people in them are not real, but the descriptions of what would happen if satellite navigation signals were no longer available are very accurate. I hope that they will help you, the reader, to better understand the many ways in which satellite navigation applications affect our daily lives, and hence the strategic importance of the Galileo programme.

**Antonio Tajani**  
Vice-President Commissioner for Enterprise & Industry

For more information, please visit:  
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## GNSS for finance

*Every day, banks and other institutions are called upon to resolve disagreements over the value of financial transactions. When and in what order a transaction has taken place among thousands or millions of others can be critical factors in such disputes and, in the financial world, GPS is now the principle means of exact time determination.*

Barbara Vellas is a single mother of two young children, living and working in Finsbury Park, in the London suburbs. Today, she is on her way to pick up her kids from school. "There's no milk at home", she remembers, "and we could do with some bread." She stops at a cash terminal to withdraw a few pounds. The machine indicates that the transaction has been carried out successfully but the cash does not come out.

Somewhat annoyed, Barbara walks on a few blocks to find her bank's local branch office. At another machine, she prints out her bank statements which show that her account has been debited for the withdrawal. "That was fast," she thinks, "but it's not right." So she walks over to the counter and explains to the young man behind the window what has happened.

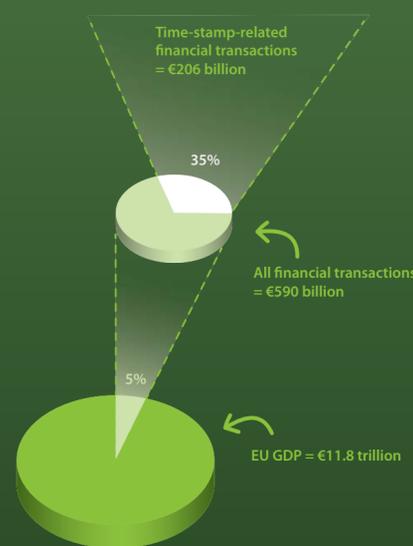
"Oh", he says, "that is a problem. We're very sorry. You see, GPS was cut off just this morning and it's not been restored. So I'm afraid we cannot authenticate your transaction at this time."

"GPS?" replies Barbara, surprised. "Isn't that something for your car? But I don't even have a car. And what does that have to do with my money?" "More than you might think," says the young man. "And you're not the only one affected. This may take some time to explain. I'd better let you speak to my supervisor."

## Time is most definitely money

Millions of terminals at financial institutions around the world, from banks to mortgage brokers to insurance companies, are linked together in a rush of transactions, including even the smallest withdrawals by people going about their daily business. How much of this depends on GPS? In 2009, the banking and financial industry accounted for about 5% of EU GDP. Of this, 35% was related to financial transactions that require time stamping, representing a total value of about €206 billion.

### GPS time-stamping and EU GDP



## Maritime navigation – with satellites for stars

*For thousands of years, man navigated the seas using only the stars and the sun or by staying within sight of land. Nowadays, satellite navigation technologies guide seagoing vessels, large and small, through even the trickiest of passages.*

Janez Omerzel grew up in Piran in Slovenia. With its small fishing port and ancient ramparts, his home town inspired him from an early age with a passion for adventure and a desire to take to the sea. And that he did. Having worked his way up through the merchant marine, Janez is now chief navigator of a large oil tanker, *Miranda*, navigating waters along the Atlantic and northern sea coasts of Europe.

Today, *Miranda* is in the Baltic, near the island of Vormsi in Estonia. The morning is foggy, but the ship is equipped with the latest GPS technologies to aid manoeuvring in close quarters. GPS antennae enable precise determination of vessel orientation, heading and direction, and allow specification of position to within a few metres.

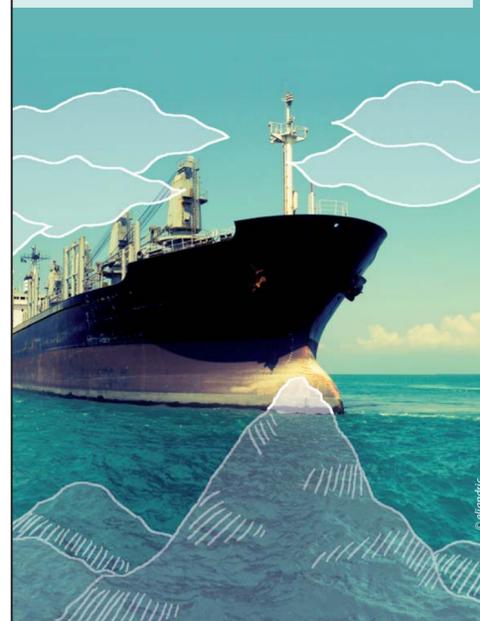
Suddenly, an alarm sounds. "What the devil is that?" shouts the ship's captain. "GPS failure," Janez responds. Checking his read-out, he continues, "This is unusual; there is simply no signal."

"Back-up systems?" the captain barks. "Negative, sir. GPS is gone. It's just gone." Another alarm sounds. "Right," says the captain, "switch to radar, get on the radio, and get someone out there on the foredeck who can see where we're going!" Just then, crew members feel a hard jolt and are thrown forward. A loud screeching, like grating metal, resonates from the lower decks of the ship.

"We've hit something," cries Janez.

## Sea vessels out on a limb?

Specialised products are now available for both the maritime industry and recreational navigators. Some hand-held units are priced at less than €150, while fixed-mount devices called chart-plotters feature more functions, larger displays and prices beginning in the €650 range. GPS units combined with other marine electronics, i.e. fish-finders, radar, etc., can cost more than €3 000. But none of these will help you find your way if the GPS signal is cut off.



## GNSS and telecomms – no digital without timing

*When you say 'GPS', most people think of satellite signals for positioning and navigation, but GPS has a lesser-known and perhaps even more important function in the world of telecommunications.*

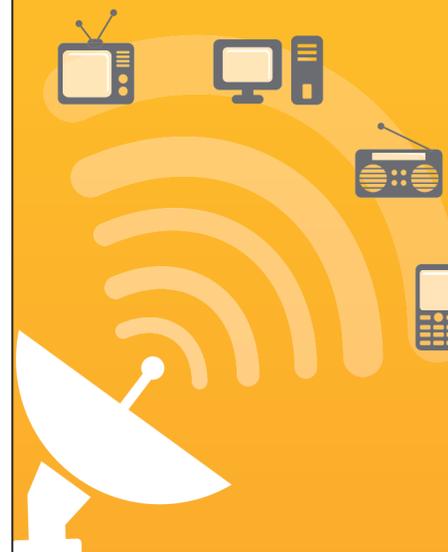
In digital telecomms, precise and stable synchronisation of transmitted signals is a sine qua non. Atomic clocks could do the job – they are extremely accurate – but they are also extremely expensive. Meanwhile, the equally accurate time signal generated by GNSS satellites is free of charge.

None of this is at the forefront of Rastislav Hviezdoslav's mind as he surfs the internet over morning coffee in his home town of Bratislava. And GPS is the farthest thing from his mind when his favourite news website suddenly freezes. He tries another page but the internet is down.

"Curses," he mutters. "I'll turn on the TV then." But, pressing the 'on' button on his television's remote control, he is greeted by a blank screen. "Right, no TV either. Never mind. Maybe I'll try the radio." He hesitates. "Then again, no, maybe I won't try the radio. I don't need to know what's happening in the world. But I do need to call Livia to confirm our lunch date." He smiles.

He picks up his cell phone and punches in his girlfriend's number. His smile turns to a frown. "What?" he cringes. "No network available? What on earth is going on today?"

Little does Rastislav know, the answer to his question is quite simple. The GPS-generated time signal used by the Synchronous Digital Hierarchy (SDH) network has been cut off. SDH is the overarching network used in Europe for high-speed telecommunications, providing support for all optical and electrical networks, including GSM, broadband internet, and digital television and radio broadcasting.



### Measuring the extent

GNSS supports applications for road, air and maritime navigation or industrial and agricultural positioning, but the accurate time signal generated by GPS satellites is also indispensable for all of today's digital electronic communications, as well as banking systems, pay terminals and cash dispensers, security systems, and much more. The full impact of a sudden loss of the GPS time signal is really quite difficult, and a bit frightening, to imagine.

## Power to the cities

*Systems that monitor and control electrical power networks require precise timing, especially where network reliability is important. GPS is now widely used to provide this crucial time reference in many European cities, ensuring synchronisation even across great distances.*

Eugene Boros manages a jewellery shop on the Károly Korút in Budapest. Mariska Pataki is his young assistant. They are standing near the shop's front door, looking nervous.

At about 3:30 in the afternoon, all electrical power had gone off – lights, clocks, surveillance cameras and the shop's state-of-the-art alarm system. There has been an unexplained malfunction at the municipal power plant and the entire city has been left in the dark. The problem was caused when the GPS synchronisation signal was cut off. But Eugene does not know much about this.

All the traffic lights are off. Cars, buses, even trams have come to a halt. Drivers and passengers are frustrated and confused. Rushed pedestrians are pushing and shoving on the pavement. Luckily, Eugene thinks, this has happened during daylight hours. At least we have some light coming in through the windows.

"The lights will be back on in a minute," he had said to Mariska when the power had gone off. "These things don't last very long, you know." But the lights have been off for two hours now and the sun is sinking low over the castle on the hill. It is getting darker. Other shopkeepers are standing nervously on the pavement in front of their stores.

Suddenly, there is a sound of shattering glass. Several young men are seen running down the street. Some of them appear to be clutching objects. "Keep your head, Mari," says Eugene. One of the boys in the street shouts, "Hey, look, there's some nice stuff in there!"

Eugene shuts the door and locks it. "It's so dark in here," says Mariska. "Go home now, Mari. Go out the back way," urges Eugene. "I'll stay on a bit longer. Without power, the alarm system won't work, and I can't get the shutters down to protect the front windows either. So I'll just wait here for a while."

### Confidence or vulnerability?

Accurate synchronisation devices for power networks have long been available, but they are expensive. GPS timing signals make it possible to maintain accurate timing at low costs. While few doubt their utility, no one can say what would happen if the GPS signal were to be lost.



## Keeping transport fleets up and running

*GNSS-based technologies have revolutionised the way transport companies track, trace and direct numbers of vehicles, allowing for more efficient and streamlined services. But total reliance on GPS could be a double-edged sword.*

Danny Theodoros manages a family-owned taxi company in central Athens. Founded in the 1950s by his grandfather, the Friendly Cab company, which once numbered just three vehicles, one of which had only three wheels, now comprises 33 cars and three mini-vans.

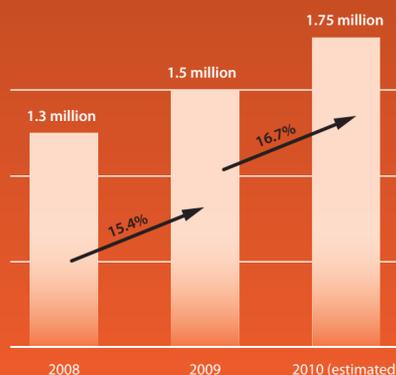
Two years ago, after long consideration, he and his management team decided to take the plunge and replace the radio-based communication system his father had set up when he was boss.

Sitting in a café, sipping strong coffee with an old friend, Danny explains, "In the old days, we used radio to talk to our drivers. When a customer called needing a car, we would call our drivers by radio, all of them at the same time. Anyone near the customer could answer and we would assign the job. It was a perfectly good system for the 1970s, but we started to think a GPS-based solution would be more efficient."

And it was. With GPS units in each car, Danny could see where his drivers were, plotted on a city map. "That made the work of dispatching about a hundred times easier, and we were even able to hire some new drivers."

"I sure wish we had that old radio equipment back now," he says. "Now that the GPS signal has been cut off, I've had to lay off those new drivers. I hated doing it, but we just cannot manage the dispatching of that many cars without GPS. Now we are feeling it; last month my turnover was down by 20% compared to the year before, and that's not to mention the trouble our customers are having getting a taxi. I guess all those business people got used to calling us at the last minute."

### GNSS-based fleet management systems deployed in commercial fleets in Europe



### Not slowing down

In 2009, the number of vehicles equipped with fleet-management and vehicle-tracking systems was 6 million in North America and roughly 5 million in the EU. A recent market report by industry analyst RNCOS forecasts total sales of GPS-based telematics and fleet-management devices to grow three-fold from €7 billion in 2009 to €20 billion in 2015. In addition to vehicles, freight containers are increasingly being equipped with GNSS-enabled devices.

