Optimistic Outlook for Galileo

This month we bring you an extended interview with engineer Pedro Pedreira, executive director of the European Global Navigation Satellite System Supervisory Authority (GSA)since July 2005, the body charged with managing the development phase of the much-troubled European Satellite navigation system Galileo. Our wide-ranging discussion with Pedreira appears on these pages accompanied by detailed background information (boxed text). Despite the spiralling costs of Galileo, its anticipated economic benefits, in terms of revenue, employment and expanding markets, are many. Galileo is being funded by the EU taxpayer, so it is important that these benefits be realised.

Please introduce yourself and tell our readers a little about your career and how you came to be appointed head of the European Global Navigation Satellite System (GNSS) Supervisory Authority (GSA).

My background is mostly in telecommunications. I worked for eleven years in satellite communications at Eutelsat (Paris), and that was my first contact with the space industry. When in 2004 I came across the vacancy for executive director of the newly created European agency entrusted with the management of the European GNSS programmes (Galileo and EGNOS), I was attracted by the great challenges of Galileo, the first EU infrastructure, and a pioneering project in many aspects. I had also followed the EGNOS programme since its conception. I decided to apply, and after a competitive selection process was appointed by the GSA Administrative Board.

Who are the main stakeholders in Galileo?

The new legal framework has also introduced new governance for the deployment phase, which assigns to the European Commission the role of programme manager. The European Space Agency is the procurement agent on behalf of the European Commission, and design authority. The GSA is in charge of security accreditation of the system, operation of the security centre, preparation for commercialisation of services and other tasks delegated by the European Commission, e.g. management of the R&Dprogrammes. The Council is the top decision-making institution and the European Parliament, in its role of budgetary authority (with the Council), oversees management of the programme.

You have been executive director of the GSA for almost four years. What are the crucial steps to be taken and obstacles negotiated on the way to full implementation of the Galileo programme?

The Galileo programme suffered a setback in 2007 with the premature termination of negotiations on a concession contract which aimed at the deployment and operation of the system under a public-private partnership. The European Parliament and Council then decided to deploy the system under public procurement, fully funded by the Community budget, and the respective legal basis was consolidated in July 2008. The new procurement process is now underway, and contracts expected to be concluded in 2009, with full operational capability of the system expected in 2013. In the meantime, 2010 will see a start to launching the four satellites built in the development phase. Initial operational capability, with about eighteen satellites in orbit, is planned for 2012.

In what ways do you think the present global economic crisis may affect the programme?
It is not expected that the current economic crisis will directly affect the deployment of Galileo, as funds necessary for the procurement (EUR3,405 million) have been earmarked in the Community budget for the period until 2013. In fact, the investment in Galileo is also one of the public stimuli to recovery of the economy.

However, the current capital squeeze may affect the development of new applications, in particular by small and medium-sized enterprises, which is very important in order for Europe to reap the full benefits of Galileo. The GSA recently launched a new call for proposals for the 7thFramework Programme of Research and Development on satellite navigation, with a budget of EUR40 million, to continue stimulating innovation. A new call will be put out next year.

What are the functions of the Geostationary Navigation Overlay Service (EGNOS) and Galileo in Orbit Validation Element (GIOVE), and what are they expected to yield?
EGNOS is a satellite-based augmentation system that improves the accuracy of positions derived from GPS signals. A special feature of EGNOS is the provision of information on the instantaneous reliability of GPS signals (integrity), which is of utmost importance for safety-of-life applications such as air navigation. EGNOS, a regional system mainly covering European air space, will become fully operational in April 2009 and certified for air navigation by early 2010. Certification for maritime and other safety-critical applications will follow. EGNOS will pave the way for Galileo services.

GIOVE satellites A and B were launched in 2005 and 2008, respectively, with the purpose of securing the Galileo frequencies through early broadcasting of Galileo signals and testing in space new technology developed for it; for example, atomic clock, and signal generator.

Will the system be freely available, as is still the case with GPS?
Galileo was designed to provide five services with differing signals. One is called ?Open Service?, and is fully interoperable with the civil signals of GPS using the same receivers; it will be provided free of charge. There will also be a premium ?Commercial Service?,

addressing the specific needs of high-precision professional applications. ?Safety of Life?, mainly for aviation, maritime, road and railways applications, and ?Search and Rescue? are the other two global services to be provided on a non-discriminatory basis. Finally, the ?Public Regulated Service? is reserved for government applications, under conditions of access to be defined by the Council.

Once the programme is implemented, how will Galileo integrate with already existing GNSS systems? Has the GSA established agreements with other agencies checking them, for example, the US National Oceanographic and Atmospheric Administration?
There is close co-ordination between Galileo and GPS, since a specific EU/US agreement was established in 2004. Co-ordination has also been initiated with GLONASS and COMPASS.

Galileo will provide a worldwide service compatible with requirements defined by the International Maritime Organization (IMO) for future navigation systems for oceanic, coastal, harbour-entrance and approach operations. Galileo will contribute to the IMO World Wide Radio-Navigation Service (WWRNS).The level of performance expected from Galileo has been standardised and adopted by the IMO. Maritime user receivers can be designed to combine the signals coming from Galileo and GPS. For highly demanding operations authorities may continue to provide local differential GNSS services.

Marine navigation is already by display of position provided by the US GPS or Russian GLONASS on an electronic chart. How will Galileo enhance the accuracy of positional information?
Galileo will provide single-digit, horizontal accuracy as opposed to the current GPS double-digit accuracy. It will also give better vertical accuracy, important for aircraft operations. The better accuracy stems from use of multiple frequencies and advanced signal modulations.

In addition to improved accuracy, Galileo will provide information on the integrity of signals in space; their reliability will be continuously monitored and warnings broadcast in case of a failure being detected that may affect positioning performance. This information will be especially valuable for safety-critical navigation in the air, on land or at sea, as users will always know the level of uncertainty affecting its positioning.

The high-accuracy and innovative return-communication channel, which may provide a rescue worker with acknowledgement of a distress call and other information, will make Galileo?s Search and Rescue Service another major improvement in terms of safety at sea.

As an aid to hydrographic survey, what are the horizontal and vertical positioning accuracies obtainable from Galileo?
The Galileo Commercial Service will provide high-precision positioning at sub-metre level. This will greatly improve geodetic and hydrographic surveys.

It is said Galileo will provide thousands of new jobs. Can you give us some examples? What education qualifications will be required for these posts?
Galileo will produce significant external positive effects, including socio-economic benefits such as job creation. New jobs will be created not only in the space industry but also, and to a much larger extent, in downstream industries that will develop new applications and services based on, or incorporating, satellite navigation. Galileo will generate a large, incremental economic effect on current satellite-navigation business in Europe and will give an edge to the European high-tech industry. Technical and scientific education in satellite navigation is an important lever to further push forward the frontiers of this promising technology.

Europe's GNSS

Europe's global navigation satellite system (GNSS) Galileo will complement and rival the US Global Positioning System (GPS) and the Russian GLONASS. From a network of thirty satellites and several ground-stations, Galileo will provide users with a highly accurate positioning service.

Other Systems

China has launched a satellite with satellite navigation capability, COMPASS, or Beidou 2. There is very little information in the public domain concerning the signal and data structures of this system; no Interface Control Document (ICD) has been published. However, various organisations have managed to decode the signals and successfully track the satellite. Another system, due for launch in 2009, is the Japanese regional Quasi-Zenith Satellite System (QZSS), designed to work with GPS and always with one of its three satellite vehicles available at an elevation angle of 60? over Japan. The Indian Regional Navigation Satellite System (IRNSS) provides regional coverage for India and consists of three geostationary and four orbiting satellite vehicles, with system completion expected in 2011/2012.

Galileo Services

The Galileo positioning information, based on precision timing, will be used in many areas, such as transport (vehicle location, route finding), social services (assistance for the elderly or disabled), the judicial system and customs (location of suspects, border controls), the public sector (GIS), leisure (at sea or in the hills) and navigation. Table 1 lists the projected range of navigation and search-and-rescue services.

Funding crisis

In our March 2006GIM Internationalinterview with Owen M. Goodman, chief operating officer at Fugro NV, he forecast that Galileo was heading towards a funding crisis. Galileo was originally planned as a public?private partnership (PPP). In 2006 it was intended that private companies and the EC/European Space Agency (ESA) would jointly contribute two-thirds and one-third of the cost, respectively, towards

the estimated EUR2.4 billion overheads for the deployment phase. However, in early 2007 the consortium of eight leading aerospace and telecom companies, known as the European Satellite Navigation Industries, formally abandoned the project. The consortium could not reach agreement on issues such as the allocation of lucrative contracts, and the EU took control.

Lack of public funds then led to a period of great uncertainty for Galileo. Although the original aim had been to have the system operational by 2008, by 2007 only one test satellite was in orbit and just four of the thirty in the projected constellation had been ordered. The EC now proposed it fund 100% of the project using public money, leaving private companies to run the system. The EC funding was to come from its surplus agriculture and administration budgets for 2007 and 2008, leading to the project being referred to as the ?Common Agricultural Policy of the Sky?.

The project was finally approved by the 27 EU transport ministers in November 2007. Spare funding from agriculture was used to finance the system, and it was given a new completion date of 2013. However, the increasing costs of Galileo mean it now has many detractors. Many members of the EU believe the funding should have been diverted towards improving current transport systems. Supporters of Galileo point out that the projected commercial benefits of the system will continue to outweigh spiralling costs.

EGNOS

The first three services listed in Table 1 are already being provided by the European Geostationary Navigation Overlay Service (EGNOS), the essential first step in the development of Galileo. Consisting of three geostationary satellites and a network of ground-stations, EGNOS augments the existing GPS and GLONASS systems. EGNOS sends information on the reliability and accuracy of GPS and GLONASS to receivers in Europe, readying them for safety-critical applications.

GIOVE

Signal transmission and reception testing began in 2005 with the first of the GIOVE (Galileo In-Orbit Validation Element) series. GIOVE satellites transmit signals in the frequencies that will be used by the future Galileo satellites, and cannot be used for navigation. GIOVE-A (Figures 2 and 5) is still operating today, although it was only expected to have a lifetime of 27 months. The second test satellite, GIOVE-B (Figure 3), was launched in April 2008 from Kazakhstan and is said to be working well. Included in its payload was the very first maser atomic clock to be flown.

A tender process was put out in July 2008 for the six proposed areas of work: system support, ground-mission segment, ground-control segment, space segments (satellite), launch services and operations. No single company is allowed to win contracts in more than two areas. Of the 21 industrial groups originally expressing an interest in competing for contracts, a shortlist of eleven was drawn up in September 2008. It is anticipated that all contracts will be in place by mid-2009. The four in-orbit validation satellites are under construction and the first is expected to be put into orbit in 2010. Two ground-control centres are currently being built.

Interoperability

Interoperability refers to the ability to use any combination of the three networks, Galileo, GPS and GLONASS, in order to obtain an enhanced service. In July 2007 the EU and USA signed an interoperability agreement under which they approved design for a common civil signal. Incorporation of the multiplexed binary offset carrier (MBOC) frequency means future users will be able to obtain signals from either, using a single handset. Similarly, discussions are underway between the Russian Federal Space Agency and the EU to ensure a degree of interoperability between GLONASS and Galileo. The ability to receive signals from more than one GNSS can only mean improved continuity and accuracy.

?Main Differences?
?Integration of different GNSS helps prevent reliance on just one system and provides more opportunity for a more robust positioning system. The main difference between GPS and GLONASS is the frequency of transmission; GLONASS uses ?frequency division multiple access? to uniquely identify each satellite, while GPS broadcasts at two frequencies using different codes for each satellite.

Pros and Cons

The advantages brought by changes in satellite navigation involve better availability due to an increased number of satellites and signals. Multiple signals at different frequencies should also help make the solution more resilient to interference. There is also the potential to use each system independently or in a combined solution. The disadvantage is that it is perceived to be a (cheap) consumer technology.

Galileo Projections

In January this year a progress conference, 'Growing Galileo', was attended by policy-makers, researchers and industrial partners in Brussels. Presentations were made on programme status and key GNSS market predictions and climate. According to the European GNSS Supervisory Authority (GSA), Galileo and EGNOS mean a huge increase in business for both downstream (i.e. device manufacturers and service providers) and upstream (i.e. satellite construction and telecommunications) industries. By examining potential user needs, a ?limitless? range of services, applications and business opportunities can be defined.

Galileo will contribute to industries such as location-based services (LBS, see feature on page 35), road, rail, aviation and maritime. Despite the current economic crisis, it is anticipated that Galileo will benefit the economy to the tune of about EUR60 billion by 2030 (Figure 4). According to business consultants LEK, around 30% of the population will be using navigation and emergency services by 2020, implying a total of three billion handsets on the market. The proportion of vehicles with in-built navigation devices is predicted to be 50% by 2020. It is estimated that from 2015 all new commercial aircraft will be fitted with a dual GPS/Galileo receiver.

Promising Future

The improved accuracy and integrity of Galileo is expected to encourage a flood of new applications in key downstream markets. It is thought LBS and road GNSS will demonstrate huge increases in revenue, and many other market opportunities arise in other transport industries. As well as providing thousands of jobs, Galileo is projected to increase competitiveness within European industry. Despite its troubled financial history and the current economic climate, the future appears extremely promising for Galileo. It is hoped that answers will soon emerge to the question of whether projected economic benefits will actually outweigh the growing costs of deployment.

Growing Galileo

The GNSS Research and Applications Centre of Excellence (GRACE), based at the University of Nottingham (UK), hosted ?Growing Galileo? 30thJanuary 2009. The event focused on access to new funding from the European GNSS (Global Navigation Satellite Systems) Supervisory Authority (GSA) for collaborative Research and Development projects under the European Framework 7 Programme (FP7). Held just 48 hours after the official European ?Growing Galileo? event in Brussels, the day gave delegates valuable insights into how to apply for European funding for GNSS research and development. With EUR40 million available, a 60% increase on previous funding levels, the delegates learned a great deal to their advantage. One key message was that small and medium-sized enterprises (SMEs) should be encouraged to apply, as over 40% of development funds were awarded to SMEs in the first tranche.
