RESPONSE TO THE HOUSE OF COMMONS TRANSPORT SELECT COMMITTEE

INQUIRY INTO GALILEO

Memorandum submitted by
The Royal Academy of Engineering

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Executive Summary

The Royal Academy of Engineering is pleased to submit evidence to the House of Commons Transport Committee's Inquiry into the Galileo satellite system. The Academy has a number of Fellows with direct experience of the Galileo project and many with broader experience of the space industry. This response draws upon their knowledge in answering the Committee's questions; however, the Fellows have felt unable to comment on the area of security raised in two of the Committee's questions. Questions on such security issues could probably only be adequately addressed by representatives from the MoD or DSTL.

The Galileo satellite navigation system currently under development has similarities with other satellite navigation systems such as GPS (Global Positioning System) and GLONASS (Global Navigation Satellite System) but also has a number of important differences, particularly in that it is a civilian owned and operated system, and in the types of services that will be offered.

The standard GPS signal is not offered with any full-time performance guarantee and therefore is not considered suitable for fail-safe "safety of life" applications. However, there are currently two systems available in Europe which provide a degree of enhancement to the GPS system. Differential GPS (dGPS) monitors the error in the GPS signal from ground stations at known positions and then broadcasts an error correction signal to nearby receivers. A free dGPS service is operated by the General Lighthouse Authorities for navigation around UK waters. EGNOS (European Geostationary Navigation Overlay System), a collaboration between the European Commission (EC), the European Space Agency (ESA) and Eurocontrol, the air navigation safety organisation, provides an enhancement of the GPS system using three geostationary satellites and a network of ground stations to provide a wide area differential GPS service and integrity monitoring service.

The Academy sees merit in a European owned and controlled non-military satellite navigation system that offers users a guaranteed level of service. It also seems likely that additional services offered by the Galileo system will be of great benefit to European industries especially in the transport sector with a number of UK companies standing to benefit from developing those applications. Galileo's interoperability with the existing GPS system is a major advantage.

(a) What benefits will Galileo Phase II bring that EGNOS (European Geostationary Navigation Overlay System) will not?

GPS is an independent global satellite positioning system, with many military and civilian applications. However, it exhibits several drawbacks, especially when used for civilian applications. These include low availability/coverage in environments with an obstructed view of the open skies, such as high rise urban canyons (a problem that Galileo will alleviate), no system integrity (i.e. inability to inform users when the system is not reliable) and, of course, the joint military-civil ownership of the system, which does not allow it to offer guarantees of service performance. These are essential not only for safety-critical transport, but also for many government and commercial applications.

EGNOS, one of several regional augmentation systems to GPS, does mitigate some of the drawbacks of GPS. Through the continuous monitoring of the GPS satellite signals, it can generate and broadcast corrections, which improve navigation accuracies, and information about the current system integrity of GPS. It also improves availability/coverage marginally, acting as 'extra' (2 or 3) satellites in the visible sky.

EGNOS demonstrators showed that it was possible to use very effectively, and with high accuracy, the existing and proven GPS system with a group of European based integrity and quality monitoring stations. If the argument were limited to whether Galileo would provide a better or more accurate navigation system alone, then it would be unclear as to why Galileo is required when it has been proven over many years that GPS with EGNOS is available, robust, reliable and accurate.

However, EGNOS cannot operate on its own as a global satellite navigation and positioning system. This is not the case of Galileo which, like GPS, has been designed from the beginning as an independent global satellite navigation and positioning system, but for civilian use and controlled by the EU. As a result, it does not suffer from some of the drawbacks of GPS. Moreover, it is proposed that Galileo will offer several types of service. These include the free Open Service (OS) similar to that offered by GPS at present, the Safety of Life (SoL) service, the enhanced Commercial Service (CS), the Public Regulated Service (PRS), and Search and Rescue (SAR) service. Last, but not least, Galileo has been designed to be compatible and interoperable with GPS. The resulting combined Global Navigation Satellite System (GNSS) will overcome several of the drawbacks of GPS, offering a significantly better availability/coverage in environments with an obstructed view of the open skies, a significantly higher level of system integrity, and considerably improved navigation and positioning services, than those offered by GPS augmented with EGNOS and the other regional augmentation systems. The new GNSS will also generate many more new applications, including several so far unforeseen ones.

The Academy believes that Galileo will therefore not only bring many commercial and industrial benefits to EU businesses and governments, but also help countries in other regions of the World (some of which are already participating in the Galileo Project). Ordinary citizens will also reap benefits through the development of many applications of significant benefit to society.

(b) How important is it for the EU to be independent of the US Global Positioning System (GPS) and the Russian Global Navigation Satellite System (GLONASS)?

Both GPS and GLONASS were originally designed, operated and controlled as military systems. GPS has since evolved to become a dual military-civilian facility, with hundreds of scientific, commercial and industrial applications. GLONASS, on the other hand, has declined over the years due to lack of funding, leaving GPS as the only fully operational global satellite navigation system. The arrival of Galileo will bring two distinct advantages to GNSS users, both in the EU and elsewhere.

Firstly, GPS and Galileo, as two compatible but independent systems, will reduce the economic risks of relying on a single global satellite navigation system. Even a short outage of GPS, due to malfunction, or deliberately for test purposes, or even as a result of a premeditated attack on its infrastructure, could cause significant disruption. This would affect many commercial, government and private system users relying on GPS for navigation and positioning, with inevitable safety-of-life and financial consequences. This is important not only for EU member states, but also for the US and the rest of the world. The recently signed agreement between the US and the EU, on the interoperability of GPS and Galileo, implicitly recognises that these two systems can act as back ups for one another, in case of major system failures.

Secondly, GPS and Galileo operating together, and thus offering a much larger number of satellite signals, will lead to a more accurate and dependable global satellite navigation and positioning system for many current and new applications. Furthermore, the civilian design, operation and control of Galileo, together with the public-private-partnership approach, will create additional incentives for new market driven applications, products and services. The potential of two independently operated, yet compatible and interoperable satellite navigation systems has been recognised not just by industry and commerce in the EU, but also in the US and several other countries. These include India, Israel, China, Brazil and Mexico, who have expressed the wish to become involved in the Galileo Programme.

(c) What are the potential benefits of the Public Regulated Service (PRS) system? Is it realistic to expect that Member States will not want to cross-subsidise PRS from commercial services?

Not much information exists in the public domain on the Public Regulated Service (PRS), other than what is available on the Galileo websites. This is partly due to the need to protect the evolving PRS system from potential future threats, but also because its precise mode of operation and target user communities have not been clearly defined yet. Nevertheless, although not specifically publicised, the recent classified US-EU agreement on the interoperability of GPS and Galileo[1] would have included an understanding allowing the projected PRS signal of Galileo to co-exist with the military precise signal of GPS.

Unlike the Open Service (OS) signal of Galileo, which will be freely available, the encrypted PRS signal will have features which will make it more resistant to jamming and interference and will remain available when the OS is deliberately denied locally or regionally. This is both to protect the PRS from threats, disruption and other subversive activities by hostile agencies or individuals, directed against national security, law enforcement, economic activity and emergency situations.

The precise method of funding the PRS service will not be decided until after the Concessionaire, who will be operating Galileo, has been decided upon at the next EU Transport Council meeting in December 2004. Possible funding methods could include, for example, each EU member state being given the option of contributing to the funding of PRS, should they plan to use it. Another option would be for the user agencies to pay the Concessionaire directly, not unlike satellite TV. A third option would be for the EC to pay the Concessionaire an availability fee for each Galileo service being made available. The final choice, which will have to be approved by the Transport Council, could well include elements of all these 3 options.

There are, however, numerous possibilities for cross funding which probably cannot be ruled out. The use of Galileo as a means for Member States to collect road tax or tolls could see the compulsory fit of devices to all road vehicles.

[1] "Done Deal" GPS World July 20th 2004

(f) What are the potential benefits of the programme to UK industry, and to UK users of Galileo, such as NATS?

Satellite navigation and positioning has a wide range of industrial, scientific and commercial applications, some of which are already visible in everyday life, most notably in car navigation. The arrival of Galileo and its interoperable usage with GPS will lead to a substantial increase in applications in all sectors, because of the resulting significant improvement in system integrity, accuracy and coverage.

UK industry is well placed to benefit from both the core Galileo development activities (including the space-based hardware), which will ultimately lead to the Galileo navigation signals, and the future industrial activities which will exploit these signals by providing commercial services and applications. Indeed, UK industrial companies are already leading the production of the first experimental satellite and its ground control, and are contributing substantially to the second prototype Galileo satellite. UK industrial companies are also expected to make major contributions to both the space and ground infrastructures of the main Galileo system. This is also the view of UKISC, the United Kingdom Industrial Space Committee.

Some negative impacts of Galileo have also been noted although these may be overcome in the fullness of time. In particular, Galileo is less efficient in terms of radio spectrum usage than the current GPS system requiring 122MHz compared to GPS's 71MHz[2] leading to potential interference with other systems including air traffic control radars.

UK companies will also lead in the exploitation activities which will accelerate when Galileo becomes operational. This is because of the expertise and experience traditionally associated with UK industry and business to generate revenue from new technical developments, as was the case with GPS and satellite communications. Indeed, UK companies are already key players in the two consortia short listed for the concession to operate Galileo. UK companies also have key roles in several of the EU Framework Programme's R&D activities directed towards the exploitation of Galileo over a wide range of professional and mass market applications, ranging from agriculture and surveying, to location-based-services.

The UK also has a longstanding tradition of university based research leading to the development of new scientific and commercial applications, as was clearly demonstrated with GPS, when it started life as a military utility. Moreover, in many cases, university research has also led to the formation of Small-to-Medium Enterprises (SMEs). This has happened over a wide range of technologies, including satellite navigation. This will repeat itself when Galileo comes on stream and provides existing and future SMEs with added incentives to develop new GNSS applications and business opportunities.

While the benefits in terms of jobs and work of investing in Galileo systems can clearly be seen, some of these benefits could be accrued from continued investment in the development of current GPS systems.

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[2] "Galileo Frequency and Signal Design", J-L Issler, G W Hein, J Godet, et al, GPS World, June 1st 2003

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