COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

State of progress of the Galileo programme

(COM(2002) 518 final)

(2002/C 248/02)

Explanatory memorandum

The Galileo satellite navigation programme is the first major programme to bring the European Union and the European Space Agency together. It aims to develop cutting-edge technology to enable a user equipped with a receiver to receive signals from several satellites and thus determine his exact position in time and space anywhere at any given moment. Galileo is based on a constellation of 30 satellites placed in a medium earth orbit (at an altitude of approximately 24,000 km) continuously covering the entire surface of the earth. The final component is the ground stations which manage the system.

Following the Council Decision of 26 March 2002, the Regulation setting up the Galileo Joint Undertaking was formally adopted on 21 May 2002 (1).

The purpose of the Galileo Joint Undertaking is to complete the development phase of the programme (2002-2005). Thereafter, in view of the many commercial spin-offs associated with the growing satellite navigation service markets in many areas, the programme will be managed during the deployment phase (2006-2007) and the commercial operation phase (after 2008) by a private entity. The Galileo Joint Undertaking will therefore issue a call for tenders in order to select the private consortium which will be awarded the concession for the deployment and operation of the system.

Four months after the historic decision of 26 March 2002, it seems appropriate to review the state of progress of the Galileo programme. The following five aspects will be discussed in turn:

— establishment of the Joint Undertaking,
— system security;
— definition of services and the frequency plan,
— reservation of frequencies,
— relations with third countries.

1. SETTING UP THE GALILEO JOINT UNDERTAKING

There have been delays in setting up the Galileo Joint Undertaking following problems within the European Space Agency in finalising the respective contributions of the participating States contained in the programme declaration relating to Galileo. Some Member States are, mainly for political reasons, claiming the status of the foremost contributor to the programme, difficult situation to deal with in the framework of the European Space Agency Convention. If no solution is found in the short term, the matter will have to be referred to the European Union. The Joint Undertaking must be set up as quickly as possible so that the plan for the call for tenders for the development phase can be approved. If no decision is taken on this, the industrial operators involved will have the greatest difficulties in keeping their teams of engineers working on the project.

When these problems have been overcome, the first meeting of the Administrative Board of the Joint Undertaking can be held, preceded by the meeting of the Supervisory Board in accordance with Article 3 of the Regulation. The Commission’s representative on the Administrative Board of the Joint Undertaking has been appointed (2). According to the statutes, the Administrative Board must decide the following at its first meeting:

— the rules of procedure of the Administrative Board,
— the Agreement between the Joint Undertaking and the European Space Agency, defining the relationship between the Agency and the Joint Undertaking in particular, the Joint Undertaking’s authority to supervise the execution of the programme by the European Space Agency,
— the financial regulations of the Joint Undertaking,
— the 2002 budget of the Joint Undertaking, including in particular the EU’s 2002 contribution to the Joint Undertaking (EUR 70 million + EUR 170 million),
— the appointment of the Director of the Joint Undertaking, based on a proposal from the Commission.


(2) Mr Ravasio, Honorary Director-General at the European Commission.
One urgent task facing the Joint Undertaking will be to draw up the terms of reference of the invitation to tender to be issued in order to initiate the process of selecting the future system operator, that is, the private entity which will manage the deployment and operation phases of the Galileo programme. The Commission will submit the results of the invitation to tender to the Council to enable the latter to have all the facts when deciding upon the concession holder. It will be a very important decision as it will also determine the EU budget allocations needed for the deployment and operation phases. Indeed, one of the criteria for the selection of the concession holder will be the financial contribution they can make to the programme, which will determine the respective contributions of the European Union and the private sector.

In order to draw up this invitation to tender, contacts must be stepped up with financial institutions of all kinds, such as the European Investment Bank, institutional investors, investment banks, insurance groups, etc., and with the major European groups providing services or supplying equipment. Many promotional events are planned for the next few months. They will be launched at the beginning of 2003, holding a major symposium on Galileo, bringing together the financial sectors, service providers, the main users of navigation and the manufacturers of space and ground station equipment, including manufacturers of receiving equipment. A call for expressions of interest in this event has already been published in the Official Journal of the European Communities.

2. SYSTEM SECURITY

Article 7 of Regulation (EC) No 876/2002 stipulates that a Security Board shall be established in order to deal with security matters regarding the Galileo system.

The Council did not set up this body at present. In the interests of efficiency, and in order to begin work on the fundamental questions at the earliest possible opportunity, the Commission has wasted no time in convening an initial meeting with the security experts of the Member States. It was an expert committee meeting chaired by the Commission on 8 May 2002, which was followed by other meetings on 25 June and 13 September 2002.

At the meetings, some Member States expressed the wish for these meetings to be chaired by a Member State representative, and even co-chaired by a Member State and the Commission, with the Commission fulfilling the role of Secretary. The Commission is of the opinion that, until the Security Board is in place, these expert meetings should continue operating in its present form.

The Commission considers that the missions of the Galileo Security Board are as follows:

— bring its expertise in the form of advice on technical characteristics of the system with regard to security (encryption, etc.),
— helping the Commission in its negotiations with third countries by bringing its expertise, in particular on the issue of sharing frequencies with the United States,
— helping to set up the future operational framework for security, responsible for the relationship in the event of a crisis to interrupt or restrict signal emissions, the definition of users to be authorised to own encrypted receivers, supervision of the compliance with international commitments on non-proliferation and export control, etc.

3. DEFINING SERVICES AND THE FREQUENCY PLAN

3.1. Definition of services

Work has been carried out for several years on defining the services and the frequency plan. The first version of the technical document defining Galileo’s mission and, hence, also the range of associated services, was produced at the beginning of 2001. It has been widely distributed and discussed, by both user groups and Member States, particularly at a meeting of the Member State representatives held in the European Space Agency in March 2001. The second version of the document, widely circulated in April 2001, was the result of this consultation.

Following the Council Decision of 26 March 2002, and developments in the technological concepts resulting from work carried out during the definition phase, a new version was produced (see summary in Annex 1) taking into account fresh consultations of large user groups for whom a number of forums were specifically organised in May and June 2002. The consolidated version of the technical document has just been forwarded to the Member States. It should help define:

— the list of services which Galileo should offer,
— service performance (quality),
— technical characteristics of services.

If the programme is to run smoothly, it is essential to make final decisions on these aspects by the end of 2002 since they will determine the technical specifications of the system (satellite design, ground station architecture, frequency plan, etc.) which must be identified before issuing the invitation to tender for the whole of the development phase (2002-2005). Making substantial amendments to these specifications would significantly increase the costs of this phase of the programme.
In addition, the services must be defined before progress can be made in international negotiations, particularly with regard to aspects of interoperability with the American GPS and Russian Glonass systems, and in order to define the specification for the future operator of the Galileo system. The industrial and financial groups interested in tendering for the operating concession must have the information in order to draw up their bid and their business plan. Lastly, European equipment manufacturers have to start designing their products as of today. Failing to define and make known the services will compromise the design of the receivers (with the sale and provision of associated services accounting for 85% of the market created by Galileo) and the development of the satellite navigation applications market.

Galileo will offer several service levels, from open access to restricted access of various levels:

— an open, free basic service, mainly involving applications for the general public and services of general interest. This service is comparable to that provided by civil GPS, which is free of cost for these applications, but with improved quality and reliability,

— a commercial service facilitating the development of professional applications and offering enhanced performance compared with the basic service, particularly in terms of service guarantee,

— a ‘vital’ service (Safety of Life Service) of a very high quality and integrity for safety-critical applications, such as aviation and shipping,

— a search and rescue service that will greatly improve existing relief and rescue services,

— a public regulated service (PRS), encrypted and resistant to jamming and interference, reserved principally for the public authorities responsible for civil protection, national security and law enforcement which demand a high level of continuity. It will enable secured applications to be developed in the European Union, and could prove in particular to be an important tool in improving the instruments used by the European Union to combat illegal exports and illegal immigration.

The real needs of future Galileo users need to be identified before the characteristics of the package of services can be decided. Studies have already been carried out in various standardisation institutes and international bodies, such as the International Civil Aviation Organisation, the International Maritime Organisation, etc.

The range of Galileo services is designed to meet practical objectives and expectations, from improving the coverage of open-access services in urban environments (to cover 95% of urban districts compared with the 50% currently covered by GPS alone) which will benefit the 160 million private vehicles in Europe, or enabling the use of satellite navigation applications ‘indoors’, in buildings and even in tunnels, or indeed mobile telephone services based on identifying the caller’s position.

The guarantees regarding the specific basic parameters of the services provided (precision, availability, etc.) will be of benefit not only to the insurance sector (tracking stolen vehicles, premiums adjusted to the actual movements of the vehicles, monitoring movements of goods, etc.), but also in high-tech sectors such as oil prospecting, precision crop management, freight management, etc.

The provision of an integrity message to determine the reliability of the satellite signal is also essential in the many sectors where a legal guarantee is required (service industries) and in cases where human life is at risk. For example, in some phases of flight, civil aviation demands that there be a delay of no more than six seconds between the detection of abnormal operation and the user’s receiving an appropriate warning signal.

The existence of a very low speed communication channel (in the order of 500 bits per second) can also be used to transmit commercial information from service centres to users. The detailed content of such information (distribution of encryption decoding keys, traffic information, routing of different users, etc.) may be determined by the future operator according to their business plan.

All services are directly accessible worldwide. However, local bodies may have to make some adaptations to specific environments or user communities (tunnels, airports, ports, etc.). In addition, the satellite infrastructure can be complemented by regional components, particularly for producing the integrity message.

It is worth emphasising that the services offered by Galileo will cover the whole planet, particularly areas at a geographical disadvantage and the outermost regions of the European Union.

3.2. The need for a public regulated service (PRS)

Satellite navigation enables a user to determine his position in time and space to an unprecedented degree of precision at very little cost, thus explaining why it is widely used in all sorts of areas. However, open signals are extremely sensitive to interference or to deliberate — potentially hostile — manipulation. The need for a PRS service is conditioned by the vulnerability of satellite navigation signals, the special features of the service and the very sensitive nature of the anticipated applications.
(i) The vulnerability of satellite navigation signals

A report commissioned by the American authorities (1) highlights the vulnerability of the entire US transport infrastructure, which is increasingly dependent on the American satellite radionavigation system, GPS, used both as an aid to navigation and as a tool to determine the precise position of vehicles within new improved surveillance systems and as a synchronisation reference for the majority of networks (energy, telecommunications, etc.). It concludes: 'The civil transportation sector, seeking the increased efficiency made possible by GPS, is developing a reliance on GPS that can lead to serious consequences if the service is disrupted, and the applications are not prepared with mitigating equipment and operational procedures.' In particular, the report recommends using interference suppression technology (special antennas and receivers). These recommendations were accepted by the United States Ministry of Transport.

In five years’ time, the European Union’s dependence on satellite radionavigation will be as far-reaching as in the United States. Disrupting or jamming the Galileo signal by the intelligent use of sources of interference in the hands of economic terrorists, criminals, hostile agents could prevent continuous signal reception over a wide geographical area, seriously impairing the efficiency of national security and police forces, or of economic activities, and even leading to the complete shutdown of services in some areas. This would seriously undermine user confidence in the system.

(ii) Special features of the Public Regulated Service

With its specific interference suppression technology, the PRS affords a degree of resistance to jamming not offered by other Galileo services. The PRS signal will therefore be transmitted on two frequencies, each occupying a wide bandwidth, providing a signal structure that is resistant to interference. In addition, the frequencies will be distinct from those of the open access services, and one of the PRS signals will be in a frequency band quite different from those used by the GPS and Glonass systems or other Galileo signals. These factors singularly complicate the job of a terrorist attempting to cause interference on all the signals. In addition, PRS signal code and data will be encrypted, ensuring protection against ‘intelligent’ interference. The use of encryption will enable the introduction of encryption technology and the means to control users since access will require a special key available only to authorised users.

The special optimised PRS signal receivers and antennas, and licences for their use, will be very strictly controlled. The introduction of interference suppression technology will give the European Union responsibility for controlling access to the technology in order to prevent criminal or hostile use against the interests of the Member States or their allies. Access to the PRS service will be controlled by means of encryption systems approved by the governments of the Member States. Crisis management plans to handle terrorist threats or the risks of conflict will be drawn up between the Member States in the context of the public supervision of Galileo and a structure will be set up at European Union level.

(iii) Planned applications

The public regulated service is designed to reduce the risk of government-authorised users losing access to a continuous signal in space and time in the event of threat or a crisis. There will be a limited number of authorised users. Application include, for example:

(a) Europe-wide:

— the European Police Office (Europol),

— the European Anti-fraud Office (OLAF),

— civil protection services, safety services (Maritime Safety Agency), and those emergency response services (peacekeeping forces, humanitarian response teams);

(b) in the Member States:

— law enforcement and security services,

— forces or services engaged in fighting crime,

— intelligence services responsible for national security,

— services responsible for controlling and supervising external borders.

By way of example, without the PRS service, the speedboat of a drugs trafficker equipped with a jamming device pursued by a customs vessel could, in poor weather conditions, prevent his pursuer ascertaining his position within a radius of more than 10 kilometres by means of satellite navigation, and could thus evade arrest. With a special PRS receiver and antenna, however, the customs official could counter this threat and ascertain his position in real time. If he were also equipped with a jamming device, he could stop the trafficker using satellite navigation positioning.

In conclusion, under European civilian control, the PRS will be a robust and resistant controlled-access service available to the EU Member States. It will enable them to promote European policies which require great confidence in the continued availability of the Galileo signal.

3.3. The problem of the overlay of signals

A number of signals and frequency bands are associated with the various services offered.

Considering the limited space in the frequency spectrum allocated to satellite navigation, the overlay of frequency bands used by GPS and Galileo is inevitable, particularly for secured signals. Such overlay complies with international regulations provided that there is no harmful interference to either of the two systems. However, the United States, who until now enjoyed a de facto monopoly of satellite radionavigation, are currently — for strategic reasons — opposed to overlay of one of the two PRS signals and one of the two military (or code M) GPS signals at a specific modulation in the high frequency band.

The selection of frequencies for Galileo's PRS signal is perfectly justifiable in technical terms, however, as this is the frequency spectrum which offers the best performance in peacetime, particularly in terms of resistance and robustness, the best cost/benefit ratio, and the best guarantee of continuity and integrity. These qualities are equally valuable in a crisis. The arguments put forward by the European Community are as follows:

— it has the know-how to operate a secured signal,
— it believes that the complementary operation of the GPS and Galileo systems must depend on mutual trust, and
— it has a prior claim on the right to use the signals.

Accordingly, the total overlay of one of the two PRS signals on one of the M code signals is not only possible but desirable, especially as:

— overlay is authorised by international regulations,
— the possible alternatives are less efficient and have not been technically validated.

In order to settle this difference of opinion with the United States, the Commission has in particular proposed an exchange of technical information to the American authorities. It has also stressed that, to that end, the Galileo Security Committee was a trustful interlocutor to discuss matters with the corresponding American security body (see point 5.1 below and Annex 2).

4. RESERVATION OF FREQUENCIES

The definition of services and the frequency plan presented below presuppose that Galileo has access to the frequency spectrum needed for the transmission of the corresponding signals. The World Radiocommunication Conference (WRC), under the aegis of the UN, is the international forum where over 150 countries negotiate the allocation of the frequencies available within a physically limited spectrum to different services. It is vital that the next WRC in June and July 2003 confirms the frequency plan already allocated to Galileo, as well as its characteristics. This conference will be prepared pursuant to the provisions of the Radio Spectrum Decision of the Council (1).

4.1. Rights gained at WRC-2000 in Istanbul

At the Istanbul World Radiocommunication Conference, a further frequency spectrum was allocated to satellite radionavigation services. No frequency spectrum was, however, allocated specifically to Galileo or to other radionavigation systems.

Following the Istanbul WRC, a number of countries applied to the International Telecommunication Union (ITU) to be allocated frequencies for different satellite navigation systems, particularly Galileo. Given the limited frequency spectrum available, the next WRC in 2003 must validate the coexistence of different systems within that spectrum. What is more, a large part of the frequency spectrum allocated to satellite radionavigation is already reserved as a priority to aeronautic radionavigation services (ARNS) (2). All new satellite navigation systems, including Galileo, must therefore demonstrate that they do not cause interference with these priority services.

4.2. Objectives for the next WRC

At WRC-2003 there will no longer be the need to seek access to the frequency spectrum for Galileo, unlike the situation at WRC-2000. What we must do, however, is ensure that the frequency spectrum allocated to satellite navigation affords the flexibility needed for Galileo to provide all the planned services. We must therefore ensure that the WRC ratifies the technical characteristics of the frequency spectrum to be used for Galileo services and their compatibility with other systems in terms of the acceptable level of interference.

The outcome of WRC-2003 will be crucial to the coordination of the various satellite radionavigation systems (Galileo, GPS, Glonass, the Chinese systems) within the allocated frequency spectrum.

We must therefore prevent countries such as the United States or the Russian Federation or organisations such as the International Civil Aviation Organisation (ICAO) imposing excessive restrictions on the frequency spectrum already allocated to Galileo.

(2) ARNS includes all the existing terrestrial navigation systems used for civil aviation.
Since all the issues of concern to Galileo at WRC-2003 are related to the frequency spectrum allocated as a priority to civil aviation, chiefly ground-based air navigation and radar guidance systems, it is of prime importance to reach agreement in advance with air navigation organisations, particularly the ICAO.

4.3. The strategy to be adopted to defend Galileo’s interests at WRC-2003

Preparations for WRC-2003 should focus on the following four priorities:

— final definition of the services and the frequency plan (see section 3 below) in order to complete the technical specifications for Galileo,

— ensuring consistency between the various EU policies on frequencies and between the various EU players,

— maintaining close relations with the main non-EU players involved in preparing WRC-2003 (CEPT, ITU, Eurocontrol, ICAO, etc.),

— enlisting the widest possible support for Galileo from third countries and world regions at the WRC. The necessary action should be taken on these priorities.

5. RELATIONS WITH THIRD COUNTRIES

5.1. The importance of international cooperation

Galileo is a worldwide system. International cooperation is essential if maximum advantage is to be gained from the Galileo programme. It should also help increase European know-how and reduce the technological and political risks of the programme. As well as assisting technical standardisation with existing systems, cooperation is essential for penetrating markets and developing ground-based equipment. It therefore also falls into line with the European Union’s objectives in terms of foreign policy, development cooperation, employment and the environment.

Since the Council Decision to launch the Galileo programme, a number of third countries have expressed a wish to be involved in the programme in some way. Moreover, the Commission regards the Galileo programme as being of world importance and, as such, of interest to all third countries.

In practical terms, cooperation with third countries means solving problems such as system supervision and security, technology transfer, intellectual property and control of exports. In opening up to third countries, the Community and its Member States will in particular adhere to the international commitments they have entered into on non-proliferation and export control, especially with regard to dual-use goods. In this context, consideration must be given to the differences in the application of export controls noted between the Community and some third countries that are members of international systems, particularly with regard to arrangements for monitoring intangible technology transfer, the extraterritorial aspects of some legislation, re-exporting conditions, etc.

(a) United States

The principal partner involved, the United States has displayed renewed interest in signing an agreement with the European Community. A successful initial negotiation meeting was held in Brussels on 21 and 22 June 2002. The next meeting is planned for October. The aim is to reach a cooperation agreement with the United States by the end of 2003, outlining the principles of interoperability and governing the commercial questions related to the use of Galileo and GPS.

With regard to the commercial issues, the United States have acknowledged that satellite radionavigation (equipment and services) is covered by the multilateral commercial rules issued by the World Trade Organisation. It should however be examined whether some loopholes (goods or services) would require introducing a special clause in the future bilateral agreement presently under negotiation.

A great step forward was also achieved in terms of interoperability. The United States were notified that the European Community would be using its own standards, often identical to the international standards, rather than the GPS system standards, a choice dictated by the quality of the services to be offered to users (signal continuity and reliability, precision, low cost of receivers, etc.). Galileo is also a commercial project, after all, and GPS is not the international standard. Galileo will be a constellation that, while complementary to GPS and interoperable for GPS users, will be quite independent of the GPS system.

The European Community also presented the project’s state of progress and illustrated the suitability of the technical solutions adopted (time, geodetic, frequency planning) in terms of quality of service and interoperability with GPS for the user. The best experts from the Member States were brought in to participate in the meeting. They presented a united front. The European and American experts will meet before the next negotiations in October. Technical work on the specific questions at issue should make it possible to overcome the final obstacles to defining the principles governing Galileo/GPS interoperability.
It has not, however, been possible to make progress on the thorny issue of the overlay of one of the frequency bands intended for Galileo's future public regulated service on one of the future American military (code M) signals. The US negotiators are not authorised to tackle this matter, given its high political sensitivity. The United States regards NATO as the only forum in which the matter may be discussed.

On behalf of the European Community, the Commission has made the following points:

— the Galileo programme is a civilian programme supported by the European Union and the negotiating mandate which the Council has given the Commission covers all aspects connected with Galileo, including frequencies. While the matter of frequencies may be of interest to NATO, finding a solution to the problem comes under relations between the European Community and the United States,

— the planned overlay with the American military code, which moreover complies with the decisions taken by the International Telecommunication Union in 2000 regarding access to frequencies, is dictated by technical and practical considerations, such as signal robustness and acceptable levels of interference,

— the Commission wishes to initiate a purely technical discussion of the matter with the American authorities in order to understand their concerns. Awaiting for the setting up of the Security Board, the task is entrusted to the working group responsible for international issues of the expert committee for Galileo security (whose members are authorised to handle and exchange any confidential information, even of military origin). A political decision on the issue of possible overlay cannot be made until technical information has been exchanged and all the possible implications have been reviewed.

Until now, in its negotiations with the Americans, the Commission has put forward the scenario that the United States will not be able to jam one of the planned PRS signals because it will be overlaid on one of the future military GPS signals and it is not possible to selectively jam one of two signals overlaid on a single frequency band with the same modulation. As explained in point 3.3 above, the modulation used for the overlay would enable Galileo to transmit a much more robust and reliable signal. As a result, the United States would not be able to selectively jam Galileo PRS users. A political agreement on the cooperation necessary between the two radionavigation systems is required in preparation for a crisis or in the event of a crisis.

The Europe Community's political decision to equip itself with its own satellite navigation system is based on the supposition that it should retain genuine control of the secured PRS signal and, therefore, runs counter to accepting a situation of relative independence in which the use of the 'government' signal would be subject to certain conditions.

(b) Russian Federation and China

Contacts with Russia and China regarding Galileo cover many areas of cooperation. Both countries have advanced satellite radionavigation programmes and view cooperation with the European Community as a strategic objective. One major issue is the relationship between Glonass and Galileo systems and standards. In tandem with its expressed wish to participate in the Galileo programme, China is independently developing a regional system adapted to its own needs and has applied to the International Telecommunication Union for access to frequencies dedicated to satellite navigation.

Russian Federation: The value of developing cooperation on Galileo has been emphasised at every summit between the European Union and Russia. In the past, formal negotiations with Russia have focused on defining scenarios for cooperation and joint industrial projects and on the possibilities for collaboration on frequencies. Following recent bilateral contacts between the Commission and Russia, in particular at the summit of 29 May 2002, both parties decided to re-examine the precise scope of cooperation. They have a mutual interest in expanding cooperation in terms of both developing technology and financial investment.

Politically, the European Community and Russian should attempt to combine forces (Galileo plus Glonass) in order to create a worldwide satellite radionavigation system integrating the existing and planned systems. Coordinating their respective positions within international organisations with an interest in satellite radionavigation (ITU, ICAO, IMO) should help attain this objective.

In practical terms, it is important to exploit the synergies which the coexistence of the two systems, Galileo and Glonass, can offer European users in terms of quality and availability of services. The possible modernisation of Glonass standards is also up for discussion since the Russians have declared their interest in civilian and, more especially, commercial radionavigation markets.

As well as promoting industrial and scientific links, it has been agreed that negotiations will be resumed with a view to concluding a cooperation agreement at the earliest possible opportunity. The Commission will draw up a draft agreement in the autumn.
The Commission has organised a large roundtable meeting with the representatives of the major Russian firms in order to encourage cooperation on satellite navigation applications and to inform them of the possibilities available to them of participating directly in the Joint Undertaking as future users.

**People’s Republic of China:** The demographic, economic and political role of China and its satellite radionavigation activities warrant the country a special place in the Galileo programme. Following the Sino-European summit held in June 2001, cooperation with China took the form of visits by experts and two major conferences bringing together all the Chinese scientific, technical and commercial operators. The last such conference, held in Beijing on 3 and 4 June 2002, was organised with the help of the European Space Agency.

When Vice-President de Palacio met Minister Xu Guanhua on 17 June 2002, an announcement was made regarding the future establishment in China of a Sino-European centre for cooperation on satellite radionavigation. It is intended to set up teams of European and Chinese researchers working on Galileo and on radionavigation in general with a view to promoting industrial partnerships to research and exploit the applications of this technology.

The Chinese Prime Minister, Zhu Rongji, expressed his country's interest in being fully involved in the Galileo programme financially, technically and politically. The Chinese Ministry for Research presented a list of areas of cooperation which could be covered by formal agreements between the European Community and China.

Considering both the state of progress of potential cooperation with China, the importance of the stakes of collaboration with this country in terms of markets, policies on standardisation and frequencies, and the political objectives of both parties in terms of sovereignty, technology transfer, etc., the Commission will shortly present a proposal for a directive on specific negotiations with China.

The Mediterranean region has expressed great interest in Galileo and in its precursor, Egnos. Because of their geographic and economic proximity, the countries of the Mediterranean are favoured sites for Egnos ground stations. One of the planned MEDA Programme projects involves setting up training and demonstration activities on satellite radionavigation in the Mediterranean partner countries. The chief objective is to inform and raise awareness among decision-makers in these countries regarding the possibilities afforded by the use of Galileo and this technology.

**Latin America:** The support of the Latin American countries is vital in order to protect the frequencies allocated to Galileo. It is important to demonstrate Galileo's potential and importance for Latin America.

Initial contacts with some Latin American countries, including Argentina, Brazil, Chile and Uruguay, show that these countries are keen to counterbalance their relations with the United States by forging strong links with the European Union. The geographic, climatic and demographic situation of the region intensifies infrastructure and transport safety problems there.

The European Union's approach in Latin America should stress European know-how in the field of satellite radionavigation. A major regional cooperation project is already under way. As in the Mediterranean region, it involves setting up a cooperation centre responsible for carrying out training and demonstrations on satellite radionavigation, using in particular the Egnos system, which gives an idea of the future potential of Galileo. The objective is to influence as many decision-makers and future users in those countries as possible. In addition, Galileo may play an important role in the regional civil aviation plan developed for Latin America under the auspices of the International Civil Aviation Organisation.

**Canada:** In political terms, Canada has shown interest in potentially participating in the Joint Undertaking via its national space agency, with greater involvement in the programme than simply as a European Space Agency 'cooperating State'. The matter is currently under discussion in Ottawa. In technical terms, Canada is still taking part in the Galileo studies managed by the Commission and the European Space Agency.

**Australia:** Australia was initially reluctant to cooperate with the European Community on the Galileo and Egnos projects. This attitude has since changed, however, into a wish for cooperation. This was shown by the Australian transport authorities' visit to the Commission in April 2002. They expressed their interest in using Galileo applications and in siting and managing Galileo ground facilities in Australia. The Commission has therefore started to draw up a list of possible areas for cooperation.

(c) Other third countries

**Mediterranean countries:** The Fifth Euro-Mediterranean Ministerial Conference on 22 and 23 April 2002, marking the renewal of the Barcelona Process, adopted an action plan for the development of the Euro-Mediterranean partnership in association with the regional strategy (2002-2006) for the Mediterranean region. Satellite radionavigation is a priority component of this action plan which seeks to promote regional strategies of benefit to multimodal transport systems in these countries.
Japan: Japan is an important country because of its many political and economic links with the European Union. It is also a country which has developed advanced satellite navigation technology, even if the Japanese authorities have yet to choose between the various positioning systems, such as the combined use of GPS and MSAS or Galileo and GPS. Significantly, American industry, supported by the Federal Aviation Authority, has established close links with the Japanese authorities by exporting American technology in order to develop the Japanese equivalent to Egnos, the MSAS system. Moreover, Japan was opposed to allocating frequencies to Galileo at WRC-2000 in Istanbul. Negotiations with Japan must focus on this.

Satellite radionavigation was one of the seven priorities for cooperation agreed by the Commission in its forthcoming communication on establishing economic and commercial partnership with Japan. The priority was confirmed at the latest summit between the European Union and Japan on 8 July 2002. It reflects the interest of the Japanese Government and industrial authorities in playing a more important part in the Galileo programme.

Ukraine: Ukraine has advanced aerospace capacity, having in particular taken part in the development of the Russian Glonass programme. At recent summit meetings between the European Union and Ukraine, it was decided to step up contacts between experts on the Galileo programme with a view to possible cooperation. Ukraine, as a neighbour of the European Union, is interested by the development of Galileo applications in the transport sector. With Ukraine, the Commission has always maintained the line that exchanges should proceed as part of a cooperation and partnership agreement.

India: The Indian aviation and research authorities are trying to set up a first-generation (Egnos or WAAS type) satellite radionavigation system. European and American industries are in competition over this. The aviation sector is of critical importance in this project because of the imperatives of air safety, with Indian airspace crossed by a considerable number of international flights.

In this context, the European Community has initiated cooperation with India to allow it to use Galileo’s precursor, the Egnos system. The aim is to ensure that European technology forms the basis of any future navigation system developed by India, which claims to own its own radionavigation system.

Candidate countries

The problem explained above with regard to third countries does not of course apply to the candidate countries which are destined to become members of the European Union. They have a key role in the Galileo programme as future co-owners of the system. It is moreover essential, as of now, to enlist their support for Galileo in international forums, and to prepare them to take on their future role as members of the European Union and participants in the Galileo programme structures.

Bilateral and multilateral contacts (UN) have shown the capacity of these countries to use and develop satellite navigation services for uses in transport, geodesy and science in general. The conference currently being prepared in Poland will significantly help to make these countries aware of the value of the Galileo programme. An initial planning meeting was held in Warsaw on 19 and 20 June 2002, as part of a conference on all space applications organised jointly by the Commission and the European Space Agency.

5.2. Participation of third country members in the Joint Undertaking

On the subject of the possible forms of cooperation with third countries, it should be noted that Article 5 of the Regulation setting up the Galileo Joint Undertaking specifically provides for third country members to take part in the joint undertaking.

In addition to the negotiating directives issued by the Council which, by definition, cover a wide range of subjects (scientific and industrial cooperation, commercial matters, etc.), there is the specific issue of third country participation in the activities of the joint undertaking.

At present, a number of countries have expressed interest in becoming involved in the Galileo programme in this way. This means, however, that the countries concerned and the Joint Undertaking will have to have discussions in order to work out appropriate arrangements. In any case, final approval must be given by the Council.

The founding members of the Joint Undertaking, applying their own decision-making procedures, will have to assess the terms of this participation, including, in particular, the amount of the financial contribution to the joint undertaking, the approval — by the country concerned of the key elements of Galileo strategy (1), protection of Galileo infrastructure, acceptance of the EU principles regarding the transfer of technology and intellectual property.

The Council still has to approve their participation, on the basis of Commission proposals, and any conditions attached.

(1) Support for Galileo standards in the IMO and ICAO, non-discrimination of Galileo services and equipment according to WTO rules, non-discrimination of Galileo in the ITU.
5.3. Negotiating directives

**China:** The Commission is preparing a proposal for a negotiating directive to be adopted in the near future by the Council, with a view to reaching a formal agreement on cooperation with China after the pattern of the mandates obtained for negotiations with the United States and Russia. The negotiating mandate covers the range of subjects, from scientific and industrial cooperation to political cooperation.

**Other third countries:** In view of the large number of applications and the need for a consistent approach, the Commission is proposing that the Council in the near future adopt a negotiating directive in the form of a *model agreement* that can be used for all third countries rather than taking each third country individually.

This directive would cover areas such as political cooperation, technical (e.g. interoperability), industrial and financial cooperation, the management of Galileo, including the Joint Undertaking, scientific collaboration and research/training.

Cooperation with a view to promoting regional and local services is an important element for the development of Galileo, considering sovereignty issues.

The final content of the cooperation agreements will vary according to the countries concerned. The wider the anticipated cooperation (1), the more detailed the Commission proposal to the Council will be.

**CONCLUSIONS**

The forthcoming deadlines are listed in Annex 3. Political guidelines should be issued as quickly as possible on the following points:

— the definition of Galileo services and the frequency plan based on the most recent version of the technical document produced by the Commission services,

— the overlay of PRS frequencies and the discussions to be conducted on the subject between the European Community and the United States,

— plans for negotiations with China and other third countries.

---

(1) Potentially, e.g. Japan.

**ANNEX 1**

**GALILEO MISSION AND SERVICE DEFINITION**

**General introduction**

The main characteristics of the Galileo programme and the services and performances offered are presented in the high-level definition document. It is used as the framework for the Galileo programme and is applicable to the mission requirement document. The document prepared by the European Commission and the European Space Agency results from a consultation process with users, Member States and prospective investors and takes into account the latest results of technical definition studies performed so far.

The European objective of full autonomy in satellite navigation will be achieved in a two-step approach, starting with the EGNOS system in 2004 and then with the Galileo system, which is aimed at full operational capability by 2008. Galileo will be the first civil satellite positioning and navigation system, designed and operated under civil control. Galileo will be interoperable with other systems to facilitate their combined use. For safety of life and commercial applications, the navigation services will offer a guarantee, which is not only advantageous, but also an important differentiation with respect to the current GNSS. Special attention has been given to security aspect of Galileo, to protect its infrastructure and to avoid the potential misuse of its signals.

Four navigation services and one service to support search and rescue operations have been identified to cover the widest range of users needs, including professional users, scientists, mass-market users, safety of life and public regulated domains. The following Galileo satellite-only services will be provided worldwide and independently from other systems by combining the Galileo's signals in space:

(i) The Open Service (OS) results from a combination of open signals, free of user charge, provides position and timing performances competitive with other GNSS systems.
(ii) The Safety of Life Service (SoL) improves the open service performances providing timely warnings to the user when it fails to meet certain margins of accuracy (integrity). It is envisaged that a service guarantee will be provided for this service.

(iii) The Commercial Service (CS) provides access to two additional signals, to allow for a higher data rate throughput and to enable users to improve accuracy. It is envisaged that a service guarantee will be provided for this service. This service also provides a limited broadcasting capacity for messages from service centres to users (in the order of 500 bits per second).

(iv) The Public Regulated Service (PRS) provides position and timing to specific users requiring a high continuity of service, with controlled access. Two PRS navigation signals with encrypted ranging codes and data will be available.

(v) The Search and Rescue Service (SAR) broadcast globally the alert messages received from distress emitting beacons. It will contribute to enhance the performances of the international Cospas-Sarsat search and rescue system.

The Galileo satellite-only services can be enhanced on a local basis through combination with local elements for applications with more demanding requirements.

Galileo signals can also be combined with other GNSS system (Glonass, GPS) or non-GNSS systems (e.g. GSM and UMTS) to allow enhanced services for specific applications.

A service-oriented approach has been used to design the Galileo architecture. The Galileo global component, comprising the constellation of 27 active satellites + three spare satellites in medium earth orbit and its associated ground segment, will broadcast the signal in space required to achieve the satellite-only services. The local service enhancements will be facilitated, as the global component will be designed to easily interface with local elements. In the same way, the interoperability between Galileo and external components will be a major driver of the Galileo design to allow the development of applications combining Galileo services and external systems services (e.g. navigation or communication systems).

OPEN SERVICE

**Purpose**

The Galileo Open Service provides positioning, velocity and timing information that can be accessed free of direct charge. This service is suitable for mass-market applications, such as in-car navigation and hybridisation with mobile telephones. The timing service is synchronised with UTC when used with receivers in fixed locations. This timing service can be used for applications such as network synchronisation or scientific applications.

**Performance and features**

The performance objectives in terms of position accuracy and availability will be competitive with respect to existing GNSS and further planned evolutions. In addition, the Open Service will also be interoperable with other GNSS, in order to facilitate the provision of combined services.

**Implementation**

The Open Service signals are separated in frequency to permit the correction of errors induced by ionospheric effects by differentiation of the ranging measurements made at each frequency. Each navigation frequency will include two ranging code signals (in-phase and quadrature). Data are added to one of the ranging codes while the other 'pilot' ranging code is data-less for more precise and robust navigation measurements.

COMMERCIAL SERVICE

**Purpose**

The Commercial Service will allow the development of professional applications, with increased navigation performances and added value data, compared with the Open Service. The foreseen applications will be based on:

— dissemination of data with a rate of 500 bps, for added value services,
— broadcasting of two signals, separated in frequency from the Open Services signals to facilitate advanced applications such as integration of Galileo positioning applications with wireless communications networks, high accuracy positioning and indoor navigation.

**Performances and features**

The Galileo Operating Company (GOC) will determine the level of performance it can offer for each commercial service together with ascertaining the demands of industry and the needs of the consumer. It is intended to provide a guarantee for this service.

The Commercial Service will be a controlled access service operated by commercial service providers acting after a licence agreement between them and the GOC.

Commercial service providers will make decisions on the offered services: e.g. integrity data, differential corrections for local areas, etc., which will depend on the final characteristics of the other services offered by Galileo.

**Implementation**

The Commercial Service signals will be the Open Services signals, plus two encrypted signals (ranging codes and data), on the E6 band.

**SAFETY OF LIFE SERVICE**

**Purpose**

The target markets of the Safety of Life Service are safety critical users, for example, maritime, aviation and trains, whose applications or operations require stringent performance levels.

This service will provide high-level performance globally to satisfy the user community needs and to increase safety especially in areas where services provided by traditional ground infrastructure are not available. A worldwide seamless service will increase the efficiency of companies operating on a global basis, e.g. airlines, transoceanic maritime companies.

**Performance and features**

With regard to Safety of Life Services, there are certain levels of service that are stipulated by law in various international transportation fields, for example, standards and recommended practices (SARPs) by ICAO. A very specific level of service from Galileo will be needed to comply with legislation applicable for all considered domains of transport and existing standards. It is intended to provide a guarantee for this service.

This service will be offered openly and the system will have the capability to authenticate the signal (e.g. by a digital signature) to assure the users that the received signal is the actual Galileo signal. This system feature, which will be activated if required by users, must be transparent and non-discriminatory to users and shall not introduce any degradation in performance.

The provision of integrity (1) information at global level is the main characteristic of this service. Non-European regions could also support the provision of this service on a regional basis by delivering regional integrity information through the Galileo satellites.

The Safety of Life Service will be provided globally. Its specification include two levels to cover two conditions of risk exposure and are applicable to many applications in different transport domains, for example air, land, maritime, rail:

— the critical level covers time critical operations for example, in the aviation domain approach operations with vertical guidance,

— the non-critical level covers extended operations that are less time critical, such as open sea navigation in the maritime domain.

(1) Integrity is the ability of a system to provide timely warnings to the user when it fails to meet certain margins of accuracy.
The SoL Service signals are in the E5a + E5b and L1 bands. Galileo will offer a robust service to the Safety of Life community providing also alternative levels of service for degraded modes of operation (e.g. where one or two frequency would not be available due to interference).

**Implementation**

The Safety of Life Service signals are separated in frequency to permit correction of errors induced by ionospheric effects by differentiation of the ranging measurements made at each frequency. Each navigation frequency will include two ranging code signals (in-phase and quadrature). Data are added to one of the ranging codes while the other ‘pilot’ ranging code is data-less for more precise and robust navigation measurements. The integrity data will be broadcast in the L1 and E5b bands.

**PUBLIC REGULATED SERVICE**

**Purpose**

The Public Regulated Service (PRS) will provide a higher level of protection against the threats to Galileo signals in space than is available for the open services (OS, CS and SoL) through the use of appropriate interference mitigation technologies.

The need for the PRS results from the analysis of threats to the Galileo system and the identification of infrastructure applications where disruption to the signal in space by economic terrorists, malcontents, subversives or hostile agencies could result in damaging reductions in national security, law enforcement, safety or economic activity within a significant geographic area.

The objective of the PRS is to improve the probability of continuous availability of the signal in space, in the presence of interfering threats, to those users with such a need. Applications include the following:

(a) Europe-wide:

---

- the European Police Office (Europol),
- the European Anti-fraud Office (OLAF),
- civil protection services, safety services (Maritime Safety Agency), and those emergency response services (peacekeeping forces, humanitarian response teams);

(b) in the Member States:

---

- law enforcement and security services,
- forces or services engaged in fighting crime,
- intelligence services responsible for national security,
- services responsible for controlling and supervising external borders.

The introduction of interference mitigation technologies carries with it a responsibility to ensure that access to these technologies is adequately controlled to prevent misuse of the technologies against the interests of Member States. Access to the PRS will be controlled through key management systems approved by Member States' governments.

**Performance and features**

The Public Regulated Service access will be controlled by the authorities to be defined at European level, through the encryption of the signals and the appropriate key distribution.
**Implementation**

The Public Regulated Service signals are permanently broadcast on separate frequencies with respect to open Galileo satellite-only services, so as not to lose the PRS when the open service is denied locally. They are wide band signals so as to be resistant to involuntary interference or malicious jamming and therefore offer a better continuity of service.

The use of PRS will be restricted to clearly identified categories of users authorised by EU and participating states. Member States will authorise users through the implementation of appropriate controlled access techniques. Control of distribution of receivers will be maintained by Member States.

**SEARCH AND RESCUE SERVICE**

**Purpose**

The Galileo support to the Search and Rescue service — herein called SAR/Galileo — represents the contribution of Europe to the international Cospas-Sarsat cooperative effort on humanitarian search and rescue activities. SAR/Galileo shall:

- fulfil the requirements and regulations of the International Maritime Organisation — via the detection of emergency position indicating radio beacons of the Global Maritime Distress Security Service and of the International Civil Aviation Organisation via the detection of emergency location terminals,

- be backward compatible with the Cospas-Sarsat system to efficiently contribute to this international search and rescue effort.

**Performances and features**

SAR/Galileo will allow for important improvements of the existing Cospas-Sarsat system:

- near real-time reception of distress messages transmitted from anywhere on earth (the average waiting time is currently one hour),

- precise location of alerts,

- multiple satellite detection to avoid terrain blockage in severe conditions,

- increased availability of the space segment (27 medium earth orbit satellites on top of the four low earth orbit satellites and the three geostationary satellites in the current system).

In addition, SAR/Galileo will introduce a new SAR function namely, the return link from the SAR operator to the distress emitting beacon, thereby facilitating the rescue operations and helping to identify and reject the false alerts.

**Implementation**

The search and rescue transponder on Galileo satellites detects the distress alert from any Cospas-Sarsat beacon emitting an alert in the 406-406.1 MHz band, and broadcasts this information to dedicated ground stations in the 'L6' band. Cospas-Sarsat Mission Control Centres (MCC) carry out the position determination of the distress alert emitting beacons, once they have been detected by the dedicated ground segment.
### Appendix 1

**Galileo services — main characteristics**

#### Open Service (positioning)

<table>
<thead>
<tr>
<th>Type of receiver</th>
<th>Carriers</th>
<th>Single frequency</th>
<th>Dual frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computes integrity</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionospheric correction</td>
<td>Based on simple model</td>
<td>Based on dual-frequency measurements</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Global</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Accuracy (95 %)</th>
<th>H: 15 m</th>
<th>H: 4 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>V: 35 m</td>
<td></td>
<td>V: 8 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrity</th>
<th>Alarm limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-to-alarm</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrity risk</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Availability</th>
<th>99.8 %</th>
</tr>
</thead>
</table>

#### Open Service (timing)

<table>
<thead>
<tr>
<th>Carriers</th>
<th>Three frequencies</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Global</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Timing accuracy wrt UTC/TAI</th>
<th>30 nsec</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Availability</th>
<th>99.8 %</th>
</tr>
</thead>
</table>

#### Safety of Life Service

<table>
<thead>
<tr>
<th>Type of receiver</th>
<th>Carriers</th>
<th>Three frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computes integrity</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Ionospheric correction</td>
<td>Based on dual-frequency measurements</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Global</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Accuracy (95 %)</th>
<th>H: 4 m</th>
<th>H: 220 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>V: 8 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrity</th>
<th>Alarm limit</th>
<th>H: 12 V 20 m</th>
<th>H: 556 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-to-alarm</td>
<td>6 seconds</td>
<td>10 seconds</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrity risk</th>
<th>(3.5 \times 10^{-7}/150 ) s</th>
<th>(10^{-7}/)hour</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Continuity risk</th>
<th>(10^{-3}/15 ) s</th>
<th>(10^{-4}/)hour-(10^{-6}/)hour</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Certification/liability</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Availability of integrity</th>
<th>99.5 %</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Availability of accuracy</th>
<th>99.8 %</th>
</tr>
</thead>
</table>
### Public Regulated Service

<table>
<thead>
<tr>
<th>Type of receiver</th>
<th>Carriers</th>
<th>Dual-frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computes integrity</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Ionospheric correction</td>
<td>Based on dual-frequency measurements</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (95 %)</td>
<td>H: 6.5 m</td>
</tr>
<tr>
<td></td>
<td>V: 12 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrity</th>
<th>Alarm limit: H:20-V:35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-to-alarm</td>
<td>10 s</td>
</tr>
<tr>
<td>Integrity risk</td>
<td>$3.5 \times 10^{-7}$/150 sec</td>
</tr>
<tr>
<td>Continuity risk</td>
<td>$10^{-5}$/15 s</td>
</tr>
<tr>
<td>Timing accuracy wrt UTC/TAI</td>
<td>100 nsec</td>
</tr>
<tr>
<td>Availability</td>
<td>99.5 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Galileo support to search and rescue service (SAR/Galileo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
</tr>
<tr>
<td>Forward system latency time</td>
</tr>
<tr>
<td>Quality of service</td>
</tr>
<tr>
<td>Acknowledgement data rate</td>
</tr>
<tr>
<td>Availability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of local elements</th>
<th>Broadcast of differential corrections</th>
<th>Broadcast of differential corrections</th>
<th>Indoor assisted users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (95 %)</td>
<td>$&lt; 1 \text{ m}$</td>
<td>$&lt; 10 \text{ cm}$</td>
<td>50 m (TBD)</td>
</tr>
<tr>
<td>Integrity TTA</td>
<td>Up to 1 second</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Integrity alarm limit</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Availability</td>
<td>99-99.95 (TBD)</td>
<td>99-99.9 (TBD)</td>
<td>99-99.9 (TBD)</td>
</tr>
<tr>
<td>Communications</td>
<td>Broadcast</td>
<td>Single-/bi-directional data</td>
<td>Single-/bi-directional data and voice</td>
</tr>
</tbody>
</table>
Appendix 2

Galileo signals — main characteristics

The following chart describes the Galileo navigation signal emissions:

— four signals are transmitted in the frequency range 1 164-1 215 MHz (E5a-E5b),
— three signals are transmitted in the frequency range 1 260-1 300 MHz (E6),
— three signals are transmitted in the frequency range 1 559-1 591 MHz (L1).

Both the ranging code and data carry the specific information needed for a specific service. Among the 10 navigation signals:

— six are designed for OS and SoL (signals 1, 2, 3, 4, 9, 10),
— two are designed specifically for CS (signals 6, 7),
— two are designed specifically for PRS (signals 5, 8).

The table below summarises the characteristics of navigation signals and their service allocation:

<table>
<thead>
<tr>
<th>Signal ID</th>
<th>Frequencies</th>
<th>Navigation services</th>
<th>Signal characteristics</th>
</tr>
</thead>
</table>
|           | E5a, E5b, L1 | OS, CS, SoL, PRS    | Ranging code type: 
| 1, 2, 3, 4, 9, and 10 | Open access |
|           | E6         |                     | Data type: 
| 6, 7      | Commercial encryption |
| 5, 8      | E6, L1     |                     | Governmental encryption |

<table>
<thead>
<tr>
<th>Navigation services</th>
<th>Signal characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS</td>
<td>Navigation data, Integrity data</td>
</tr>
<tr>
<td>CS</td>
<td>Commercial data</td>
</tr>
<tr>
<td>SoL</td>
<td>SAR data, commercial data</td>
</tr>
<tr>
<td>PRS</td>
<td>PRS data</td>
</tr>
<tr>
<td>Signal ID</td>
<td>Signals</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>data signal in E5A</td>
</tr>
<tr>
<td>2</td>
<td>pilot signal in E5A</td>
</tr>
<tr>
<td>3</td>
<td>data signal in E5B</td>
</tr>
<tr>
<td>4</td>
<td>pilot signal in E5B</td>
</tr>
<tr>
<td>5</td>
<td>split-spectrum signal in E6</td>
</tr>
<tr>
<td>6</td>
<td>commercial data signal in E6</td>
</tr>
<tr>
<td>7</td>
<td>commercial pilot signal in E6</td>
</tr>
<tr>
<td>8</td>
<td>split-spectrum signal in L1</td>
</tr>
<tr>
<td>9</td>
<td>data signal in L1</td>
</tr>
<tr>
<td>10</td>
<td>pilot signal in L1</td>
</tr>
</tbody>
</table>

ANNEX 2

ISSUES RELATING TO GALILEO SIGNALS

Introduction

The European Commission, European Space Agency (ESA), certain Member States (1) and the business world, notably firms active in receiver design, have taken part in the work of the 'Signal Task Force' attached to the Galileo Steering Committee. This Task Force began work in March 2001. One of its missions was to help define the signals to be transmitted by Galileo. In this context, the best possible scenario in terms of the frequency and type of signals used was devised to ensure that signals transmitted by Galileo would deliver optimum performance and thereby enable it to penetrate the satellite navigation market. The experts appointed by the Member States reached a consensus on this scenario.

Galileo will offer a range of services each using at least two frequency bands. Two of these services use unencrypted signals. Two others rely on encrypted signals, one for commercial purposes and the other for critical and sensitive applications under government control. This ‘governmental’ or Public Regulated Service has a high level of protection.

The American GPS system has two types of signals: civilian and military. The current GPS military signals are called P(Y) and the future military ones are called code M.

The Signal Task Force has allowed for interoperability between GPS and Galileo. It works by overlaying the Galileo open signals with two of the GPS frequencies, which will enable future open-signal satellite radionavigation receivers to use GPS and Galileo signals together. It also allows for partial or total overlay of one of the encrypted PRS signals with one of the forthcoming GPS code M signals. These overlays are possible from the technical and legal points of view.

For the moment the United States is opposed to the overlay of one of the Galileo PRS signals with one of the GPS code M signals. It cites its defence policy priorities as its reason for wishing to retain the possibility of jamming the Galileo PRS signal.

The analysis below first explains the issues raised by the United States and then goes on to set out the EU’s position regarding the choice of the Galileo PRS frequencies.

(1) United Kingdom, Germany, Italy, France, Spain and Finland.
1. OVERLAYING THE PRS AND CODE M SIGNALS

1. The Galileo PRS signal

Of the various navigation services to be provided by Galileo, the PRS service is designed to ensure continuity of service for certain sensitive applications (security, police, customs, fraud prevention), even in an emergency.

To ensure continuity of service and to prevent access to unauthorised users, the PRS signals are continuously encrypted by a cipher or a government code and supervised by an appropriate European body.

PRS receivers will therefore be specific and very strictly controlled: users are identified by name, receivers are traceable, stolen receivers are reported and disabled in accordance with a special procedure.

The PRS is composed of two signals: one in the medium-frequency band known as E6, the other in the high-frequency band known as L1. The signal located in the E6 band is defined without any overlay with GPS signals as it has sufficient bandwidth. The GPS code M also uses the L1 band, however.

2. Worldwide regulations (ITU)

According to current international regulations laid down by the International Telecommunications Union (ITU), the frequencies that can be used by satellite navigation systems do not belong to any particular country or system. If a country wishes to use a frequency band it must file an application with the ITU. The first country to file an application for a frequency has a priority claim on its use. However, any country may use the same frequency for its own navigation system provided that it does not cause excessive electromagnetic interference affecting other systems in use, including those having a prior claim.

3. Overlaying PRS and M code signals

The GPS code M and Galileo PRS signals each use different frequency bands. At the World Radiocommunication Conference (WRC) held in Istanbul in 2000, it did not prove possible to obtain sufficient bandwidth in the L1 band for all the potential signals. The GPS M code therefore overlaps with the Galileo PRS signal.

Two years of studies on interference by the best European experts have led to the firm conclusion that the European Union is capable of designing a PRS navigation service that will not interfere with the GPS M code, including in the high L1 band.

Therefore, international regulations allow the Europe Community to use for its own Galileo system the frequencies on which GPS operates, including the GPS military signals and in particular M code, provided that Galileo does not cause interference harmful to the American system. There is no technical or legal obstacle standing in the way of overlaying one of the two Galileo PRS signals with one of the GPS code M signals.

4. The military, industrial and commercial stakes

There are several reasons why the Americans oppose the overlay of the two signals.

(a) Military reasons

The United States considers that any civilian satellite navigation signal may be used for hostile or even terrorist purposes against national or NATO interests. In order to counter that threat, the US and soon NATO plan to develop an electronic warfare system called Navwar, that can locally jam civilian signals without interfering with the GPS M code.

In accordance with that approach, the Americans also want to be able to jam the Galileo signal where circumstances dictate, since it is not a military signal. However, the use of a single frequency band with the same modulation by one of the two PRS signals and one of the two GPS M code signals does not allow this jamming system to be applied directly. It would indeed be technically difficult to jam one of the two signals selectively without degrading the other.

The following political question therefore arises: does overlay create unacceptable risks for the EU and NATO and how can any such risks be managed?
(b) Industrial and commercial reasons

It cannot be ruled out that, in 10 years’ time, the GPS M code could be used not only for military purposes as it is today, but also by other categories of users, such as coastguards, customs, etc., in many countries. Over 25 countries already use it. The potential market probably embraces hundreds of categories of users.

However, the Galileo PRS signal is also designed to meet the needs of all applications in the European Union requiring secured signals (transport of nuclear materials, customs, police, etc.).

Even though Galileo is a civilian system, the European Union’s PRS is an encrypted signal potentially as well protected as the GPS military signal.

Since it is impossible to selectively jam a navigation signal using the same modulation and frequencies as another signal without seriously degrading it, allowing a full overlay with the same modulation of one of the two Galileo PRS signals with one of the two GPS M code signals means that the United States must reach an agreement with the Europe Community to ensure that its policy on any exports of PRS receivers is coordinated and compatible with theirs.

II. ARGUMENTS FOR OVERLAY

1. Technical justification

(a) The need to overlay the GPS signal

In order to attain metre precision and reject interference, the Galileo PRS signal must use two frequency bands that are wide enough and spaced far enough apart. It was this frequency configuration, which was also adopted for the most demanding signals of the American GPS and Russian Glonass systems, that led to the choice of the Galileo signal scenario (1).

Taking account of international telecommunications regulations, the only available frequencies are in band L1 which is reserved for satellite navigation. This band is already used by GPS and Glonass for their top-level signals. The frequency band used by the PRS signal must therefore be overlaid on either the GPS or the Glonass band. The latter is ill advised for technical reasons since Glonass is based on a totally different design from GPS and Galileo.

As stated earlier, the Galileo PRS signal in the L1 band is in any case overlaid by the GPS signals in the same band, without leading to any degradation of performance according to ITU criteria, as is demonstrated by interference calculations. Overlaying automatically requires reciprocity between GPS and Galileo, i.e. a good level of interoperability between the two systems (a similar level of interference, for example).

(b) Choice of signal type in band L1

The specifications of the Galileo PRS signal are defined so that they are flexible. There are two main options for a signal located in the L1 high band, one using a signal with ‘BOC (10,5)’ type modulation, the other a ‘BOC (14,2)’ type signal. BOC (10,5) modulation involves a full overlay with one of the two GPS code M signals, whereas a BOC (14,2) type signal corresponds to a 75 % overlay (6 MHz of code M overlaps with the 8 MHz allocated at the World Radionavigation Conference held in 2000 in Istanbul).

The choice remains open but BOC (10,5) is the preferred option for the following reasons:

— this type of signal costs the same but is more efficient than BOC (14,2) modulation. The two GPS code M signals and the PRS signal in the E6 medium-frequency band are of the BOC (10,5) type. If the European Union were to give up this type of signal for Galileo PRS in band L1, we would end up with a less efficient and less competitive system,

— it has not been proven that a BOC (14,2) signal can provide certain technical functions essential to the smooth operation of a PRS receiver,

— a BOC (14,2) signal could be unilaterally jammed by the United States, which in practice would mean giving them the right to control Galileo PRS users. On the other hand, the Americans would have no technical means of jamming a BOC (10,5) signal that was fully overlaid on the GPS M code in band L1. Control of the users of this signal would be exercised by an appropriate European body using encryption techniques.

(1) Scenario A.
In order to respond to American concerns, the Commission suggested the choice of a generic signal, known as BOC (n,m), in the high-frequency L1 band for one of the two PRS signals, leaving the modulation type flexible at this stage of the project. However, of the available modulation types, BOC (10,5) is the most efficient.

2. Political arguments

(a) The European Union has the essential security know-how

Although a civilian signal, PRS will be restricted to certain strictly governmental applications and secured under government control. The argument that the PRS signal should be jammed in the same way as the other Galileo signals carried much less weight if that signal is appropriately secured (government encryption, users approved by the European Union, service controlled by a European body).

Some EU Member States have the know-how to design and implement effective government encryption. The resulting technology could be made available to the European authorities controlling the Galileo PRS signal.

(b) The need for mutual trust

Since October 1993, when the Memorandum of Understanding between the American Department of Defense and the NATO member countries for access to the GPS encrypted navigation service was signed, a dozen non-NATO countries and a few civilian administrations (American federal agencies and the Norwegian police, for example) have had access to the service. However, the NATO member countries were never consulted on this American policy of exporting a service which has become the main navigation system in the NATO Countries. Similarly, the NATO member countries never worried about the possible consequences of that export policy for NATO security because they knew that American and NATO interests were compatible and because they trust the security mechanisms that the Americans have put in place for GPS.

Moreover, the choice of the GPS frequency band for the Galileo PRS signal was governed not only by technical compatibility issues but also by a high level of trust in American security capabilities. This choice represents a clear distinction between the secured signals (GPS M code and Galileo PRS) on the one hand and the unsecured signals (all except M code and Galileo PRS) on the other. This split is compatible with the implementation of the local jamming technology favoured by the United States and NATO.

The EU would like the US to show the same trust regarding its capability to implement a secure Galileo system.

Conclusion

The European Union acknowledges the wish of the United States to have a properly secured signal (M code) for military and security reasons. The Commission's proposal takes account of both parties' security concerns, firstly by using flexible modulation for the PRS code, which can be adapted as required, and by setting up a security structure to monitor and control the use of the PRS code during the operational phase of Galileo. This security structure would be an appropriate interlocutor for the American security bodies. The European Community is prepared to seek a political agreement with the United States on the cooperation necessary between the two satellite navigation systems in preparation for a crisis or in the event of a crisis.

ANNEX 3

IMPORTANT FORTHCOMING MILESTONES IN THE GALILEO PROGRAMME

— Autumn 2002: Galileo Joint Undertaking to start operation.
— End of 2002: Commission report to the Council on integrating Egnos into Galileo and the model for the concession.
— December 2002: Council to decide on the services to be offered by Galileo and the frequency plan for these.
— Summer 2003: Commission proposal to the Council on creating the future security body.
— End of 2004: launch of the first experimental satellite.