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THE POLITICS OF GALILEO

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THE POLITICS OF GALILEO[1]

BY JOHAN LEMBKE

Background to the Galileo Project

Europe had virtually no presence in satellite navigation in the 1990s. The two existing global satellite navigation systems were the US Global Positioning System (GPS) and the Russian Federation's Glonass constellation. Basically, there was no military pressure for satellite navigation in Europe before the 1990s as there was in the US. Policymakers and industrialists in Europe acquired an incentive to develop satellite navigation when GPS was made available to civilian users and when conflicts erupted close to the European borders in the 1990s. Then a race developed for market share and strategic independence. The belief that GPS, a militarily-controlled system, would not become accessible to the public had helped to keep European ambitions on the backburner.[2]

Aside from some preliminary work in the late 1980s and early 1990s, the first political initiative came in 1994, when the European Commission launched a proposal for Europe to engage in satellite navigation.[3] The initiative prepared the ground for the development of the first-generation of Global Navigation Satellite System (GNSS-1) called Egnos (European Geostationary Overlay System), scheduled to enter operation in 2003. GNSS-1 was intended to give Europe the experience it needed to launch a second-generation satellite system (GNSS-2), which in early 1999 was dubbed "Galileo."

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[1]I wish to thank those officials in the European space sector at national and European levels who offered their valuable time to discuss the EU satellite navigation policy. I also acknowledge, with gratitude, the assistance of Martin Staniland, Professor at the Graduate School of Public and International Affairs, and Robin Skulrak, masters student at the Graduate School of Public and International Affairs and editorial assistant, in editing the policy paper.

[2]ESA official, interview with author, 23 October 2000.

[3]Commission of the European Communities (1994), *Satellite Navigation Services: A European Approach*, COM (94) 248, Brussels.

The world civil aviation community set the tone. In the early 1980s, it became interested in using satellite-based navigation aids for such critical purposes as enabling aircraft to land in bad weather and at night depending exclusively on satellite navigation. Because of the increasing restrictions of current air navigation systems and the high annual cost of operating conventional ground-based infrastructure in the early 1990s, the aviation community intensified its efforts to develop a strategy that would allow a gradual transition from conventional navigation systems to global navigation satellite systems.

The International Civil Aviation Organization (ICAO) took the lead in this campaign.[4] It was searching for ways to increase airspace capacity, provide substantial economies in flight operations and enhance the punctuality of air transport.[5] In 1991, ICAO proposed the Communication, Navigation and Surveillance/Air Traffic Management (CNS/ATM) concept, which involved, as a first stage, the establishment of a global navigation satellite system around 2005, with a second system (GNSS-2) - relying on a civil satellite constellation – to be installed around 2010. ICAO's activities, a tender issued by the international satellite service provider

[4] The ICAO was created in 1944 to promote the safe and orderly development of civil aviation worldwide and is a specialized agency of the United Nations (UN). Headquartered in Montreal, ICAO develops inter-national air transport standards and regulations and serves as the medium for cooperation in all fields of civil aviation among its 185 Contracting States (as of the year 2000). This global undertaking has been viewed as the most complex and far-reaching initiative ever pursued in the history of civil aviation. As such, it required an unprecedented level of collaboration between aircraft operators, service providers, manufacturers, interested associations and organizations, and governments, all working together with the goal of building the safest global aviation system. The objective of the world aviation community has been to create an integrated global system of air traffic management linking together CNS/ATM systems.

[5] In 1997, total world airline schedule passenger traffic in terms of passenger-kilometers was expected to grow at an average annual rate of 5.5 percent over the period to 2005. The total growth in freight traffic over the same period was estimated to be even stronger and amount to 7.0 percent annually in terms of freight ton-kilometers. Finally, the annual total number of domestic and international aircraft departures on scheduled services was estimated to grow more than a quarter and the number of aircraft-kilometers flown by more than a half. The international routes that would experience the fastest growth in passenger traffic would be the Transpacific and Euro-Asia/Pacific ones. ICAO (1997), 'Growth in Air Traffic to Continue: ICAO Releases Long-Term Forecasts', *Press Release*, Montreal, March.

Inmarsat in 1994 for the use of satellite transponders, and the growing use of the US GPS constellation for non-military services triggered the launching of European efforts.

European Initiatives

In Europe, the emergence of satellite navigation was largely the result of a confluence of activities undertaken by three European organizations: the European Space Agency (ESA), Eurocontrol (the organization responsible for coordinating air traffic control), and the Directorate General for Transport and Energy of the European Commission (DG TREN). In June 1994, the Transport Ministers from members of the European Civil Aviation Conference (ECAC) met in Copenhagen. They gave two clear Directives to Eurocontrol, the European Commission, ESA and ECAC Member States.[6] First, Europe should develop a component of the first-generation Global Navigation Satellite System (GNSS-1). Second, and more importantly, Europe should be in a position to contribute to the second-generation system (GNSS-2). The former system would be based on the US GPS and different augmentation systems, while the latter would constitute a future system for civilian-controlled satellite navigation. The ECAC Directives gave a political mandate for formal cooperation between the three European-based organizations. The European Commission responded that it would seek consultation with all the parties concerned to decide what was necessary to ensure reliable and efficient position-fixing services for European civil users.

Integrating Transport in Europe

The European Commission's view of GPS emphasized the need for coordination at EU level to construct, integrate and rationalize trans-European communications and transport infrastructures. It saw the promotion of efficient transport systems as a tool to generate and meet demand for deeper European economic and social integration, which in turn required the

integration of different modes of transport (inter-modality). The density of population in Europe, like that in the northeastern and southeastern US, caused congestion and bottlenecks in transport systems. Until the late 1990s, all transportation functions had been managed with ground-based infrastructure and technology. This situation started to change with the introduction and expected implementation of satellite-based systems, which could provide the same services – and could help to solve the crisis in air traffic management in Europe. But future satellite navigation had to be inter-modal in nature, covering and integrating different transport modes.

This overall strategy led to cooperation between Eurocontrol and ESA in the 1990s, while DG TREN, with support from the then-Commissioners for Research (Cresson), Transport (Kinnock) and Industrial Affairs and Telecommunications (Bangemann), actively supported the introduction of satellite navigation. DG TREN, specifically, conceived satellite navigation at an early stage not as a space development program but as a broader transport infrastructure program. In addition, there were people within the European Commission who were interested in the military potential of Galileo. Finally, France, Italy and Spain in particular wanted to strengthen Europe's commercial and strategic independence and viewed Galileo more as a public service than as a solely commercial enterprise.

The European Space Industry

Satellite navigation also offered opportunities for the European industries. Both ESA and national space agencies in Europe were looking for an opportunity to launch a key project, in a sector where large-scale European projects were lacking. The European space industry, which has not enjoyed the same amount of public funding and military contracts as the US industry, wanted to expand European involvement in space. Consequently, the ESA Ministerial Council invited the ESA Director General to draw up, in close consultation with the EU, a program

[6]Eurocontrol official, interview with author, 12/21/2000

proposal for a European contribution to a satellite navigation system.[7] Furthermore, the European space hardware industry started to recognize the benefits of, and the potential market for, satellite navigation equipment.

The Transport Council's Decisions

In 1998, the European Commission provided an outline of available strategy options for GNSS-2, which was followed by a refined proposal in February 1999.[8] This proposal also gave the system its name – "Galileo."[9] In June 1999, the EU Transport Council decided that the EU should embark on the Galileo definition phase (2000-2001).[10] This decision meant that the EU could move ahead with plans to build its own global satellite navigation system, but it did not represent a major financial commitment. In November 2000, the European Commission published a report on the results of the Galileo definition phase prior to the EU Transport Council meeting in late December 2000.[11]

Transport Commissioner Loyola de Palacio argued that the EU Transport Council would be crucial for the future of Galileo[12] and she argued for an unequivocal commitment by the Community. In fact, Palacio threatened to withdraw support for Galileo if the EU transport ministers did not firmly commit to invest public funds in a timely manner. The European

[7]Barbarance, K. et al. (1996), 'Satellite Navigation Activities: The International Context', *Space Communications* 14:155-161.

[8]Commission of the European Communities (1998), *Towards a Trans-European Positioning and Navigation Network: A European Strategy for Global Navigation Satellite Systems*, COM (1998) 29, 21 January, Brussels.

[9]Commission of the European Communities (1999), *Galileo: Involving Europe in a New Generation of Satellite Navigation Services*, COM (1999) 54, *Brussels*, February 10.

[10]Commission of the European Communities (1999), *Galileo: Global Satellite Navigation Services for Europe*. Meeting of the Council of EU Ministers of Transport, 17 June, Luxembourg; Council (1999), *Council Resolution of 19 July 1999 on the Involvement of Europe in a New Generation of Satellite Navigation Services – Galileo Definition Phase*, 1999/C 221/01, Official Journal of the European Communities, August 3.

[11]*Commission Communication to the European Parliament and the Council on Galileo*, COM (2000) 750, 22 November, Brussels.

Commission has estimated that designing and deploying the Galileo constellation would cost about Euro 3.25 billion ($2.86 billion). It argued that the EU and ESA should invest about Euro 2.1 billion and the private sector 1.1 billion in the project. A total of Euro 1.1 billion would be invested up to 2005 (the development phase). The European Commission suggested that the continuation of Galileo beyond 2001 would be attached to three broad conditions.[13] First, the EU would have to deploy an independent satellite navigation system. Second, adequate guarantees for funding would be required, including investment from the private sector of up to Euro 1.5 billion for the deployment phase (2006-2007), in order that full Galileo services could start in 2008. Third, an adequate legal and financial framework would be necessary in order to attract the private financing needed to operate Galileo, while a provisional, coordinated management structure for the project would have to be created in 2001.

The EU Transport Council's Deliberations on Galileo

Despite the urgings of Commissioner Palacio, however, the EU Transport Council decided in December 2000 to postpone a firm, unconditional commitment to the development of Galileo, a decision that surprised ESA, the European Commission, and the space industry. In February 2001, the European Commission president, Romano Prodi, nevertheless expressed the hope that the EU Council and European Parliament could reach an agreement on Galileo by May.

The concerns that led to the deferral of a political decision on Galileo related mainly to:

- Funding and the exact source and size of the Galileo's revenue streams;
- Defining security aspects and services; and
- Arriving at a legal structure for management of the system.

[12]Commission of the European Communities (2000), 'Continuation of the Galileo Project: The Commission Underlines the Need for Rapid Decisions', *Press Release*, 22 November, Brussels.
[13]Commission of the European Communities (2000), 'Continuation of the Galileo Project: The Commission Underlines the Need for Rapid Decisions', *Press Release*, 22 November, Brussels.

Moreover, there were a number of "second-order" topics: how the European Egnos system would be integrated with (and what the market potential was for) Galileo; the framework for assigning legal liabilities associated with damage or injuries resulting from a potential malfunction of the Galileo system; the allocation of frequencies; and the overall design of the ground infrastructure.

Galileo: Public Service or Commercial Infrastructure

European policy-makers and industrialists involved in deciding on the Galileo project have been divided on the speed and scale of commitment. While all ESA/EU Member States agree that the envisaged Galileo infrastructure should be placed under civilian control, they differ over the exact nature of the control and the role of the public sector. Some countries want a lasting commitment at the earliest date, while others want to obtain more information before deciding at a later date on the entire project. France, Italy, and Spain, together with the European Commission and ESA, belong roughly to the former political grouping. In addition, together with the aforementioned countries, Finland and smaller ESA countries such as Norway and Switzerland stress the political-strategic importance of Galileo and view it as a public service system. Germany, the Netherlands, the UK and Sweden want a clear role for and commitment by the private sector at an early stage. Moreover, the latter governments (not necessarily their military authorities, however) opposed the idea of using Galileo for military purposes since that would jeopardize business investments.

France has repeatedly stressed that Europe should not subject the Galileo project to detailed cost analyses and to the promise of a public-private partnership. In its view, delays and strategic fine-tuning must not cause Europe to miss out on what it considers a unique window of

opportunity.[14] The French argument has been accepted by Italy, Norway, Portugal, Spain and Switzerland, all of which regard a European navigation system as having a political and strategic purpose rather than being purely a source of profit. They agreed early on that strategic issues were driving Galileo and that those issues fell within the domain of the EU. Germany, the Netherlands, and the UK use a more commercial argument, holding that the development of Galileo is urgent because of the need to compete in the satellite applications market.

A Public or a Private Market: Funding Considerations

The European Commission has stated that financing based on public subsidies (Euro 1.1 billion) is indispensable for the development and validation phase of Galileo between 2001 and 2005. Public funding would come from the EU and ESA budgets, the organizations which share responsibility for the development of Galileo. Moreover, investment from the private sector (around Euro 1.5 billion) would be necessary for the deployment phase (2006-2007). At the end of 2000, the cost of Galileo was estimated at Euro 3.25 billion for the period 2001 to 2008, with annual operating costs of Euro 220 million. The total Galileo investment, including investment and operating costs, would amount to Euro 7 billion by 2020. DG TREN compares the cost of building Galileo to high-speed train infrastructure, which was a hot topic among EU transport ministers. "The development cost of Galileo corresponds to the development cost of about 100 km of High Speed Train!"[15] This argument can be even more specific. Thus Pascal Campagne writes: "Public funding during the initial project phases should not be a real problem, given all the important political, strategic, and social advantages that Galileo will provide Europe. For

[14]Because of its long experience in space affairs, France has been engaged in long-term and detailed analyses, including the issues of potential military requirements and obligations toward the North Atlantic Treaty Organization (NATO). The question of whether Galileo should be incorporated into a wider and coordinated European defense structure, into the EU Member States individually, or whether it should address military aspects at all, has been discussed. The European Commission has suggested that the Western European Union (WEU) might be a possible partner to deal with security aspects of Galileo.

example, the construction of the Innsbruck-Fortezza high-speed train sections (55 kilometers) amounts to Euro 3.8 billion, while the development of Galileo is estimated at around Euro 3 billion."[16]

Essentially, the European Commission and EU Member States prefer a clear financial commitment on the part of industry and user communities. The European Commission believes that equipment manufacturers and service providers should be involved at an early stage in order to ensure full commitment by industry to the design and implementation of Galileo. In the industry's view, however, European governments would have to spend public funds to bring Galileo to the point at which it would be equivalent to GPS before they would invest heavily.[17] From a commercial point of view, the early stages of Galileo entail too much uncertainty.

A central political issue is whether satellite navigation should be offered through a publicly funded market or through a privately funded service market. The main participants disagree over whether Galileo can generate commercially significant revenues in the shorter term. They also disagree about the potential size and importance of the market. The space industry claims that forecasts made by the European Commission, based on assumptions about the long-term market, are unrealistic because a great degree of uncertainty is involved in the early stages. Astrium, a leading European space hardware producer, has elaborated the figure below based on various studies.

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[15]Tytgat, Luc and Pascal Campagne (2000), 'Galileo: A New GNSS Designed with and for the Benefit for all Kind of Users', *ION GPS 2000*, 19-22 September.

[16]Campagne, Pascal (2000), 'The Road Ahead: Galileo Economics', *Galileo's World*, Special issue (Autumn): Building and Using Europe's Global Navigation Satellite System, pp.18-21.

[17] European industry has prepared to step up efforts to help the European Galileo initiative by coordinating their activities. The four largest industry actors in Europe (Alcatel Espace, Alenia Spazio, Astrium GmbH and Astrium

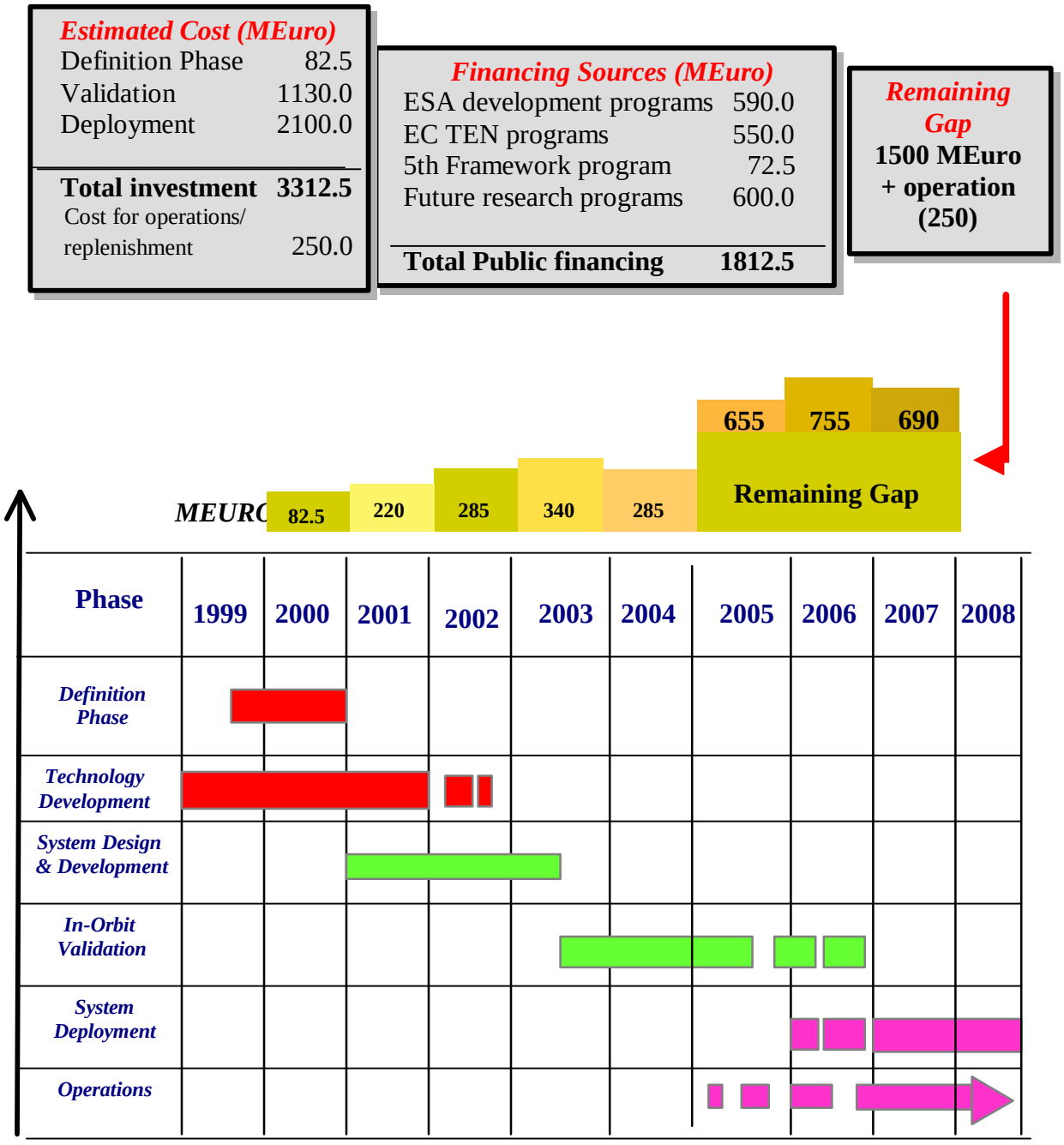

Figure I: Galileo Program Cost and Schedule. Source: Astrium, 2001.

Ltd) consolidated into a joint venture, dubbed Galileo Industries. This was a signal at the industrial and political level that industry supported the Galileo program while the degree of financial investment remained an open issue.

The difficulty of accurately determining future market value is closely linked to the debate about how the costs for the development of Galileo should be distributed. European governments and the European Commission naturally prefer industry to commit clear financial support, while industry is reluctant to invest heavily in the early stages. Industry wants action taken to increase regulatory and operational certainty. The size of private investment would depend on the legal structure created by public authorities for particular commercialization services and their official strategies to generate revenue sufficient to maintain the Galileo constellation. Industry suggested that it could help fund deployment costs under a Private Financing Investment (PFI) scheme, which has been used in some infrastructure projects across Europe.

In summary, the issue of how investments can be recouped (and how Galileo could run on a commercial basis to attract private investment) will remain an open and controversial topic in Europe. Industry has been concerned to make a heavy investment early on in a system that would be on the market at the same time as GPS. The timing of commercial operation would be a decisive factor in determining the interest of industry, that is, whether it would be able to make a profit from the system from the start.

The Interim Management Structure

Galileo has until now been largely a research and development (R&D) oriented program. Institutional arrangements are lagging behind. It is generally recognized that the European Commission is not in a position to be an operator of Galileo, while its role as a regulatory authority has been widely discussed by the EU Member States. Regarding the organization and management of Galileo, European governments agree that there must be efficient governance for the project to allow for democratic influence and political control by all participating countries

and private sector organizations. A problem here is that there is no clearly defined public customer for Galileo. The issue is that of how far European governments are prepared to delegate power to the European Commission. A related problem is in what way the program should proceed if no flexible and firm commitment can be reached to move ahead with Galileo in a manner that is satisfactory for those governments that view Galileo as an urgent EU priority. What will happen if the reluctance of some European governments to proceed rapidly actively clashes with the desires of staunch Galileo supporters? Will the whole program be taken out of the EU framework and given to a less politicized and bureaucratic governance mechanism?

Services

How should the services of Galileo be provided? Three levels of services have been proposed: an open access service (OAS); a commercial access service (CAS); and public service (consisting of safety-oriented and regulated services). OAS will be provided free of charge to users and will have an accuracy of within 6 meters and a service availability of around 99%. The commercial service will include a charging mechanism to generate revenues.

One problem is whether the safety service should be encrypted. The international civil aviation community has opposed encryption of the safety-critical services, arguing that it could jeopardize security. Alcatel Space of France, the lead contractor of the GALA consortium comprising more than 60 firms, argued that the safety-critical service should not be encrypted in order to generate revenue. Racal, on the other hand, which headed the GEMINUS consortium, preferred to have this service encrypted.

Disagreement has also focused on whether Galileo should include a communication payload to transfer navigation information. The GEMINUS consortium argued that such a payload would generate additional sources of income through management of truck, taxi and bus

fleets. The European Commission supported this view. The GALA consortium argued that no such communication payload should be included. The GALA consortium stressed instead the importance of the mass market, and the professional and emergency services market segments, while the GEMINUS consortium stressed the safety services market segment.[18]

The public regulated services are aimed at emergency services, humanitarian operations and implementation of EU transport policies (such as road tolling, dangerous goods transport, etc). This service level has been linked to a political debate on the definition of security. While most European governments recognize the linkages between Galileo and security matters, they have differed on what is meant by security. A central issue is whether Galileo should provide a Governmental Access Service (GAS). The French government, in particular, has promoted the interpretation of security for Galileo as including military security. In addition, parts of the EC services are willing to work more with the so-called Pillar II of the EU, that is, the foreign policy and security domain. They may see Galileo as an opportunity to informally address the question of further incorporation of security issues into the jurisdiction of the European Community. The European Commission is not yet in a legal position to make any strong statements on military aspects, but this situation will probably change in the future.

Military authorities within the EU Member States have taken part in planning discussions about Galileo at different levels, including at the highest level in working groups of the EU Galileo Steering Committee (the executive body that is chaired by the European Commission and that consists of EU government representatives). The military have been particularly

[18]The European Commission has anticipated that Galileo will include a capability to improve the current Search and Rescue services (SAR). Involvement of the SAR service could provide a number of additional benefits. First, it could provide faster alerts and more accurate information to the SAR rescue center. Second, it could provide an acknowledgement function that would give the user in trouble a psychologically important confirmation that the call for rescue assistance has been received. The SAR service would also allow the broadcasting of messages to alert other users in the vicinity of a distress situation.

influential in the larger EU Member States. No country has a single position on Galileo; different groups have different interests. Some governments, such as those of Germany, Sweden and the UK, stress that Galileo should be a purely commercial navigation system. They argue that any government access service provision must be preceded by detailed cost/benefit comparison analyses. What would be the added value of Galileo if it was to be perceived as partly a military-oriented system? The answer is uncertain since it is defined in technical, commercial and safety-of-life (emergency) terms, rather than in military terms.

A Second-Order Topic: Backward Compatibility with Egnos

Europe is currently developing a first-generation satellite navigation system, Egnos, which will go into operation around late 2003. The objective in developing Egnos has been to enable industry to acquire the necessary expertise (and to demonstrate the European capability) for high-performance satellite navigation systems. This effort is particularly aimed at the improvement of the civil aviation system. Most European governments and their air traffic control organizations have invested in Egnos and have an interest in protecting those investments by ensuring backward compatibility, that is, building Galileo on and integrating it with Egnos. They have consistently requested information on how Egnos should be integrated into Galileo.

Several governments, such as those of Denmark and Sweden, have not committed themselves. Denmark has been reluctant to commit because of financial costs. Sweden deliberately stayed outside the development of Egnos for strategic-technical reasons. In any case, the definition of "integration" presents a political problem. Specifically, Egnos relies on a geostationary satellite constellation that provides poor coverage at northern latitudes. Not surprisingly, the Swedish government saw no compelling justification for close integration of Egnos into Galileo. Instead, it suggested that the scarce financial and intellectual resources

involved in European satellite development should be concentrated on building Galileo into a robust and high-performing infrastructure. Interestingly, Norway, which might be expected to have similar strategic-technical concerns, has actually been more positive toward Egnos, apparently because of the stake that the Norwegian industry has in contracts for Egnos work.

The Association of European Airlines (AEA) has also voiced strong opposition to Egnos. It is worried that the airlines would have to pay for both the development and the deployment of Egnos, as well as for Galileo. It criticized the European Commission's failure to promote Galileo as a commercial venture that took the interests of the civil aviation community into account. The AEA's criticisms are important because it, and the whole civil aviation community, have considerable political and economic power. While European governments pointed out that the civil aviation market is likely to be only a small share of the market, the European Commission has to make sure that the air transport industry is satisfied that it will only have to pay for receiving additional services that it can actually use. The airlines (as Egnos opponents) and air traffic control organizations (who are Egnos supporters) eventually reached an agreement when governments gave them satisfactory answers regarding the question of payment.

The protection of the interests of smaller European countries, not least those ESA Member States that are not members of the EU (Switzerland and Norway), constitutes a further, if unofficial, problem. At a time when industry is shifting to commercial production and is envisaging a larger role for the EU in the space sector, smaller countries with weaker space agencies and industries are anxious that they will be left behind. Smaller countries strongly support ESA, which has as an aim the balancing of national interests. ESA distributes contracts

to industry throughout Europe to assure ESA governments that they will receive contracts in return for their investments in ESA.

Implications

There are essentially four general justifications for moving ahead with Galileo: technical; political; industrial; and macro-economic.

Technical Performance

Regarding technical performance, Galileo is expected to increase the integrity, accuracy and availability of current GPS signals. In terms of integrity, the user with a GPS receiver is currently not informed in real time of service errors and does not know whether a signal is reliable or not. Secondly, the accuracy of current signals for civil applications must be improved for particularly safety-critical and emergency applications. Finally, service is not available in some areas because current signals are too poor – a problem in urban areas and in northern Europe, where Galileo is expected to improve performance considerably.

Sovereignty and Security

Satellite-based applications and services are of strategic value to Europe. Politically, they represent an instrument of global influence, since independent satellite capabilities ensure control of the information gathered. The development of Galileo will provide Europe with an independent satellite system and a navigation infrastructure. Moreover, it will challenge the current de facto monopoly of GPS by the United States and still provide Europe with control over its own system. Without an active and timely European commitment to Galileo, Europe's safety-critical transport needs have to depend on a system that is not under European control.

A basic question is therefore whether governments can acquiesce in a situation in which Europe's safety-critical services and transport infrastructure continue to depend on navigation

systems that are completely outside of European control. The US government has indicated from the outset that it envisaged no "real transatlantic partnership" (that is, joint ownership and control of GPS), citing military and industrial policy reasons. This led (as might be expected and was probably anticipated) to a demand for development of a European system. In a 1995 report to the US Congress and Department of Defense (prepared by the US National Academy of Public Administration/National Research Council), the authors argue that GPS hardware, software and services constitute an important export market that must be promoted:

> For several reasons, it is in the US interest to see GPS become widely accepted and employed around the world. First, the globalization of GPS markets provides an economic stimulus to firms in the growing US GPS industry, many of which already rely on exports for a significant share of their revenues. Second, technological preeminence is an important pillar of national power. The acceptance of GPS as the world standard for position, velocity, and timing applications enhances the position of the US and allows it to lead in one important part of the process of technological and economic globalization. Third, US national security is well served by the international acceptance of GPS […] The international acceptance of GPS would also slow the development of alternative satellite radio-navigation systems, the adverse use of which could be more difficult for the US military to control or counter in wartime.[19]

Considering that the world GPS market was projected at around $ 31 billion in 2005, and that the US GPS industry dominated the equipment market, there was a strong interest in protecting the preeminent position of US industry. Concerns emerged when Europe initiated attempts to participate in the field of satellite navigation:

> "For geopolitical or economic reasons (the report continued), a number of foreign governments have adopted policies detrimental to the spread of commercial GPS. For example, the European Commission wants to implement a common European navigational transport network that will rely on radio-navigation systems […] European governments worry about the political leverage and commercial advantages that may

[19]NAPA/NRC, National Academy of Public Administration/National Research Council (1995), *The Global Positioning System: Charting the Future*, Report for the US Congress and Department of Defense, pp.14-15 (Washington, DC: National Academy Press).

> accrue to the US as the owner, operator, and manager of a system upon which so many other nations increasingly depend. Further, they are concerned that DoD's dominance of GPS policy-making and management may result in a lack of attention to civilian needs".[20]

The report concluded that it was not likely that Europe would get its act together. "European apprehensions regarding US dominance and control of GPS are not confined to any particular nation, nor do they represent a united position within any country. In fact, no single nation, let alone the European Union, appears able to unite in opposition to GPS."[21]

Translated into policy objectives, the European Commission stressed that a "real partnership" required a full European role in systems development and operation, guarantees of adequate control of satellite signals, and the opportunity for European industry to compete on equal terms.[22] In common with many officials interviewed by the author, a French official stated that Europe must move ahead quickly to avoid remaining "under the yoke of an American monopoly".

> Military location capabilities and air transport safety would be subject to American standards and entirely in the hands of the US. Given the weakness in Europe's communication, navigation and observation systems already highlighted by the recent conflict in Kosovo, this would be unacceptable.[23]

Moreover, although the present basic service provided by GPS is free, GPS operators may decide in the future to charge for the use of GPS. In such a scenario, the EU would have no influence on the fixing of charges. It could not guarantee that the currently free-of charge

[20]NAPA/NRC, National Academy of Public Administration/National Research Council (1995), *The Global Positioning System: Charting the Future*, Report for the US Congress and Department of Defense, pp.39/42 (Washington, DC: National Academy Press).
[21]NAPA/NRC, National Academy of Public Administration/National Research Council (1995), *The Global Positioning System: Charting the Future*, Report for the US Congress and Department of Defense, p.45 (Washington, DC: National Academy Press).
[22]Commission of the European Communities (1999), *Galileo: Global Satellite Navigation Services for Europe*. Meeting of the Council of EU Ministers of Transport, 17 June, Luxembourg.

services will not be subject to intentional degradation through jamming. Further, without developing its own system, Europe will remain subjected to a de facto monopoly. Europe should certainly expect that the US will retain its right to restrict access to the GPS signal in time of war. Generally, there is a need to provide a backup system since the risk of loss of the signal should be assumed. Such a backup system is also favored by air traffic control organizations in Europe since it would provide them with better guarantees of functionality. In sum, establishing a European global satellite system has to face at the outset the basic question of whether it will relate to the existing US-owned GPS system, which is militarily-owned and paid for by US taxpayers.

Industrial Considerations and Satellite Application Markets

The "political-industrial dimension of Galileo" has been translated into the goal of moving from "dominance of the US industries to a fair international competition in mass markets for user equipment and services".[24] Galileo has the potential to contribute substantially to the European economy. Two central aspects of this contribution are (1) the industrial, economic and strategic importance of access to and control of specifications and standards, and (2) the central role of the satellite applications market segments.

First, whoever defines the requirements, develops the specifications and sets the standards for satellite signals and equipment will have tremendous commercial leverage, and will gain a head start over commercial rivals. Since GPS standards are effectively set by the US Department of Defense (DOD), and US Administration policy officially aims to support GPS worldwide through its associated industry, it is crucial to ensure access to specifications for

[23]Salomon, Arnaud (1999), 'A Question of Independence and Sovereignty', *CNES Magazine*, No. 6 (August), p. 20-21. Director of space and aeronautics, French Ministry of Education, Research and Technology.

industries in other parts of the world, including the European industry. The US industry already dominates the market for GPS equipment and naturally wants to maintain its global leadership.

Secondly, European governments, the European Commission, and the European industry view satellite navigation applications as the most important future markets. The experience of Europe's lagging position in the world market for computer operating systems and software has shown the costs of dependence associated with applications. Time is running short, however, because more and more applications in Europe and elsewhere are becoming dependent on GPS; such dependence is a critical problem (Europeans argue) because GPS has no functional guarantee – if it fails, there is currently no back-up system.

Galileo is intended to be an integral part of European traffic policy. It would enable implementation of a harmonized traffic management system based on a satellite navigation and positioning service and complementary data communication. Satellite navigation can improve traffic management through the new technological possibilities of satellite navigation-based telematics. In the civil aviation sector, the application of satellite navigation, combined with a suitable communication system, would offer shorter routes, quicker access to airports through simplified navigation procedures, and would enable precise final approach and landing at most airports, thereby improving passenger safety and reducing the cost of ground infrastructure. Satellite navigation can provide a more efficient use of the existing aircraft fleet and airport infrastructure. In the maritime sector, satellite navigation is used for safety-critical navigation, fishery control, container tracking (fleet management) and maritime distress systems. In the

[24]Commission of the European Communities (1999), *Galileo: Global Satellite Navigation Services for Europe*. Meeting of the Council of EU Ministers of Transport, 17 June, Luxembourg.

railway sector, satellite-based rail applications may be used for fleet management, signaling and train control, although these applications are still at an early stage.[25]

In addition, satellite navigation is used for many non-transport applications. In the agricultural sector, satellite navigation can be used to minimize fertilizer and pesticide usage and to maximize yield ('precision farming'). Satellite positioning plays a central role in offshore exploration (for example, for exploration work, the operation and servicing of platforms, and the precise allocation of claims). There are also applications for surveying purposes, for example, to help determine deformations of dams at a very detailed level. Finally, satellites can provide a global time reference (the timing market), mainly for the synchronization of communication systems. Galileo will potentially promote opportunities for European industry to participate in all areas of the GNSS market and to develop the European market for added-value applications.

Macro-Economic Implications

EU governments have announced as a long-term strategic goal that the EU should "become the most competitive and dynamic knowledge-based economy in the world by around 2010". Galileo, in their view, would provide Europe with wider economic and social benefits (that is, apart from the direct benefits to suppliers and users). Based on the investment and operating cost of Galileo, the European Commission predicted in the late 1990s that more than 100,000 new and high technology jobs would be created between 2005 and 2025. In 2001, Commissioner Palacio claimed that Galileo would create 140,000 jobs and a potential market of Euro 9 billion a year. In addition, in the same period, Galileo would lead to Euro 200 billion in indirect savings for each one percent reduction in travel time in road transport alone. Galileo would help to reduce traffic congestion, safety and pollution and thus make government

[25]Technomar GmbH (2000), *Structural Analysis of the European Satellite Navigation Applications Segment*, Report commissioned by DG TREN/Commission of the European Communities, July, Brussels.

spending more efficient. The diagram below presents a profile of projected annual benefits that would accrue from Europe's participation in the satellite navigation market. The cumulative total benefits over the period 2001-2020 (Euro 74 billion) can be divided as follows: producer benefits (Euro 12.2 billion), social benefits (Euro 5.6 billion) and user benefits (Euro 56.2 billion), with investment and operating costs amounting to Euro 7 billion over the same period. The industry presented these estimates to the European Commission and EU Member States in early 2001.

Profile of Annual Benefits

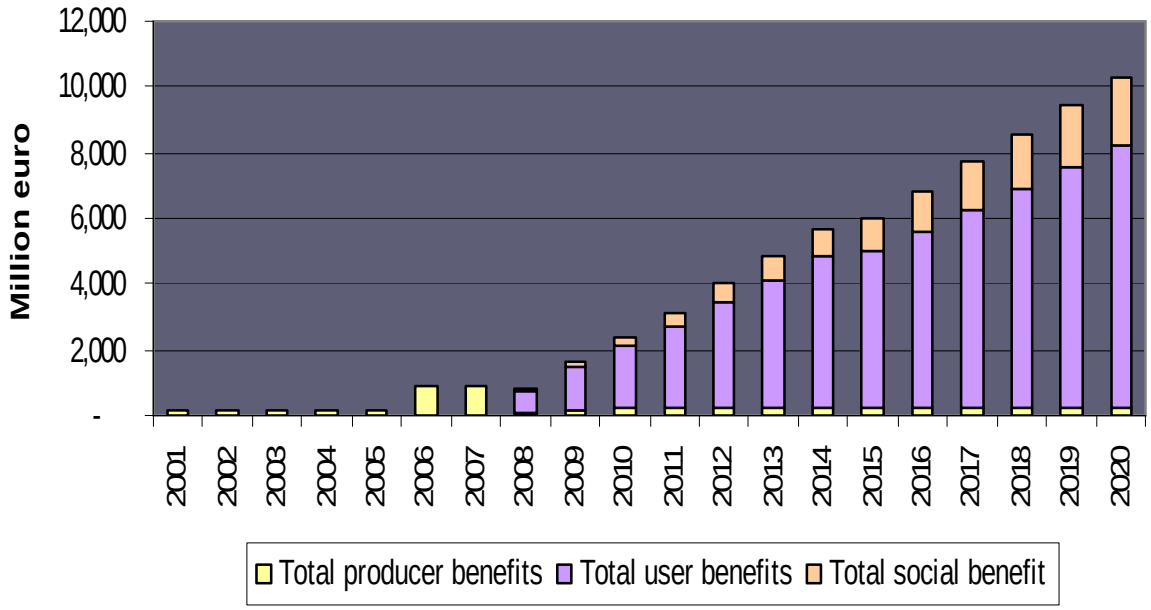

Diagram 1: Profile of annual benefits of European satellite navigation. Source: Astrium, 2001.

Choices for Europe

Forecasts about the costs and benefits of European engagement in satellite navigation are difficult to assess because of the high degree of uncertainty and the often-contradictory reports from the actors involved. In Europe, there is a heated debate about the extent to which satellite navigation should initially be a publicly or a privately funded market. This situation is not

unusual in relation to the development of large-scale projects. The European Airbus 380 project, which will produce the largest transport aircraft ever built, has been involved in a similar debate. US industry spearheaded by Boeing has repeatedly claimed that airlines will not be interested in superjumbos. In late March 2001, Boeing management announced that it had given up its plans to develop a superjumbo in direct competition with Airbus to pursue instead a different type of commercial jet, which could enter service around the same time as the European Galileo system.[26]

The European Commission has stressed the need to ensure that the EU is not locked out of the market for satellite-based services which could be worth $50 billion a year by 2005.[27] The main market focus has shifted to the promise of land transportation, which is expected to provide nearly 80% of Galileo's potential market. This sector includes cars, trucks, and fleet management and assumes the integration of Galileo capabilities with mobile phone services. The EU estimates that there will be a potential market for navigation equipment in Europe of around Euro 122 billion for 2005-2023, with an expected market for services of Euro 113 billion and an export market of Euro 50 billion during the same period.

The European space industry and the future Galileo operator would enjoy value-added benefits of around Euro 190 million annually, with an extra Euro 740 million during the deployment phase. The Galileo users' net benefits, which would climb steadily, would amount to around Euro 8 million by 2020. Rough estimates of economic and social benefits down to 2020 are Euro 62 and 12 billion, respectively. Moreover, according to the European

[26]Boeing, which had failed to win a single order by spring 2001, instead decided to focus its resources to develop a longer-range commercial jet designed to carry between 100 and 300 passengers. The new aircraft would travel just under the speed of sound (Mach.95-Mach.98) and would fly at about 45.000 feet in uncrowded airspace and thus above the cruising height of conventional aircraft (35,000 feet).
[27]Commission of the European Communities (1999), *Galileo: Global Satellite Navigation Services for Europe*. Meeting of the Council of EU Ministers of Transport, June 17, Luxembourg.

Commission, the European market for terminals could amount to Euro 370 million worth of produced terminals by 2020.[28] The table below shows the breakdown of market size (in monetary terms) by application area as predicted for 2005.

Market segment	**1999** (M€)	**2005** (M€)	***% growth***
Aviation – products & services	44	65	*48*
Commercial maritime	4	6	*50*
Car navigation – products & services	680	1 920	*182*
Fleet management – products & services	40	90	
Rail	1	24	*140*
Surveying & mapping, off-shore	49	86	*76*
Agriculture	5	12	*140*
Augmentation services	45	60	*33*
Mobile communication (excl. services)	0	6 000	*6000*
Timing	6	10	*67*
Personal navigation	50	90	*80*
Total European GNSS market	**935**	**8 383**	*795*

Figure 2: GNSS market segments for Europe. Source: European Commission [29]

The European Commission expects all markets to grow, with the largest growth occurring in the mobile communications market. The market for mobile positioning services would start from zero since no mobile phones were equipped with GPS positioning devices. It is expected to

[28]Genesis Office (2000), *Galileo Newsletter*, No. 10, December.
[29]Commission of the European Communities (2001), *Summary of Market Analysis Results for Galileo*, January; Commission of the European Communities (2000), Galileo: Situation Report. Interim Report to the Transport Council of 28 June, Brussels.

amount to around Euro 6 billion (assuming partial GNSS localization in mobile communication) or a 20 billion (assuming mandatory GNSS localization in mobile communication) by 2005.

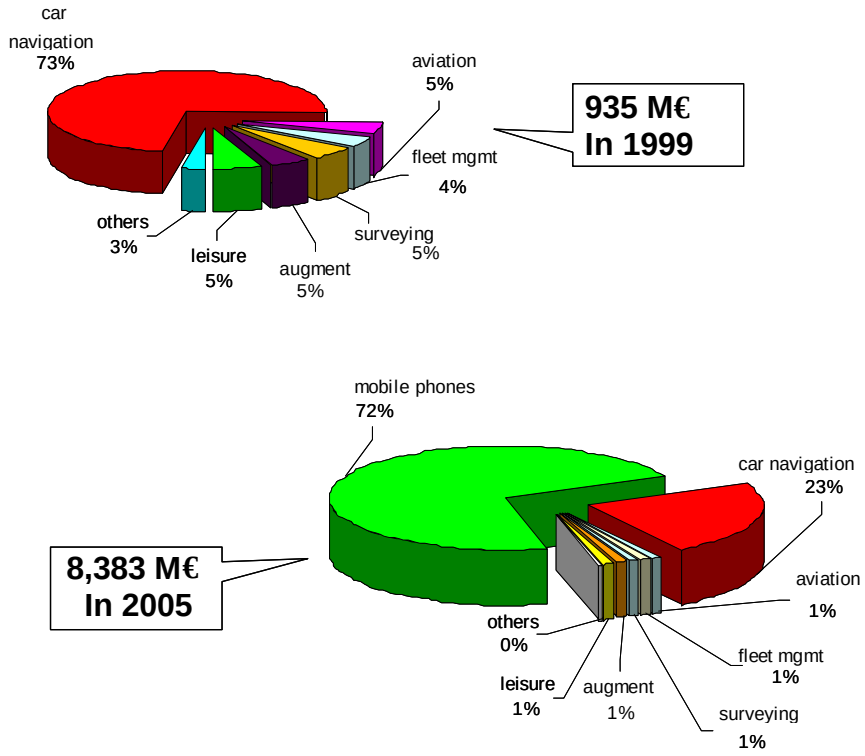

Figure 3: The European GNSS market in 1999 and 2005. Source: European Commission.[30]

All such estimates are uncertain, because of uncertainties about the technology. The take-off of satellite navigation services will depend on the future choice of positioning technology chosen for integration into mobile phones. Tough competition is likely over network-based positioning services. The European Commission reasons that added value such as greater accuracy, global coverage, and proven technology will increase the chances of satellite navigation technology being chosen. But the best technology does not always win the day. The figure above shows the relative size of various market segments. Substantial growth is expected

[30]Commission of the European Communities (2001), *Summary of Market Analysis Results for Galileo*, January; Commission of the European Communities (2000), Galileo: Situation Report, Interim Report to the Transport Council of 28 June, Brussels.

in the car navigation market, but the European Commission believes that the mobile communications market will overtake it.

Regarding possible revenue streams, European governments, industry and user groups have discussed in particular two possible alternatives: a general levy on receivers, and controlled access services. Germany and France suggest that a levy on GNSS receivers should be explored in order to strengthen the GNSS-2 business plan. One suggestion being studied is to ask the EU to require that every car be equipped with a Galileo receiver and a wireless communications device to convey the car's position to a control center. The justification for requiring satellite navigation might come from a need to control traffic on Europe's increasingly congested highways. Moreover, a significant revenue stream may be generated by a levy on receivers. However, this levy will have to differentiate between various user functions so as not to impede the development of a GNSS mass market. The introduction of a levy on receivers will depend on the political will of European governments to implement such a measure throughout Europe.

A controlled access service implies that the signal would be available on a subscriber basis, would come with guarantees as to its availability, and could be certified. Such an approach would be feasible for applications such as road pricing, tracking and tracing, fishery surveillance, and precision farming. Any mandatory measure would obviously depend on the willingness of public authorities to support it. The financial return to governments through direct and indirect taxes would amount to around Euro 45 billion, which might represent twenty times the initial up-front investment.

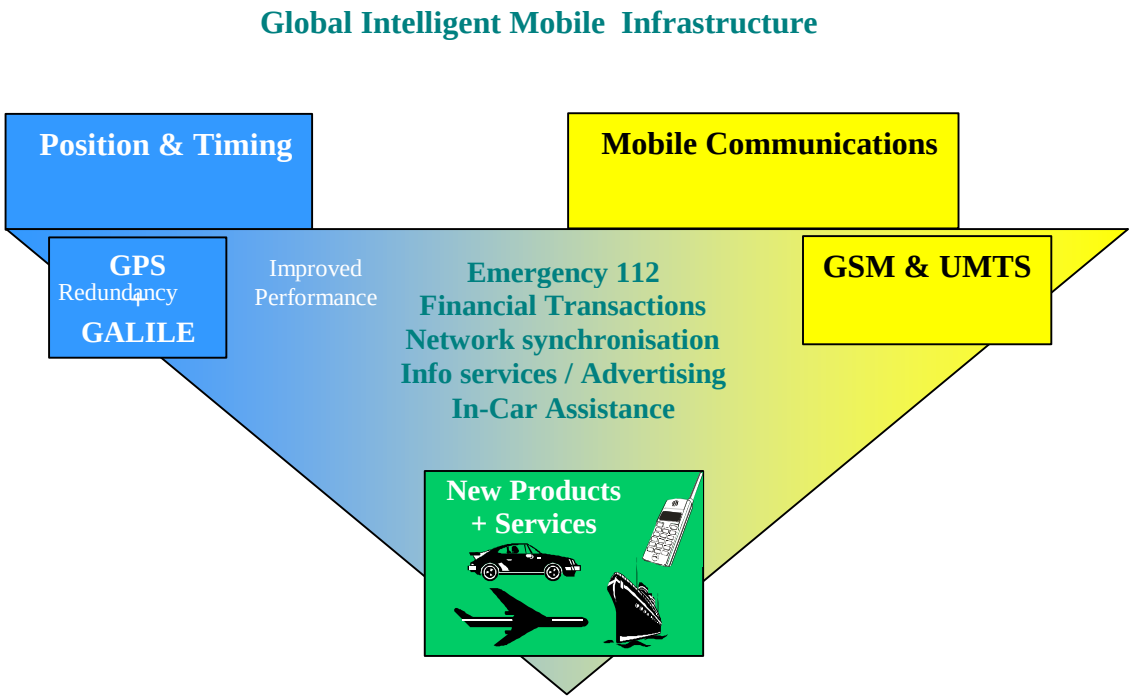

Figure 4: The Main Emerging Markets for Galileo. Source: Astrium, 2001.

Concluding Remarks

A clear decision by the EU Member States to firmly commit funding and political support for satellite navigation and Galileo is imperative. Active support would constitute an endorsement of Europe's high technology ambitions and a political recognition of an ambitious European federal program. Europe is being offered an opportunity to assume a leading role in satellite navigation on a global scale. Not to commit politically to Galileo would mean that Europe is willing to remain on the sidelines and to bow to continued US global dominance. Satellite navigation is a high-technology, high-capability industry. Nevertheless, its development involves considerable uncertainty. In addition, as this paper has shown, political problems remain. During spring 2001, France reduced its emphasis on exploring the military

potential of Galileo. Together with Italy and Spain, France accepted that the system would be used strictly for civilian purposes under private sector control. On the other hand, Germany has softened its demand for a dominant private sector role early on, although the Netherlands in particular continues to call for clearer wording on the role of the private sector.

A final decision on funding of the Galileo development phase is not expected until December 2001. Since Galileo is designed to both compete, and be complementary, with the US GPS system, timely implementation of Galileo is important. The US GPS industry and government are, of course, less enthusiastic about the European ambitions to strengthen Europe's commercial and strategic independence.

A central question is how to keep the implementation of advanced mobile wireless infrastructures compatible with satellite navigation. The EU gave regulatory and political backing to the high-speed mobile cellular communications in the 1990s. The question will no doubt arise how this European undertaking (which goes under the name Universal Mobile Telecommunication System, UMTS) will fit into Europe's efforts in the skies through satellite navigation. It is not yet clear whether Europe's ambitions in mobile cellular communications will pay off in light of strong Japanese and increasing Korean competition, along with growing American markets. If the European UMTS system becomes another export success, and the European Galileo system is closely integrated with it, the initiative will have paid off. However, this is a high-risk game where the outcome is uncertain. What investors normally try to do under such circumstances is to hedge their risks or to sit on the fence. However, customers, not politicians, will choose what technology they want to use. The increased use of mobile terminals together with wireless technology will pave the way for completely new services and lead to mobile multimedia terminals. Mobile telephony already has location and positioning service

capability and this market will most likely grow considerably in the years to come. Can Galileo and future mobile telephony, therefore, interact and come together?

In terms of institutional arrangements, the Galileo program can provide a stepping-stone and an example for more formal and permanent relations between the EU and other organizations, not least the European Space Agency (ESA). The European Commission and ESA have worked together through ad hoc arrangements. They need to harmonize different decision-making procedures, institutional arrangements, and working practices.

Finally, regarding international cooperation and interoperability, the European Galileo system should be made interoperable with GPS in a cost-effective way to increase performance for the benefit of service providers, large user communities and individual end-users around the world. The European program should remain open to international cooperation and partners (such as Brazil, Japan, Turkey, and Russia). While meeting European strategic, industrial and economic requirements, Galileo provides a unique opportunity to develop a truly global Europe satellite navigation system. Users worldwide could benefit from a truly seamless, interoperable global navigation satellite architecture more capable and reliable than any one system alone. While assuming a world economic and technological position, Europe must respect the concerns and needs of third countries. Furthermore, Galileo has to be global since (1) safety-related applications in the civil aviation or shipping sectors using transport networks integrated across boundaries demand a global system, and (2) manufacturers want to market interoperable user equipment directly for global markets.