Claremont-UC Undergraduate Research Conference on the European Union

Volume 2016 Article 4

9-22-2016

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Abstract

This paper examines the Galileo satellite navigation system as an example of European collaboration, and illustrates how the project has put Europe and European industry at the forefront of the space industry. It discusses the history of the program as well as its technical and financial aspects. The collaboration efforts are discussed highlighting the nature of the political, economic and technological forms of both intergovernmental and supranational cooperation. In addition to the Galileo system, the paper also includes a brief discussion on the Global System for Mobile Communications, one of the greatest successes of European technical collaboration.

Keywords

Galileo, satellite navigation, European collaboration

Introduction

In a recent New York Times article titled *Europe the Unready*, Paul Krugman states that "European unity has suffered setbacks" but that "ideally, Europe would respond to these setbacks by strengthening its union, creating more of the institutions it needs to manage interdependence" (Krugman, 2015). Today, some even go so far as to question the whole concept of a Union, and others seem to want the European Union to disintegrate. Collaboration at various levels has been key to maintaining unity, peace and prosperity, and remains at the core of the Union. Since the beginning of what was essentially an economic project albeit with a political end- peace - what helped the European Union develop into a political union has been collaboration, especially industrial collaboration, and many successes have emerged, including in the telecommunications, space and aviation industries. Major programs such as Galileo could not have been launched as national programs. But their success has depended on strong political will of European partners as well as on buy-in from industry. This collaboration and cooperation at various levels has created the tools and framework necessary for the success of these programs and projects.

This paper offers a brief analysis of one of the key European collaboration efforts in the space sector - the Galileo satellite navigation system - and compares this project to one of the most successful cases of collaboration in the telecommunications sector - the Global Standard for Mobile Communications (GSM) - where cooperation and collaboration between European governments, industry, and standard setting bodies under the guidance and leadership of the European Commission helped to establish the GSM project as a global standard for the communications sector in Europe and around the world.

Galileo

According to the European Commission, the European Union's executive body that represents the interests of the European Union as a whole, "6-7% of European Global Domestic Product – representing a value of around 800 billion Euro– is already dependent on satellite navigation" (European Space Agency [ESA], 2014). This has had an important impact on the European economy, both in terms of opportunities for the space, defence, and aviation industries, as well as in terms of the ripple effects of the space industry and its developments on other industries and sectors – transport, health, education, and electricity to name but a few. The market for satellite navigation services alone is expected to be worth EUR 250 billion per year by 2022, and estimates indicate that Galileo could contribute EUR 90 billion to the European economy over the first 20 years of operations (European Commission, 2016).

For many years, the American Air Force satellite navigation system – the Global Positioning System (GPS) - dominated the satellite navigation market. The GPS system has both military and civilian purposes. Since the 1990s, for a variety of reasons, including the protection and promotion of national and European defence and industrial policy and industries, European politicians and industry have realized the need to create less dependence on GPS and indeed to develop their own system. They believed that this could protect European defence interests while also promoting industrial policy and increasing the competitiveness of a key industry for Europe. In addition to independence from GPS, the system was also created to be a civilian system, with the aim of creating jobs and other economic opportunities across Europe. The main concerns that the United States had with the Galileo satellite navigation system were security and commercial issues, i.e. the US saw Galileo as

competition. However, an agreement was reached in 2004 which acknowledged that Galileo is complimentary to GPS and created collaboration efforts within Europe and between Europe and the United States. Indeed, this agreement built on already existing strong cooperation efforts in the space sector between the European Union and the United States. The Russian Government also owns a satellite navigation system, Globalnaya Navigazionnaya Sputnikovaya Sistema or Global Navigation Satellite System (GLONASS), which was created during the former Soviet Union regime, with the first satellite set in orbit in 1982. When the Soviet Union fell, significant budgetary cuts affected the GLONASS project, and it was not until 2001 that the GLONASS constellation started to be modernized. In 2007, Russia announced that it would finish GLONASS and make it available to customers. Like GPS, this system is a military system. Competing with GPS and GLONASS, both military-run programs, has been a challenge for Galileo.

A 1999 European Commission Communication listed three reasons why a European satellite navigation system had become essential. This positioning was also confirmed in a 2015 Paper entitled *Europe Must Succeed in the Global Navigation Market Race*, where Galileo Services stated that there was a real need for "a coordinated industrial policy to support the European economy and to contribute to the competitiveness of European enterprises. It addresses the specific case of the European industry of applications and services based on satellite positioning, navigation and timing - the European Global Navigation Satellite System (GNSS) downstream industry" (Galileo Services, 2015).

The first European satellite navigation system - the European Geostationary Navigation Overlay Service (EGNOS) - and precursor to Galileo, consists of three geostationary satellites and a network of ground stations. EGNOS still uses the American GPS satellite navigation system and is used for safety critical applications including aviation and shipping. EGNOS is a first example of collaboration in this field, joining the European Space Agency (ESA), the European Commission, and the European Organisation for the Safety of Air Navigation in a first phase for the development of the system. After the first phase, ownership and management of EGNOS was transferred to the European Commission on 1 April 2009. Operations are defined through a contract with the European Satellite Services Provider, an operator based in France (ESA, 2013). Air Traffic management agencies from a plethora of different European countries were key players in EGNOS by contributing to the Advanced Research in Telecommunications Systems funding.

Although the EGNOS uses the GPS satellite navigation system for safety critical applications, including aviation, the aim of creating Galileo was to have an even more precise and European-led project.

The first European Commission Communication specifically on Galileo was published in 1999 and was entitled *Involving Europe in a New Generation of Satellite Navigation Services*. The Communication specifically recognized that even though the United States already had a head start in developing global navigation systems, Europe had much at stake and therefore needed to make a decision quickly on its stand in terms of developing a next generation of positioning, navigation, and timing systems (European Commission [EC], 1999). Several Member States did not want to share their industrial power or had a fear of a lack of political will for the project. Different member states also wanted different objectives for the program, i.e. France wanted a large military use, whereas the United Kingdom did not. However, although the European Commission illustrated the political will to support the project, including the fact that it created the Galileo Task Force and launched the Galileo

Overall Architecture Definition Project to define what the Galileo project would achieve, some Member States were reluctant to join in the efforts. The Treaty of Lisbon strengthened the space policy in the European Union by allowing the European Union to conduct a Space Policy, which it was not authorised to conduct before. It also required the European Union to create relations with the European Space Agency.

The Galileo program "was financed jointly with ESA in the first stages, its full deployment has been financed with European Union budget funds. The European Commission, as the executive arm of the European Union, is the program manager. As any other undertakings of the European Union, the EU Member States are the ultimate stakeholders of the program and play a major role in the decision-making process" (Bartolomé et al., 2015, p 10). Part of the reason for its survival was that although the project was initially designed as a partnership between the public and public sectors, meaning that its cost and revenue would be shared, support from France and Germany in particular allowed for its transformation into a new financial structure. The initial phase, meaning the definition phase, development, and In-Orbit Validation phase of the Galileo program were carried out by ESA and co-funded by ESA and the European Union. However, this structure could not be continued due to the perceived risk and cost of the project by key stakeholders. China became involved in 2003, and even funded the project. However, after being shut out of the decision making bodies and Chinese companies not being awarded projects, the partnership was halted. In 2007, sceptics thought the project would not be realized and an article in *The Economist* even stated that Galileo was "a political creation founded on national vanities rather than commercial logic" (The Economist, 2007). In 2007, the Public Private Partnership (PPP) scheme for Galileo funding failed, and this could have been the end of Galileo.

Despite its challenges, though, the project continued, with European Funds being leveraged for the project – again an example of political will as well as leadership from the European Commission and the realization that it was a priority to pursue the project. Although at first the financial actors (which includes European nations as well as private industry and China) were not able to agree and the European Union Transport Commissioner Jacques Barrot personally even stopped the PPP, the European Union Transport Council at its session of 29 and 30 November 2007 decided to support the future developments of Galileo. Indeed, the Transport Council did not terminate the project, but rather "endorsed a fully public funding scheme for the construction and deployment of the funding modalities" (Nardon, 2007). The Transport Council also gave the European Union funding authority. This decision together with the European Union Economic and Finance Ministers Council and European Parliament decision of 23 November 2007 on the financing of the program gave the European Commission the basis to implement the next phase of the European Global Navigation Satellite Systems program by providing that the next phase would be carried out and financed by the European Union (EC, 2007).

Since then, the political will for this project, and for some kind of collaboration between the European Union, the European Space Agency, and the Member States has reemerged in part due to a changing world order, where dependence on non-European space infrastructure is not perceived as optimal to the future development of Europe. Having an independent, civilian European global positioning system, which could be used for both military and civilian purposes creates less dependence on other countries and regions and is key to European autonomy and its economic and industrial development. Today, there are numerous examples across the sectors where precise information is key for effective

operation. Satellite navigation systems provide key positioning and other types of information which are essential for the effective operation of, for example, smart grids, oil fields, telecommunication networks, transportation networks, and banking networks.

Today, the Full Operational Capability phase of the Galileo program is completely funded by the European Union as seen in the Draft General Budget of the European Union for the Financial Year of 2016 and managed by the European Commission. The European Union plans to spend about 7 billion Euro to get Galileo to Full Operational Capability by 2020 (European Union, 2015). As seen in many other European Union decisions, the true motor of the Galileo project has been the Franco- German partnership (many of the contracts were given to French or German entities), with the French Space Agency; *Centre National d'Etudes Spatiales* (CNES), and the German Space Agency; *Deutsches Zentrum für Luft-und Raumfahrt* (DLR) doing a substantial amount of research.

Galileo will be comprised of 30 satellites in Middle Earth Orbit (which is at about 23,000 kilometers above the Earth's surface). These satellites have an inclination of 56 degrees (European GNSS Service Centre, 2015) and there will be three orbits with two redundant satellites in each. The first satellite for Galileo was launched in 2005. This satellite, GIOVE-A was meant to prove the technology. The first In-Orbit Validation (IOV) satellites were launched in 2011 to prove that the ground segment works and that the system meets all the requirements. After the four IOV phase satellites proved that the technology was a success, eight more satellites have been launched and the system is now progressing towards Full Operational Capability (FOC). There are currently 12 satellites in orbit, with the last two being launched in December 2015. Galileo will be able to provide initial operational compatibility by the end of 2016 and FOC is scheduled for 2020 (EC, 2016). A further launch is scheduled to be in May 2016 from French Guiana, with four more scheduled to be launched by December 2016.

Satellites also need to have a ground segment to be able to communicate with the Earth. Today, there are two main Control Centers, the Fucino Control Center in Italy and the Oberpfaffenhofen Control Center in Germany, which control the satellites and the mission. The site in Italy primarily manages the data whereas the site in Germany controls the satellites. These control centers are also redundant for each other (i.e. they can take on the other's responsibilities in case of need). There are many other Sensor Stations that manage different tasks such as sending navigation instructions, tracking, and connecting the ground stations. The full infrastructure is as follows and is additionally shown in Figure 1:

- "16 sensor stations;
- 2 control centres;
- 5 mission uplink stations;
- 5 telemetry, tracking and command (TT&C) stations;
- 4 service facilities: the Galileo service centre, the Galileo reference centre, the Search and Rescue data service provider, and the Galileo security monitoring centre" (EC, 2016).

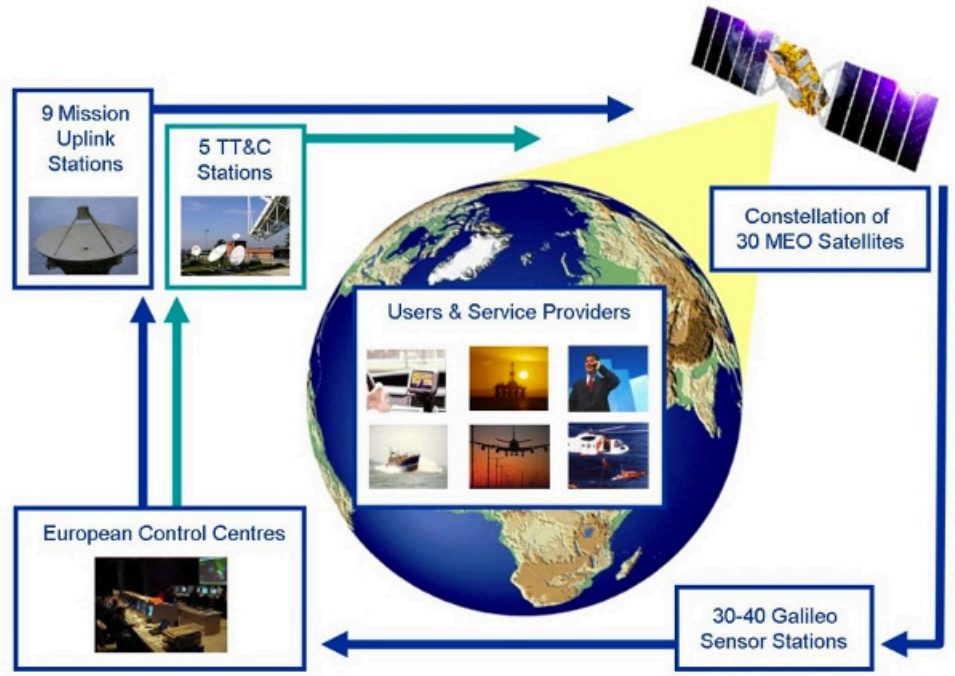

Figure 1: Full Infrastructure of the Galileo Navigation System (EC, 2016)

An important fact about Galileo is that it is complementary to GPS, meaning that both systems can be used together. According to a 1999 European Commission publication entitled *Involving Europe in a New Generation of Satellite Navigation Services,* "Galileo gives Europe clear opportunities for strengthening political ties with other countries" (EC, 1999). This publication also rejects the zero option which is Europe's withdrawal from having a role in Global Navigation Satellite System.

The fact that the European Union only recently got involved in the European space sector and the strong political will to make Europe a world space power comparable to the United States and Russia as well as the new space powers (i.e. China and India) makes the need for the success of the Galileo satellite system crucial. With guaranteed funding until 2020, and recent progress in launches, this project could be the next success story of European collaboration. However, a major problem of Galileo still seems to be its competitive viability and its profit capacity versus GPS. In the first years, the United States challenged the need for the program and was concerned about possible non-civil uses of the system. Today there is still political support as illustrated by the incorporation of the project in the Europe 2020 Strategy, the Horizon 2020 program, as well as European space industry's competitiveness at the global level.

Another Example of European Collaboration

In the late 1980s, liberalisation in the telecommunications sector was starting around the world, presenting governments and society with a great challenge, and many opportunities. Times were changing at economic, political and social levels and the European Commission and key Member States were realizing that there were long-term economic goals in Europe that had to be addressed, including in the telecommunications sector. The *Conference des Administrations Europeans des Posts et Telecommunications* (CEPT) also saw that it needed to address specific sector needs. In Europe, although many of its member states still had state monopolies for telecommunications, with national interests dominating their respective agendas, they were also aware that in order to develop and benefit from an industry that was showing economic promise, significant levels of pan-European co-operation were becoming essential, if only to provide economies of scale for new business models. And yet, differences in relation to cellular technology standards still existed inside CEPT, and negotiations were difficult.

The process of making a unified European mobile standard was not easy since standards were scattered – even across the Union – and commercial interests, security, and political interests intervened in the quest for harmonization. Like many EU developments, the central core of political and economic power consisted of French and German cooperation, and here too the insights and political willingness to succeed and move forward proved to be key to the success of GSM. In 1984, France and Germany signed a joint development agreement for GSM (GSMA, 2016). Both governments saw a need for Europe-wide regulation and, working together with the European Commission, who wanted to bring in funding and support and threw their political support behind the process with the adoption of the Frequency Directive for the 900 MHz Band, and with other member states, they led the effort to lobby the mobile industry in each member country of the European Union to convince them of what they essentially saw not only as an economic opportunity, but also as a political opportunity for European industry.

Politicians and stakeholders realized that by harmonizing communications standards at European level, more than just a technical standard would be achieved. It would also contribute to the freedom of movement of people, goods, and services – one of the core items on the agenda of Jacques Delors who had become President of the European Commission in 1985. This created momentum with European mobile industry players who, realizing the economic benefits of a harmonized European and even of a global standard, started putting their weight behind the call for and development of this harmonized standard. Governments supported industry and France, Germany, and the Nordic countries in particular were central to the process. The European Commission also saw the opportunity and threw their weight behind the work of governments, industry, and standards setting body. At first there was some resistance as CEPT saw no need for Commission support or interference. But the momentum could not be stopped and political, technical and economic support was needed at all levels.

What also helped was political momentum – politically the European Commission was empowered – Jacques Delors was President of the European Commission from 1985 to 1995 and he was looking to achieve the further success and unity of the European Union. Although CEPT did not see the need for the European Commission to intervene in GSM, through its work in the World Radio Communications Conferences (WRCs) and the adoption in 1987 of the GSM Directive that reserved part of the 900MHz spectrum band

for GSM technologies like mobile phones, the role of the Commission was recognized, and made significant contributions to the process, both at standards, political, regulatory and promotional level. One of the most important documents produced by the European Commission was a Green Paper, in 1987, on the development of the common market for telecommunications services and equipment. This Green Paper emphasized the importance of a "technically advanced, Europe-wide, low-cost telecommunications network" (European Union, 1987) for a competitive European economy. The Green Paper suggested European competition in the areas of network equipment, terminals, and communication services. With this Green Paper, industry had finally achieved the political support it needed to advance its objectives. In 1998, another European Union Green Paper was written – the Green Paper on Convergence – that started a debate on the implications of the convergence of the telecommunications, media and information technologies sectors. The success of the Green paper, and its related discussions and decisions can be attributed to the success of GSM since the European Commission was able to use its authority and employed t to further liberalise the telecommunications market as a whole in the next years – a process started in 1987, with full liberalisation by 1998. This led to the digital mobile telephony boom in Europe and around the world. This standard is an example of swift and effective European Union cohesion and collaboration, not only between countries, but also between politicians, industry and consumer interests.

Conclusion

Today, there are multiple crises within the European Union. Some even threaten to tear the Union apart, which has kept peace for over six decades.

As seen by the GSM story - a past example of European collaboration, when EU member states work together - great technological progress has been made in Europe, and the projects have also had a global impact. The collaboration to create GSM led to what is today one of the most (if not the most) important communications standard. Although the Galileo satellite navigation system is not yet completely developed, it has also shown signs of just how important it will be in the future. And its development is also due to the fact that it is a pan- European project that has benefitted from collaboration between institutions and countries. Galileo's strength comes from the fact that it "seems to be in line with the story of EU integration since the 1950s" (Nardon, 2007). It is also a strong program because the European Commission supports it. As Paul Krugman said, the Union has had its challenges but that "ideally, Europe would respond to these setbacks by strengthening its union" (Krugman, 2015). The Galileo project has the potential to be the next great European success. However, if it fails, a great opportunity will be lost, and the window of opportunity for European industry to benefit from the current GNSS market boom will be closed. Harnessing technological advances has more often than not strengthened the Union, and in a time where nationalistic parties are growing and advocating for the end of Schengen, the Euro or even the whole Union, these advances will foster solidarity, create job opportunities and can thus lead to stronger integration, and ultimately to hope for a better life and continued peace for its citizens.

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