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Building a Multinational Global Navigation Satellite System

An Initial Look

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Prepared for the United States Air Force

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Summary

GPS and Galileo (see pp. 13–20)

The Global Positioning System (GPS) has been the preeminent source for positioning, navigation, and timing (PNT) data in many nonmilitary applications, including various modes of transportation. GPS and its U.S. government augmentations are managed by the Interagency GPS Executive Board (IGEB), which was established by Presidential directive in 1996.[1] The IGEB's functions and responsibilities support the U.S. objective of establishing GPS as the standard PNT source for the national and international community. This objective enables the United States to retain control of a critical information technology and ensures that U.S. organizations can actively participate in the economic growth and technical maturity that result from this technology. No other system has presented a credible competitive threat to this objective, until now.[2]

Galileo, a European space-based PNT system, will be similar to GPS in many ways, such as providing a free service for mass-market applications; but it will be very different in other ways, such as having civilian management and control, as well as a fee-for-service compo-

[1] http://www.igeb.gov.

[2] The Russian military-operated PNT system, known as the Global Navigation Satellite System (GLONASS), began operating in 1993. However, it has not been maintained well, and aging satellites have not been replaced. Russian officials have announced a development program to increase the constellation size to 18 by 2008 using longer-life satellites ("GLONASS, GPS and Galileo: A Multi-Expert Interview," 2003).

nent. The significance of these similarities and differences partly depends on the user's perspective. For example, consistent spectrum use across both systems would benefit the civilian user but could complicate U.S. military objectives. The dimensions of GPS's and Galileo's coexistence encompass technical, geopolitical, regulatory, national security, and economic issues.

Of the many uncertainties about a future world in which GPS and Galileo coexist, economic impact is the one that implicitly embodies the concerns of some in the GPS civil community and directly challenges the motivations for Galileo. There are concerns that the competitive environment ushered in by Galileo, with its different technical design and management practices, will create a fragmented or shifted (from GPS to Galileo) user base for PNT information and services. The stated motivations for Galileo are to create jobs, to increase market participation of European firms, and to reduce reliance on the United States—motivations that have caused some to view the Galileo competitive approach as more destructive than constructive.[3] Which competitive environment Galileo will present is not yet clear.

When viewed from a broader perspective, competition is seen as a positive condition, even when it reshapes the landscape (Lancop, 1997). And the landscape in aerospace has seen this sort of change before. Certainly the success of the European Space Agency (ESA) in establishing a European presence in launch activities via Ariane and in commercial aircraft via Airbus is enough to give one pause about what Galileo might mean for GPS. Who will benefit and who will pay as a result of the changes ushered in by Galileo?

To explore the economic ramifications of Galileo, we considered a competitive environment in which competition is defined by three factors: interoperability and/or compatibility, strategies employed to foster Galileo adoption, and the schedules for GPS modernization and Galileo development. What influence might these factors have on

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[3] *Constructive competition* refers to surpassing the competition by providing a superior product/service. It may lead to continual innovation. *Destructive competition* refers to prohibiting, outmaneuvering, or otherwise decimating the competition to create an advantage for one competitor over the other.

the economic impact of GPS and Galileo coexisting? How should the United States respond in anticipation of Galileo, regardless of whether it succeeds or fails?[4]

Study Boundaries (see pp. 9–11)

The complexity of the GPS and Galileo situation necessitated that we set firm boundaries for our assessment of the three factors. For the interoperability and compatibility assessment, we adopted the parameters currently used by the GPS community and then limited our inquiry to considering the ramifications of these parameters, particularly along economic lines. We do not comment technically on Galileo's design, and we make no comparisons intended to rank the two systems.

For the second factor, strategies employed to foster Galileo adoption, we explored the economic ramifications of mandating the use of Galileo (in certain markets) or restricting (industry) opportunities for participating in Galileo, without commenting directly on the soundness of the business model.

For the third factor, GPS modernization schedules and Galileo development, we considered the incremental capabilities offered by GPS and Galileo. Although we note challenges for both efforts in attaining their schedules, we make no prediction about when the enhanced/new capabilities will actually emerge.

We used the PNT industry as a proxy for the user in our assessment of economic benefits because of the industry's inherent connection to the user base. Literature reviews, discussions with domain experts, and industry surveys informed our observations about the competitive factors in areas related to performance, management, and use of satellite PNT. We talked to representatives of the GPS Joint Program Office (JPO), the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence

[4] This study assumes that Galileo succeeds—in other words, that it achieves the advertised capability as planned.

(OASD C3I), members of the Institute of Navigation (ION), and members of the GPS Industry Council. Additionally, we held exploratory discussions with several manufacturers and service providers to probe the significance of GPS and Galileo coexisting and the consequences of the competitive factors.

Collectively, these sources were used to develop, distribute, and evaluate surveys to better understand the potential economic ramifications. Of the approximately 250 contacts we made with industry, only 19 completed the survey, and even with the direct industry contacts, the sample size is not representative. Therefore, the results are illustrative but cannot serve as the basis for generalizations. The companies that we interacted with (either directly or via survey) are listed in Appendix A. Both forms of respondents, along with other domain experts, constitute an informal panel of experts; their responses, combined with other research, formed the basis for our observations.

Suggestions (see pp. 49–70)

We were not able to quantitatively determine the economic benefit, partly because we lacked the market information necessary to assess how the user *values* the services and performance from combined or independent constellations. However, we were able to qualitatively consider the implications for U.S. PNT providers, as well as for users in general. In developing the following list of recommendations, we considered the needs and objectives of the stakeholders (providers and users), as well as plausible civilian user responses to GPS and Galileo coexisting:

1. The United States should remain indifferent to Galileo, from an economic standpoint, as long as the European Union (EU) does not apply restrictive policies/regulations. U.S. responses to such restrictions could include retaliatory practices (e.g., mandating GPS), providing a superior civilian service based on market research, and increasing cooperation with Galileo. We do not rec-

ommend the first action; we view the second and third actions as more likely to result in an increased net economic benefit.

2. The United States should directly address the political impediments to greater cooperation in order to explore the range of options for bringing about greater opportunities in providing PNT data/services. It is important for the United States to establish GPS as a trustworthy and reliable resource for the global community, to leverage opportunities (such as Galileo) to modernize GPS and offer enhanced augmentation services, and, potentially, to maximize GPS's use for future coalition operations. Working with the EU as a cooperative partner in the provision of PNT data/services may help attain these goals.

3. The United States should reevaluate the *implications* of GPS's dual-asset nature. Clearly GPS is and will remain a dual-use system, but a potential opportunity exists to improve the civilian service in ways the United States can do only if it shares the burden. Should the United States seek to formally share the responsibility of satisfying civilian user needs with the EU? Included in this decision is another one: What level of commitment will GPS providers offer to the civilian user base above and beyond what is currently offered? Both the GPS and the planned Galileo system are trying to provide a level of robustness and service that is difficult to meet individually but may be more easily achieved jointly. A combined system may allow both the United States and the EU to provide high performance and robustness without maintaining the current 24+ satellite constellation at all times. This possible scenario—combined, cooperating GPS and Galileo systems—should be examined in earnest but raises many additional questions that require further analysis and evaluation, such as: How much U.S. independence is needed and how much interdependence is tolerable, particularly for national security concerns? What metrics are available for assessing how well these changes would meet U.S. national security objectives, missions, and concerns? What assurances would be required of the EU to demon-

strate its commitment as a reliable partner capable of developing, deploying, and sustaining the Galileo constellation over time? What would be the impact on the many and diverse augmentations that have emerged to satisfy the growing civilian need?