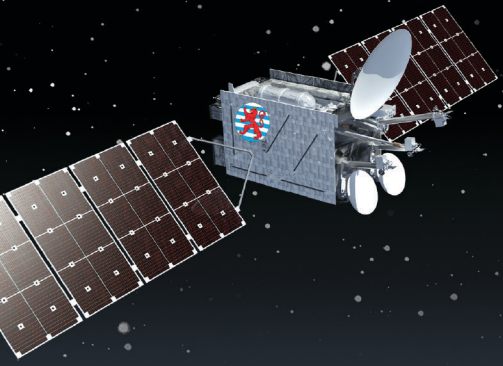


**CENTER FOR SPACE  
POLICY AND STRATEGY**



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***A MODEL FOR SPACE SECTOR GROWTH:  
A LUXEMBOURG CASE STUDY***

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## Summary

Luxembourg's space policy and strategy provides a unique case study for space sector growth. While traditional space sector growth is spurred by government directed space activities, the Luxembourg government has supported commercially directed activities for growth of its space sector. The country has demonstrated the success of this approach through sustained space activities since the 1980s and is actively growing its space industry via attracting new space companies through its space resources initiative. Qualitative analysis of Luxembourg's policies, programs, and strategies have yielded several emergent themes. These themes form the basis for a model of economic diversification via space sector growth that could be utilized by other nations. The U.S. could support non-spacefaring and emerging spacefaring nations in the adaptation and application of this model. Increasing the space capabilities of friendly foreign nations may provide numerous benefits to U.S. national security, civil space, and the commercial sector.

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### Introduction

Governments are—and are likely to remain for the foreseeable future—the major drivers of space capability establishment and growth. Geopolitics is the most common impetus for developing space capabilities because such capabilities spur national power and national pride. Thus, most countries establish their space capabilities through government-directed activities, meaning that the initial growth of their space sector is dominated by government space activities. Private space companies generally develop as contractors for government space activities, and thus do not direct space activities. Commercially directed space activities are secondary, cropping up only if policies are in place to enable them and only after government-directed space activities are well established.

Although government directed space activities are the norm, there is an alternative approach to space sector establishment and growth that may provide significant advantages, especially for small, resource-constrained countries. This alternative approach is best exemplified by Luxembourg. The government of Luxembourg has focused on promoting and supporting commercial space activities, with government activities typically undertaken for the benefit of private space companies. This approach has been successful for Luxembourg thus far, as demonstrated by its status as a major player in the satellite communications business. It remains too early to judge the success of Luxembourg's latest ambitions to advance space resources, but the initiative has attracted numerous companies to open offices within the country.

Luxembourg’s strategic approach to space sector development could serve as a model for non-spacefaring and emerging spacefaring countries that aim to establish or expand their space capabilities. It also presents an opportunity for the U.S. public and private sectors to leverage this model in supporting non-spacefaring and emerging spacefaring countries, which could produce a number of short- and long-term benefits for U.S. national security, civil space activities, and commercial markets.

### Luxembourg’s Approach to Space

Luxembourg has had sustained space activities since the 1980s when Société Européenne des Satellites (SES), a satellite communications company, was founded in the country. Although the desire for a Luxembourg satellite was instigated by the government, its implementation was entrepreneurial and focused on private sector development. Luxembourg’s push for a private telecommunications satellite was fraught with significant political and financial risk, and the first two ventures the government supported to create a communication satellite business, Compagnie Luxembourgeoise de Télédiffusion (CLT) and Coronet, both failed to do so.<sup>1</sup> After these failures, the tenacious Luxembourg government continued its pursuit of a satellite, but this time it took a central role in bringing investors to the table to reduce the risk of politically driven failure.<sup>1</sup> This third attempt at a Luxembourg satellite led to the start of SES in 1985. After the launch of SES’ first satellite in 1988, SES continued to grow its satellite fleet and expand its customer reach. This led to the growth of Luxembourg’s space sector, as many new companies started in the country to support or use SES’ products and services in various ways.<sup>2</sup>

In parallel to this private space sector growth, the government took steps to increase its standing in the space community and expand opportunities for its private space sector. In 2000, Luxembourg entered into a cooperative agreement with the European Space Agency (ESA) to participate in its Advanced Research in Telecommunications Systems (ARTES) program, which was initiated to support telecommunications research and development with the goal of transferring technologies to commercial applications.<sup>3</sup> In 2005, Luxembourg became the 17th member state of ESA, which provided expanded research and development opportunities from which its private space sector could benefit.<sup>3</sup> Additionally, in 2014, Luxembourg became a member of the United Nations’ Committee on Peaceful Uses of Outer Space (COPUOS).<sup>4</sup>

Although Luxembourg has been an established player in the satellite communications market for decades, the Luxembourg government continues to support the expansion of commercial capabilities in this area. In 2015, SES and the Luxembourg government entered into a public-private partnership, establishing the company GovSat with the intent to provide military satellite communication capabilities. The company’s first satellite, GovSat-1, was launched in 2018 and has been made available for use by members of NATO. According to GovSat CEO Patrick Biewer, the company is actively considering further expansion of GovSat’s assets and capabilities beyond GovSat-1.<sup>5</sup>

Until recently, Luxembourg’s space activities have primarily revolved around telecommunications, but in 2016 the government started its space resources

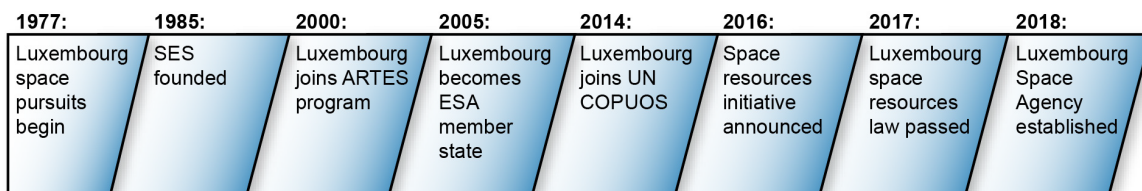


Figure 1: Timeline of Luxembourg Milestones in Space Activities

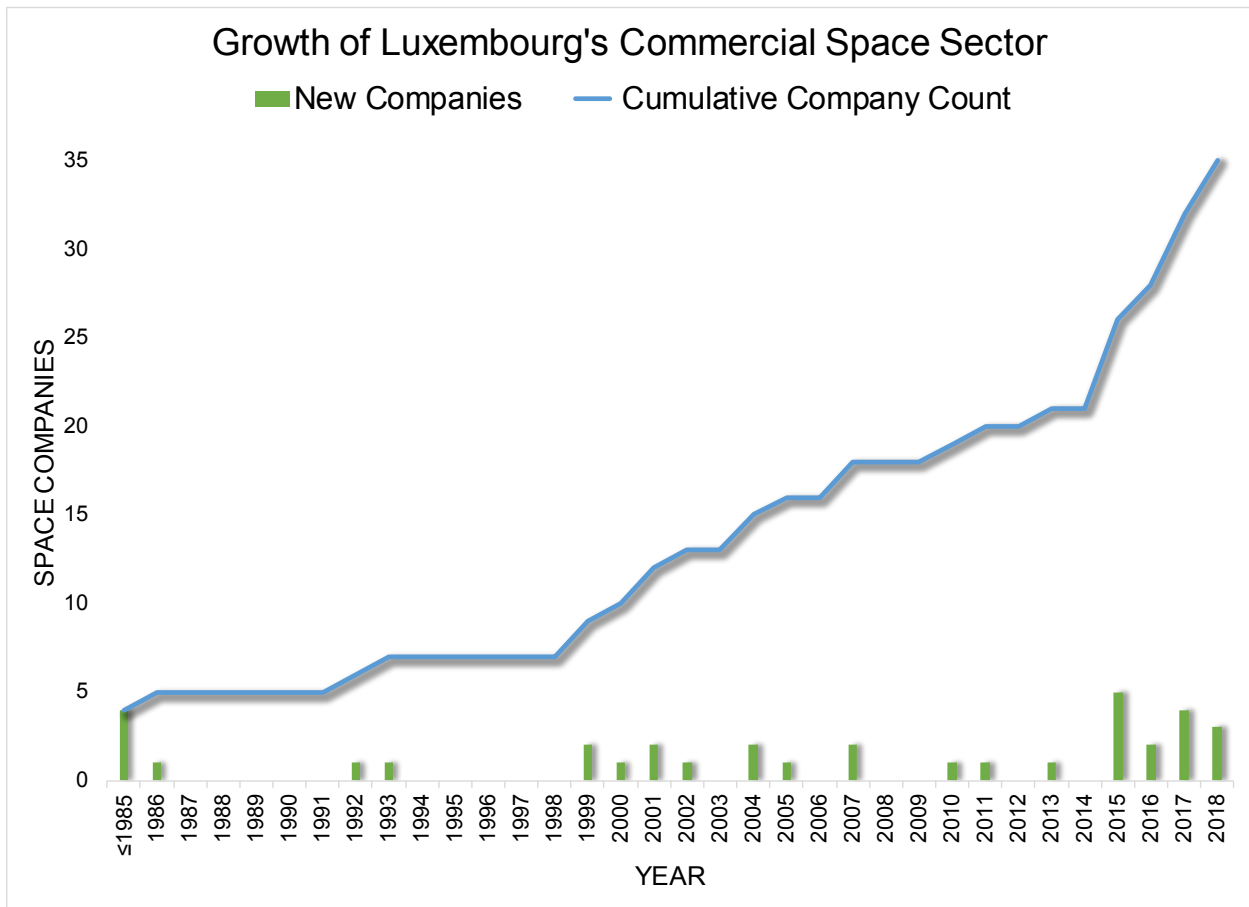
initiative to further grow the country’s space sector and expand its space capabilities.<sup>6</sup> In the same way that the government supported SES, rather than delving into satellite communication itself, the initiative is specifically laid out to support the activities of private space companies. This has enticed numerous space companies to open offices in Luxembourg in recent years and has led to a rise in Luxembourg’s global visibility through national legislation on space property rights, and resulted in numerous international agreements.<sup>2,7,8,9,10</sup>

extent and sustainability of this growth remains to be seen, but these early indicators are promising. Although it is too early to judge the full impact Luxembourg’s recent focus on space will have on its economy, the country’s policies, programs, and strategies demonstrate a well-articulated plan. Luxembourg’s approach, coupled with its history of tenaciously pursuing space, indicates that a few failures along the way are unlikely to deter Luxembourg’s newest space ambitions.

As shown in Figure 2, Luxembourg’s recent efforts have resulted in an increase in the number of companies opening offices or announcing their intention to open offices in the country. The full

**Luxembourg Space Policy, Programs, and Strategy**

The policies, programs, and strategies underpinning Luxembourg’s robust and growing space sector are integrative and comprehensive, but driven by the



Note: The data shown is derived only from the cited references. It may not take into account company mergers, acquisitions, or dissolutions that may have occurred during the time period shown.

Figure 2: Growth of Luxembourg Commercial Space Sector<sup>2,11, 12,13,14</sup>

resource constraints inherent to a small country. The approach includes a space policy intimately connected to the wider national economic policy, financial incentives for commercial companies, legal frameworks to support commercial activities, academic and professional development programs, and international engagement.

Luxembourg's economic policy has identified increased economic diversification and growth of high-tech activities as priorities for the country. The implementation of that policy through the government's LuxInnovation program focuses on eight priority sectors, including space.<sup>15</sup> "Space is a focus in our policy, which isn't necessarily true for other countries, but space is really important to us," says Marc Serres, Director of Space Affairs in the Ministry of Economy (now CEO of the Luxembourg Space Agency).<sup>16</sup> Despite this space focus, the government does not view each sector singularly. "You can't consider a sector by itself. Space. Materials. IT. Cyber. It's all interconnected to every other sector," says Sasha Baillie, deputy chief of staff to Deputy Prime Minister Etienne Schneider.<sup>17</sup>

To promote commercial space activities, the country provides financial incentives in the form of research and development (R&D) grants and direct investments. As part of the space resources initiative, the government set aside €200M for commercial companies through these two mechanisms.<sup>18</sup> This incentive is a major reason that new entrants into Luxembourg's space sector have opened offices in the country. GomSpace, a Denmark-based small satellite company with no near-term space resource plans, chose to expand its operations into Luxembourg due, in part, to the R&D grants available in the country, according to Lars Alminde, chief product and innovation officer at GomSpace.<sup>19</sup> Similarly, the moon mining startup ispace, based in Japan, opened its European headquarters in Luxembourg in early 2017. "It was the money and the policy that caught our interest,"

says Kyle Acierno, managing director of ispace–Luxembourg.<sup>20</sup>

Beyond financial incentives, Luxembourg provides companies within its borders the legal framework and stability to support their business dealings. To provide that stability to space resource companies, the country passed a law in 2017 allowing companies to own resources extracted from celestial bodies.<sup>7</sup> "We aren't creating a legal niche, but creating legal clarity for companies operating in the country," says Baillie.<sup>17</sup> Currently, the only other country to have similar legislation is the U.S. Although this legal step is important for the legitimacy of space resource companies in Luxembourg, it remains unproven; however, that does not deter space resource companies. "We're going to test it, and see if it actually works," says Acierno regarding Luxembourg's new space resources law.<sup>20</sup>

For a commercial sector to grow, a pool of skilled professionals is essential. The Luxembourg government therefore promotes academic and professional development programs to support space companies. In 2010, the University of Luxembourg partnered with SES for research in satellite applications, services, and related technology. The university now offers a master's degree program in space, communications, and media law.<sup>21,22</sup> The government is in discussion with the university to set up similar synergies between university offerings and the space resources initiative. "You need to have a complete ecosystem, which means higher education and research," says Serres. Plans for space resource-related academic programs are still being formulated.<sup>16</sup> However, opportunities do currently exist for aspiring Luxembourgish professionals to gain broad space experience through the LuxYGT program, which provides ESA internships to students.<sup>23</sup>

The current and growing talent pool is a draw for commercial companies. For GomSpace, a major factor in deciding to establish an office in Luxembourg “was the availability of a relevant work-force.” Spacecraft operations will be a principal component to GomSpace Luxembourg, and satellite operations is a central space capability already well established in Luxembourg.<sup>19</sup> For GovSat, the recent focus on expanding space capabilities in Luxembourg bodes well for the long-term talent pool: “The space resources initiative is set to strengthen the space ecosystem in Luxembourg and attract more talent, from which eventually all local actors, including GovSat, expect to benefit,” says Biewer.<sup>5</sup>

Finally, international engagement is central to Luxembourg’s approach to space. “The openness of the country is key. It’s important to always be working in cooperation. We need partners,” says Serres.<sup>16</sup> As part of the space resources initiative, Luxembourg has already entered into cooperation agreements with Japan, China, and the United Arab Emirates, and has strengthened and expanded its relationship with ESA for cooperation on space resource exploration and utilization.<sup>8,9,10,24</sup> Beyond partnership and collaboration opportunities, international engagement is also critical for attracting both talent and investment from abroad, which is paramount for a small country with inherently limited financial and human resources. This need for open borders is viewed as a positive: “We’re a very multicultural country. It makes us very different, but gives us an advantage,” says Serres.<sup>16</sup> Despite the small size of the country necessitating international engagement, this also presents a challenge. “We’re a small country, so we have limited resources, so it’s hard for us to be all over the world for developing collaboration,” says Baillie.<sup>17</sup>

Luxembourg did not establish a national space agency until September 2018; however, the agency it has established is considerably different from

space agencies found in other countries. Traditional space agencies almost exclusively plan and promote government space activities, but the purpose of Luxembourg’s space agency is to continue the commercial focus of the country’s space strategy. “Agency may not be the right word. It’s not going to be defining activities,” says Serres. “It’s for aiding visibility. It’s about having a single, clear, visible entry point.”<sup>16</sup>

The Luxembourg Space Agency echoes the same themes seen throughout the country’s space history: “The mission of the Luxembourg Space Agency is to promote the economic development of the space sector in Luxembourg by providing support to the space industry, attracting new businesses, developing human resources, offering innovative financial solutions and supporting academic learning and research.”<sup>25</sup> The new agency provides a focal point for the nation’s space sector growth and cross-cutting approaches to enable that growth. The agency is the first of its kind as no other national space agency in the world has the primary focus of economic development.

### Luxembourg as a Model

Examination of Luxembourg’s policies, programs, and strategies reveals five key themes: (1) commercially focused, (2) risk tolerant, (3) a cross-cutting strategy, (4) international engagement, and (5) visibility as a priority.

1. **Commercial Focus.** The commercial focus of the Luxembourg government’s approach to space could be described as an industrial policy, but it is distinctly different than a traditional industrial policy. For instance, the European Space Agency (ESA) Convention states that “The industrial policy [...] shall be designed in particular to meet the requirements of the European space programme and the coordinated national space programmes in a cost-effective manner.”<sup>26</sup> This implies that industrial policy is a means of supporting

government-directed space activities, which is distinct from fostering commercial space sector growth as an end unto itself. However, Luxembourg's approach does align with the European Commission's space strategy of "Fostering entrepreneurship and new business opportunities."<sup>27</sup>

The distinction in Luxembourg's approach to commercial space sector growth is also apparent in recent analyses on the space entrepreneurial environment. In the 2018 report, "Start-Up Space: Update on Investment in Commercial Space Ventures," produced by Bryce Space and Technology, Luxembourg manifests as a unique case: "The data set generally excludes government funding, except for certain grants, such as those provided by the Grand Duchy of Luxembourg." Furthermore, the report's analysis classified Luxembourg's investments with those of venture capital firms.<sup>28</sup> As outlined in the report, there are other examples of governments with funding mechanisms that resemble venture capital firms, but the practice is uncommon for the industry.

Luxembourg's new national space agency further exemplifies this commercial focus as the agency is not planning government space endeavors, but rather is providing support to commercial companies looking to pursue their own space endeavors. The advantage of this approach is that the government is not the sole source of funding for space activities. Private investment and revenue generation drive much of the activity, which allows Luxembourg's space pursuits to be disproportionately larger than those of a country with commensurate government funding toward only government-directed space activities. The disadvantage of this approach is that, compared to the traditional contractor relationship, the government has less oversight and influence

over exactly how allocated funds and resources are used.

2. **Risk Tolerant.** Luxembourg has been willing and able to tolerate significant risk to pursue its space ambitions. For instance, the country faced substantial political risk during the early years of its activity in the satellite communication sector because neighboring countries saw private satellite communications as a "trojan horse for U.S. imperialism" and attempted to stop Luxembourg's plans.<sup>1</sup> Similarly, Luxembourg has continued this trend of risk tolerance into its space resources initiative.

Space resources remains an unproven segment of the space sector and thus significant market risk exists. In the same way that numerous failures happened at the beginning of the satellite telecom industry, failures will also occur in the space resources industry. Luxembourg is willingly accepting financial risk in its strategy to invest in early-stage companies similar to angel investors and venture capital firms.

3. **Cross-Cutting Strategy.** Luxembourg's approach to space is a well-thought-out strategy that creates an entire ecosystem for fostering space sector development, involving cross-cutting coordination across government, commercial, and academic capabilities. The strategy includes the following:
  - a. Funding for commercial firms and innovative financial options by leveraging the country's strong financial sector.
  - b. Legal and regulatory frameworks that give commercial firms the confidence and stability they need for sustained operation.



- c. An academic environment for conducting innovative research and training space professionals.
- d. Integration with other relevant sectors to encourage multi-disciplinary collaboration.
- e. International engagement for useful knowledge and capability sharing, and attraction of foreign investors and companies.

This cross-cutting strategy is essential for generating sustainable and responsible space activities. Without it, resources spent on space may provide short-term gain but are unlikely to spur long-term returns as well.

4. **International Engagement.** Luxembourg has consistently taken an international approach to its space activities. It has demonstrated that multi-national collaboration and an open-borders approach can have profound national benefits. Luxembourg’s small size and subsequent resource constraints are an impetus for this international approach. Regardless of any necessity, the success that Luxembourg has achieved through leveraging international resources is a testament to the value of international cooperation for national advancement.
5. **Visibility As a Priority.** Luxembourg’s national space policy specifically calls out the importance of highly visible space activities, “as access to activities is only possible if players are known and recognized by major established players in the field.”<sup>29</sup> This point is also emphasized throughout other documents released by the government.<sup>2</sup> The focus on visibility may in part be due to Luxembourg’s small size and tendency to be overlooked, but, more than that, visibility is intricately connected to its overall strategy. The visibility

of space activities can attract international partners and foreign investors, and provides free marketing for commercial companies based within its borders. The risk posture of the country aids in boosting its visibility by its boldness and forward-thinking stance.

Visibility can allow a nation to establish a reputation, and Luxembourg’s focus on being seen has resulted in a reputation for taking space seriously—a reputation that expands to include the companies within the country. According to Biewer, the Luxembourg government is actively engaged in the development of space as an economic pillar of the country; “this adds immediate credibility to the GovSat public-private partnership.”<sup>5</sup> The country’s space resources initiative was in part motivated by a desire to increase visibility. “We chose space resources, because it distinguishes Luxembourg from others,” says Serres.<sup>16</sup>

### **Applying the Model to Other Countries**

Although Luxembourg’s approach to space has derived from the needs, realities, and specific ambitions of the country, the five points in the Luxembourg model certainly have application outside its borders. Furthermore, the model has applicability beyond governments and could act as a framework for other organizations contributing to growth of the space economy.

- ◆ Adopting a *commercial*-focused view of space activities with a concentration on spurring sustainable commercial ventures is an approach that could be adopted by any country that places priority on economic growth.
- ◆ Adopting a forward-leaning and *risk-tolerant* posture, accepting that failures will occur, and remaining tenacious in one’s pursuits applies to any organization that prioritizes innovation in space.

- ◆ Coordinating a *cross-cutting* strategy leverages the strengths of government, commercial, and academic capabilities and increases the likelihood of success and long-term sustainability of space activities.
- ◆ Engaging in *international* partnerships and collaborations and building international coalitions allows for an increase in the benefits of space beyond those possible with national fiscal constraints.
- ◆ Increasing the *visibility* of space activities not only supports the other four points of the model but promotes responsible behavior in space, which can aid in developing new partnerships, promoting commercial ventures, and influencing the future of space.

To demonstrate how the five-point Luxembourg model could be applied, Paraguay offers an interesting test case. In 2014, Paraguay announced its space ambitions with the founding of its space agency, Agencia Espacial del Paraguay (AEP).<sup>30</sup> “The AEP Strategic Plan has four main objectives: (i) capacity building by training highly skilled human resources and encouraging [the] next generation of scientists and engineers in the space industry; (ii) build the space and ground infrastructure, (iii) develop the space sciences and technologies in the public and private sectors; (iv) promote international partnerships to improve and strengthen the Paraguayan Space Program.”<sup>31</sup> In 2018, Paraguay applied to join the United Nations Committee on Peaceful Uses of Outer Space (COPUOS)<sup>32</sup> and recently announced its intention to launch its first satellite (with an Earth observation mission) by 2021.<sup>33</sup> Paraguay is actively looking to become an emerging spacefaring country and thus provides a compelling test case for applying the Luxembourg model.

1. *Commercial Focus*. The goals of AEP do demonstrate some focus on commercial

activities; however, that focus appears to be more consistent with an industrial base policy typical of a traditional space agency engaged in government-directed activities. If Paraguay were to place more emphasis on private sector development, this could help the country attract investment to further its space capabilities beyond the limits of government funding.

2. *Risk Tolerant*. It is difficult to judge the risk posture of Paraguay from the limited information that is publicly available. Additional information is needed to evaluate.
3. *Cross-Cutting*. Initial indicators demonstrate a cross-cutting strategy. The government has been engaging internationally both regionally and with the United Nations.<sup>26,28</sup> The space agency has placed an early focus on education and training, including academic partnerships. And, although the space agency is taking a traditional approach, it is already considering the role of the private sector.
4. *International*. Paraguay is actively pursuing international partners and recognizes the importance of leveraging international expertise to grow its domestic capabilities.<sup>26,28</sup>
5. *Visibility*. The visibility of Paraguay’s space endeavors is minimal. Increasing its visibility will help identify and establish international partnerships. Plus, depending on the private sector approach that AEP ultimately adopts, an increase in visibility could aid in attracting foreign investment.

The Luxembourg model is by no means essential for Paraguay to grow its space sector. However, for Paraguay and other non-spacefaring and emerging spacefaring nations, the model may help alleviate funding challenges by enabling new funding sources for the country’s space economy and aid in

creating a sustainable space sector that is less reliant on government funding. Regardless of whether a country looks to the Luxembourg model for its policies, programs, and strategies, there is one reality: “There is no magic effect. It takes a lot of work to develop competencies and opportunities. And you’re always looking to deepen those every day. You’re always learning. And you should always remain pragmatic,” says Serres, based on his direct experience with the spurring growth of the Luxembourg space sector.<sup>16</sup>

### **Relevance to the United States**

The number of international players in space is on the rise. As well, many established international players are keen to expand their space activities. This rise in international space endeavors coupled with the rise in commercial space pursuits has generated a space environment that is “congested, contested, and competitive.” This new reality of the space environment must be addressed to ensure that the benefits of space remain open to all humankind and to ensure the U.S. can continue to leverage space for its national interests. Despite the challenges associated with new entrants to space, it is important for the U.S. to also recognize and seize the opportunities they bring.

Opportunities abound for the U.S. public and private sectors with the growth of international players in space. International cooperation enables the U.S. to leverage more allied space systems to increase the resilience of the national security enterprise. The potential for collaboration on deep space exploration is also enhanced, allowing for cost-sharing among countries to meet ambitious exploration goals that are currently out of reach due to national fiscal constraints. The growth of international players may also generate new customer segments seeking the products and services of U.S. space companies and open new markets into which U.S. space companies can expand.

In addition to the above, the growing international interest in space also presents a diplomatic opportunity for the U.S., especially as it pertains to emerging and non-spacefaring nations. Many nations are keen to reap the benefits of space but currently lack the ability to do so and often do not know where to begin. Thus, they look to established space actors for support in getting off the ground. By supporting these countries in their space ambitions, the U.S. can promote responsible behaviors in space, increase its influence abroad, mitigate the risk of countries seeking support from U.S. adversaries, open new markets for U.S. companies, and secure future partners in space.

The policies, programs, and strategies that enabled the U.S. to become a space player and grow a robust space sector came out of the geopolitical realities of the Cold War. Thus, the approach that enabled U.S. entry into space would be prohibitive for many emerging and non-spacefaring nations looking to the U.S. for support. The Luxembourg model presented above provides an approach that the U.S. public and private sectors could leverage in their support of other countries around the globe.

### **Conclusion**

Luxembourg has taken a unique approach to space sector development, opting for a commercial-centric strategy rather than the traditional government-centric strategy. It has demonstrated success in this approach through sustained space activities since the 1980s and has attracted numerous space companies to the country through its recent space resources initiative. Examination of Luxembourg’s approach to space reveals five key points that can be extracted from it: commercial focus, risk tolerant, cross-cutting, international, and visible. These five points can be used as a model that others can use as guidance in starting or growing their space sectors. With the rise of nations that have ambitions to diversify their national economies or grow their space capabilities, the U.S. public and private sectors have ample opportunity to provide support

to these countries, which could open doors to many opportunities for the U.S. The Luxembourg five-point model offers a potential framework for supporting foreign nations in their space capability development.

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