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U.S. House of Representatives
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"The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges"

Chairman Babin, Ranking Member Edwards, Committee Members, Friends, and Staff, on behalf of the Space Foundation Board of Directors and the entire Space Foundation team, I thank you for the opportunity to testify today on matters having to do with the space launch and satellite markets. In addition to my testimony, I would like to enter into the record a brief report on these markets gleaned from our online research source, *The Space Report*, included as an addendum to my remarks.

I am here today to provide data and perspective on behalf of the Space Foundation, a 501(c)(3), nonprofit, nongovernmental organization. The Space Foundation strives to be an entity that all stakeholders in the space policy realm can trust to provide fair, balanced and well-researched information, and to help educate and advise, consistent with our mission: "To advance space-related endeavors to inspire, enable and propel humanity."

Last week in Colorado Springs, Colorado, we held the 32nd Space Symposium, the largest single space gathering in the world. More than 10,000 space professionals from all over the globe came together to talk policy and conduct business. I can say the energy at the Space Symposium speaks to the dynamism we are seeing the in the space industry.

The easiest way to characterize the current international launch market is that it is highly competitive and abundantly supplied with a variety of launch systems, with new systems and suppliers entering, or attempting to enter the market, virtually every day. In 2015 there were 39 different launch vehicle models in operation, accounting for 86 launches around the world. In simple math this is less than three launches per vehicle, which is not commercially sustainable and means that some systems enjoy a backlog of orders, while many, many launches depend upon government involvement of one kind or another.

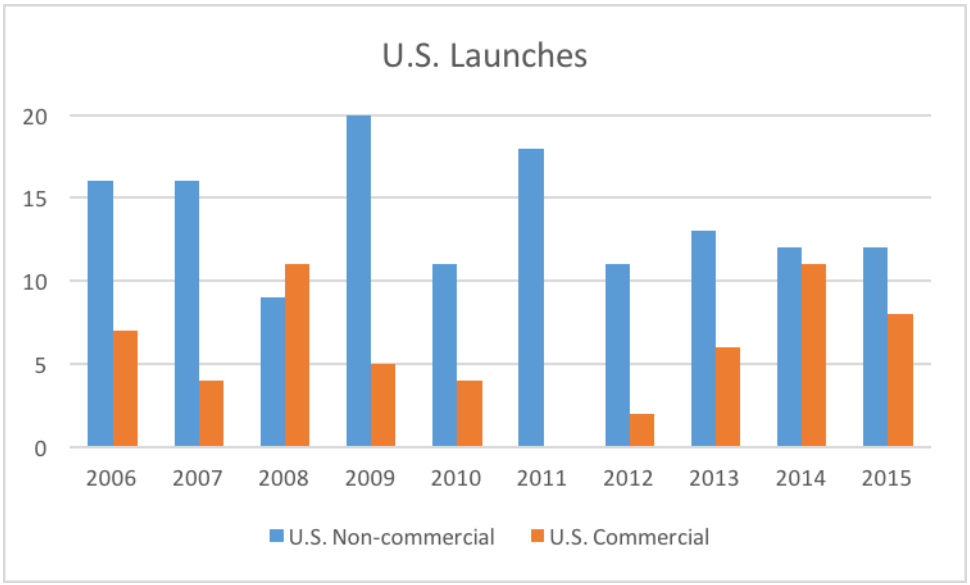
Regarding the notion of permitting or prohibiting access to foreign launch services, our experience is that it is very hard to characterize levels of government support for the many competing systems, because of the many different cultures, economies, types of government and their perceived societal roles, etc. It is safe to say that there are very few launch systems in the world that have not had some kind of government "support" or another over time, although this is beginning to change with some of the small commercial launch vehicles. The issues, I think, are fairness to the satellite manufacturers of the U.S. and our allies, reasonable access to launch options, and attention to security concerns that do not constitute a broad or overly restrictive over-reach by regulators.

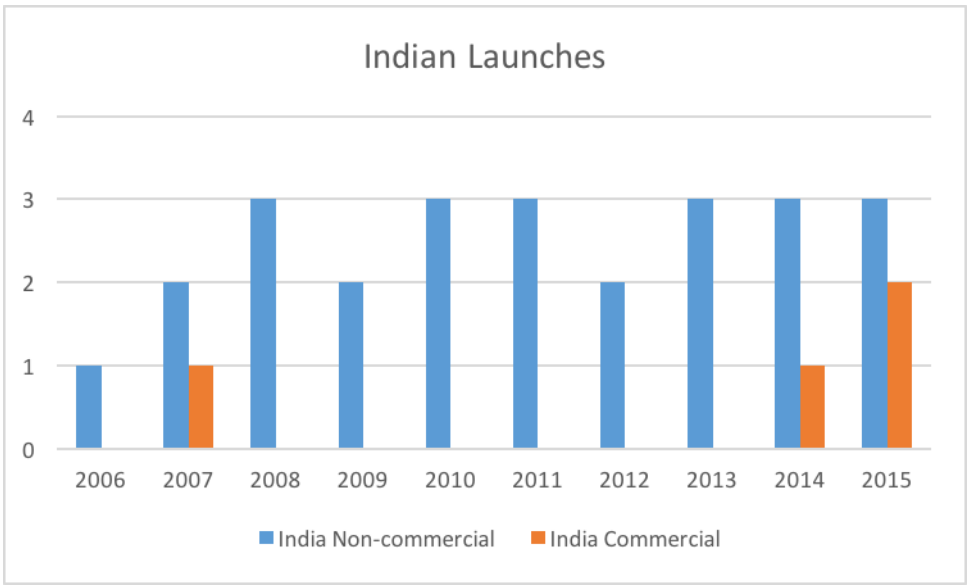
The impact of ITAR restrictions over the past 20 years has mostly been a body of unintentional consequences that have injured U.S. satellite manufacturers while promoting the development of so called "ITAR Free" and "No U.S. Content" satellites in Europe and Asia. Many of the satellite orders once routinely filled by U.S. companies are now filled by others.Even good friends and allies, who really, really would like to buy American, find themselves frustrated and buying elsewhere. Significant changes to ITAR have been made, but implementation of the changes within the U.S. Government has been excruciatingly slow.

In terms of launch pricing, foreign launch providers that are keen to create viable commercial space businesses will price as close to the top of market values as possible. It is in their interest to profit. Where you have disparity is in clearly government owned systems with no private investment. They have no profit motive, and one must, in each case, ask what the motive is.

Specifically, there has been some recent discussion about allowing U.S.-built satellites to fly on boosters such as the Indian PSLV. This kind of discussion has taken place before, in the case of allowing U.S.-built satellites to fly on Chinese boosters. This was permitted but came to an end in the late 1990s with the failure of a Long March booster and the subsequent accident investigation, which resulted in the ITAR changes already mentioned. Since then, no U.S. satellites have flown on Chinese boosters.

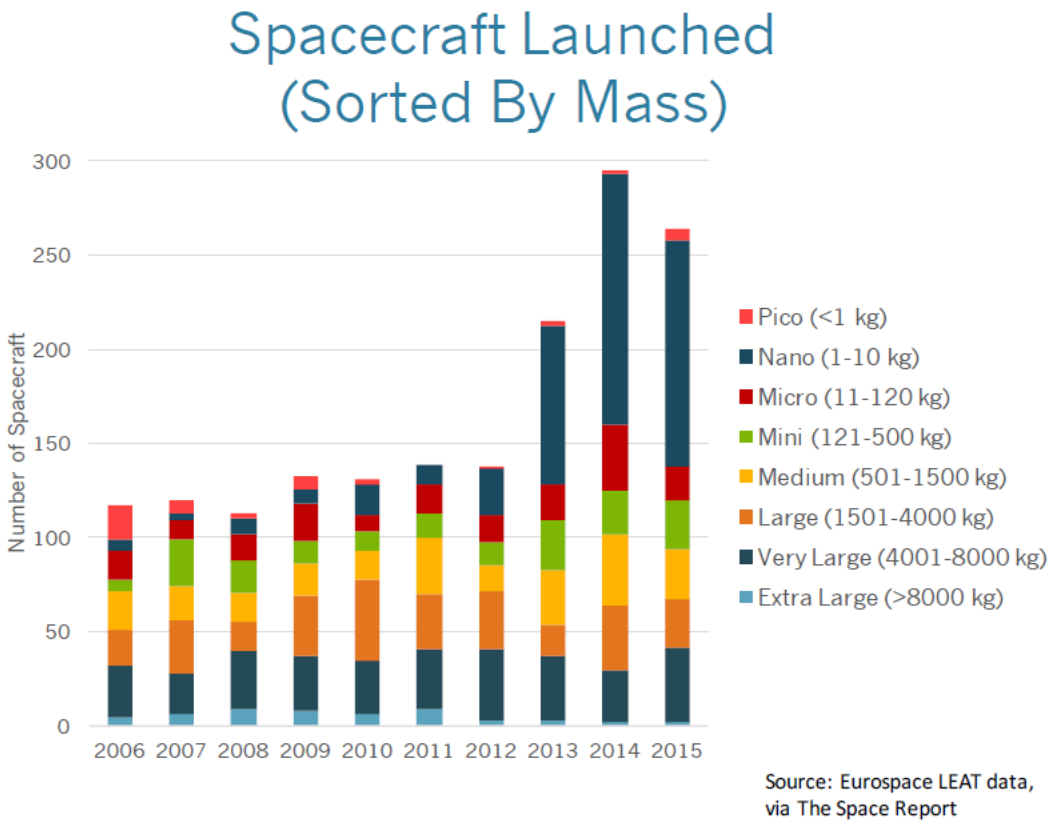
The concern about using Indian boosters is not so much the transfer of sensitive technology to a nation that is a fellow democracy, but rather whether Indian launches are subsidized by the Indian government to the degree that other market actors, for example American launch companies or those of allies, would be priced out the market. I would point to the chart that shows launch rates for the past decade. India has not managed to launch more than half a dozen times a year. They've also had some reliability challenges with their systems. I do not see India as a clear and present danger to U.S. launchers quite yet.





Demand for commercial satellites remains high, and the major operators continue to add capabilities and mass to their geostationary spacecraft. We are seeing an emerging sweet spot for what I would call small-"ish" satellites, special purpose spacecraft built at the size of a hotel refrigerator, and really well tuned to a specific task and, usually, a unique orbit.

With the boom in small satellites, there is also a boom in the development of launchers dedicated to the smallsat, cubesat or nanosat market. This boom has numeric interest, but its market impact remains to be seen. The total mass of nano satellites launched in 2015 only equals one percent of the total mass launched. If it were not for the unique orbits required for various small satellite missions, all 120 of the nano sats with a combined mass of less than 500kg launched in 2015 could have been orbited on a Delta II.



In the space economy, space transportation only accounts for one or two percent of total global space revenues per year, and the small sat segment only one percent of that. The technological advances we have seen in the past twelve months alone are astonishing. Constellations of small

satellites will no doubt be a viable market for some, and we encourage you to support it, but not to over react to it.

We've seen a similar story before, when forecasts for thousands of new, small satellites, envisioned for constellations like Teledesic, led to wildly ambitious launch forecasts in the 1990s – forecasts that did not materialize and have had a negative impact on national security space launch capacity ever since. Then, as now, there was enthusiasm for the spin-in of technologies and management architectures from the non-space world. But space was, and is, hard. The ability to succeed in cellular communications did not translate into success in the satellite marketplace then, nor does acumen in information technology necessarily equate to satellite success today. Many of the investments being made in small satellites today are driven simply by the smaller costs of these diminutive spacecraft. Small cost, and big capability, seldom arrive hand in hand. There are other major policy considerations that accompany the proliferation of small satellites – including the necessity of getting our arms around a space traffic management regime which will ensure continued long term access to space for operators of all sizes.

I do not want the committee to think that I am saying that this new flurry of emergent space systems is doomed to the same fate of the "Little LEO" phenomena of the 1990s, but rather I am saying we need to be cautiously optimistic and not be overly bullish. At a recent House Armed Services Committee hearing, Air Force Space Command Commander, General John Hyten stated that it was incredibly difficult for government to accurately forecast launch industry trends and say with certainty where the industry will be several years from now. The industry cannot accurately forecast the future trends, either, in fact – which is why we don't try. What we at the Space Foundation endeavor to do is to synthesize data to show historical trends. Government policy should not become based on forecasts and predictions that in hindsight may be found to be off the mark. Instead, policies should enable all space companies to operate with the least amount of intrusive regulation and maximum ability to operate successful businesses.

Technology improvements since the 1990s have resulted in components becoming less expensive and utilized in new emerging satellite systems. I am not saying this technology is just as good as the most exquisite imagery or communications satellites out there, but it is good

enough for a market they think can exist and are trying to address. Emerging players in the satellite field offer technology advances such as rapid iteration, constantly increasing communications speeds and bandwidth, imagery resolution, and data integration. We have heard that these capabilities may be in many cases complementary and compatible with legacy companies' products and services. I think the Pentagon's recent outreach to Silicon Valley speaks to the recognition that there are new things to be learned.

Partially or fully reusable launch vehicles have been the "holy grail" of the space transportation sector for decades. We're seeing great work being done, and the economic models are promising. Again, however, this is harder than it looks. Our only true data point on a partially reusable system is the Space Shuttle program, a wonder of engineering that proved much more costly, and difficult, than originally imagined. We are seeing tremendous work on reusability, mostly borne by private investment, but the ultimate viability of these systems and their impact on overall launch costs remains to be seen. I believe these systems will prove their worth, but we have miles to go. I am excited to continue to watch the developments on the reusability front.

Finally, I want to address an issue that is larger than the focus of today's hearing. Last month the Space Foundation, along with 13 other space-related associations, including my colleague organization the Commercial Spaceflight Federation, with me here today released "Ensuring U.S. Leadership in Space." This document is intended to be an apolitical statement from the space industry to primarily inform the candidates for president as well as other candidates for elected office to educate them how important and essential space efforts, technology and capabilities are for all Americans. I encourage you all, as leaders in driving U.S. space policy, to be familiar with this document. Even if you may not have a direct "space constituency," for example a NASA center in your district, the people you diligently represent depend on space every single day. I would ask that you insert this document for the record of this hearing.

I thank the Committee and staff for the opportunity to testify today, and look forward to your questions.

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