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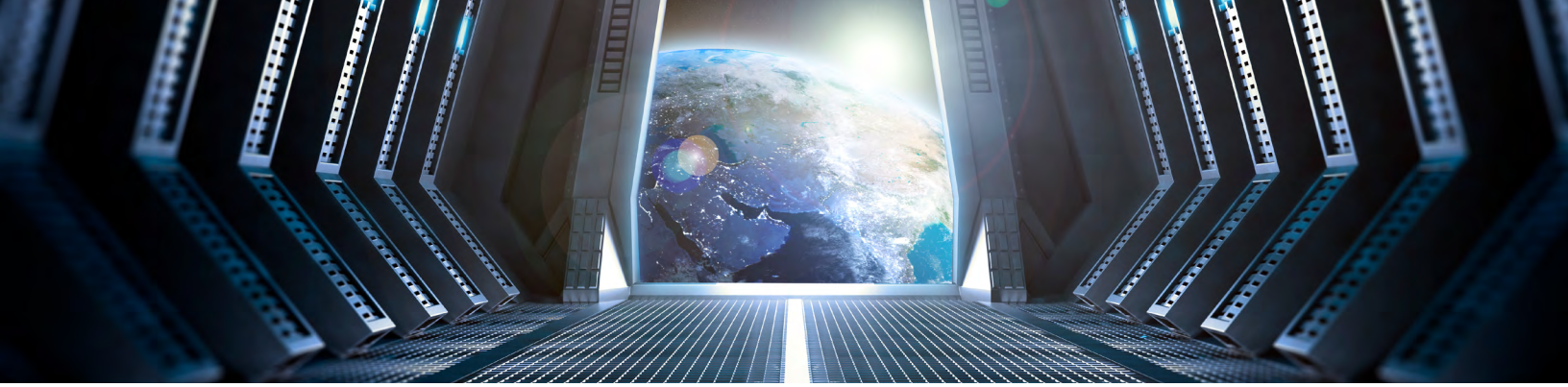
Space

Spaceports of the future

Positioning America's space launch capability for the booming space economy.

Contents



Introduction to US spaceports

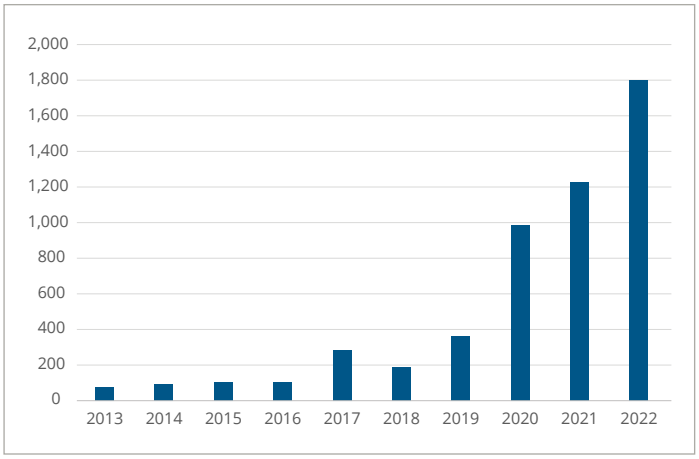
The United States' space launch infrastructure is running out of capacity as public and private sector demand for access to space is accelerating faster than ever before. The next 'Space Race' is well underway as a diversity of nation states – including the People's Republic of China, Russia, India, the European Union, and Japan among others – have emerged as major players in government-sponsored space missions to low Earth orbit (LEO), geostationary orbit, cislunar space, and well beyond. A Chinese company's recent announcement of plans to build a new spaceport in Djibouti underscores the competitive environment on a global scale.[1]

At the same time, commercial sector space launch is increasing exponentially as private companies are investing in the space economy. A decade ago, the US launched a few dozen objects into orbit per year. As of November 2022, this number was almost 1,800 (Figure 1).[2] Additional planned satellite constellations from established companies as well as myriad startups (particularly telecommunications, internet, and optical earth observation companies) are poised to accelerate the demand for launches even further.

US space launch infrastructure is struggling to keep pace with this exponential growth in demand. Federal Government orbital launch capabilities are highly concentrated within a few Federal facilities that were originally developed in the 1960s and 1970s. After remaining largely vacant for years, they are now reaching capacity and need investment to modernize and expand.[3]

In this environment, the United States Space Force (USSF) was established on December 20, 2019, creating the first new branch of the armed services in 73 years. This was in part from widespread recognition that maintaining superiority in space is a critical national security imperative.[4] The USSF has coined the term "Spaceport of the Future" to describe its plan to meet these increases in demand and complexity. This document explores this concept further, to include how the public and private sectors can work in further concert to expand, modernize, diversify, and harmonize range infrastructure development to meet both national security and civilian government needs while keeping pace with private sector demand.

FIGURE 1 | **US Objects Launched into Orbit by Year**



What is a spaceport?

For some, the term 'spaceport' may evoke images of a futuristic setting or even thoughts of science fiction. But the reality is, spaceports have been around since the dawn of space exploration in the 1950s. Like airports and seaports serve other modes of transportation, spaceports comprise the collective infrastructure and operations that enable space vehicles to access space.

Spaceports facilitate a wide range of necessary functions including payload integration, vehicle testing, fueling, range instrumentation, security, and ultimately launch. And, as it does for their air and sea counterparts, location matters for spaceports. Launching closer to the equator makes for efficient access to low-inclination orbits, while adding distance from the equator makes high-inclination and polar orbit easier to reach. Today, locations that allow flight over open ocean or sparsely populated areas are also preferred.

In another parallel to other ports, spaceports must also be updated over time to support growth and evolution in the industry they serve. With the rising demand for launch, the prospect of modernizing spaceports stands to create jobs and economic opportunities across both the public and private sector.

Sunset at Vandenberg
Image Credit: NASA

US space launch facilities today

The US has a mixture of space launch installations with varying degrees of ownership and operations across the public and private sector. Federal facilities managed by the Space Force and NASA oversee government launches, but also lease some of these facilities to the private sector. At the state level, there are several facilities owned and operated by state-owned companies. Increasingly, the private sector is investing in privately-owned facilities for research, testing, and suborbital launch. Highlighted below are the facilities responsible for the vast majority of orbital launches to date:[5]

Federal Spaceports

1. **Cape Canaveral Spaceport, FL:** Collectively refers to both NASA's Kennedy Space Center (KSC) and the Cape Canaveral Space Force Station (CCSFS). KSC and CCSFS are located next to one another on the east coast of Florida, but they serve different purposes and have distinct roles in supporting US space launches. However, they do collaborate on certain missions and USSF provides range services to launch providers as well as owns and enforces the DoD range safety requirements.[6] Notably, Cape Canaveral Spaceport is the only US spaceport used for orbital-class, human-rated spaceflight today.

   KSC is a NASA-owned and operated complex, primarily focused on space exploration and research with a focus on launching spacecraft and conducting scientific experiments in space. KSC is home to the Vehicle Assembly Building (VAB) as well as several operational launch pads. Launch Complexes (LC) 39A and 39B support NASA and private sector launches of medium, heavy, and super-heavy rockets. Additionally, KSC has on standby Launch Complex 48 as a third orbital and suborbital-class launch pad to support small and medium weight rockets. The Shuttle Landing Facility (SLF) is also being repurposed to provide horizontal launch capabilities.

   On the other hand, the CCSFS is a military installation that is operated by the USSF. CCSFS is home to four active launch pads, including Launch Complexes 16, 37B, 40, and 41, which are used for the launch of both military and commercial satellites. The CCSFS is ideal for spacecraft requiring a west-east orbit with 'future-use' launch pads already designated and one unused launch pad currently suitable to support future customers with large launch vehicles.

2. **Vandenberg Space Force Base, CA:** Located along California's central coast between Los Angeles and San Francisco, Vandenberg Space Force Base (VSFB) is the preferred launch facility for heavy and super heavy spacecraft requiring a north-south orbit. Boasting over 99,000 acres, Vandenberg houses eight Space Launch Complexes (SLC). Of these, four are active for orbital launch and conduct a mixture of commercial and government launches. Vandenberg also houses an airfield suitable for horizontal launch and landing. In addition to the processing and launch of both military and commercial launch activities, VSFB plays a role in range management during DoD space and missile testing.

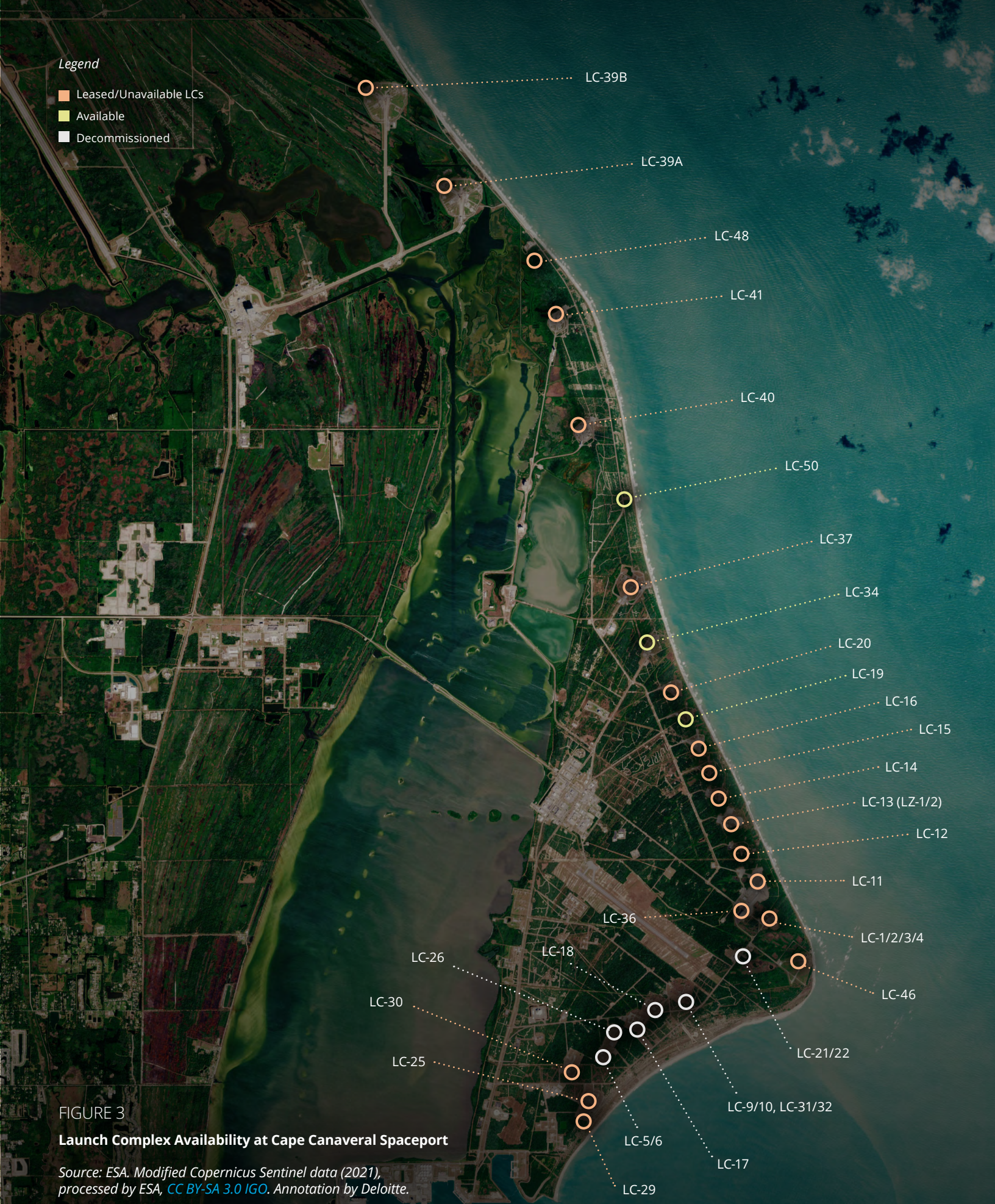


FIGURE 3

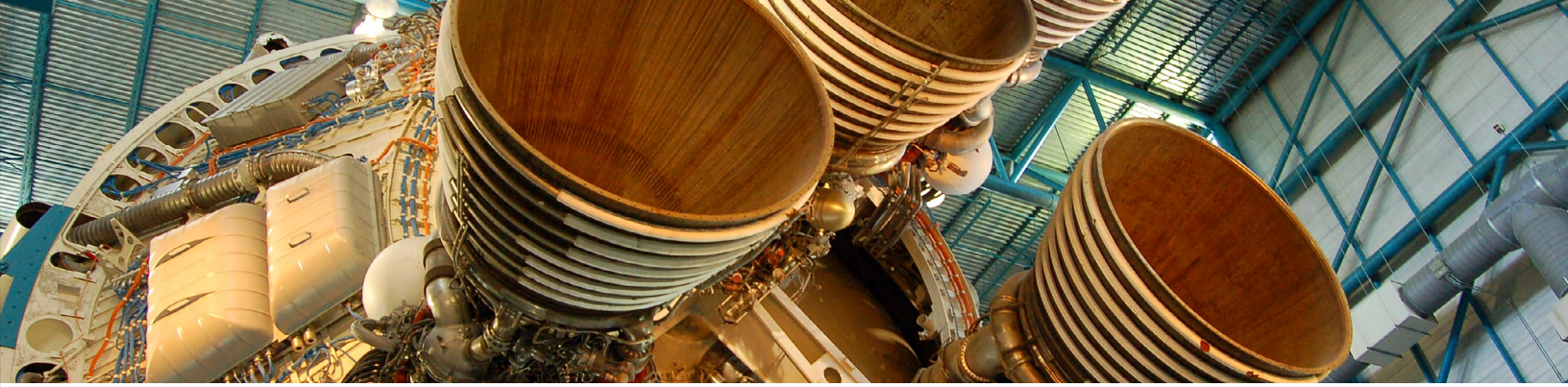
Launch Complex Availability at Cape Canaveral Spaceport

Source: ESA. Modified Copernicus Sentinel data (2021), processed by ESA, CC BY-SA 3.0 IGO. Annotation by Deloitte.

FIGURE 4

Launch Complex Availability at Vandenberg Space Force Base

Source: ESA. Modified Copernicus Sentinel data (2020), processed by ESA, CC BY-SA 3.0 IGO. Annotation by Deloitte.



Public/Private Spaceports

1. **Mid-Atlantic Regional Spaceport, VA:** Located on the Eastern Shore of Virginia at Wallops, the Mid-Atlantic Regional Spaceport (MARS) is owned and operated by the Virginia Commercial Space Flight Authority (Virginia Space), a political subdivision of the Commonwealth of Virginia. This spaceport includes three launch pads, an unmanned aircraft systems airfield, a payload processing facility, and an integration and control facility. Virginia Space is a tenant organization on NASA's Wallops Flight Facility operated by Goddard Space Flight Center, NASA's principal facility for suborbital research programs.
2. **Pacific Spaceport Complex, AK:** Operated by the Alaska Aerospace Corporation, the Pacific Spaceport Complex-Alaska (PSCA) on Kodiak Island provides access to space for small payload vertical rockets and stratospheric balloons. It houses six launch pads that support suborbital, light-lift, and small-lift launch vehicles. One of the novel features of PSCA is its economic model. It was the first Federal Aviation Administration (FAA)-licensed spaceport not co-located on a federal range and has not accepted state or federal funding for operations and maintenance since 2015.[7]
3. **Spaceport America, NM:** Spaceport America is managed by the New Mexico Spaceport Authority. Self-described as "the world's first purpose-built commercial spaceport,"[8] Spaceport America provides horizontal launch and vertical launch areas for small payloads. The facility features access to 6,000 sq. miles of restricted airspace, allowing customers to launch without commercial air traffic restrictions.
4. **Mojave Air and Spaceport, CA:** Self-described as "America's first civilian spaceport,"[9] Mojave is a research center for aviation and commercial space flight and houses facilities for horizontal launch of small payloads, including several successful air launch-to-orbit missions since 2020.

Private Spaceports: Two of the major private space companies are also working towards independent operation of their own facilities as well. Both 'Starbase' in Boca Chica, TX and 'Launch Site One' in western Texas are undergoing construction. Although there have been no orbital launches out of these facilities to date, they have seen a rapidly increasing pace of research and development, manufacturing, equipment testing, and suborbital recreational launch and landing.

Other Facilities of Note: In addition to the facilities highlighted above, it is worth noting various additional operational Space Launch and/or Reentry facilities in varying stages of developing small payload horizontal launch, orbital reentry, and research and development facilities.

State	Facility Name
Alabama	**Huntsville International Air and Space Port**
Colorado	**Colorado Air & Space Port**
Florida	**Space Florida Launch Complex 46**
Florida	**Space Florida Launch and Landing Facility**
Florida	**Cecil Air and Space Port**
Florida	**Space Coast Regional Airport**
Georgia	**Spaceport Camden**
Oklahoma	**Oklahoma Spaceport**
Texas	**Houston Spaceport (Ellington Airport)**
Texas	**Midland Spaceport**

Supply and demand outlook for spaceports

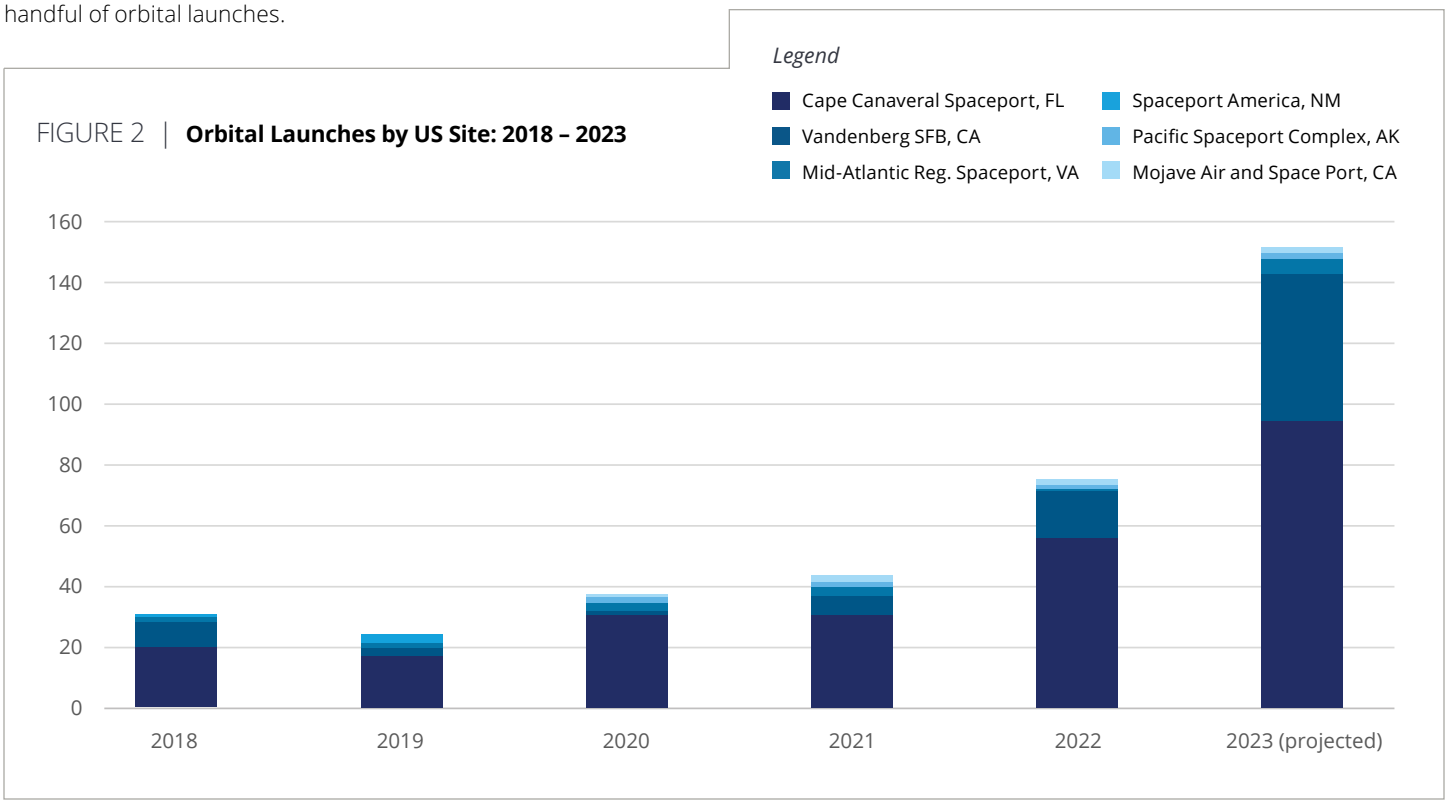
Orbital launches from the US are highly concentrated. Over the last five years, over 93% of all orbital missions launched from Federal facilities, including 70% from Cape Canaveral Spaceport, 17% from Vandenberg, and 5% from the Mid-Atlantic Regional Spaceport. As illustrated in Figure 2, launch volume from Vandenberg has doubled over the last 5 years and is projected to increase launch volume from 16 in 2022 to 50 in 2023. Launches from Cape Canaveral Spaceport have nearly tripled over this same time.[10] While the FAA is forecasting commercial launch and re-entry activity to increase to as many as 186 by 2026,[11] the Space Force estimates suggest an even faster pace, with over 150 launches projected for 2023. As this is occurring, these facilities are struggling to keep up with demand as Cape Canaveral Spaceport is running out of room. The Cape hosts five companies today – three more than it had a decade ago. Fifteen new companies applied for launch property leases between 2019 and 2020.[12] Vandenberg has various space launch complexes that have been decommissioned and require significant investment and modernization to meet increasing demand.[13] While additional facilities are taking their first steps into orbital launch, they have collectively only completed a handful of orbital launches.

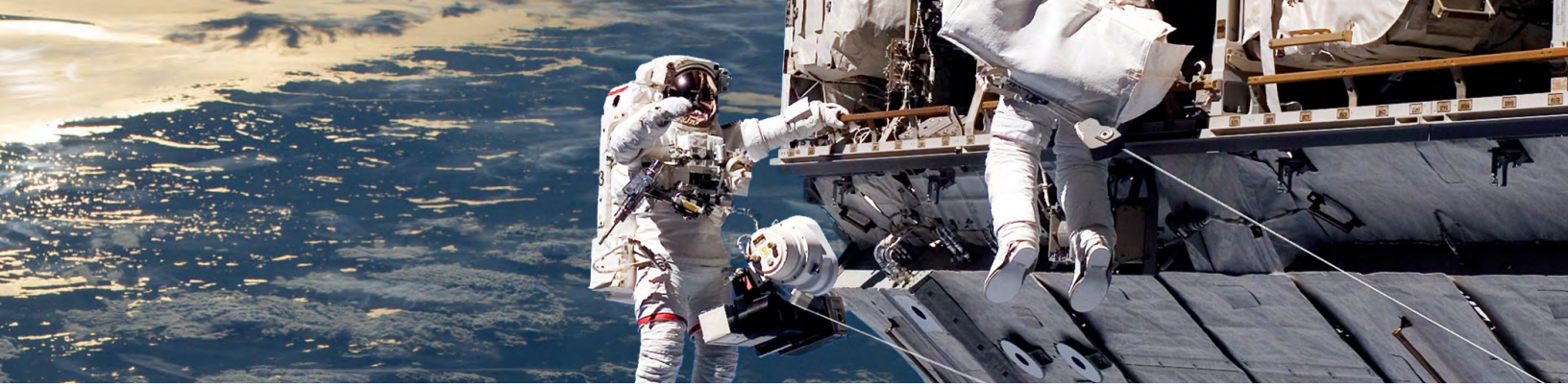
Keeping pace with rising demand for assured access to space is of keen interest to the private sector and US Government. Space launch alone is projected to be a $30 billion market by 2029.[14] For the US Government, national interests require the government to maintain launch ranges with capacity to support national security, civil, and commercial launch and test operations on demand.[15] Achieving this assured access to space requires the US to have modern launch facilities capable of meeting industry and government launch demand.

Spaceports of the future

The following sections explore how the vision for *spaceports of the future* may take shape with the right actions from Federal and state government as well as commercial industry. Specifically, we look at three key strategies to do so: 1) increase the supply and availability of US-based space launch facilities, 2) modernize spaceport operations to support the increasing cadence of spaceflight; and 3) adapt current government-centric operating and financial models for an increasingly commercially-driven orbital launch market.

FIGURE 2 | **Orbital Launches by US Site: 2018 – 2023**





Strategy 1: Increasing US supply and availability of spaceports

The US space industry requires a cohesive approach to public and private sector investments to increase the number and capacity of spaceports and ancillary launch facilities. In the near term, this includes increasing orbital launch capacity and throughput for medium, heavy, and super heavy launches at Cape Canaveral Spaceport, VFSB, and Wallops Island while fostering further growth and maturity of burgeoning spaceports that can focus and specialize on small and other niche launch services. Doing so requires significant infrastructure development; especially LCs, which are a critical infrastructure component and often must be designed to handle a variety of launch vehicles with different sized payloads, propulsion systems, and orbital trajectories. The priority needs vary by facility, but the spaceports of the future will require significant infrastructure development for launch/landing pads, ground support equipment, communication systems, tracking and telemetry facilities, range safety equipment, data integration centers, security and more. All of this will require significant investment and a cohesive development approach between the public and private sector.

Government expansion efforts at Cape Canaveral Spaceport

Cape Canaveral Spaceport is a mature launch site with limited land availability and, as of 2023, has limited available launch pads for development. Today, there remain only three vacant sites with the infrastructure ready to support additional launch efforts. In an effort to increase the availability of spaceport infrastructure and efficiency of spaceport operations, continuous expansion efforts are underway at CCSFS. Major improvements are slated for LC-20, LC-39, LC-41, and LC-46. Additionally, the Florida Department of Transportation identified several projects to improve existing capability as well as additional vehicle processing facilities, manufacturing facilities, and other key common use infrastructure.[16]

Cape Canaveral Spaceport also has several decommissioned sites, many of which have been converted to historical landmarks or repurposed. For example, LC-5/6 have been reassigned to the Air Force Space Museum. LC-9/10 now house military personnel. Others like LC-17 have been partially demolished, while others like LC-21/22 and LC-47 are smaller sites that have not yet been repurposed.[17] Reactivating these sites, many of which went offline in the 1970s could be more costly than more modern sites but may begin to look like more attractive investments as available launch pads approaches zero.

Government expansion efforts at Vandenberg Space Force Base (VSFB)

Vandenberg handles a diverse portfolio of commercial, DoD, and other Federal Government launches and is primed for development and infrastructure upgrades with ample space for spaceport development. VSFB has the land available for development, but older Space Launch Complexes (SLC) have not been updated in decades, and many greenfield sites do not have the electricity, water, or road infrastructure required to quickly realize an increase in spaceport capacity.

VSFB is renovating SLC-8 to be a new multi-use pad for customers. Additionally, there are multiple inactive SLCs and "green field" sites available for future development. These facilities would require significant investment to make operational but would significantly increase the availability of launch infrastructure. Much of the current focus of infrastructure improvement at VSFB centers on critical basic infrastructure systems such as a payload processing facility, utilities, communications upgrades, and transportation system enhancements.

VSFB is located in a remote part of the central Californian coast. The closest international airport is LAX, 166 miles away and the surrounding area is absent any regional port authority, NASA Center, or major city. The result is that all infrastructure, including roads, water, electric, and communications, are funded through the military. However, unlike the space-constrained CCSFS, Vandenberg SFB has a lot of available land—it is a geographically larger area than Denver, Colorado. Despite the isolation, VSFB is still an incredibly busy base. Beyond military and commercial launches, VSFB supports a wide range of military activities up and down the California coast and throughout the Pacific Theater. Vandenberg is primed to become a spaceport of the future if it can capitalize on the available land and continue building and upgrading the necessary facilities and supporting infrastructure.

Artemis Logos Installation on Crawler Transporter
Image Credit: NASA

Public/Private Spaceports

While Cape Canaveral Spaceport and VSFB still manage the vast majority of US launches, smaller, public-private spaceports are demonstrating that launch is viable from these sites and are investing in additional capacity and capability to make them even more competitive in the market.

The PSCA at Kodiak Island, Alaska is a prime example. Investment into PSCA is estimated to be $22.4 to $31.2 million over the next decade for multiple projects. Two of these projects will see launch pads converted to multi-use government and commercial launch pads. While the pad conversion project is taking place, there is additional emphasis on establishing new capabilities to enhance storage and staging areas, communications systems, and other launch support infrastructure. Other launch pads will receive enhancements to support vehicle integration facilities, and enhanced telemetry and optics capabilities.[12] In another example, the New Mexico Spaceport Authority intends for Spaceport America to accommodate commercial launch providers of all sizes, and is making efforts with the State of New Mexico to stimulate growth with grants, tax credits, and tax deductions as incentives for aerospace companies to build and operate spaceports.

Recommendations

Given the diverse landscape of spaceport operators and investors today, as well as potential new entrants in the years to come, it is important to consider how their individual actions impact the collective capability of the network of all US spaceports. Collectively, US spaceports should enable assured access to space and support the anticipated growth in demand. As such, industry and government should collaborate to **establish and maintain a national strategy to guide infrastructure development priorities** across the full spectrum of spaceport functions. It is critical that any national strategy reflects the diversity of federal, public-private, and private facilities and incorporates the needs and faculties of commercial industry, DoD, civilian, and regulatory agencies.

The National Spaceport Intergovernmental Working Group (NSIWG), spearheaded by the FAA and with participation from other Federal agencies, has already begun to develop a national spaceport strategy. The NSIWG charter calls for it to develop plans for spaceport strategy and policy through engagement with state and local governments, spaceports, the launch industry, the financial industry, and academia.[18] Organizations representing those stakeholders have emerged, and partnership between them and NSIWG may be an effective model for the necessary collaboration.

Cape Canaveral Spaceport: As demand at Cape Canaveral Spaceport continues to grow, the USSF and NASA should consider further investment **in common use infrastructure that will facilitate further private sector investment to modernize aging launch complexes and break ground on new ones** where there is still space available on the periphery of the installation. At a minimum, this means extending physical infrastructure (e.g., roads, electricity, water, sewer, communications, fuel transportation, etc.) from Cape Canaveral Spaceport's current LC footprint out to new development areas. More ambitiously, this should also include additional rail access as well as expanded capacity at Port Canaveral to transport payloads, large spacecraft components, construction materials, etc. To help prioritize infrastructure projects, USSF and NASA should work collaboratively to define a cohesive plan that reflects a holistic approach to assessing future needs. Leveraging enabling technologies to run discrete event simulation and risk analyses can help inform the plan by understanding maximum capacity and identifying critical choke points and possible points of failure.

In parallel, Cape Canaveral Spaceport may **consider efforts to implement multi-use LCs** that will allow for multiple launch companies with common launch requirements to access space. While standardization to the degree of commercial aviation may not be necessary, steps can be taken today to address the most common launch requirements and minimize needed customization.

VSFB: While Vandenberg does not currently have the same space constraints of Cape Canaveral Spaceport, VSFB will require additional investment (via appropriations and/or or private partnerships) to develop additional capacity. Like Cape Canaveral Spaceport, this could include common use infrastructure to update aging/decommissioned SLCs. VSFB has already developed a multi-use complex at SLC-8, though it is not currently in high demand[19] as many commercial companies prefer to invest in a dedicated complex given the available real estate.

Public/private Spaceports: The public/private and fully privately-owned facilities that today are mostly focused on testing, research, and development may find value in expanding these facilities into fully capable launch facilities – either exclusively for their own purposes or to provide a suite of launch services to the market. As with many emerging markets, these private facilities may find it most viable to focus on particular competitive niches (e.g., rapid small payload access, space debris return and processing).

Strategy 2: Modernizing spaceport operations to support the increasing cadence of spaceflight

As mentioned, the rate of orbital launches will outstrip the capacity of today's spaceports within the next decade. While adding more launch pads at Cape Canaveral Spaceport, VSFB, and the host of smaller spaceports is an important step to meeting that demand, doing so without modernizing their end-to-end operations is only a partial solution. New technologies, standards, and procedures would improve the efficiency, safety, and resiliency of the US spaceport network.[20] Such outcomes stand to benefit not only government and commercial space launch customers, but also the commercial aviation industry.

Managing a crowded launch manifest

Spaceflight operations start well upstream from the day of any given launch or reentry. A host of regulatory, licensing, and logistical requirements must be met for each operation, and no two are identical. Launch systems and their respective FAA licenses are unique, possible launch windows vary based on the payload and its destination, and clearing each launch and reentry requires coordination between multiple agencies. Every operation takes careful planning on its own, and the choreography becomes much more complex when considering the increasing congestion at spaceports.

As launch dates near, issues ranging from off-nominal test results to payload integration delays can require the launch operator to reschedule. Of course, not all delays are preventable. Adverse weather conditions, for example, are a common culprit. But, in a future in which Cape Canaveral Spaceport and other spaceports are operating at maximum capacity, missed opportunities could mean cascading delays and cost. The ability to anticipate delays sooner and adjust the mission manifest appropriately becomes an imperative for operational efficiency.

To optimize scheduling and logistics, the decision-makers at spaceports and within oversight agencies like the FAA need access to reliable information that helps them balance the needs and resources across the ecosystem of spaceflight operators, spaceports, and other users of the national airspace. Strategies to do so could involve enhancing the data-sharing systems used to enable collaborative decision-making across relevant agencies or using new digital tools for systems engineering that enable confident, risk-informed plans. However, better technology can only go so far. Standards and procedures, like those included in licenses issued by the FAA, need to work in harmony with any new technology systems.

Safety and efficiency in congested spaces

To get to space and back from US soil means traveling through some of the busiest and most complex airspace in the world. To launch and return safely, large volumes of airspace must be cleared. Rerouting flights around closed airspace burns fuel, and those costs add up. Some have estimated the total excess fuel consumption resulting from a single launch will exceed $200,000 later this decade.[21] As spaceflights become more frequent, lessening the impact on commercial airlines is a major concern, particularly in congested airspace like Florida's, which saw over 700,000 flights in, out, and across the state in 2022.[22]

At a basic level, the approaches to minimize disruption are simple: close less airspace for a shorter period that impacts fewer flights. Advanced technologies that improve position determination, real-time telemetry, and trajectory prediction may be key inputs to shaving off miles and minutes from closed airspace. But with safety as the primary objective, high confidence margins are needed for any new technologies or procedures to be implemented. Together, government and industry should continue sharing information, converging on standards of behavior, assessing risk, and carefully testing and piloting new systems as they are rolled out.[20]

Due to the hazards of launch, including the potential for catastrophic explosions, an "exclusion zone" surrounding the launch site must be carefully cleared. Cape Canaveral Spaceport is a prime example of this challenge, as the surrounding area is host to many activities that have the potential to disrupt launch activities. Such activities include military operations at Patrick Space Force Base (PSFB), commercial and recreational fishing, watersports, construction projects, and commercial maritime and air traffic. For example, Cape Canaveral Spaceport neighbors Port Canaveral, which sees 4 million passengers and 5.4 million tons of bulk cargo annually and, as of 2023, is the world's busiest cruise port.[23] Any boats transiting through exclusion zones that extend into the surrounding waters can lead to scrubbed launches.

Launch control operators at spaceports need real-time situational awareness of what's happening on and around the launch pad, including ground, air, and sea, before giving the final 'go' for launch. Relying on manual checks across a disparate network of sensors and tracking systems is not only costly and inefficient, but also prone to error. Advancing the systems used to ingest and analyze data, such as computer vision and AI, may help drive operational efficiency while maintaining high safety standards in a future with many more launches.

Test complex panorama
Image Credit: NASA

Industry innovation

Among the possible means to improving operational efficiency at spaceports is the use of automated flight safety systems (AFSS). AFSS uses an internal navigation system to track a rocket's path during launch and, if necessary, self-destruct. Because it is automated, it relies on fewer ground-based radars and personnel, allowing the range to streamline its launch support. To date, only two companies have transitioned to AFSS technologies, and the US Space Force is pushing for more to join.[12]

As launch providers develop and field new vehicles, they are typically focused on shortening the time to first launch. To move faster, companies are showing a preference for controlling their own launch complexes and the use of shared launchpad infrastructure may become less attractive. As such, its likely industry will continue to innovate new ways to increase automation, control costs, and build the capabilities needed to enable next-generation launch vehicles.

Government state of play

Assuring access to space for national security is a key tenet of US space policy[24] and several federal agencies are engaged in modernization efforts that focus on US spaceports and related operations. The Space Force's Spaceport of the Future initiative is one example, through which the service has a policy directive that all launch providers integrate AFSS technology by 2025. The USSF is also actively fielding new capabilities of its own. For example, CCSFS has begun testing a software program, Range Application Deployment, which is aimed at virtualizing situational awareness systems and enabling remote access for launch control officers and other range personnel.[25]

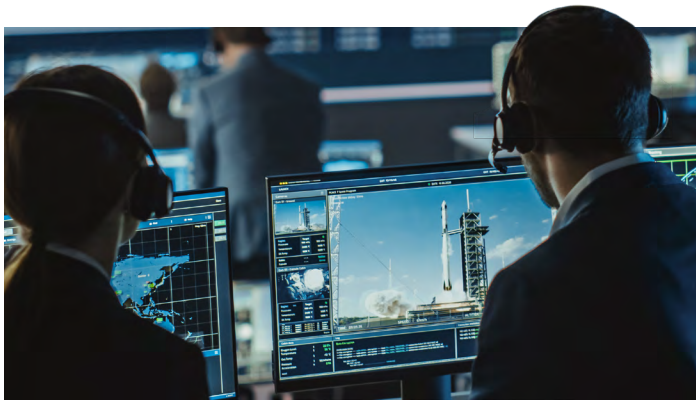
The FAA, given its integral role in licensing and oversight for commercial spaceflight and managing the National Airspace System (NAS), has been active on multiple fronts. For several years, the FAA has been exploring new standards, procedures, and technologies to modernize space vehicle integration in the NAS. For example, in 2021, the agency debuted the "Space Data Integrator," which helps provide the FAA near real-time data on a rocket's flight and allows FAA to see the rocket "on the same piece of glass" with commercial aircraft.[22] FAA also recently created a Space Collaborative Decision-Making (CDM) Committee for government and industry to explore potential solutions together.[26] Through these and other efforts, the FAA has been able to make significant strides in reducing the duration of airspace closures per launch. But as the cadence picks up, more improvement is still desired.[22]

Recommendations

Industry and government efforts to modernize spaceport operations are well underway but may not be moving fast enough to sustainably support a several-fold increase in launch frequency anticipated within the next few years. Through collaborative forums like the CDM Committee or similar, **government and industry should seek alignment on a clear framework for prioritizing new standards and technologies that are most likely to safely increase throughput for government, private, and public-private spaceports**. For example, standards may include those that enable broader integration of digital systems engineering tools to modernize spaceport logistics. In turn, agencies like the FAA and Space Force should consider additional incentives and enforcement levers to accelerate the adoption of key standards, like AFSS, across commercial providers.

It would also help for multi-use spaceport operators **to invest in common, supporting launch infrastructure and software that will benefit both current and next-generation launch and reentry operations**. For example, additional investment in technologies that enhance real-time telemetry and trajectory prediction would help improve both safety and efficiency.

Finally, Congress should **consider implementing strategies to equip FAA and/or other agencies with the resources and authority needed to manage the increased demand for licensing, oversight, and air traffic control functions while continuing investment in capabilities to improve commercial space integration in the NAS**. Additional studies may be warranted to explore the potential benefits and drawbacks of fee structures for commercial spaceflight through national airspace (like those paid by commercial airlines) to support FAA operations and modernization efforts.



Strategy 3: Adapting government-centric operating and financial models for an increasingly commercially-driven launch sector

Realizing the upgrades to spaceport capacity and capability explored above requires significant additional investment from both the public and private sectors. Funding is available from several sources today, but there are notable constraints that limit both the speed and scope of public infrastructure improvements possible with that funding. Additionally, today's policies and legal authorities make it challenging for government owned spaceports to adopt financial operating models that would help scale up capabilities and services for commercial launch operations.

NASA and USSF use Congressionally appropriated funds for many purposes, including investments in space launch infrastructure. Requests for major construction projects are planned and programmed years in advance, often via multi-year strategic plans, and submitted via the agencies' Congressional budget request processes. State governments follow a similar process for appropriations via their state legislatures.[27] At the local and regional levels, development groups like Space Florida, REACH in California, and the proposed Texas Space Commission[28] serve to attract, incentivize, facilitate, and at times capitalize private investment in the space ecosystem. Just as important as raising capital, however, is having effective means to use it. Private sector investment on government land is typically limited to improvements made on the land and facilities leased to these companies. As such, it can be difficult to invest in common use infrastructure and capabilities that would increase capacity for all space launch customers.

While the reimbursable fund and contract authority granted to the Department of Defense in Title 10 U.S.C. § 2276 allow the government to accept contributions from the private sector, they do not allow private contributors a monetary return on investment. As a result, these mechanisms have not proven effective in stimulating cooperative investments from commercial space launch companies to date. The net effect is that critical infrastructure projects are typically subject to years-long appropriations requests.

Further legal limitations hinder the Federal Government's ability to support the exponential growth of commercial space launch. Under current authorities and statutory requirements, the government is limited to providing launch services or property "otherwise not needed for public use" and may recover the *direct* cost of civilian and contractor personnel only. Thus, the government is bearing the additional *indirect* costs of providing these services, as well as the full costs of military personnel to do so. These challenges further strain government operating budgets in the short-term and do not allow for cost recovery to capitalize long-term investments in critical infrastructure and equipment.

Recommendations

Investment for major US launch facilities is critical to meeting rising commercial demand and national security needs. Obtaining the billions of dollars in critical infrastructure upgrades to the primary launch facilities at Cape Canaveral Spaceport and VSFB requires additional funding that can only be effectively realized via Congressional appropriations in the near term. These **investment requests should consider and plan for common use infrastructure** (e.g., roads, electricity, water, sewer, communications, fuel transportation from the "hubs" of these facilities out to the leased "spoke" LCs). Such **investments should be future-focused and support improvement at all identified LCs** – those currently in use, those recently leased and undergoing modernization from the private sector, as well as previously decommissioned sites that will require both public and private sector investment to rebuild and modernize.

In the medium-term, government should **consider how possible changes to statutory authorities may add flexibility and sustainability in the financial operating models for government owned spaceports**. For example, allowing indirect cost recovery for space launch services could reduce current strains on critical support functions (e.g., program management, contracting, finance). This could enhance the government's ability to support commercial demand while also maintaining adequate availability to carry out the nation's national security and science and exploration missions.

Longer term, the US launch infrastructure may benefit from **evolution to a Spaceport model that incorporates the leading practices from commercial airports and other transportation modes**. In such a model, industry standards developed and refined in concert with the private sector and enforced by regulating agencies to reduce costly customization, lower barriers to entry, and further facilitate economies of scale across the industry. Federal and state-owned launch facilities could take on a role like a Port Authority – a self-sustaining organization that owns and leases the land for facilities developed and run by the private sector. Taxes and/or fees levied for land use, services, and cargo could fund the operations of these facilities and allow for long-term investments in periodic upgrades to IT, instrumentation and communications equipment, and other common use infrastructure. This public-private partnership is

already emerging in the non-Federal spaceports at MARS, the Pacific Spaceport Complex, Spaceport America, and the Mojave Air and Spaceport described above as these facilities are operated in partnership with commercial or quasi-commercial entities that run them as a business. As these smaller spaceports continue to grow in size and complexity, scaling these public/private spaceport operating models may serve as key guideposts for Federal spaceports' transition. Achieving this shift at scale at the state, local, and Federal levels could facilitate national standardization of services, standards, infrastructure, and performance benchmarks that would be truly transformative.

Conclusion

The US space industry is at one of the most exciting points in its development in decades. Today, the industry is changing more rapidly than ever before, across the US government and the private sector. Access to space via cargo and crew launch services are increasingly dominated by the private sector, but would not be possible today without the land, infrastructure, support services, and regulatory compliance provided by the Government. The Spaceport of the Future is the vision of continued evolution of this public-private partnership to standardize and sustainably grow and accelerate the US's position as a commercial leader in space while preserving national security interests.

Let's talk

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