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The Maine Space Complex

WHY MAINE?... WHY NOT MAINE?

Strategic Plan

Prepared for:
The Governor of Maine
The Maine Legislature

Submitted by:
Maine Space Grant Consortium

Prepared by:
Emily Dwinnells, Project Director
Jeremy Ashlock, Research Analyst
Thomas Stahlhuth, Research Analyst
Terry Shehata, Ph.D., Executive Director

Contact Information:
Terry Shehata, Ph.D. (terry.shehata@msgc.org)
Emily Dwinnells (edwinnells@gmail.com)

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"...We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too."

President John F. Kennedy
Rice University Stadium, Houston, Texas
September 12, 1962

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Table of Contents

Executive Summary

NEW SPACE ECONOMY

Historically, space has been the exclusive domain of enormous government-funded projects executed by a small handful of aerospace and defense contractors. Over the past two decades, this paradigm has shifted as entrants from the commercial sector have disrupted the paradigm to the extent that the commercial industry now launches more satellites than the government. Evolving hardware and software have significantly increased performance and reduced the cost and size of componentry for spacecraft development. This evolution unlocked the value of creating smaller satellites and corresponding micro launch vehicles, reducing the cost of launching payloads into space. This new cost-effective technology has, in turn, lowered capital requirements and barriers to entry, attracting a wave of commercial participants into the new space industry around the globe and here at home in Maine. This has unleashed a significant influx of private capital to finance research and development, creating innovation and unlocking value across the new space value chain. Poised for tremendous growth, 'New Space' is one of the fastest-growing, high-tech future-forward industries emerging this century. Small satellites such as CubeSats that are the size of a bread loaf are among the fastest growing and most dynamic aerospace markets, attracting a high level of venture capital and federal attention. This market was valued at $4 billion in 2020 and is projected to grow to $25 billion by 2030.

With this reality, in 2018, the Maine Space Grant Consortium and a group of Mainers from aerospace businesses and academia asked the following questions:

1. Can Maine's involvement in the new space economy attract people to Maine's talent pool, grow the average annual wage, increase the value of what we sell per worker, and increase the percentage of Mainers that hold the credentials valued by Maine's businesses and industries as called for in the state's Economic Development Strategy and by MaineSpark? Specifically, can our involvement in the new space economy facilitate and enable:
    - Research, entrepreneurship, innovation, startups, and business expansion spur MTI's technology sectors to develop globally based applications for commercial and consumer users.
    - Maine industries growth and the mitigation of the threats they are confronting.
    - The attraction of highly skilled workers and their families from out of state.
    - State government and local communities' ability to monitor the impacts of climate change and mitigation.
    - Communities' improvement of local planning efforts.
    - Maine high school and college graduates to stay in state and capitalize on employment opportunities in the new space economy.
    - Maine's immigrant population to grow Maine's economy.
    - Advancement of Maine to a new competitive level in a fast-grow new space economy.
2. Does Maine have the assets to capture a meaningful share of the growing global new space economy and the small satellite markets? These assets include but are not limited to its geographic location for polar orbits; R&D, education, and physical assets at UMaine, USM, the Roux Institute, and other institutions; proximity to academic and business centers in the Northeast region; physical and business assets at Brunswick Landing and Loring Commerce Centre; Maine's aerospace and manufacturing supply chains;

companies directly involved in space exploration and development such as VALT Enterprises, blueshift Aerospace, and Fiber Materials; and Maine's entrepreneurial ecosystem support network.

At first, we were skeptical, but after looking deeper into our assets, and reviewing the results of a market demand study funded by the Maine Technology Institute, the answer to these questions was Yes, and the attitude shifted from **WHY MAINE?...WHY NOT MAINE?** The next question was how?

THE MAINE SPACE COMPLEX

Maine's citizens conceptualized the Maine Space Complex as the aspiring vision for a coordinated effort to leverage these assets, build capability and facilitate growth throughout the new space economy value chain and in doing so, position Maine to become a leader in the emerging and fast-growing market of launching low-cost small satellites into polar orbits using small, low-cost launch vehicles. The Maine Space Complex is not about launching small satellites on small rockets. It is about engaging students, researchers, businesses, state and local governments, and communities across the three segments of the new space economy value chain and the underlying infrastructure needed to support these segments. The upstream segment is research, manufacturing, and ground systems; all include fundamental and applied research activities, scientific and engineering support activities, materials and components supply, manufacturing of space systems, subsystems, equipment, telemetry, tracking, and command stations. The downstream segment is space operations for terrestrial use and products and services which rely on satellite technology, signal, data to function (e.g., satellite broadcasting, selected GIS, Global navigation satellite system-enabled devices). The space-related segment includes space applications, products, and services from spin-offs or technology transfer from the space sector, which use satellite technology but do not depend on it.

The three business units of the Maine Space Complex are:

A. Maine Space Data & Advanced Analytics Center of Excellence - The Space Data & Advanced Analytics Center of Excellence will be a cloud-based, digital platform resourced to import/downlink, store, cleanse, manage and analyze satellite data in concert with terrestrial data to solve local business and public policy issues in innovative ways. This will be a distributed network of nodes, offering portals from various locations (ex. Roux Institute, University of Maine, Governor's Office, etc.) to access satellite data (and other relevant data sets) for data science applications (ML/AI). It will be resourced with human capital that can offer specialization in satellite data and advanced analytics to drive the application of data toward the advancement of local industry and policy use cases, in addition to providing support and mentorship to data-centric startups and companies. It will require a cloud configuration within a network equipped with the hardware and software to import/downlink, store, cleanse, manage, and analyze satellite data in concert with terrestrial data to solve business and public issues in innovative ways and support the development of data-focused startups creating new data products and services.

B. Maine New Space Innovation Hub - Located at Brunswick Landing, with a spoke at Loring Commerce Centre, is envisioned as a knowledge and innovation hub for new business incubation and acceleration, hardware and materials component development facilities, and satellite launch vehicle manufacturing and testing. The shared space must contain specialized equipment to facilitate R&D, academic and scientific inquiry. It will also house joint academic-industry research initiatives, an office of tech transfer, administrative office space for businesses, and conference facilities to host national/ international events to draw users and attention

to the Maine space industry. It will also act as an educational center providing classrooms for in-person and remote K-12 and higher education learning opportunities and events.

C. Maine Launch Sites & Services - Develop a low-cost, highly accessible Low-Earth-Orbit (LEO) polar orbit launch site for small satellites and rockets with superior customer service to serve the commercial, academic/scientific, and government sectors. The site will create a need for credentialed and highly skilled technical jobs and offer workforce retraining opportunities. Launch capability will spur the development of a knowledge cluster, creating a foothold to capture prospects as the industry matures and develops. It will leverage Maine's current rocketry, data, and geospatial analytics capabilities to become a more visible national and international aerospace industry destination.

VISION, MISSION, PERFORMANCE GOALS, AND OBJECTIVES OF THE MAINE SPACE COMPLEX

Vision Statement: By 2045, Maine will be an integral player in the emerging global network of suborbital and orbital transportation to space, providing a significant return on investment as an engine of economic growth and workforce development to the state and the region.

Mission Statement: The Maine Space Complex provides faculty, teachers, students, businesses, partners, and entrepreneurs from within and outside of the state access to a plug and play infrastructure where innovations, ground-breaking research and development, problem-solving, spacecraft launch, world-class space data, and analytics capability, and dreaming big are routine occurrences, and from which virtual learning is available to teachers, students, and others.

Performance Goals: Achieving the vision is predicated on the three business units of the Maine Space Complex being fully functional and in use by customers in the business, higher education, research, government, and k-12 communities. In turn, these units will enable the Maine Space Complex to achieve the following Performance Goals by 2045:

- Facilitate the creation of an estimated 3,500 new jobs in Maine, 50% of which will be credentialed and commanding an average annual salary of $77,000.
- Capture at least 10% of the US small satellite market launch market.
- Generate an estimated $500 million in incremental GDP beyond the 2022 baseline.

Objectives: This plan lays out a pathway to position the Maine Space Corporation to achieve the Vision, Mission, and Performance Goals through short- and long-term objectives and action steps as outlined below.

Short-term Objectives (2 Years)

- **Objective #1:** Establish the Maine Space Corporation as a quasi-state body to oversee the development and growth of the Maine Space Complex.
- **Objective #2:** Identify and secure a launch site in Maine for vertical launches.
- **Objective #3:** Continue recruitment of businesses commercializing all aspects of the value chain working in proximity at Space Complex to intensify knowledge and skills transfer to facilitate the development of new technology and the growth of the New Space Economy within Maine.
- **Objective #4:** Continue engagement strategy, and dynamic communications plan to ensure transparency, positive reception within the state, and support by the government and external stakeholders.

- **Objective #5:** In partnership with the Maine Composite Alliance, continue developing and implementing training programs to update workers' skill sets in the advanced materials industry to align with the new space economy.
- **Objective #6:** Set industry topics and initiatives for Maine industries – agriculture, aquaculture, fisheries, lobster, forestry - that can benefit from satellite data and research RF remote sensing, mapping, and other small satellite data services to improve competitiveness.
- **Objective #7:** Set research topics and initiatives aligned with Maine's capabilities and emerging opportunities, especially data analytics.
- **Objective #8:** Promote STEM curriculum including Ph.D. programs advanced math and computer science in K-12 to build the capabilities to develop next-generation resources for high growth data-rich industries to prosper.
- **Objective #9:** Establish collaborative agreements with the Midcoast Regional Redevelopment Authority (MRRA) and the Loring Commerce Centre to access facilities and resources critical to the development and growth of the Maine Space Complex.
- **Objective #10:** Secure private funds, federal grants, and state investments through bond issues to support the renovations and constructions of the Space Innovation Hub at Brunswick Landing, manufacturing and integration facilities at Loring Commerce Centre, and one or more launch facilities.

Mid- to Long-term Objectives (3 Years- Ongoing)

The Maine Space Corporation will recalibrate its pathway forward based on the progress and revise or set new performance metrics. The Corporation will continue to pursue the following objectives:

- Continue to build capability within the academic sphere through alignment of programs and further development of research priorities, partnerships with industry, development of effective tech transfer, and creating a workforce strategy to ensure a strong talent pipeline in Maine and the region.
- Create and strengthen the connective tissues between academia and industry through internships, site visits, career exploration, industry-sponsored projects/research initiatives.
- Raise and secure funding for the New Space Innovation Hub to encourage new ways of collaborating and expanding academic capability and capacity.
- Continue to build upon Maine's strategic resources and capabilities to develop an integrated and robust value chain of space-related businesses and activities within Maine.
- Continue to focus on developing specializations in emerging areas of the new space value chain, including composite and advanced materials.
- Continue to focus on helping Maine existing industries mitigate threats they are facing through dedicated use of the Maine Space Complex assets.

ECONOMIC IMPACT

The Center for Business and Economic Research (CBER) at the University of Southern Maine (USM) conducted an economic impact analysis of the proposed Maine Space Complex and business components. The study developed revenue and market share forecasts for space complex business components drawing on several industry sources and experts. Four scenarios were simulated over an 18-year forecast horizon using an economic

model developed by Regional Economic Models Incorporated (REMI) and maintained by CBER. The results indicate that a new space economy in Maine could contribute:

- Between $550 million to $1.1 billion per year (in fixed 2022 $) to the state GDP by 2042.
- Between 2,800 and 5,500 good-paying jobs annually by 2042 while providing a significant source of tax revenues across the state.

Although not a comprehensive evaluation of a space complex development, these simulations represent the *potential* impacts assuming that a new space economy emerges in line with market forecasts and under the various scenarios simulated in this analysis. There are no probabilities assigned to these scenarios. The potential impact of tourism revenue has not been included and could contribute significant additional gains. The development of the Maine Space Complex and the new space economy can have substantial economic impacts on the state and regional economies. It is well-aligned with the state's 10-year economic development strategy focused on innovation and talent. The scenarios and forecasts presented in this analysis represent a subset of an industry's potential development paths.

CBER also conducted a geographic breakdown of economic impacts across seven regions that are county aggregates that closely align with the state's seven Economic Development Districts. As shown in the table below, the impacts will primarily be concentrated in a few regions across the state. However, all areas will feel indirect and induced effects across the state. These impacts' relative magnitude and concentration should remain consistent throughout the forecast period. However, some components of the space complex are spatially elastic or footloose. Unlike physical launch and control and command facilities, data analytics and, to a lesser extent, parts manufacturing are more location-dependent - they can be located anywhere. Still, there are strong pull factors for spatial proximity that may draw more of this activity closer to the core to leverage and access labor pools of similarly skilled workers and training networks, to be closer to the buzz and action and knowledge flows, and to be closer to other suppliers that help reduce transaction costs and improves coordination of more nimble launch operations.

Region	Employment	Wages and Salaries	Gross Domestic Product	Output
		In Millions of Dollars		
Androscoggin Valley EDD - Androscoggin	149	$ 7	$ 18	$ 32
Northern Maine EDD – Aroostook, Washington	339	$ 14	$ 102	$ 158
Eastern Maine EDD – Penobscot, Waldo, Hancock	1,070	$ 69	$ 153	$ 293
Greater Portland EDD – Cumberland	1,772	$ 154	$ 370	$ 561
Kennebec Valley EDD - Kennebec	85	$ 4	$ 11	$ 18
Midcoast EDD – Sagadahoc, Lincoln, Knox, Waldo	118	$ 7	$ 16	$ 29
Southern Maine EDD – York	1,990	$ 182	$ 414	$ 776
All Regions	**5,522**	**$ 437**	**$ 1,084**	**$1,866**

The estimated economic impacts on employment, contribution to GDP, and tax revenues across the state can only be accomplished by state-wide coordination of its assets to realize the potential of the Maine Space Complex. This is the role of the Corporation. No single company can unlock these benefits to the residents of the state of Maine alone. Moreover, creating a monopolistic condition to protect the competitive advantage of a

single company will deny other launch providers the opportunity to establish a foothold in Maine and all but eliminate the potential to create and retain jobs at the scale estimated by the economic impact analysis.

COST ESTIMATES FOR THE MAINE SPACE COMPLEX

The Maine Space Complex's business model relies on investments from the federal government, private investments, and the generation of fees from the use of facilities. *State appropriations are unnecessary*, but infrastructure costs will require federal and private investments and state bonds.

The Consortium conducted a rough order of magnitude cost estimate based on the vision of the Maine Space Complex and analogous project costs at other spaceports. We weighed three development scenarios for the vertical launch site, representing a beta site that would temporarily accommodate launch companies, a minimum viable product for a permanent launch facility, and a maximum potential vertical launch site that would include industry-leading facilities. We also examined how three benchmark spaceports – Pacific Spaceport, Mid-Atlantic Regional Spaceport, and Spaceport America - were funded. We considered the various stages of development and aligned that to funding sources from planning to construction and operations. Each case study provided an overview of facilities, stages of development and funding associated with each stage of entity formation, and the progression to the construction phase that proceeded. The funding mechanisms and subsequent capital and operational expenditures that occurred were examined. We reviewed revenues in great detail and operating costs as their capital footprint scaled. Finally, we compared each spaceport's operating profits or losses and the economic impact in the region to identify whether these spaceports provide an adequate return on investment for the local economies.

Rough order of magnitude cost estimates identified that a vertical launch complex could cost between $5.5 million and $90 million depending on the outfitting and phasing plans, with a beta temporary-accommodation site estimated to cost between $5.3 million-23 million. The cost for minimum viable permanent launch site ranges from $13.6 million to $32.3 million. The horizontal launch complex is estimated to cost $53.2 million, depending mainly on individual site infrastructure needs like runway improvements. The data analytics and innovation center are estimated to cost close to $1.3 million, depending on the facility location and scope of the initial build. We also retained an independent engineering firm to provide a more precise breakdown of specific costs about the launch complexes. A substantial cost consideration with an outsized impact on total project cost is the need to build traditional infrastructure like roads to the sites.

MAINE SPACE COMPLEX FUNDING MODEL

Maine Space Complex's funding model is based on Alaska's Pacific Launch Complex, which minimized state funds and staged development to start with a minimum viable product and scale growth with demand. Spaceport America in New Mexico is the most expensive spaceport built in the US, while Pacific is the least. Alaska's responsible growth and development of its launch site have allowed it to see operational profits as it has reached maturity with limited state appropriations – about $15 million over 20 years compared with $325 million in total revenues during the same period - less than 5% of the project. Alaska utilized a phased approach to its build, justifying each launchpad construction with its marginal benefits and considerations and not building the complex all at once. The complex has a limited presence and has no aesthetic gaudiness or architectural pronunciations. This provided stable income over time, minimizing the state's contribution. Most of the planning

phase spending for Alaska was from federal funds, as it was seeking to win a competitive bid to be a DoD launching site, beating out a place in the Pacific Northwest.

For these reasons, the strategic plan calls for the Corporation not to seek state appropriations for operations, programs, and infrastructure, and focus attention on positioning the state to secure existing and anticipated future federal funds and private investments for infrastructure, operations, and programs as they become available in the next several months. Financial support would also be realized from fee generation from uses of Complex facilities within ten years. Regarding infrastructure, LD 1923 includes a provision for the Corporation to issue bonds for infrastructure requirements for the Maine Space Complex. In addition to the ARPA infrastructure funds, there is bipartisan support to fund the Department of Commerce Office of Space Commerce and the FAA Office of Spaceports to provide financial support to states with spaceports to support infrastructure, operations, and programs. In contrast to the other spaceports, the diverse portfolio of activities of the Complex minimizes reliance on the launch sites for revenue generation. Even with this diversity, we expect the Complex to be profitable within ten years once the three business units are fully operational and have time to generate revenue. The Corporation will continue to support the Complex with federal and private investments during this period. For example, the MSGC is working with EDA and MTI to secure financial support for business development activities and for the startup phase of the Corporation.

THE MAINE SPACE CORPORATION

An essential objective in the strategic plan is to establish the quasi-state Maine Space Corporation to orchestrate the development and growth of the Maine Space Complex and advance a new space economy in Maine that would serve Maine and a global market of end-users. As additional federal funds become available in the next several months, the Corporation would be the best vehicle for applying for these funds. Without the Corporation, progress in realizing the potential of the Complex would be inhibited and cause the state's efforts to fall behind the competition in other states such as Michigan. The Corporation would be the best vehicle to maximize funding opportunities (as opposed to a non-profit or a strictly private organization) by providing access to the federal government and private sector funding, as well as future opportunities to levy bonds for construction. Enactment of the bill would also send a strong message to the business and investment communities inside and outside of Maine that the state supports the development of the Complex and would facilitate agreements with businesses and organizations that want to become anchor tenants and use the Complex's facilities.

COMMUNITY FEEDBACK

Although the MSGC has started and will continue conversations with stakeholders and community members from across the state and more directly in Washington County, community concerns were raised in December 2021 by the citizens of Jonesport-Beals in reaction to bluShift Aerospace's statement regarding its intention to establish a launch facility on Water Island. Among the chief concerns voiced were interference with preexisting fishing and lobstering operations as boats of any kind would be required to stay out of the rocket's flight path during launch windows. The other concern was the lack of environmental impact information and detail, which was a big concern to environmentalists, citizens, and those that depend on the surrounding area's natural resources for their livelihoods.

About the Maine Space Grant Consortium

The Maine Space Grant Consortium (MSGC) is an Affiliate-based 501(c)(3) corporation and a member of the national network of 52 state-based consortia funded by the NASA National Space Grant College and Fellowship Program. Our overarching goal is to support the expansion and diversification of Maine's space exploration research and education capacity along the K-graduate continuum by increasing statewide involvement in space research, technology development, education, and training programs that align with NASA's priorities and contribute to Maine's competitive advantage in a new space economy. We also administer the Maine NASA EPSCoR Program, which provides competitive research funding to Maine researchers to develop research capabilities directed toward long-term, self-sustaining, nationally competitive research that aligns with NASA's and Maine's research interests. This capability will, in turn, contribute to Maine's economic viability and expand the nation's base for research and development.

Introduction

Maine has long been characterized by the resourcefulness and ingenuity of its people. Whether harvesting its woods or waters, Maine has proven over again that it's capable of transforming its natural resources into the industry, creating livelihoods for its citizens, and supporting its people. The origin of the Maine Space Complex started in much the same way; a small group of dedicated citizens from the space industry came together to ask if Maine had a more prominent role to play in Maine and the nascent but rapidly growing 'new space' industry.

As the 'new space' industry has emerged over the past 20 years, the MSGC invested over $25 million to support inspiring space research across the state - from developing Mars landing systems to a sensor technology used to detect leaks in space habitats. Although innovative research has been occurring for years, Maine has not fully harnessed the full return of this investment due to an underdeveloped instate space market that could cradle and foster these students and drive opportunities to create sustainable, long-term economic growth for Maine's economy. While STEM education is critical to growing a next-generation workforce, it is not the sole strategy for economic growth.

Recognizing the immense potential of the new space economy, the MSGC asked a critical question – "How can space be used to drive not just research but true economic growth in Maine?" With this question, MSGC began a dialogue with Maine-based aerospace professionals to consider opportunities within the space industry Maine could harness. A unique natural advantage was revealed from these discussions – Maine's easternmost position in the US offers ideal conditions to launch rockets into polar orbit from its coast. With this insight, the Maine Space Complex concept was born. Asking this novel question set this group – and Maine - on a new trajectory to uncover significant, bold ways the new space industry could integrate into our local economy, drive Maine's development into the future and create high-paying jobs for our graduates.

With a grant from the Maine Technology Institute (MTI) in 2018, the MSGC undertook a market demand study to determine the public and private sectors' interests within Maine and outside in a proposed space complex. This study confirmed the public and private sectors' interest in accessing and using the complex. It indicated that Maine is poised for a leadership role in the emerging and fast-growing market for nanosatellites by launching nanosatellites using small, low-cost launch vehicles. This study was followed by 2019 awards from the MTI and the U.S. Economic Development Administration (EDA) to develop a strategic plan to set forth the vision and

mission of the Maine Space Complex, to orchestrate an integrated ecosystem of aligned interests and actors focused on achieving common strategic goals to drive the development of Maine's New Space industry forward thereby creating value and opportunity for Maine's future generations. The following report, developed with guidance from the Maine Space Complex Leadership Council, outlines the roadmap for industry development and the anticipated impacts.

Opportunities in a New Space Economy

1. Role of Space

Humankind launched its first satellite into Space in the battle for technological superiority and global hegemony amidst the backdrop of the Cold War in 1957. The old space paradigm was funded by the government in support of national security, public interest, and basic science. Since then, the role of space has evolved considerably from a federally sponsored endeavor to a commercially led industry creating new markets and serving consumers directly. However, incredible milestones have been achieved along the way, from the first government-funded human-crewed mission to the moon in 1969 to the exploration of Mars, not to mention spin-off technologies including radial tires, scratch-resistant lenses, enriched baby food, solar cells, portable cordless vacuums, and firefighting equipment, to name a few. Over the last 50 years space has become an integral piece of our daily lives. Without recognizing it, most people already depend on satellites for daily conveniences such as cell phone navigation, listening to the radio, and watching television. Space exploration and development have and will continue to play an enormous role in our lives, imaginations, and the global economy over the coming decades.

2. Market Potential

Although space has historically been considered the exclusive domain of enormous government-funded projects executed by a small handful of contractors, this paradigm has shifted toward commercial industry leadership due to technological advances over the past decade that have made it possible for private companies to enter the market. Evolving hardware and software have significantly increased performance and reduced the cost and size of componentry for spacecraft development. This has precipitated the introduction of small spacecraft like nanosatellites development of micro launch vehicles and other enabling technology that have reduced the overall cost of launching payloads into space. This new cost-effective technology has, in turn, lowered capital requirements and barriers to entry, attracting a wave of commercial participants into the new space industry around the globe and here at home in Maine. This has unleashed a significant influx of private capital to finance research and development, creating innovation and unlocking value across the new space value chain. Poised for tremendous growth, 'New Space' is one of this century's fastest-growing, high-tech future-forward industries.

Valued at $371 billion in 2020, the global new space industry is still in its infancy. Analysts such as Goldman Sachs and Morgan Stanley predict the market value will surpass $1 trillion in the 2040s, while the US Department of Commerce is forecasting the sector to reach $1.5 trillion by 2040. Approximately 95% of the market is derived from products and services produced by satellites in space for use on earth, such as telecommunications, broadband internet delivery systems, earth observation capabilities, national security reconnaissance, and more. However, products and services intended to serve the economy in space like space tourism and space habitation are starting to enter the market, opening another market segment.

Here on earth, the growth driver is the satellite market, which is large and growing. Small satellites refer to satellites ranging from 0.01 to 600kg among the fastest-growing segments of the aerospace markets. While small satellites only represent about 3% of the market, they are expected to grow to 5% by 2030, with a value of over $25 billion annually.

- The most significant components of the satellite market are information services, followed by ground equipment, satellite manufacturing, and launch.
- Nanosatellites will account for around 30% of the small satellites market, while the highest value segments are the micro-and mini-satellite classes.
- The small satellite industry will grow a market value of $69 billion by 2030 due to the rapid increase in small satellite demand; 82% of the need for small satellites will be from North America and Asia.
- The market value of nanosatellites is projected to reach $9.5 billion in 2030, mainly due to their use in a broad range of commercial applications in all regions of the world.

While the large private companies such as SpaceX, Blue Origin, and Virgin Orbit routinely grab headlines in the national media, behind the scenes, many private space companies have entered the nascent but increasingly robust new space industry ecosystem. Private industry has eclipsed the US government as the leader of the new space industry measured by payloads in space. Recognizing the potential of this newly disrupted market, several nations around the globe have positioned themselves to capture this growth and attract the industry to their respective region.

However, space is not only about the business of building and launching payloads into space; the vast majority of the revenue and benefit comes from the products and services those satellites provide. Satellites are extremely useful in overcoming various limitations of the earth's geography. They can capture more data more quickly than a plane or drone because it is higher above the earth's surface. Satellites collect an immense amount of data using a variety of sensor and imaging technology. This data is used in natural resource management, agriculture, forestry, aquaculture, fishing, oceanography, and climate change science, among many other use cases. Harnessing satellite data can help professionals in those fields make better and more informed business management decisions.

Figure 1: SEQ Figure * ARABIC 1: Satellite Classification

	Mass Class Name	Kilograms (kg)
Smallsats	Femto	0.01 – 0.09
	Pico	0.1 – 1
	Nano	1.1 – 10
	Micro	11 – 200
	Mini	201 – 600
	Small	601 – 1,200
	Medium	1,201 – 2,500
	Intermediate	2,501 – 4,200
	Large	4,201 – 5,400
	Heavy	5,401 – 7,000
	Extra Heavy	> 7,001

From FAA *The Annual Compendium of Commercial Space Transportation: 2018*

3. What are Small Satellites?

Satellite size is categorized by weight measured in kilograms (kg). The Maine Space Complex is considering weight classes of satellites from Femto (0.01-0.09kg) up to mini satellites (weighing less than 300kg) as potential launch customers (Figure 1).

Nanosatellites (1-10kg) have grown in popularity over the past two decades due to the creation of CubeSat reference design which became an industry standard for the design and deployment of these satellites. This 10cm x10cm x 10cm satellite is commonly used in academia and commercial test cases (Figure 2).

Due to the miniaturization, increased reliability, and performance of many electronics inputs, including commercial off-the-shelf (COTS) (as opposed to custom-built electronics hardware) the cost to build satellites have fallen dramatically. The benefits accrued by this miniaturization include:

- Decreased weight per payload allowing more satellites to be launched simultaneously creating economies of scale
- Frequently, small satellites are secondary payloads on a large rocket with a launch schedule dictated by a primary payload and, as a result, can ride more cheaply.

There are risks, however, and they include:

- The electronics are smaller and are therefore more sensitive to radiation and prone to failure.
- Cannot carry large instrumentation payloads with them.
- They are generally designed to last only a few weeks, months, or years before ceasing operations (and for those in low Earth orbit, falling back into the atmosphere).

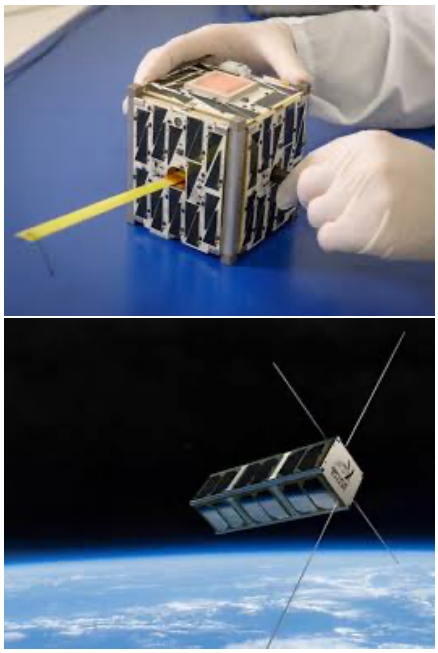


Figure 2: Top image is a CubeSat and the bottom image is a 3-unit CubeSat

4. Innovations in Small Launch Vehicles

Launch vehicles were initially designed to carry payloads greater than 1000kg into LEO, approximately 1,200 miles or less from the earth's surface (Figure 3). The launch vehicle industry has only recently started to adapt to the proliferation of small satellites with the development of smaller launch vehicles. While small satellites can find rideshare opportunities as a secondary payload on a much larger rocket, such as SpaceX's Falcon 9, they are often relegated to the primary payload's schedule and have less control over the launch timing and orbital trajectory.

Figure 3: SEQ Figure * ARABIC 3. Launch Vehicle by Weight Capacity

Launch Vehicle by Weight Capacity

Size	Payload Capacity
Micro	≤ 500kg
Small	500 – 2 tons
Medium-LV	2 to 6 tons
Heavy-LV	6 to 30 tons
Super Heavy	>30 tons

Dedicated small sat launch vehicle

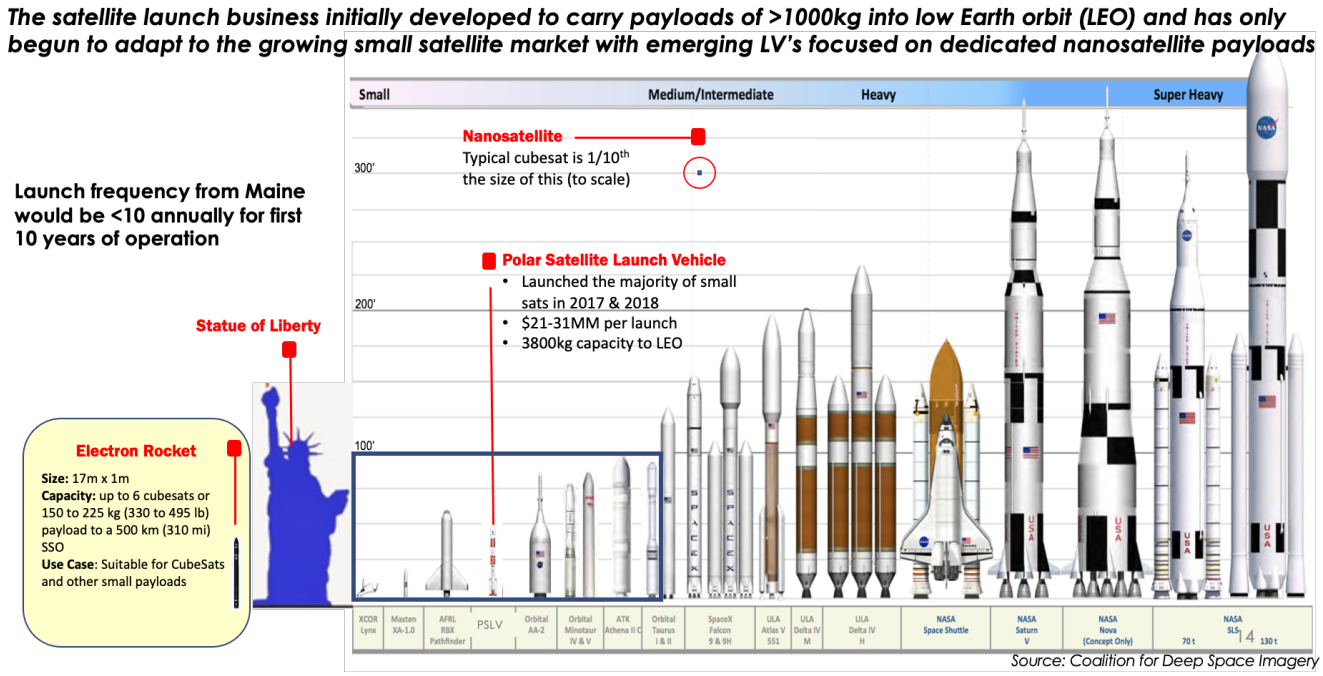
Smallsats travelling as secondary payloads

*1 ton = 907 kg/ 2,000 lbs

A new class of emerging launch vehicles called micro launch vehicles is tailoring their vehicles to cater directly to small satellites as a dedicated launch provider. This offers a couple of advantages in that the small satellites will be able to choose their orbital trajectories and have greater control over the launch manifest and timing. It is the difference between an Uber (custom point-to-point transport) vs. a bus (generalized point-to-point transport).

The first commercially viable U.S.-based small launch vehicle is Rocketlab's Electron rocket which measures 59 feet in height and 3 feet 11 inches in diameter (Figure 4). As a point of comparison, the Falcon 9, SpaceX's reusable rocket frequently launched from Kennedy Space Center, stands 230 feet and 12 feet in diameter (larger than the Statue of Liberty). The Space X Falcon Heavy, first launched on February 6, 2018, is the world's most powerful rocket and includes 3 Falcon 9 cores. The Maine Space Complex launch services will launch small satellites using micro launch vehicles.

Figure 4. Launch Vehicles in Perspective



5. Potential Applications

Small satellites can now achieve more in a smaller format than ever before. According to the International Organization for Economic Cooperation and Development (OCED), Space does not have international standards for industrial classification, which means worldwide national space statistics differ in definition, coverage, and methodology, generating a lack of international comparability. The structure of space economy data is therefore highly fragmented, and the space sector standardized data collection and reporting to support the evaluation of socio-economic impacts. However, with the impetus of the OECD, a global dialogue has paved the way towards shared definitions, starting with the expanding space value chain (Figure 5).

Figure 5: New Space Value Chain – Upstream & Downstream

The space industry value chain includes upstream activity, which consists of the design, manufacture, and launch of spacecraft (satellites and rockets) that collect data and provide services that are then transmitted back to earth in the downstream portion of the value chain, which includes space infrastructure operations, “down-to-earth" products and services that rely directly on satellite data and signals to function. The OECD defines three space segments setting up the perimeters of space activities, products, and services as follows:

- UPSTREAM SEGMENT includes R&D, manufacturing (satellites, rockets, ground stations, and systems that connect satellites to earth), and launch services. Activities include fundamental and applied

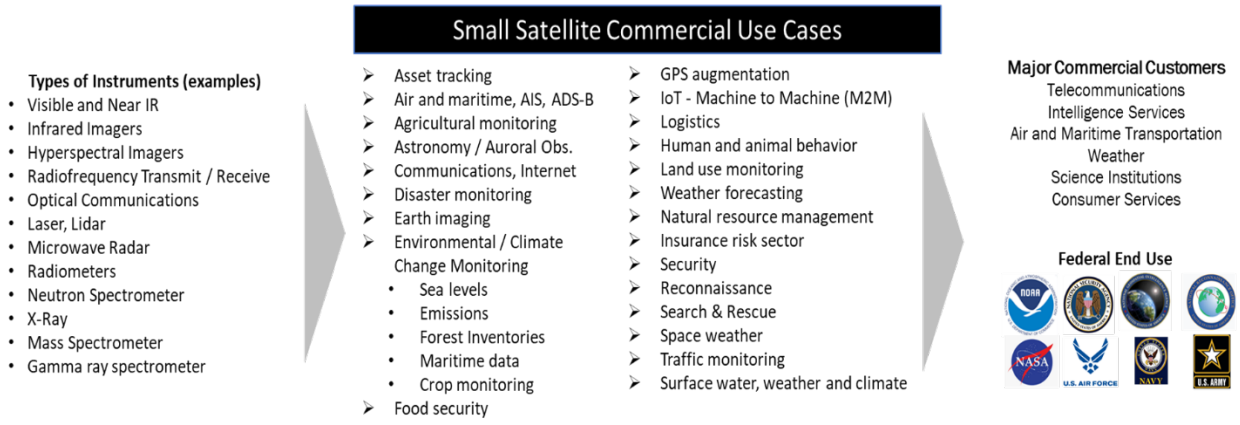
research, scientific and engineering support, material, and components supply, space systems, subsystems, equipment, telemetry, tracking, and command stations.

- DOWNSTREAM SEGMENT - includes operating the infrastructure downlinking of data from space operations for terrestrial use, products, and services that rely on satellite technology (e.g., satellite broadcasting, selected GIS, GNSS-enabled devices). Activities include downlinking, storing, cleansing, management, and use of satellite data for specific use cases.
- SPACE RELATE SEGMENT - includes space applications, products, and services from spin-offs or technology transfer from the space sector, which use satellite technology but do not depend on it (low incorporated quantities of "space" components).

The Maine Space Complex will focus on developing both upstream and downstream market segments. Concerning the downstream market, small satellites contain a variety of instrumentation in their payloads for an even broader set of use cases for various industries. The most prevalent use cases (Figure 6) for polar LEO payloads are:

- Earth Observation (EO) - electro-optical and radar observation of Earth used for meteorology and Earth-science/climate-related research.
- Telecommunications (Satcom) - satellites for commercial and government operators providing broadband communications.
- Information -satellites providing narrowband communications services (IoT and Machine-to-Machine) and collecting data from ground, aerial and atmospheric sensors.
- Security - satellites for space surveillance and tracking, missile early warning, near-Earth object monitoring, electrical intelligence, and space weather.
- Technology - satellites primarily from academics and government, built to test new technologies such as sensors and other components.

Figure 6. Downstream and Space-Related Segments of the New Space Value Chain

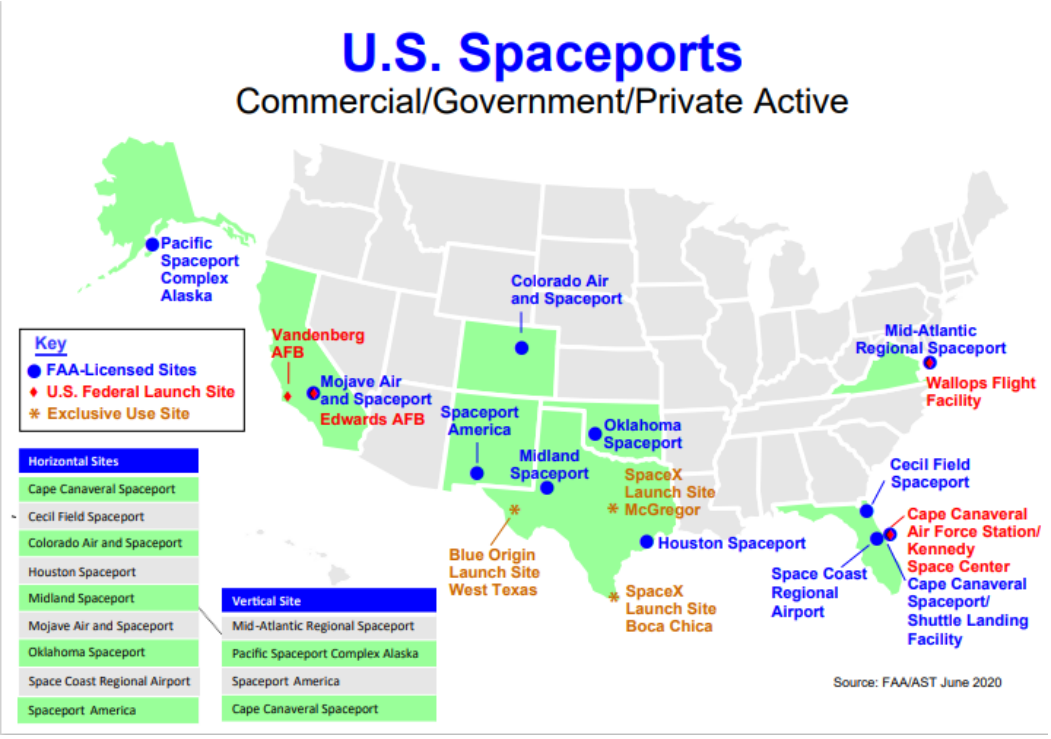


A number of these use cases apply to Maine industries, including agriculture, maritime navigation and communication, environmental and climate change monitoring, land-use monitoring, forestry, aquaculture and fishing, natural resource management, and weather forecasting, among others.

Existing FAA-Approved Spaceports

The United States is home to 13 FAA-licensed spaceports and one government-operated site at Vandenberg Space Force Base (Figure 7). There are nine horizontal launch sites and five vertical launch sites that regularly host polar orbit-bound launches for small launch vehicles. The nine horizontal launch sites are located at the following facilities: Cecil Field (FL), Colorado Air & Space Port (Front Range), Houston Spaceport (TX), Midland International Air & Space Port (TX), Mojave Air & Space Port (CA), Oklahoma Spaceport (OK), Space Coast Regional Airport (FL), Space Florida Launch & Landing Facility (SLF), Spaceport America (NM).

Figure 7. US Spaceport Map



The five vertical launch spaceports: Mid-Atlantic Regional Spaceport (MARS) (VA), Pacific Spaceport Complex Alaska, Space Florida Launch Complex 46, Spaceport America (NM), and Vandenberg SFB (CA). Spaceport Camden (GA) was granted FAA approval for vertical launch in December 2021. Blue Origin (Launch Site One) and SpaceX operate private launch sites in West Texas and Boca Chica, Texas.

1. Pacific Spaceport Complex (Vertical)

The Pacific Spaceport Complex achieved five commercial launches between 2018 and 2021 and hosts companies like Astra and Northrup Grumman. The complex is one of the few in the United States that can accommodate polar launch. It is also home to a very active scientific ballooning community. Under the management of the Alaska Aerospace Corporation, the launch complex turns a yearly net operating profit, with $2.6 million in net operating profit in 2020. The Pacific Spaceport Complex is expected to generate a cumulative total economic impact exceeding $100 million to the region by 2028.

2. Vandenberg Space Force Base (Vertical)

Vandenberg Space Force Base in southern California is primarily a government-used facility but has plans to expand more directly into the commercial market. It is the most-frequented polar launch facility in the United States, hosting 19 commercial launches between 2018 and 2021. With over 16 launch facilities and complexes, Vandenberg hosts companies like Firefly Aerospace, SpaceX, United Launch Alliance, and Northrup Grumman. Located on over 100,000 acres, Vandenberg provides 16,000 jobs and generates $4.5 billion annually for Santa Barbara and San Luis Obispo counties.

3. Space Florida Launch Complexes (Vertical & Horizontal)

With its rich launch history, Florida was the first U.S. launch site and most frequently associated with the space age; it has several spaceports operated by different entities. Kennedy Space Center and Cape Canaveral, Space Force Base, use vertical launch sites. Space Florida, the public-private partnership representing a state effort to facilitate launches and commercial space ecosystem growth, leases space from Cape Canaveral to achieve their launches. These three bodies completed 65 commercial launches between 2018 and 2021. Florida hosts SpaceX, United Launch Alliance, and Astra for launch. At the same time, Blue Origin and Harris Corporation have manufacturing and operational facilities onsite. The yearly economic impact of Florida's space coast from NASA operations alone exceeds $5.9 billion.

4. Spaceport America (Vertical & Horizontal)

Opened in 2011, Spaceport America facilitates horizontal and vertical launches from its $220 million site. It is famously home to anchor tenant Virgin Galactic, which provides horizontal space tourism launches; they also host UP Aerospace, which conducts vertical sub-orbital launches at the complex. Spaceport America has also seen considerable success in hosting its Spaceport America Cup – with over 1,700 students and faculty competing on designed launch systems. Spaceport America experiences a yearly net operating loss of over $5 million but provides annual economic impacts exceeding $50 million per year in 2019. By 2029, Spaceport America is expected to generate close to $200 million in total yearly economic impact.

5. Mid-Atlantic Regional Spaceport (Vertical)

The Mid-Atlantic Regional Spaceport (MARS) is home to the International Space Station resupply missions launched by Northrup Grumman and has recently announced it will host RocketLab's Electron rocket. MARS was conceived with the idea that the State of Virginia would benefit from a more coordinated and local effort to build a space ecosystem on top of what NASA's Wallops Flight Facility had already started. It has been seen as a success - while MARS experiences similar income statement losses as Spaceport America, the entire infrastructure on Wallops Island, including the NASA facility located there, generates a total economic impact of $1.37 billion annually for the State of Virginia.

Planned Spaceports

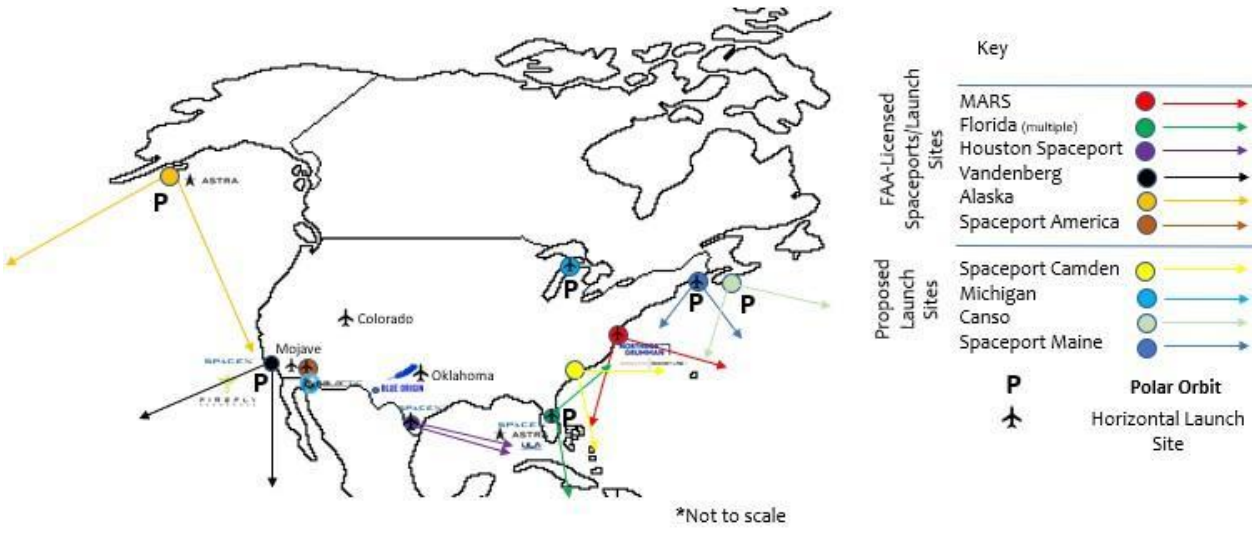
The proposed sites at Michigan and the Canso Spaceport in Nova Scotia represent current efforts to open additional launch infrastructure to serve small satellites and polar orbits (Figure 8). Alongside these direct competitors to the Maine Space Complex are the myriad sites currently licensed but not yet operational for horizontal launch in the United States. Maine would combine these capabilities and serve each launch method.

Aside from the proposals in Michigan and Canso is the threat of existing spaceports expanding their footprints to cater to under-serviced market areas, including polar and Sun Synchronous Orbit (SSO) launch of small satellites.

1. Michigan Spaceport (Vertical & Horizontal)

The Michigan Spaceport, led by the Michigan Aerospace Manufacturers Association, envisions vertical and horizontal launch sites, with access to polar orbits and SSO being integral to their plans. A launch site on the Upper Peninsula would allow a vertical launch northward over the great lakes to avoid overhead flight. The planned location for the horizontal launch site is the Oscoda-Wurtsmith Airport, a former Air Force base in the Lower Peninsula. The State of Michigan has funded the Michigan Spaceport to the tune of $2 million to undergo the feasibility and site study, hoping that the Michigan Aerospace Manufacturers Association can take the baton and leverage private equity money to build the facility. Operations are expected to begin by 2025.

Figure 8. Existing and Proposed Spaceports in the U.S. and Canada



2. Canso Spaceport (Vertical)

Canso Spaceport in Nova Scotia envisioned and managed by Maritime Launch Services, has taken the unique approach of privately financing the spaceport infrastructure. In May of 2021, it had secured $10.5 million from a Toronto investment bank and is planning its first launch in 2023 if construction can move forward as planned. Canso has traction, securing a launch agreement with Nanoracks, a Texas-based commercial payload provider which also offers satellite services to the Canadian Space Agency. Alongside this payload partnership, Canso plans to host the Ukrainian-built Cyclone-4M rocket, which has 877 successful missions under its belt. Canso plans to provide polar-orbit access to small satellites.

3. Vandenberg + Florida Spaceports Expanding Existing Capacity

Existing spaceports have the ability and are planning to increase their capacity to accommodate small launch vehicles and polar launches specifically to capitalize on the growing demand in the marketplace. Vandenberg recently released a master plan outlining a planned “Commercial Space Enterprise Zone” to bring companies to use the base’s existing infrastructure and build new and improved launch sites to increase the cadence of launches. Florida has started to provide polar launches due to the technological advancements in Automated

Termination Systems (ATS), cost-effective only for large-scale rockets, providing tolerance for some overhead flight as dictated by the FAA. There are five polar launches planned in Florida in the coming months.

Maine Assets for A New Space Economy

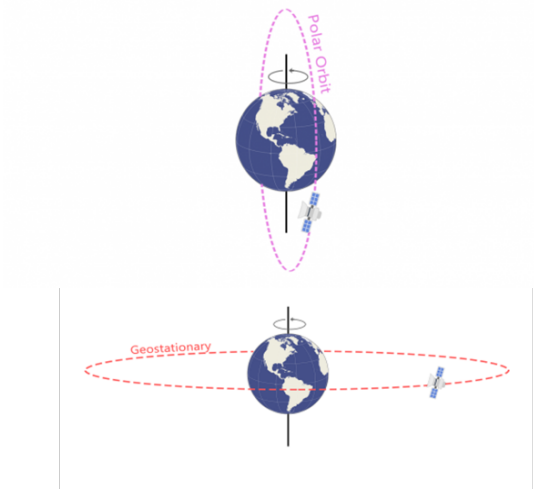
1. Maine has a unique geographic advantage to access space.

Maine is uniquely positioned in the northeastern corner of the United States that projects out over the Atlantic Ocean, presenting a coastline well suited for launch activity due to a clear path southward. With little interference from established air flight patterns minimal overflight of densely populated areas, Maine presents an excellent opportunity to launch southerly into a polar orbit (Figure 9) that passes close to or directly over the poles. This is a desirable orbit for many LEO missions operating, which is the orbit of choice for most commercial operations in space.

2. Maine is already home to a small but thriving space industry.

The economic development of an industry often begins by leveraging local assets and capabilities as a platform for future growth to build upon pre-existing strengths, expand capacity and ensure efficiency in resource allocation. Establishing the current state of the aerospace industry within Maine was the first area of focus in the strategic planning process. The Maine Aerospace Industry Assessment considered the number and variety of companies in Maine participating in the aerospace and space industries, the level at which they participate in the industry supply chain, and the related skills and capabilities of these companies' workforce.

Figure 9: Polar and Geostationary Orbit



The industry analysis included companies directly engaged in the new space industry (n=20), the broader collection of companies serving the aerospace industry (n=85), inclusive of space, and an overview of companies serving adjacent industries with skills and capabilities applicable to but not in service of the aerospace industry at this time (n=127). The analysis indicated that a small but thriving new space industry exists within Maine focused primarily on the upstream portion of the new space value chain engaged in the manufacturing of hardware components and subsystems (mWave, Texas Instruments, AVX Corp., Comnay, and Garmin), high-temperature carbon fiber composite systems (FMI and Auburn Manufacturing, craning services (Greison Aerospace), and a host of machining companies (Kennebec Technologies, Hunting Dearborn, Northwood Machine, PTE Precision Machining, Cascon Inc. Numberall Stamp and Tool Co.) and consulting services (Maine Aerospace Consulting and Hanna Consultants).

A. Launch Vehicle Systems

Maine is home to two launch systems designers, VALT Enterprises and BluShift Aerospace, who are developing micro-launch vehicles specifically for small satellite delivery into LEO. They have been recipients of various types of US Government funding, including prestigious SBIR awards, to continue R&D on their path toward commercialization. Although still under development, they are poised to become key contributors to the space

economy with a competitive advantage in environmentally sustainable solutions. VALT focuses on hypersonic delivery systems and can deploy from a vertical or horizontal launch; bluShift is vertical only.

B. Composite Systems & Advanced Materials

Fiber Materials Inc. (FMI) develops and manufactures high-temperature materials and carbon-reinforced composites for industrial, commercial, and aerospace applications. FMI fabricated the thermal protection system for the Mars 2020 transport/entry aeroshell and was recently awarded a $24 million contract from NASA to provide thermal protection systems (TPS) to support several emerging missions to Mars. As a recognized leader in the manufacture of high-temperature composite materials, FMI produces components and products that serve a range of applications from industrial insulation and friction hardware and from thermal protection systems to rocket motors to nose tips. FMI materials can be found inside industrial furnaces, at the National Air and Space Museum, and on the surface of Mars. Other companies participating in the space industry include Flagsuit LLC in Southwest Harbor, which provides advanced materials and textiles for spacesuits.

C. Hardware Componentry

mWAVE, a medium-sized company, specializes in custom antennas used on satellites, bringing capabilities across many radio frequencies like KA bands, KU bands, X bands, U bands across many applications. Several companies specializing in ground stations and satellite management and control services have also expressed interest in establishing operations in Maine, building upon our legacy as home to the ground station for Telstar, the first US communications satellite launched in 1962. Not only does Maine have a legacy in space, but it also has the potential to thrive and grow with the industry as it expands in the future. With its component and chip focus, Texas Instruments contributes to the new space economy and has a presence in South Portland. VX Corp, a Kyocera subsidiary in Biddeford, is a global manufacturer of advanced electronic components including antennas. Comnav Engineering produces microwave filters for wireless communication and navigation systems in Portland. Last on the list is Garmin in Yarmouth, provides downstream global positioning data and devices to the consumer market. Cascon Inc is a custom componentry developer in Yarmouth, specializing in pumps.

D. Machining Services

Kennebec Technologies is a machining shop in Augusta. Southern Maine Specialties provides anodizing, electroplating, and metal finishing technologies. Hunting Dearborn provides drilling, boring, and other machining services in Fryeburg. Northwood Machine is a CNC machining shop in Thorndike. PTE Precision Machining is a full-service machining shop in Kittery. Numberall Stamp and Tool Company provides metal marking equipment for industries, primarily stamps that engrave serial, part numbers, etc., in Sangerville. Thermoformed Plastics of New England is a custom thermoforming company that offers complete design, prototyping, tooling, and production services in Biddeford.

E. Professional & Technical Services

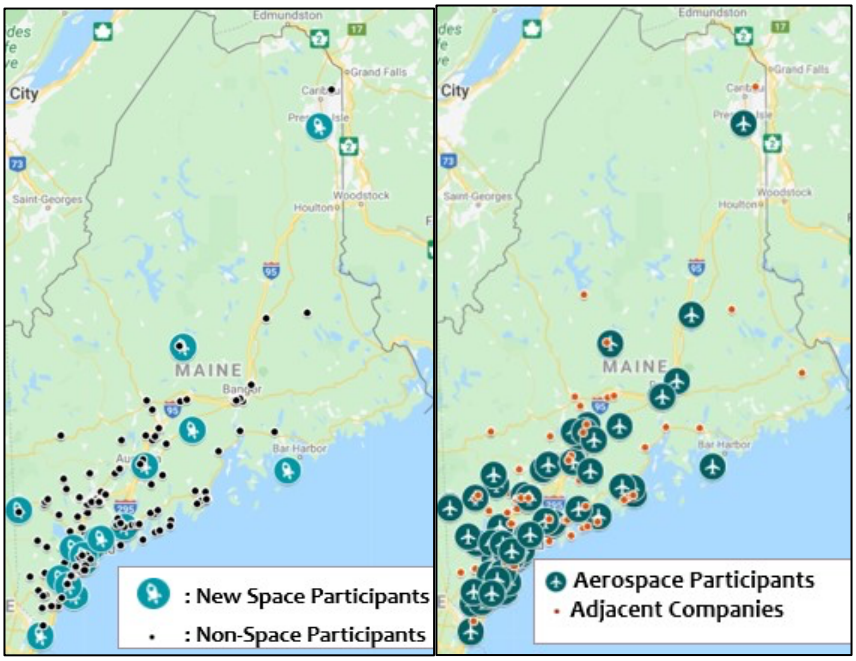
Hanna Consultants uses analytics to assist with dispersion analyses in Kennebunkport. Maine Aerospace Consulting provides industry-relevant engineering consulting in Falmouth. Greisen Aerospace provides advanced lift, craning, and loading/staging services in Brunswick.

3. Maine's Aerospace Industry & Workforce

The aerospace industry in Maine comprises 85 companies that serve the aerospace industry exclusively or that serve the aerospace industry and other markets (non-exclusive) (Figure 10). This collection of 85 aerospace industry participants employs ~5,000 workers. The largest aerospace company in Maine is Raytheon subsidiary Pratt & Whitney, a Tier 1 manufacturer of jet engines and after-market service and repair in North Berwick. Pratt & Whitney employs approximately 2,100 workers in North Berwick. Another 36% of all aerospace industry companies are small to mid-sized machine shops serving multiple industries, including aerospace as tier 3 component suppliers. Few of these companies are poised to expand their role in the aerospace industry due to a lack of industry certification (AS9100), a quality control standard required by many companies across the value chain. Maine's companies show depth in machining and modest progress toward automated processes. Adjacent industries, such as defense and manufacturing, have capabilities transferable to the space sector and could support future industry growth. Many aerospace participant companies are not aerospace-focused but contribute to the aerospace value chain.

A gap analysis was prepared to inform recommendations for how a Maine Space Complex could address local gaps in the value chain and workforce capabilities to create stronger linkages to the local and national space/aerospace industry to foster participation across Maine's new space value chain. Our findings show that Maine is missing links mainly in the downstream end of the new space value chain. We also identified a consortium-driven effort of higher education institutions and private sector companies to utilize the complex's innovation center to spur innovation in downstream activities.

Figure 10. Locations of Maine's New Space and Aerospace Participants.



A qualitative study distributed by the Manufacturers Association of Maine (MAME) to its members on behalf of the Maine Space Initiative analyzed the level of interest of its member companies to participate in the new space industry. The survey provided insight into the matter, highlighting the lack of a central industry repository of information and industry insight and labor/space/budget constraints. Answers included "No central resource to get answers about industry need," "Limited workforce to staff my company," "Asset needs to meet industry demands," "Limited space for manufacturing (physical capacity of the plant," and "high insurance costs to participate." The space industry provides more questions than answers for Maine companies at this juncture. Not enough certainty or insights exist for companies in Maine to understand how they can best fit into the supply chain. One MAME member was quite clear with their needs: "Access to the decision-makers in

engineering and purchasing at the manufacturing companies to become a valued resource and supplier to them." Maine's industrial players are at a disconnect to the needs of the mainstream space market currently.

Alongside bluShift, FMI, and VALT Enterprises, commercial launch vehicles solutions providers are interested in becoming an additional tenant launch supplier in the proposed Maine spaceport. With continued developmental success, these parties could provide a launch or two per year starting in 2025, with subsequent ramping up of launches over the years to come from an appropriately developed Maine launch site to the tune of 1-2 launches per month by 2035. Launch services are a linchpin for future industry development as regular access to polar orbit in the US is currently limited primarily to operations on the West Coast – Vandenberg AFB and Kodiak Island, Alaska.

A. Adjacent Capable Companies

Adjacent companies included in the study represented companies that serve industries other than the aerospace industry but display capabilities that would apply to the aerospace industry. Examples of an adjacent company fit to serve the aerospace industry could be as obvious as a machining shop not already serving the aerospace industry to as broader as a boat builder working with composite materials that display skills and capabilities that could be used in an aerospace function.

B. Industry 4.0 Practices and Maine's Ability to Compete

The manufacturing industry has experienced several technological periods of advancement. The most recent is often referred to as Industry 4.0. Its practices are characterized by the adoption of automation, additive manufacturing, IoT solutions, et al., with data becoming the primary driver of productivity to improve conformity, quality assurance and alleviate hiring pressures facing manufacturing firms globally. We identified this theme toward adoption of Industry 4.0 practices across the Aerospace and New Space value chains, with companies like Relativity Space promising mass-produced rockets in a matter of days and weeks versus what previously took months or years to build.

Table 1 shows how Maine's aerospace participants are keeping up with the advancement of the industry toward Industry 4.0 skills and practices. On a scale from 0-4.75, the analysis considered 0 to be not at all prepared, and 4.75 to be in a leadership position in categories relevant to Industry 4.0 – Organization, Technologies, Testing and Development, and Management. Under Organization, we graded the cohort of companies on their Industry 4.0 Strategy, their Industry 4.0 Leadership, and their Quality Standard Certification. Under Technologies, the study considered the cohort's Machining processes, Digitization of their Production, Engineering, and Data Utilization. Testing and Development broke down a company's ability to prototype and interlace good quality assurance practices in their business. Lastly, Management was broken down into financial resources and staffing. Overall, we found that the cohort of Maine firms ranked at a position of 2 out of 4.75. We concluded that Maine is not keeping up with the new Industry 4.0 positioning needs. Maine's engineering capabilities earned it its highest category marks on the matrix.

Table 1. Industry 4.0 Maturity Matrix

			0 - Beginner				1 - Intermediate				2 - Experienced				3 - Expert				4 - Top Performer				Score
Organization	Industry 4.0 Strategy	Explanation	Status quo; protecting against risk reacting to demand but not planning for it				Company leaders are aware of IR4.0 but unsure what it actually means in practice				Familiar with industry 4.0 technology and its value; has planned to implement some aspects				Comprehensive roadmap to implement industry 4.0 developed and ihas started adopting				Leaning into industry 4.0 and adopting it for competitive advantage against industry peers				1
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Industry 4.0 Leadership	Explanation	Not aware of industry growth trends or future state of industry				Aware of where the industry is heading - has a general picture of the future state, but has no active plan to evolve.				Familiar with future state of industry trends and understands benefits. Has high-level plans to get involved with trends.				Actively planning on 4.0 development strategy with holistic approach to capturing value in future economy with their firm.				Fully onboard and implementing 4.0 into operations for competitive advantage today.				1.5
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Certifications	Explanation	Not aware that certifications exist for their industry.				Aware of standards but too costly or burdensome to follow.				Planning to be ISO or AS9100 within 1 year				ISO certification				AS9100 Certification				1.75
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
Technologies	Machining	Explanation	2-axis/ 3 axes (X,Y and Z)				3-axis machining - CNC work remains very labor-intensive.				5-axis machining capabilities with limited capacity.				Fully/semi-autonomous 5-axis machining that has minimized the amount of set-up time and labor involved.				>5-axis fully/semi-autonomous machining.				1.75
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Digitization of Production	Explanation	No Automation; all manual				Some hybrid of manual and computer-aided shortcutting.				Computer aided manufacturing software utilized partially automated with some advantages				Computer aided manufacturing software utilized, fully-automated faster machining speeds, high yields, ability to manufacture very large-sized parts, etc.				Fully automated				2.25
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Engineering	Explanation	No engineering team, no technicians on board with CAD abilities.				CAD capability of technicians to employ plans into production				CAD capability to modify existing plans to fit specific machine, process, or conformance.				Design capabilities based on user specifications and provided engineering specs.				Full-suite designing and development capabilities.				3
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Data Utilization	Explanation	All analog processes, unable to produce cost of goods sold calculation (cash versus accrual).				Keep internal productivity data, internal accountant/bookkeeper to keep track of financial records.				All production runs standardized, cost estimated, and automatically facilitated. Runs associated with lot numbers for quality assurance.				Management of production able to establish key performance metrics, oversee cost of production, and understand plant capacity and efficiency.				Data collected and used at a productive rate, with central repository to facilitate all business processes.				2.25
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
Testing & Development	Prototyping	Explanation	Cannot produce prototypes				Quoting process, Expensive prototyping process				Produces prototypes based on provided plans with limited functionality, able to quote scalable pricing.				Able to provide plans, develop prototypes with 30 day turnaround and give scaleable quote.				Able to develop prototypes and give scaleable pricing quote within 2 weeks.				2.75
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Quality Assurance	Explanation	No intention of quality assurance implementation, no standard practices				Systemic quality assurance in written processes or forms				Forms and processes that ensure allowable quality assurance with a proven track record.				Quality assurance that meets ISO/AS9100 certification standards				Full scale quality assurance department				2.5
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3 Quality	3.25	3.5	3.75	4	4.25	4.5	4.75	
Management	Financial Resources	Explanation	Need Financial Resources				Have Financial Resources, unwilling to invest				Have financial resources, evaluating next investment				Recently made significant investment				Has long-term growth plan and strategic vision for capital expenditures				1.75
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
	Staffing	Explanation	No intention of future hiring				Currently hiring vacancies, unable to fill				Able to fill vacancies to keep up with job demand.				Able to fill vacancies in a timely manner.				Able to fill vacancies in a timely manner. On site training and workplace safety standards.				1.75
		Score	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	
																							2

4. Maine Physical & Infrastructure Assets

A. Brunswick Landing

Operated and managed by the Midcoast Regional Redevelopment Authority, is Maine's Center for Innovation and a progressive and innovative business campus located at the former Naval Air Station Brunswick (NASB), which was decommissioned in 2011. The 3,200-acre property is equipped with state-of-the-art facilities, close to 2 million square feet of commercial and industrial space, and a world-class aviation complex that hosts hangar space, a runway, and rocket engine testing capabilities. It is also home to a small aviation and aerospace cluster on site. Brunswick Landing can meet the needs of businesses looking for a small, medium, and large industrial space, maintenance and repair facilities, and professionally appointed administrative offices. The campus includes various equipment lessees have access to and is optimized for composites and advanced materials, light manufacturing, aviation/aerospace, biotech/biomed, information technology, and renewable energy businesses. Shared manufacturing equipment includes a three-axis CNC router, 3D printer, plasma cutter, drill press, vertical & horizontal band saws, Mig Welder, and many other tools that are utilized by TechPlace tenants like a Rohner Oven (21'x15'8"x10'), Grieve Oven (4'x4'x3'), Spray Booth (24'x16'x8'8"), and Freezer (12'x12'x 8'). In just over a decade since decommissioning military operations, nearly 150 businesses and 2,600 workers now call Brunswick Landing home.

- **TechPlace,** Brunswick Landing's Technology Accelerator, supports the business development needs of early-stage companies in a shared workspace. TechPlace gives entrepreneurs a place to network with others, research and develop ideas, build prototypes, test products, assemble, grow, and become successful manufacturing and technology companies. The target industries for TechPlace are Aviation / Aerospace, Biotech / Biomed, Composites and Advanced Materials, Renewable Energy, and IT.
- **Brunswick Executive Airport** offers two 8,000-foot runways, 650,000 square feet of hangar space and maintenance facilities, over 103 acres of taxiways and aircraft parking apron space, an advanced glycol recovery de-icing system, jet engine test and maintenance facilities, and a new instrument landing system.
- **FirstLight Data Center** is another asset offered at the Brunswick landing. It offers ITAR compliant data center services, carrier-grade infrastructure, light and dark fiber for data transmission, and a private, public, and/or hybrid cloud solution. It can be leveraged for use by data analytics companies for data storage on campus and low latency for advanced analytics.

B. Loring Commerce Centre

Home of the former site of the U.S. Air Force Base, the Centre is dedicated to economic development using the facilities of the former base. With aerospace-specific infrastructure on-site like large hangars, a runway that is the same size as Spaceport America's at 12,000 feet by 300 feet, a turn-key data center space, fiber optic linkages to greater New England, manufacturing space, and office space, there is certainly much to offer to any company willing to work in a more remote and private environment. With a position along Maine's fiber-optic line, low electromagnetic interference, and plenty of land available to use, perhaps the most friction-free use of Loring by the space industry could come in the form of Ground Station development and operations.

C. Maines Geographic Advantage

The state has a geographic advantage to launch satellites into polar and sun-synchronous orbits without the risk of overland flight. This risk cannot be alleviated by competing spaceports on the eastern seaboard such as Cape Canaveral, Camden, Mid-Atlantic Regional Spaceport. California and Alaska are the nearest launch opportunity for SSO and PO orbit access without the risk of overland flight. California's launch site is controlled by the United States Space Force, making accessing and utilizing the site difficult for commercial vendors. Alaska causes a logistic struggle due to the isolated nature of the launch site.

D. Maine's Low Population Density

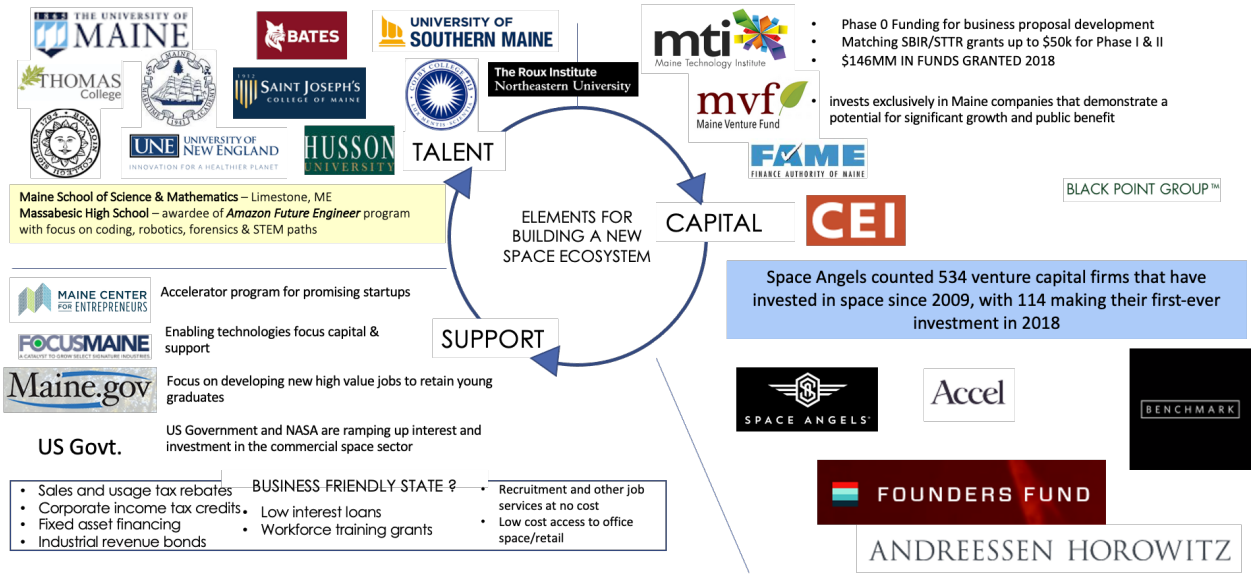
Maine has an advantage in its low population density, limiting the electromagnetic interference associated with densely populated areas. This is ideal for ground station operators, and places like Loring Commerce Centre could be potential host sites to develop for this use. Maine also has low light pollution in its remotely populated areas, which lends itself well to astronomical observation and science hobbyists. Thinking of itself as a conservator of dark skies in remote areas is another way for Maine to capture value from its existing strengths and signal its significance to the new space industry.

5. Maine Institutional Assets

As shown in Figure 11, Maine has some infrastructure to create the talent, capital, and support required to develop a New Space Ecosystem. Although Maine has many of the ingredients available to spur

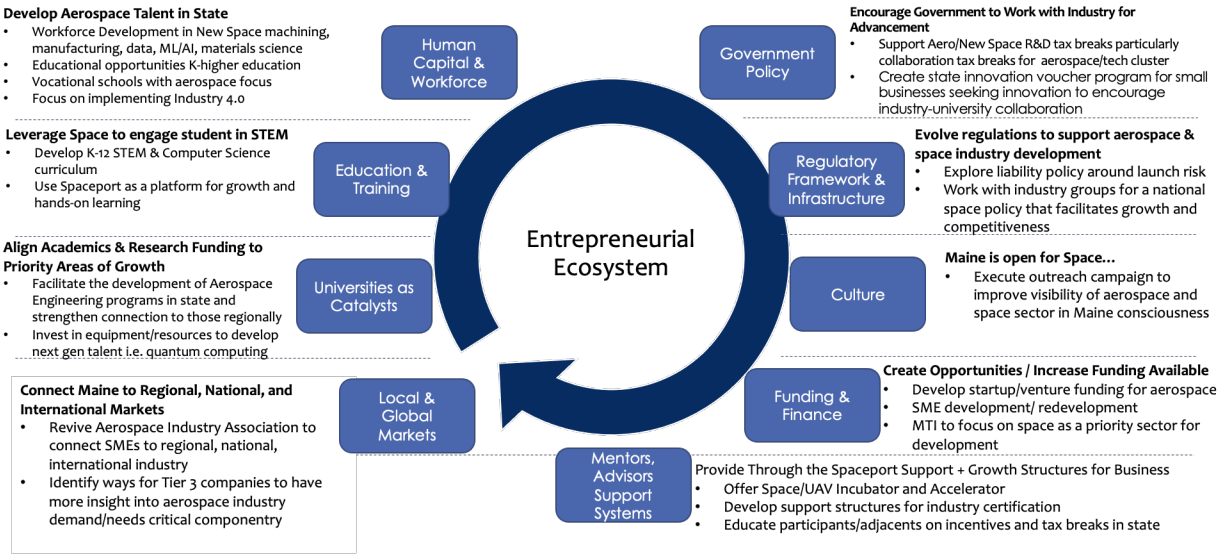
entrepreneurship, it has not activated its resources around the concept of New Space, which will be required to develop the industry. Although some of the ingredients are in place, the scale of resources is not sufficient to drive the economic development of a new space industry without assistance and support from outside of Maine. Federal funding and national risk capital networks will be critical to financing the space complex development.

Figure 11. Maine Institutional and Infrastructure Assets



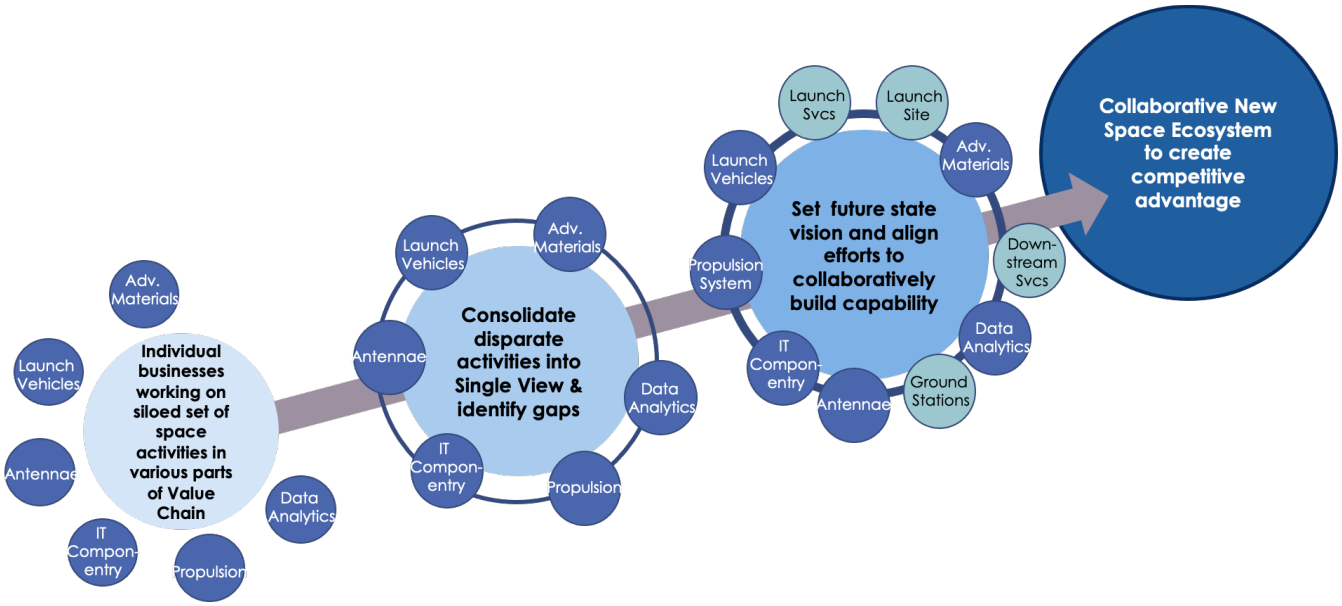
Developing a thriving space industry requires coordinated action to build capability and facilitate growth across the New Space value chain to create value. Figure 12 below illustrates how moving from a siloed set of activities pursued by independent businesses to an integrated ecosystem of aligned actors focused on creating competitive advantage will create value. There is no such organizing body for the new space industry within Maine.

Figure 12. Developing a New Space Economy Entrepreneurial Ecosystem



As shown in Figure 13, a strong cluster-based development strategy emphasizes breaking down silos and increasing collaboration among the state's myriad industry stakeholders. The centrality of collaboration to innovation makes it imperative to foster these skill and knowledge exchanges within the cluster.

Figure 13. Developing a New Space Economy Entrepreneurial Ecosystem



6. Maine Research and Education Assets

Maine has a variety of educational resources and research capabilities that can support the development of the space economy across its institutions of higher education – the University of Maine, University of Southern Maine, and the Roux Institute – with areas of research capability in geospatial analysis, data analytics, composites, and advanced materials, cube sat development and engineering among others. Technical schools whose graduates are in short supply within the space/aerospace industry are also opportunities for engagement between the *Complex* and Maine's community college and technical schools.

A. University of Maine

- **College of Engineering.** The mission of the College of Engineering at the University of Maine is to produce the graduates and new technologies needed to move Maine's economy forward. As a UMaine signature area, the College plays a vital role in our state and beyond. The College of Engineering at the University of Maine is Maine's only educational institution to offer 11 ABET-accredited engineering and engineering technology degree programs, including mechanical and electrical engineering, with an aerospace engineering certificate available.
- **Advanced Structures and Composite Center.** One of the most-notable assets in terms of its track record in gaining funding for large-scale projects and generating intellectual property that can be spun out to the private sector is the UMaine Advanced Structures and Composite Center. With an incredibly organized structural testing center focusing mainly on new materials and composites, the world's largest composite 3D printer, and a competent workforce of professionals, students, and staff, this asset is an essential piece to the puzzle of asserting Maine's excellence and growth in composite materials.

- **Versant Power Astronomy Center. Mainly noted** for its potential input to educational endeavors and its ability to generate interest in the space industry, the Versant Power Astronomy Center is led by passionate people with involvement in space academic endeavors external to just the programming of the largest-domed planetarium (seats 50 people) in Maine and the observatory on-campus.
- **WiSe-Net Lab.** The WiSe-Net Lab, led by Dr. Abedi, is a glowing example of how our institutions can continue research for the space industry. Primarily focused on the growing field of wireless sensor technology, with modules tested on the International Space Station for leak detection, communications technology, and potential applications within the realm of quantum research, the WiSe-Net Lab will not only continue to be an essential contributor to Maine's space economy but also to the potential development of future mobile networks.
- **Advanced Manufacturing Center.** With milling, turning, and miscellaneous machining tools and equipment, UMaine's Advanced Manufacturing Center specializes in applied techniques to teach students at UMaine and collaborate with the private sector on projects. Recently they have added their Center for Additive Manufacturing, housing an area to refine the process and engineering behind additive manufacturing of metals.

B. University of Southern Maine

- **Department of Engineering.** Baccalaureate degree programs include electrical engineering and mechanical engineering. In addition to the regular programs, electrical engineering has the option of a computer engineering concentration. The mechanical engineering program emphasizes electromechanical systems. Graduate-level coursework in engineering may be pursued through the Accelerated Graduate Pathway, and facilities are new or recently renovated. It provides extensive contact with local industry with opportunities for internships and cooperative education and employment upon graduation.
- **Southworth Planetarium.** USM's Southworth Planetarium seats 65, with up to 80 people capacity. Like other planetariums, the study considered its ability to disseminate and enhance educational initiatives related to space. While traditionally focused on space, the unique medium of presenting within a planetarium can play a wide array of educational and entertaining presentations.
- **Maker Innovation Studio.** Research and development initiatives shared licenses to software programs, new-tech tooling, and equipment. The CubeSat initiative operates within the lab, with advanced biomedical 3D printing and prototyping capabilities.
- **Composite Engineering Research Laboratory (CERL).** USM's Composite Engineering Research Laboratory is an industry-focused facility specializing in custom composites. Offering services such as applied engineering expertise in process development, optimization, and manufacturing and advanced analytical services with various non-destructive testing techniques, focused educational training, and prototype manufacturing.

C. The Roux Institute at Northeastern University

- Established in 2020 with a $100 million gift from David Roux and matched with another $100 million gift from the Alfond Foundation, the Roux Institute is a center for graduate and professional studies with an R1 research designation. It is focused on nurturing an environment for high-impact research and innovation in computer and data science, digital engineering, the advanced life sciences and medicine,

and other tech fields. The Roux helps entrepreneurs launch businesses focused on and powered by technology.

7. Maine Business Incentive Programs

The healthiest business ecosystems support states with the most robust economies. The development and maintenance of a healthy, innovative business ecosystem within a state's economy can be fostered by using business incentives (Table 2). Such incentives include tax breaks - tax credit or tax exemptions - and funding opportunities with grants, bonds, loans, and equity to support business growth and expansion. States with competitive private incentive packages often have the most robust industrial ecosystems and tax bases. While state-level private sector incentives can be an essential tool for growing and attracting companies to take root or relocate in a business environment, companies often consider many options when deciding on a location.

Table 2. Business Location Strategy Considerations

	Categories	Included Items
Policy Driven	Tax Breaks for Businesses	Tax Credits, Tax Exemptions
	Aerospace Business Grant/Loan Opportunities	Grants, Equity, Loans, Bonds
	State/Local Contribution	State Funding from A&D Taxes
	Federal Tax Contribution	Federal Funding from A&D Taxes
	Income Tax	Measured by Income Tax Level
	Corporate Tax	Measured by Corporate Tax Level
	A&D Economic Output $$	Measured in Millions
Industry Health	A&D Workforce	Total of workforce for Direct and Supply chain companies in A&D
	Aerospace Cluster	Measured by total number of companies participating in Aerospace operations
	Aerospace Engineering Degree Programs	Measured by total number of Undergraduate and Graduate Aerospace Engineering Programs
	Aerospace Association	Measured by advocate organizations in state
	Quality of Life	Information used from US news best rankings of states

Maine currently has a limited number of private-sector incentives that can be considered “marginally competitive” to attract and retain both business and talent (Table 3). The current incentives landscape will not be a primary driver for locating in Maine regarding aerospace and new space-specific industries.

Table 3. Overview of Maine’s Private Sector Incentives

Competitive Maine Incentives	Incentive Type
Pine Tree Development Zone	Tax/Financial
Educational Opportunity Credit	Tax Credit
Municipal Tax Increment Financing (MTIF)	Tax Credit
Maine Capital Investment Credit (MCIC)	Tax Credit
Business Equipment Tax Exemption (BETE)	Tax Exemption
Business Equipment Tax Reimbursement (BETR)	Tax Reimbursement

Multiple interviews were conducted to uncover the top criteria used by businesses when considering location/relocation strategy. ACEO of a launch company, “Where would you relocate and why?” We received the following response, “It would be California, not because of the tax incentives, but for the talent pool that you can pull from there. Florida for the same reason.” Another interview was conducted with an official from

the Colorado Office of Economic Development & International Trade. Colorado is currently ranked #1 in per capital aerospace employment, with multiple leaders in the space industry such as Boeing, Lockheed Martin, and United Launch Alliance having significant operations and facilities. In the conversation, talent arose numerous times as the only reason the cluster was not growing further, "Our biggest impediment is finding enough highly qualified talent to fill the jobs from higher education and technical schools." These interviews offered clarity into understanding the importance of talent and business clustering. To identify potential enhancements to Maines's business incentive landscape, we reviewed competing states who have robust aerospace business clusters and talent pools, an FAA-approved spaceport launch site, or are in the process of obtaining an FAA-approved spaceport launch site. The results are summarized in Table 4.

Maine struggles to compete against the states reviewed in the study on policy-driven and industry health indicators. As seen in the matrix, Maine does not have a category that is considered competitive in the attraction of business or talent relocation. The current tax incentives in Maine will struggle to recruit businesses that heavily rely on business incentive packages. Regarding funding, Maine can become more competitive due to organizations like Maine Technology Institute (MTI), Maine Venture Fund (MVF), and the Financial Authority of Maine (FAME). Talent and business clustering are currently moderately competitive. They have to be accelerated through active recruitment and business development in addition to longer-term educational strategies to produce a talent pipeline that will support industry growth. As one business professional said, "We've got to move people off the basic spreadsheet. It is a relationship-based process that we have in Maine. We are not going to win on the lowest common denominator. It does not have to be the best offer, but it has to be marginally competitive." Companies have particular needs and talent requirements, and the financial benefits that business incentive programs offer are often not the bottom line.

Table 4. State Matrix of Policy-Driven and Industry Health Variables

	Policy Driven							Industry Health					
State	Tax Breaks for Businesses	Aerospace Business Grant/Loan Opportunities	State/Local Tax Contribution	Federal Tax Contribution	Maximum Personal State Income Tax Rate	Corporate Tax Rate	A&D Economic Output $$	A&D Workforce #	Aerospace Cluster	Aerospace Degrees Awarded in 2019	Aerospace Engineering Degree Programs	Aerospace Association	Quality of Life
Florida	17	9	$1,388	$4,378	0%	4.46%	$40,203	115,261	2,300	730	6		#10
California	14	8	$6,021	$14,156	13.3%	8.84%	$119,877	310,281	609	1,159	24		#24
Washington	52	3	$2,060	$6,770	0%	0%	$137,427	260,627	1,300	128	1		#1
Colorado	18	15	$271	$809	4.55%	4.55%	$6,443	21,033	290	324	2		#16
Virginia	15	13	$409	$1,133	5.75%	6%	$16,653	64,835	285	230	2		#7
Texas	15	9	$115	$4,163	0%	0%	$90,487	201,727	1,700	451	6		#31
Michigan	9	9	$262	$770	4.25%	6%	$18,047	42,359	900	247	2		#38
Maine	23	14	$132	$279	7.15%	3.5%-8.93%	$6,139	18.267	85	0	0		#27
Alaska	9	6	$2	$10	0%	0%-9.4%	$84	394	11	0	1		#45
New Mexico	19	3	$20	$58	5.90%	4.8%-5.9%	$1,022	3,536	80	43	1		#48

Legend	
Color	Impact Scale
	None
	Low
	Medium
	High

A multi-pronged approach is required to create a business incentive landscape that addresses policy-driven and industry health indicators to support the growth of the Aerospace and New Space industries. This could be accomplished by increasing the impact of existing incentives while introducing new incentives to aid in spaceport operations and development to attract anchor tenants and customers to the state.

Benefits of Engaging Maine in the New Space Economy

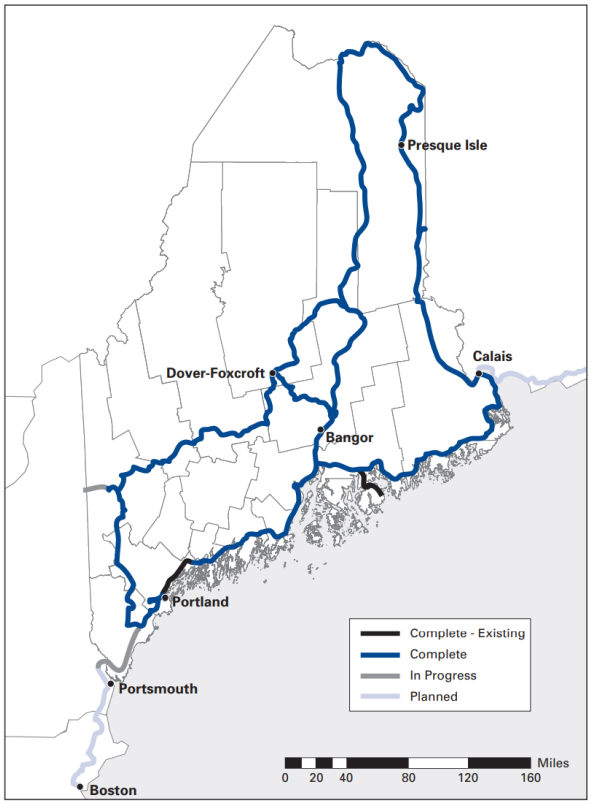
1. Talent and Innovation

- Help train and retain Maine's students and Immigrants graduating with aerospace-related STEM degrees.
- Attract highly skilled workers and their families from out of state
- Encourage startups and spur development in all seven technology sectors
- Develop globally based applications for both commercial and consumer uses
- Facilitate STEM learning opportunities for Maine high school and higher education students.
- Increased demand for broadband, quality roads, and housing
- Promote economic aspirations for All Mainers
- Advance Maine to a new competitive level in a fast-growing Knowledge Economy.

2. Support for Broadband Expansion and Road Infrastructure Investments

Internet infrastructure is an essential driver of growth and economic opportunity in modern society. Acknowledging this, Maine completed the "Three-Ring Binder" project (Figure 14) in 2012, implementing over 1,100 miles of fiber optic capable of increasing broadband access throughout the State and supporting a faster, more reliable internet to ensure its citizens are connected to the digital economy. With the implementation of the Maine Spaceport Complex, there is an opportunity to expand the fiber optic network further to support spaceport operations and its local communities across Washington and Aroostook County.

Figure 14. Maine's Three Ring Binder



Washington County currently has three transportation departments responsible for serving 31,822 people across an area of 2,563 miles. In Washington, county worker transportation commute times are over 25 minutes for 31% of the population. Also, it is essential to note that public transportation systems are minimal for its current population. The majority of the population relies on personal transportation methods creating the need for efficient and well-maintained road infrastructure. With the Maine Spaceport Complex development, the initiative will support ongoing road infrastructure investments to aid the community and fortify infrastructure for spaceport operations.

3. Promotion of Destination of Place and Potential Impact on Tourism

Few topics capture the imagination and have a mass appeal like space. Today the intrigue has become more widespread than ever before as humankind progresses further into the final frontier. On January 31, 2021, local rocket company bluShift Aerospace drew a crowd of nearly 75 onlookers to watch from their cars as the company executed its first test launch in bitterly cold temperatures from Loring Commerce Centre. They attracted a sizable crowd with no tourism infrastructure to host the eager public viewers, with some traveling over 6 hours to observe the launch. On the other end of the spectrum, NASA's Kennedy Space Center, a launch facility with a well-established 42-acre Visitors Complex that leverages its historic role in the development of the United States Space Program, drew an estimated 1.7 million tourists to its facilities in 2016, resulting in ~$1.8 billion of income according to the Florida Space Coast Office of Tourism. With over 37 million tourists visiting Maine each year, the Space Complex presents an opportunity to become a premier tourist destination drawing visitors beyond the popular Acadia National Park endpoint up into Washington County. With appropriate planning and investment, developing space tourism under the auspices of the *Complex* could have significant economic implications for rural locations and the hospitality industry at large in Maine.

The Maine Space Complex

In March 2018, MSGC hosted a two-day visioneering workshop to discuss the potential of the ***Maine Space Complex*** *(Complex)* opportunity for Maine. The group brainstormed a vision to galvanize both Maine's citizens and multiple sectors of the State's economy to invest in research and education infrastructure for a new space economy. Over 60 people participated, including representatives from the education, research, government, private sectors, NASA, and the FAA. Participants agreed that Maine is poised for a leadership role in the emerging and fast-growing market for small satellites using small, low-cost launch vehicles and leveraging, in a coordinated and collaborative effort, the assets in Maine previously described, and in partnership with other institutions, organizations and businesses in the New England region and other parts of the country. The *Maine Space Complex* was proposed to orchestrate and increase Maine's engagement in the new space economy.

After the workshop, the Consortium conducted an MTI-funded market feasibility study on the viability of the *Maine Space Complex*. Some of the significant findings of the study included: (a) NASA, DOD, Draper Labs, several small and large aerospace companies, and academic institutions in the Northeast region are highly interested in using the *Complex's* launch facilities; and (b) the *Maine Space Complex* must follow a path different from the existing FAA-approved spaceports, which have struggled due to the lack of large launch vehicles.

1. Maine Space Complex Business Units

The MTI-funded study developed a *Complex* operating model with three complex business units as described below and illustrated in Figure 15.

A. Maine Space Data & Advanced Analytics Center of Excellence

The Space Data & Advanced Analytics Center of Excellence will be a cloud-based, digital platform resourced to import/downlink, store, cleanse, manage, and analyze satellite data in concert with terrestrial data to solve local business public policy issues in innovative ways. This will be a distributed network of nodes, offering portals from various locations (ex. Roux Institute, University of Maine, Governor's Office, etc.) to access satellite data (and other relevant data sets) for data science applications (ML/AI). It will be resourced with human capital that

can specialize in satellite data and advanced analytics to drive the application of data toward the advancement of local industry and policy use cases and provide support and mentorship to data-centric startups and companies. It will require a cloud configuration with a network equipped with the hardware and software to import/downlink, store, cleanse, manage, and analyze satellite data in concert with terrestrial data to solve business and public issues in innovative ways and support the development of data-focused startups creating new data products and services.

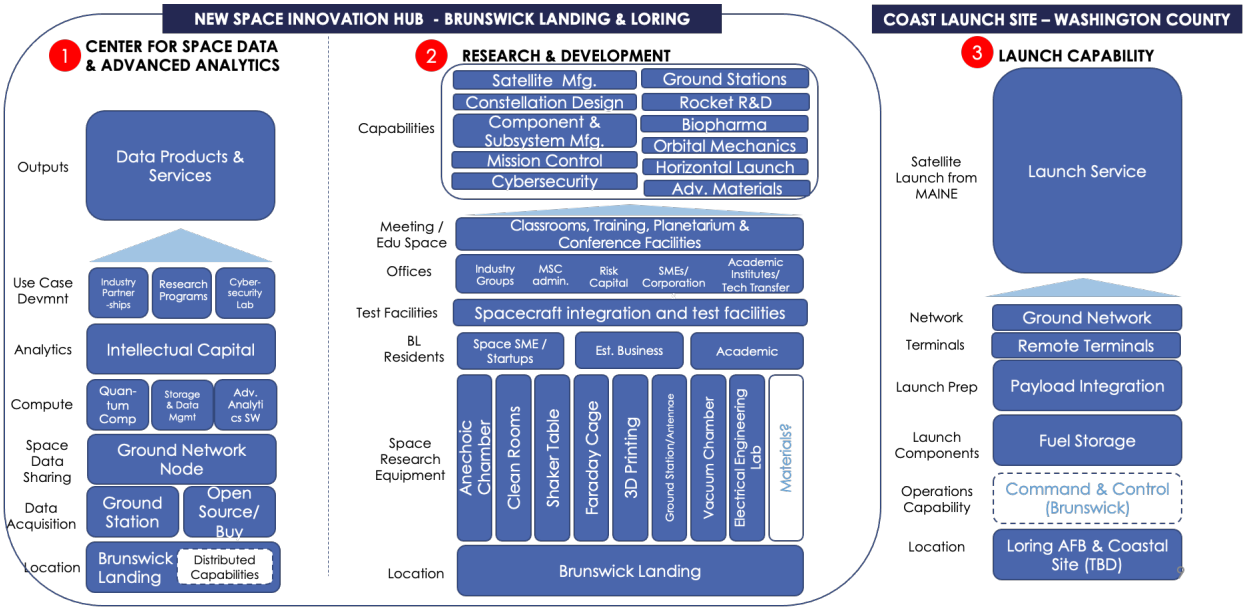
B. Maine New Space Innovation Hub

Located at Brunswick Landing, with a spoke at Loring Commerce Centre, the Hub is envisioned as a knowledge and innovation hub for new business incubation and acceleration, hardware and materials component development facilities, and satellite and launch vehicle manufacturing and testing. The shared space must contain specialized equipment to facilitate R&D, academic and scientific inquiry. It will also house joint academic-industry research initiatives, an office of tech transfer, administrative office space for businesses, and conference facilities to host national/international events to draw users and attention to the Maine space industry. It will also act as an educational center providing classrooms for in-person and remote K-12 and higher education learning opportunities and events.

C. Maine Launch Sites & Services

Develop a low-cost, highly accessible LEO polar orbit launch site for small satellites with superior customer service to serve the commercial, academic/scientific, and government sectors. The site will create a need for credentialed and highly skilled technical jobs and offer workforce retraining opportunities. Launch capability will spur the development of a knowledge cluster, creating a foothold to capture prospects as the industry matures and develops. It will leverage Maine's current rocketry, data, and geospatial analytics capabilities to become a more visible national and international aerospace industry destination.

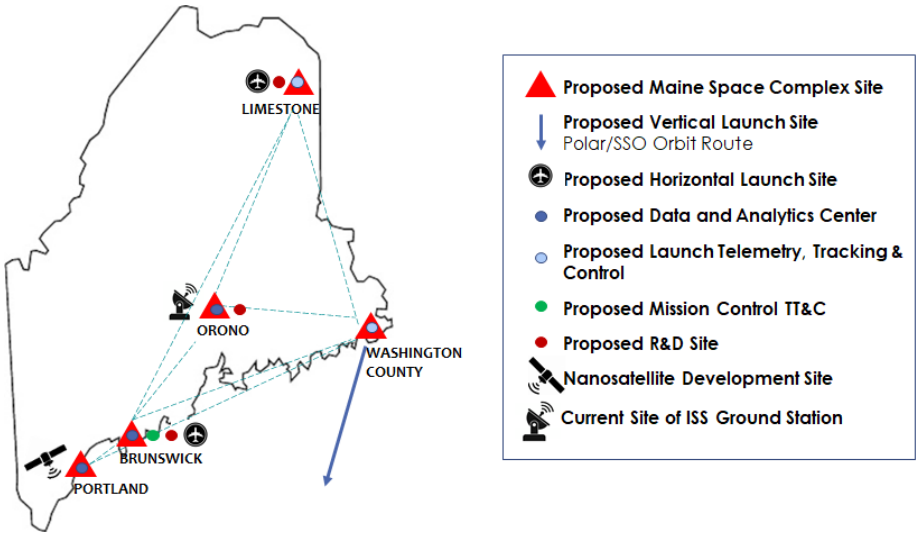
Figure 15: Proposed Business Units of the Maine Space Complex



2. Geographically Distributed Maine Space Complex

The Maine Space Complex will be geographically distributed, benefiting multiple counties throughout the State, as shown in Figure 16. Geographically distributed capabilities offer the best opportunity to align with the market demand and facilitate the growth of Maine space offerings.

Figure 16: Geographically Distributed Maine Space Complex



3. General Launch Site Requirements

The MSGC recommends that the Maine Space Corporation undergo an opt-in process for any community desiring to host a launch facility. Such an incremental shift in a community's way of life should rest in the community's hands, and publicly identifying sites that could work for vertical launch could place undue political pressure on communities that have no interest in hosting such infrastructure. Below are general requirements and a hypothetical vision for how a launch site could be constructed to allow a community to partner with the proposed Maine Space Corporation if they so choose. The section summarizes the requirements and procedures of operating a proposed launch base for nano, micro, and small launch vehicles capable of carrying payloads of 500 Kg to LEO.

Maine Spaceport Vertical Launch Complex Concept - The vertical launch complex concept is based on a launch system capable of sending 150 Kg of payload to SSO and 250 Kg to LEO. It allows for ease of evolution towards launch vehicles capable of 500 Kg in Low Earth Orbit to keep up with market demands in the future.

SITE A – Command and Control Center - At a minimum distance of 2.5 Km (7,300 feet) from the launchpad area, this center will occupy an area of around 150,000 sq. ft. with a large building offering at least a usable surface of 50,000 sq. ft. This building should house:

- Launch base control center with an ops room with consoles and large display screens.
- Launch vehicle (L/V) control center with consoles and display screens.
- Ground and flight safety control room with a separate dedicated room for flight safety.
- Localization/trajectory /TM/TCD control room and command consoles.
- Security command room with associated consoles.
- Weather forecast room with associated consoles.

- A hangar and offices beside the launch base control center building to house (around 20,000 sq. ft.) a launch base power supply command post and a technical support area.
- This building could also accommodate areas to welcome on the launch day the launch vehicle and customers teams not involved in the chronology with the appropriate amenities (or to be located on a separate site named Site D – an observation deck or visitor room). It should also have a kitchen area for all the people present in operation.

SITE B – Launch Range - The entire site will occupy approximately 800,000 sq. ft. (~19 acres) to accommodate facilities in a close configuration. The site should house:

- A large building for L/V and Payloads assembly and integration up to the constitution of the upper composite and its mating on the L/V of around 30,000-35,000 sq. ft. For the payloads, two preparation cleans rooms conform to ISO 8 cleanliness level 100000 with all the facilities and the services agreed with the customer in the launch contract and the launch demand (around 10,000-12,000 sq. ft.).
- Two launch pads should be configured with a heavy concrete launch platform with hot combustion gasses ejection ducts below the platform at the level of the L/V nozzle directly covered by a water deluge.
- Three lightning protection masts around each launchpad.
- Each launch platform should be equipped with a specific hold system in between the launch platform and the L/V to keep the L/V in a safe vertical position in case of aborted launch.
- A launch mast for each launchpad for umbilical links.
- There is a storage area for propellant and gasses products (around 800 sq. ft.).
- An on-site power supply system with an emergency substitute

SITE C – Radar and Telemetry Station - This site (50,000 sq. ft.) should be as close as possible to the Control Center to optimize the different data and communication links. This site should also be integrated into the Launch control center area if visibility is acquired.

Launch Preparation, Organization, and Management - Procedures, actions, and/or plans that are required as part of the preparation, organization, and management of a launch activity may include but are not limited to:

Launch Campaign

- User's Manual for each Launch Vehicle to be operated at a spaceport.
- Launch Demand Document (LDD) prepared by the Mission Director of the Launch Operator Organization in coordination with the Site Operation Manager.
- Necessary permits and/or licenses from Federal and State government agencies.
- Necessary Environmental Impact Analysis and Assessment to obtain the permits and/or licenses.
- Assessment of operational documentation before a launch campaign.
- Preparation of a launch rehearsal.
- Conduct reviews of the readiness of the launch vehicle, subcontractors, flight plan, and range facilities.

Safety Principles

- Safety analysis, constraints, hazardous identification, and training.
- Customer safety submission and demonstration.
- Preparation of the Ground and Flight Safety Plan.
- Installation and operation of protection systems and hardware at the Space Port.
- Continuous safety and security measures in operation.
- Conduct quality inspections and checks during the execution of critical operations.

The following figures illustrate a hypothetical layout of the proposed infrastructure and buildings listed above.

Figure 17 - Layout of Maine Spaceport Launch Preparation and Launchpad

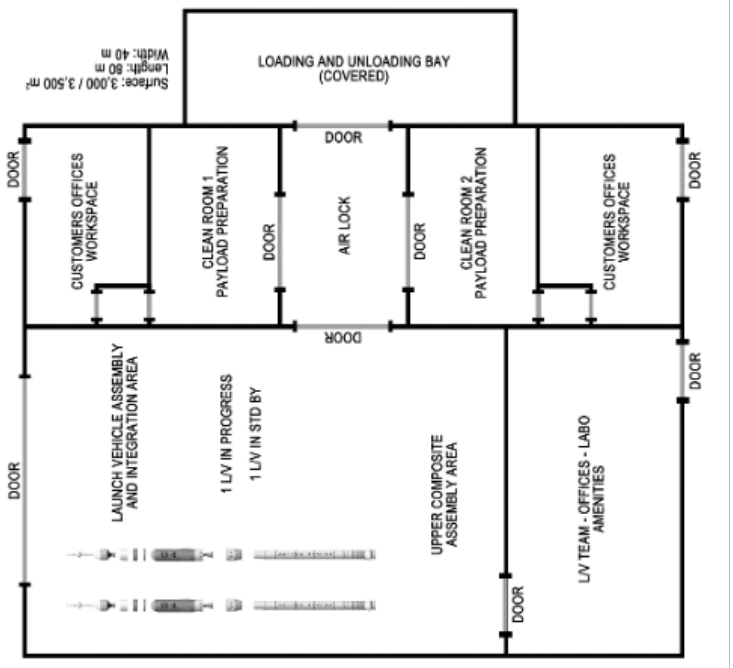
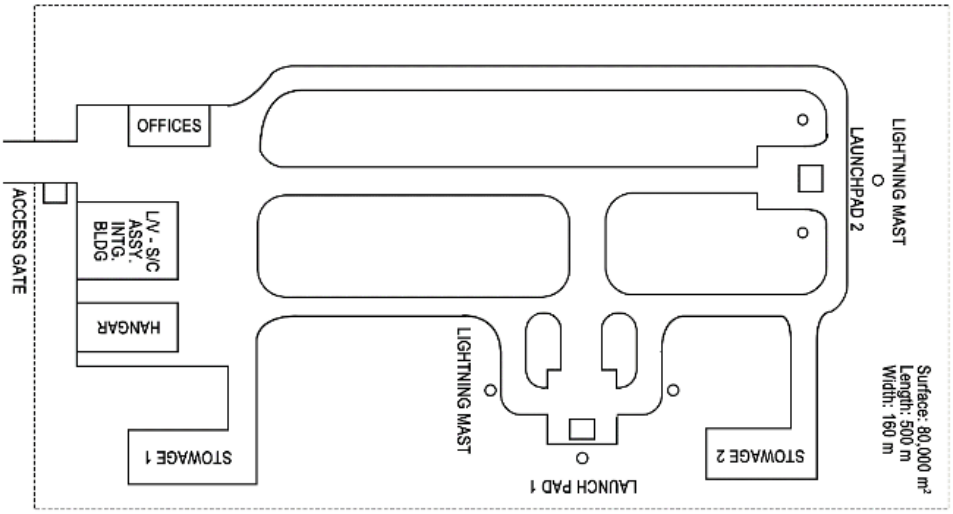


Figure 18 - Layout of the Launch Vehicle and Payloads Assembly and Integration Building



4. Vision, Mission, Performance Goals, and Objectives

A. Vision Statement

By 2045, Maine will be an integral player in the emerging global network of suborbital and orbital transportation to space, providing a significant return on investment as an engine of economic growth workforce development.

B. Mission Statement

The Maine Space Complex provides faculty, teachers, students, businesses, partners, and entrepreneurs from within and outside the state access to a plug and play infrastructure where innovations, ground-breaking research and development, problem-solving, spacecraft launch, world-class space data, and analytics capability, and dreaming big are routine occurrences, and from which virtual learning is available to teachers, students, and others.

C. Performance Goals

Achieving the vision is predicated on the three business units of the Maine Space Complex being fully functional and in use by customers in the business, higher education, research, government, and k-12 communities. In turn, these units will enable the Maine Space Complex to achieve the following Performance Goals by 2045:

- Facilitate the creation of an estimated 4,500 new jobs in Maine, 30% of which will be credentialed and commanding an average annual salary of $77,000.
- Capture at least 10% of the US small satellite market launch market
- Generate an estimated $500 million in a new contribution to the state GDP.

D. Objectives

This plan lays out a pathway to position the Maine Space Corporation to achieve the Vision, Mission, and Performance Goals through short-term and long-term objectives and action steps as outlined below.

Short-term Objectives (2 Years)

Objective #1: Establish a quasi-state body to oversee the development and growth of the Maine Space Complex.

Action: Enact LD1923. This bill would establish the Maine Space Corporation as a body, both corporate and politic, to implement the strategic plan and manage the development and growth of the Maine Space Complex. The corporation would be entrusted with leveraging Maine's rocketry and geospatial analytics capabilities to become a more visible national/international industry destination and an authority in launching small launch vehicles and small satellites into polar orbit. The need for the proposed corporation can be summarized as follows:

1. **Timing** – With additional federal funds becoming available in the next several months, the proposed Maine Spaceport Corporation, as a quasi-state entity, would be the best vehicle for applying for these funds. Progress would be inhibited without a quasi-state entity status and potentially cause the state's efforts to fall behind the competition in other states such as Michigan.
2. **Funding** - A quasi-state entity would maximize funding opportunities (as opposed to a non-profit or strictly private company) by providing access to the federal government and private sector funding, as well as future opportunities to levy bonds for construction (Table 5).

3. **Precedent** - Virginia, New Mexico, Alaska established quasi-state space authorities at a similar point in their development between strategic planning and breaking ground on infrastructure.
4. **Public Identity -** As the initiative progresses and begins public hearings, it will be essential to align the brand perception to the Maine Spaceport Corporation itself rather than the Maine Space Grant Consortium, which has been shepherding the development to date.

Table 5 - A Quasi-state Entity Maximizes Funding Opportunity and Signals Industry Support

Private Non-Profit Entity

Funding Mechanisms	Yes or No
Bonds*	Yes
Loans/Debt	Yes
VC/PE Funding	No
Crowdfunding	Yes
Grants	Yes
Equity Investment	No
Private Contributions	Yes
Corporate Partnership	Yes
Appropriations	No

Quasi-Independent State Entity

Funding Mechanism	Yes or No
Bonds*	Yes
Loans/Debt	Yes
VC/PE Funding	No
Crowdfunding	Yes
Grants	Yes
Equity Investment	Yes
Private Contributions	Yes
Corporate Partnership	Yes
Appropriations	Yes

Private For-Profit Entity

Funding Mechanisms	Yes or No
Bonds*	Yes
Loans/Debt	Yes
VC/PE Funding	Yes
Crowdfunding	Yes
Grants	Yes
Equity Investment	Yes
Private Contributions	No
Corporate Partnership	Yes
Appropriations	No

*Some can issue bonds with significant restrictions. Others can receive conduit bonds.

Objective #2: Identify and secure a launch site in Maine for vertical launches.

Action: Solicit applications from Washington County coastal communities interested in leasing land for launch sites. **After finalizing the generic launch site requirements and identifying community incentives to apply, a proposal request must be issued**. Final site selection would be integrated with FAA approval for the launch site.

1. **Environmental Impact Assessment** – perform an environmental impact assessment to understand better the environmental impacts of launch operations in Washington County.
2. **Solicit Bids for Design + Construction** – put out an RFP using the finalized requirements developed during the strategic planning process for the design and construction of the spaceport
3. **Funding** – determine funding structure for
   a. launch operations and raise money as needed
   b. through federal, state, and private sources
4. **Build** – build launch (mid-term objective)

Objective #3: Continue recruitment of businesses commercializing all aspects of the value chain working in proximity at Space Complex to intensify knowledge and skills transfer to facilitate the development of new technology and the growth of the New Space Economy within Maine.

Action: In the next phase of work, secure a budget for business development activities to pursue companies identified as high-value prospects in private-sector analysis. This will include all actors across the value chain from components, subcomponents, and spacecraft to the downstream data analytic companies.

1. **Attend industry events** – there are several key industry conferences each year that attract a variety of companies from the new space industry, including many that have been targeted as high-value prospects. Continue to raise awareness through meetings, networking, and speaking opportunities at these events.
2. **Targeted Business Development meetings**– follow up selectively with prospective tenants of companies that occupy a particular piece of the value chain absent from Maine's ecosystem for individual sessions.
3. **Develop Marketing Collateral** – develop brochures, decks, and other collateral materials for prospective clients.

Objective #4: Continue engagement strategy and dynamic communications plan to ensure that the initiative is positively received within the state and supported by the government and external stakeholders.

Action: Continue to establish a brand and raise awareness through in-person events (primarily in Washington County) and digital media.

1. **Social Media** – using Facebook and Instagram, continue to develop engaging content to reach Maine citizens to inform them about the Maine Space Complex. Use LinkedIn to establish a connection with professionals at other space companies to advertise the benefits of relocating to Maine.
2. **Print & digital media outlets** – ensure placement of timely development in various media outlets, including but not limited to Bangor Daily News, Portland Press Herald, and the Boston Globe.
3. **On-the-ground presence** – continue to be an on-the-ground presence in Washington County as the spaceport evolves and takes shape.

Objective #5: In partnership with the Maine Composite Alliance, continue developing and implementing training programs to update workers' skill sets in the advanced materials industry to align with the new space economy.

Action: As composites become an increasingly important piece of the space industry, partner with MCA to understand members' capabilities better and determine their ability to participate in the new space economy.

1. **Establish Industry Roadmap -** develop a roadmap to understand the future technology and materials needs of the space industry as well as the evolving technologies within the advanced materials and composites industry
2. **Assess capabilities -** work with MCA to assess capabilities of current composites and advanced materials manufacturers and markets served with a focus on aerospace/space
3. **Workforce Development** – determine the technical, scientific, and business skills and capabilities gaps in Maine's MCA membership and address the skills through training.
4. **Market skills/capabilities to Industry** – ensure space industry participants know Maine's technical skills/capabilities pool. It is seen as a benefit to some space companies, such as launch vehicle manufacturers.

Objective #6: Set industry topics and initiatives for Maine industries – agriculture, aquaculture, fisheries, lobster, forestry - that can benefit from satellite data and research RF remote sensing, mapping, and other smallsat data services to improve competitiveness.

Action: Work with industry members and universities to create a series of quick wins – establishing industry uses cases and ways that satellite data effectively addresses personal and public issues/problems.

1. **Engage with leading community/industry stakeholders** – to better understand the issues, Maine-based industries need solutions to identify high-value industry use cases.
2. **Engage with State and Local Government** – understand the Maine government's issues and how satellite data can build a resource called space data for better government.
3. **Collaborate with NASA to access Maine data –** NASA has an extensive satellite fleet that collects a myriad of data from space that can be cleansed to provide data specific to Maine for use cases identified**.**

Objective #7: Set research topics and initiatives aligned with Maine's capabilities and emerging opportunities, especially data analytics.

Action: Work with universities to create a series of quick wins – establishing uses cases and ways that satellite data addresses personal and public issues/problems effectively, including climate change.

1. **Climate Change** – in collaboration with the Roux Institute and Governor's Climate Council, we are looking for opportunities to leverage satellite data to solve terrestrial issues and inform better policy and management decision-making.
2. **Advanced Materials/Composites for Space –** as new opportunities for the advancement of spacecraft emerge, design emerge work in collaboration with industry to leverage this knowledge cluster at UMaine.
3. **Continue engagement w/Roux Institute** – the Maine Space Complex has sponsored a class at the Roux Institute focusing on developing use cases for Maine industries using satellite data.
4. **University of Maine GIS** – similar focus on developing use cases for Maine-based industry and government using satellite data.
5. **University of Maine Advanced Structures & Composites Center** – use roadmap and industry assessment findings to develop research topics for space-related advanced materials uses.

Objective #8: Promote STEM curriculum including Ph.D. programs and advanced math and computer science in K-2 and Career and Technical Education schools to build the capabilities to develop next-generation resources for high growth data-rich industries to prosper.

Action: Increase engagement with the Space Complex and space as a subject in the K-12 through Ph.D. programs across the state.

1. **Teacher Training** – with funding, develop teacher training to promote the use of space in teaching STEM/computer science/data analysis skills.
2. **K-12** – engage students in onsite events, create remote learning opportunities with classrooms, visiting space professional day and field trips.

3. **Community Colleges/Technical Schools –** engage the technical workforce to fill positions needed for launch operations at the spaceport.
4. **College/University** – develop a consortium of in-state and out-of-state schools affiliated with the Maine Space Complex and engage them on field trips, research opportunities, internships, and launch visits.
5. **Masters/Ph.D.** – sponsor research that aligns with spaceport priority areas of focus
    - **Space-for-earth research –** develop a track for space-for-earth focused research whose applications drive most commercial activity and are gaining wider adoption.
    - **Space-for-space research** – develop a focus on space research for products and applications used in space that will continue to grow as space tourism and space habitation advance and become commercial.

Objective #9: Establish collaborative agreements with the Midcoast Regional Redevelopment Authority and the Loring Commerce Centre to access facilities and resources critical to the development and growth of the Maine Space Complex.

Action: The Maine Space Complex seeks to leverage preexisting resources and assets within Maine to the best of its ability to ensure there is economy in development to stand up the three pillars of the Maine Space Complex – Launch Site(s), Innovation Hub, and Space Data and Advanced Analytics Center of Excellence. : The *Complex* will pursue business development activities to attract new space tenants to one of its sites and share in the benefit.

Objective #10: Secure federal grants and state investments through bond issues to support the renovations and constructions of the Space Innovation Hub at Brunswick Landing, manufacturing and integration facilities at Loring Commerce Centre, and one or more launch facilities.

Action: Seek to identify first private funding and establish anchor tenants to ensure demand for spaceport launch facilities. Once this avenue has been exhausted, look for and secure opportunities for federal funding to develop infrastructure and support the development of the Innovation Hub and Space Data & Analytics CoE.

Mid- to Long-term Objectives (3 Years- Ongoing)

The Maine Space Corporation will re-calibrate its pathway forward and revise or set new performance metrics based on progress. The Corporation will continue pursuing the following objectives:

- Continue to build capability within the academic sphere through alignment of programs and further development of research priorities, partnerships with industry, development of effective tech transfer, and creating a workforce strategy to ensure talent pipeline in Maine and the region
- Create and strengthen the connective tissues between academia and industry through internships, site visits, career exploration, industry-sponsored projects/research initiatives
- Raise and secure funding for Introduce New Space Innovation Hub to encourage new ways of collaborating and working, expand academic capability and capacity
- Continue to build upon Maine's strategic resources and capabilities to develop an integrated and robust value chain of space-related businesses and activities within Maine.

- Continue to focus on developing a specialization in emerging areas of the new space value chain, including composite and advanced materials.
- Continue to focus on helping Maine existing industries mitigate threats they are facing through dedicated use of the Maine Space Complex assets.

5. Plug and Play Business Model Built on Sustainability

The Maine Space Corporation would have direct oversight into the development and operations of the Launch Site and establishing anchor tenants at the launch complex. Anchor tenancy is a typical financing strategy to provide up-front capital investment for a specific tenant with priority use of the facilities. The launch services pillar of the Complex aims to establish an anchor tenancy and develop a multiuse launchpad that can accommodate a variety of small launch vehicles to cater to an emerging but not yet commercialized group of rocketry providers.

The Corporation will work closely with Brunswick Landing and Loring Commerce Center to establish new space operations under the umbrella of the Maine Space Complex, which will facilitate new space business development, supporting the growth of companies locally and bringing companies into Maine to develop the local ecosystem. Agreements with both entities will outline the revenue share for such activities and placement.

Table 5 – Sustainability Strategy

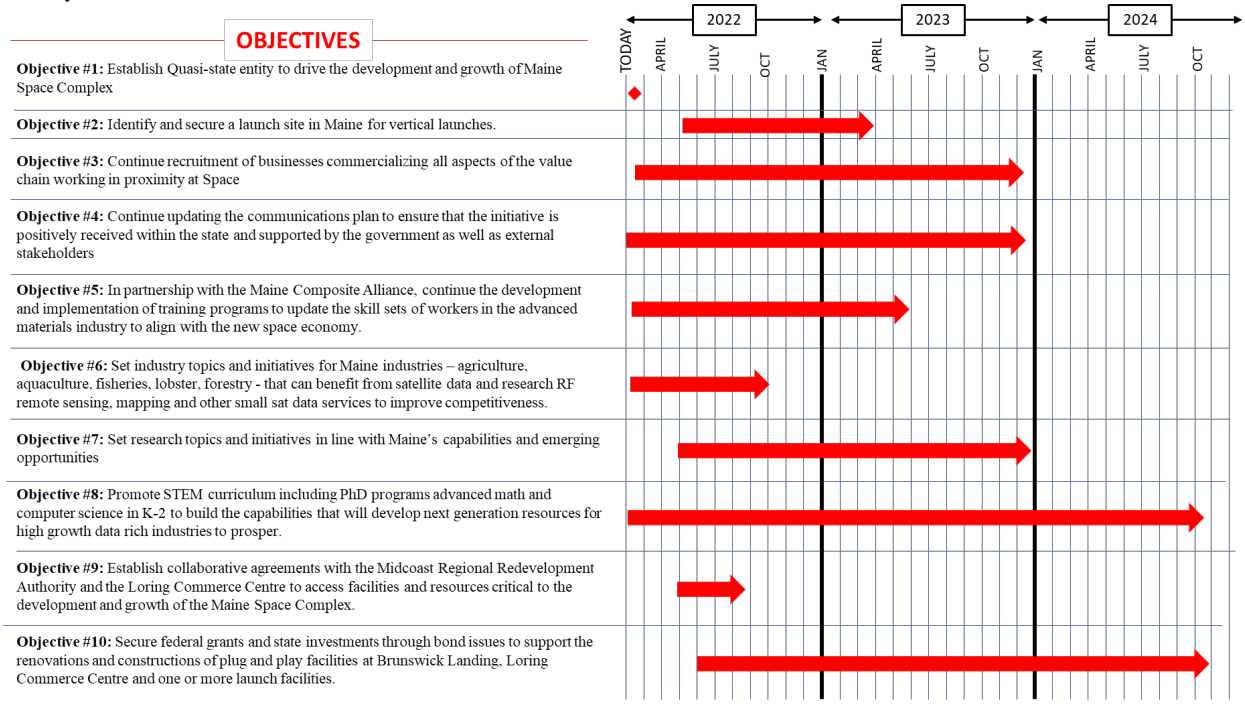
AREA of IMPACT	Maine Space Corporation STRATEGY
Carbon emissions	The space industry is going to continue to proliferate using a variety of fuels that range from toxic to environmentally low-impact. Maine will set an example catering to small launch vehicle companies using non-toxic fuels. It will also encourage R&D focused on a cleaner space industry.
Marine environment	In addition to emissions monitoring, the Maine Space Complex will produce an environmental impact assessment to better understand the impacts on the marine environment which is a resource we share and is depended upon by many industries in Maine.
Space Debris	Space debris is a growing concern – both on earth and in space - as the pace of launch increases across the globe. MSC will seek to engage companies creating solutions to managing space debris, from engineering spacecraft to deorbit, to robotics and land based solutions to address the issue.
Maine Space Complex Operations	Strive for zero/low net emissions for all Maine Space Complex operations
R&D for Clean Space	Special attention will be given to growing and attracting companies that are focused on creating cleaner solutions for the space industry. Through R&D initiatives, MSC will focus on developing a niche for clean space development
Climate Change mitigation	MSC has already begun to partner with the Governors Climate Council to provide satellite data for the science team. Approximately 50% of climate science data is derived from satellites. MSC will drive solutions to acquire/produce this data for the State in order to create the best mitigation policy and for industry to use to anticipate future impacts and make management decisions accordingly

As shown in Table 5 above, the Corporation will strive for zero/low net emissions for all Maine Space Complex operations by:

- Focusing on small launch vehicle companies using non-toxic fuels.
- Encouraging R&D focused on a cleaner space industry.
- Engaging companies creating solutions to managing space debris, from engineering spacecraft to deorbit, to robotics and land-based solutions to address the issue.
- Growing and attracting companies that are focused on creating cleaner solutions for the space industry.
- Conducting an environmental impact assessment to better understand the impacts of the Maine Space Complex on the marine environment, and

- Driving solutions to acquire/produce this data for the State in order to create the best mitigation policy and for Maine industries to use to anticipate future impacts and make management decisions.

6. Implementation Timeline



Cost Estimates for the Maine Space Complex

We conducted a rough order of magnitude cost estimate based on the proposed vision of the Maine Space Complex and analogous project costs at other miscellaneous spaceports. We weighed three development scenarios for the vertical launch site, representing a beta site that would temporarily accommodate launch companies, a minimum viable product for a permanent launch facility, and a maximum potential vertical launch site that would include industry-leading facilities.

We also examined how three benchmark spaceports – Mid-Atlantic Regional Spaceport (MARS), Pacific Spaceport, and Spaceport America - were funded. We considered the various stages of development and aligned that to funding sources from planning to construction and operations. Each case study provided an overview of facilities, stages of development and funding associated with each entity formation stage, and the progression to the construction phase that proceeded. The funding mechanisms and subsequent capital and operational expenditures that occurred were examined. Revenues were studied in great detail, as operating costs and their capital footprint scaled. Finally, we compared each spaceport's operating profits or losses and the economic impact in the region to identify whether these spaceports provide an adequate return on investment for the local economies.

Rough order of magnitude cost estimates shows that a vertical launch complex could cost between $5,305,000 and $90,000,000 depending on the outfitting and phasing plans (Table 6), with a beta temporary-accommodation site estimated to cost between $5,305,00-23,305,000. The minimum viable permanent launch site resulted in estimates ranging from $13,580,000 to $32,280,000. The horizontal launch complex is estimated

to cost $53,200,000, depending mainly on individual site infrastructure needs like runway improvements. The data analytics and innovation center is estimated to cost close to $1,295,000, depending on the facility location and scope of the initial build. We also retained an independent engineering firm to provide a more precise breakdown of specific costs about the launch complexes. A substantial consideration for these estimates depends on the cost of building traditional infrastructure like roads to the sites.

Table 6. Rough Order of Magnitude Cost Breakdown of the Maine Space Complex by Scenario

Vertical Launch – Beta Scenario

Complex	Estimated Cost
Vertical Launch – Beta Scenario	$5,305,000-$23,305,000
CoE/Innovation Building	$1,295,000
Total Cost	**$6,660,000-24,600,000**
Horizontal Launch	**$53,200,000**
Total Cost w/horizontal	**$59,800,000-77,800,000**

Vertical Launch – Minimum Viable Product Scenario

Complex	Estimated Cost
Vertical Launch – Minimum Viable Product Scenario	$13,580,000-32,280,000
CoE/Innovation Building	$1,295,000
Total Cost	**$14,875,000-33,575,000**
Horizontal Launch	**$53,200,000**
Total Cost w/horizontal	**$68,075,000-$86,775,000**

Vertical Launch – Maximum Scenario

Complex	Estimated Cost
Vertical Launch – Maximum Scenario	$45,000,000-$90,000,000
CoE/Innovation Building	$1,295,000
Total Cost	**$46,295,000-91,295,000**
Horizontal Launch	**$53,200,000**
Total Cost w/horizontal	**$99,495,000-144,495,000**

A. Vertical Launch Complex - Beta Scenario

As shown in Table 7, we considered that there might be a need to acquire land if not lease it for the Beta Scenario. There would need a launchpad, a road to the launch pad, a payload processing area, and some facilities as a bare minimum to accomplish a launch. Estimates for the cost of a beta phase launch site come in at $5.3 to $23 million, depending on the length of road needed and other exceptional considerations.

Table 7: Vertical Launch Beta Scenario Cost Breakdown

Component	Comparable Year	Comparable Complex	Description	Estimated Cost
Land Acquisition	-	-	Adequate land to facilitate safe launches according to FAA standards	$1,250,000
Launch Pad (50 ft x 150 ft)	2015	Kennedy Space Center	50 x 100 foot launch pad supporting launch vehicles and associated mounts weighing up to 132,000 pounds when fully fueled.	$900,000
Road to Launch Pad		General estimate provided by DOT to Ellsworth American	Road capable of handling weight of equipment, (1 mile)	$2,000,000-20,000,000
Payload Processing Area		-	Temporary Building for Payload and Integration	$1,000,000
Integration Area		-	Cleared area.	-
Recovery of Vessels	-	-	To be provided by launching party	-
Forklift/Misc. Lifting		-	To be provided by launching party	-
Craning Equipment		-	To be provided by launching party	-
Launch Rail		-	To be provided by launching party	-
Telemetry and equipment		-	To be provided by launching party	-
Insurance		To be quoted	To cover liability of complex	$150,000
Restroom Facilities	-	National Average	Restrooms for operating parties on site, rental toilet (x2)	$20,000
Fire/Rescue	-		Temporary Assistance from Local Resources	0
Mission Control Center	-		To be provided by the launch party	0
Parking Lot	-		Dirt Parking Lot	$5,000

Total Estimated Cost: $5,305,000-$23,305,000

B. Vertical Launch Complex - Minimum Viable Product Scenario

In the Minimum Viable Product Scenario, we estimated costs between $13.6 million to $32 million, with the same variable considerations as the beta version (Table 8). Consider that both the beta and minimum viable have one launch pad, one plot of land, marked changes are the incremental improvements like telemetry and tracking equipment and restroom facilities, additional annual expenses associated with operating, mission control area, etc.

Table 8. Vertical Launch Minimum Viable Product Cost Breakdown

Component	Comparable Year	Comparable Complex	Description	Estimated Cost
Land Acquisition	-	-	Adequate land to facilitate safe launches according to FAA standards	$1,250,000
Launch Pad (50 x 150)	2015	Kennedy Space Center	50 x 100 foot launch pad supporting launch vehicles and associated mounts weighing up to 132,000 pounds when fully fueled.	$900,000
Road to Launch Pad	-	General estimate provided by DOT to Ellsworth American	Road capable of handling weight of equipment, 1 mile	$2,000,000- 20,000,000
Payload Processing Area	-	Cecil Spaceport	Building for Payload and Integration	$3,700,000
Integration Area	-	Houston Spaceport	Clean room for payload processing	$150,000
Recovery of Vessels	-	-	Subcontracted Services	$50,000
Forklift/Misc. Lifting	-	-	On site – one year of long term lease	$6,000
Craning Equipment	-	-	On site – one year of long term lease	$24,000
Launch Rail	-	-	Outfitted for each launch partner	$300,000-$1,000,000
Telemetry and equipment	2021	Pacific Space Complex	Telemetry and Tracking System cost estimates for 1 incremental additional launch pad.	$1,700,000
Insurance	-	To be quoted	To cover liability of complex	$150,000
Restroom/Wastewater Facilities	-	Wastewater estimates online	Restrooms for operating parties on site	$1,500,000
Fire/Rescue	-	-	Local Resources on site for launches	-
Mission Control Center	-	Cecil Spaceport	Building	$1,800,000
Parking Lot	-	Estimates found online	Paved 20-car spot with 8,000 sq ft	$50,000

Total Estimated Cost: $13,580,000-32,280,000

C. Maximum Scenario

In the Maximum Product scenario, we considered what an industry-leading or high-tier vertical launch complex might look like. Under this scenario, a vertical launch site's cost is estimated to be around $50 million (Table 9).

Table 9. Maximum Scenario

Component	Comparable Year	Comparable Complex	Description	Estimated Cost
Land Acquisition	-	-	Adequate land to facilitate safe launches according to FAA standards	$1,250,000
Launch Pad	2015	Kennedy Space Center	Small/ligh lift launch pad	$3,500,000
Road to Launch Pad	-	General estimate	Road capable of handling weight of equipment, 1 mile	$2,000,000
Payload Processing + Integration Area		Cecil Spaceport	Payload preparation and integration facility	$3,700,000
Rocket Integration Area/Motor Test		Spaceport America	On site building/hangar	$20,000,000
Launch Rail	-	-	Onsite	$1,000,000
Insurance	-	To be quoted	To cover liability of complex	TBD
Utilities (Electric/Water/Sanitation)	-	National Average	Restrooms for operating parties on site	TBD
Mission Operations Control Center				$1,800,000
Range Radar, Optical, and Telemetry Tracking Instrumentation		Spaceport America		$10,000,000
Tracking and Command Destruct Systems	2020	Pacific Spaceport Complex		$5,500,000
Meteorological Modelling Software	2020	Pacific Spaceport Complex	Meteorological modelling software for launch range management and safety.	$1,000,000

Total Estimated Cost: $49,750,000

D. Horizontal Launch Complex

We explored what horizontal launch facilities would cost, as horizontal facilities are a part of the considerations for the Maine Space Complex (Table 10). We considered the approach of starting small, with a potential runway renovation (the $42,000,000 represents the cost of essentially tearing up and redoing the Loring runway at 12,000 feet, but there could be other sites with the potential for a smaller cost). Additionally, Loring's runway would need to be evaluated. We considered hangar space at Loring that the spaceport could potentially buy to lease out to users and use for payload processing and integration, with some consideration for renovations. Further evaluation of the condition of these hangars would need to be conducted to get a clearer picture of the cost associated with making each building operational. We also incorporated potential telemetry and equipment needs and some land allocation to lease to ground station partners at sites at Loring.

Table 10. Horizontal Launch Facility Cost Estimate

Component	Comparable Year	Comparable Complex	Description	Estimated Cost
Runway Renovation	2012	Spaceport America	Spaceport America spent $3.5 million per 1,000 feet of runway when extending their 10,000 foot runway in 2012.	$42,000,000
Hangar Space	2021	Loring Commerce Centre	126,303 sq ft hangar at Loring Commerce Centre, and renovations needed.	$1,250,000
Payload Processing Area	2021	Loring Commerce Center	41,114 sq ft hangar at Loring Commerce Centre, and renovations needed.	$750,000
Integration Area	2021	Loring Commerce Centre	22,260 sq ft hangar at Loring Commerce Centre, and renovations needed.	$500,000
Telemetry and equipment	2021	Pacific Space Complex	Telemetry and Tracking System cost estimates for 1 incremental additional launch pad.	$1,700,000
Land acquisition for Ground Station Leasing				$50,000-$250,000

Total Estimated Cost: $53,200,000

E. Data Analytics Center of Excellence/Innovation Hub

The cost estimates of the Center of Excellence/Innovation Hub incorporate the physical building infrastructure needed for a data analytics innovation center, alongside a year's funding for an incubator program, accelerator program, sandbox program for educational and private sector collaboration, and a visitation and information area within the center. Considerations were made for staffing in these cost estimates (Table 11).

Table 11. Data Analytics Center of Excellence/Center for Innovation Cost Estimates

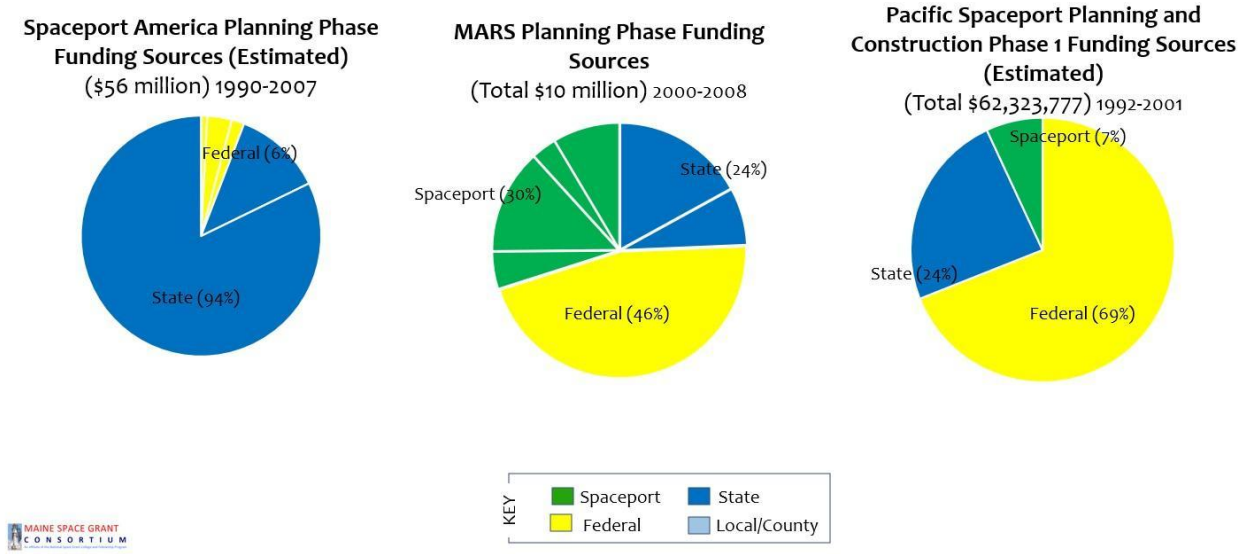
Component	Comparable Year	Comparable Complex	Description	Estimated Cost
Center of Excellence/Innovation Building	-	-	Building acquisition and needed renovations	$800,000
Incubator Yearly Funding	-	-	½ Compensation of Development Officer to oversee Incubator strategy and accelerator strategy and their interTactic with institutions, organizations, and clients ($40,000). Initial funding of incubator program ($75,000)	$115,000
Accelerator Yearly Funding	-	-	½ Compensation of Development Officer to oversee Incubator strategy and accelerator strategy and their interTactic with institutions, organizations, and clients ($40,000). Initial funding of accelerator program ($75,000)	$115,000
Sandbox Yearly Funding	-	-	Compensation of one education coordinator to facilitate strategy surrounding Maine's educational institutions Pre-K – Grad School ($75,000). One partnerships staff member to assist in maintaining relationships with institutions ($50,000). Initial program budget ($25,000).	$150,000
Visitation and Information Center	-	-	Office coordinator to facilitate visits and tours ($55,000), Furniture and interior ($10,000), Curated Materials ($50,000)	$115,000

Total Estimated Cost: $1,295,000

Funding Overview: Case Studies

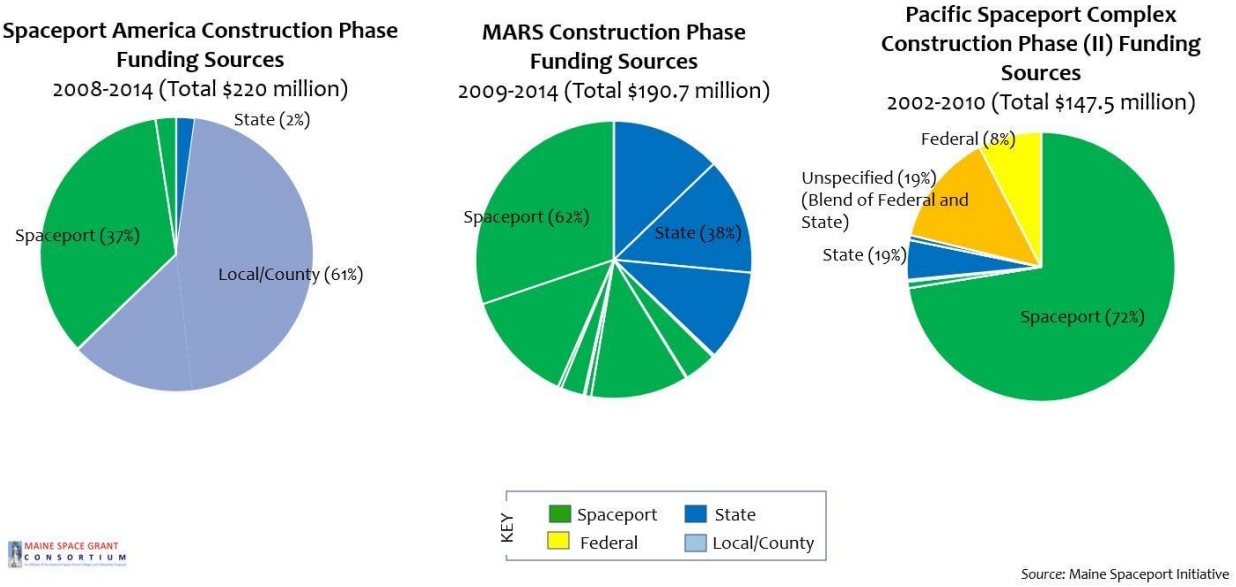
We compared the funding sources of Spaceport America, MARS, and Pacific Spaceport Complex broken down by phase of their development, comparing planning, construction, and management phases (Figure 19). A striking pattern emerges, showing all three spaceports successfully utilizing federal funds to get the idea and planning stage to the point where the state felt comfortable committing much larger sums. A largely disproportionate piece of the Spaceport America Planning Phase Funding was from a State Appropriation at the very end of the planning phase from 2005-2007, representing an investment - $46.1MM - equal to 82% of the total sum of Planning Phase Funding.

Figure 19. Planning Phase Funding for Benchmark Spaceports



During the construction of each spaceport (Figure 20), infrastructure-heavy projects required infrastructure-friendly funding sources at the state and local levels. As a spaceport gains initial revenues from one launch pad, it can continue to capture revenues while building its complex.

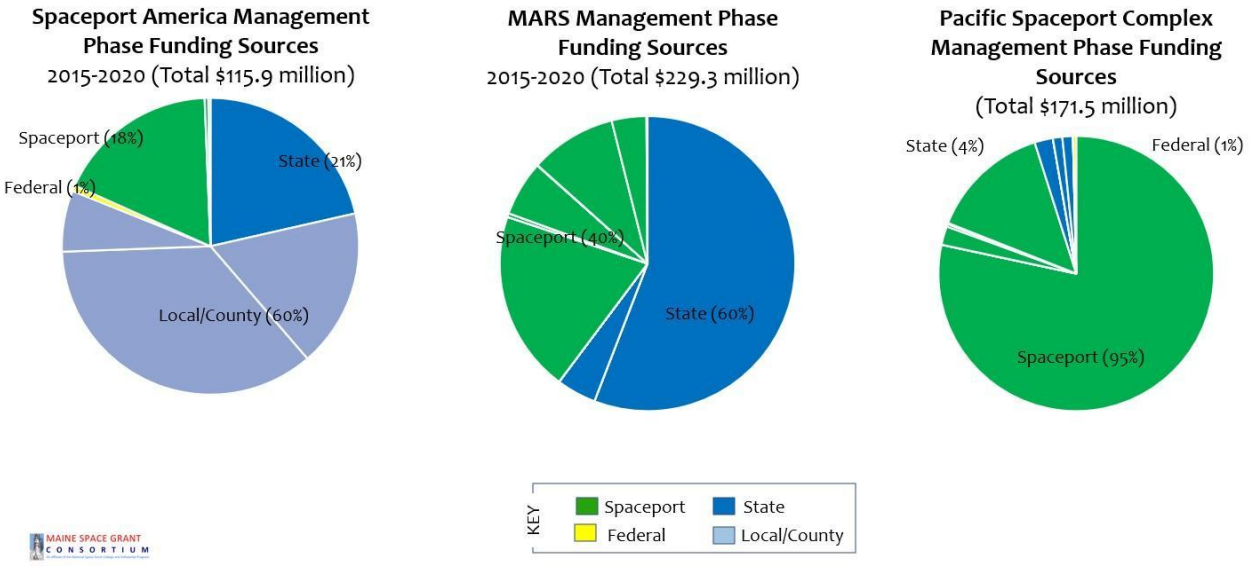
Figure 20. Construction Phase Funding for Benchmark Spaceports



Source: Maine Spaceport Initiative

There was not much federal involvement in the management phase– spaceports are more reliant on operating revenue streams (Figure 21). Spaceport America perhaps is the exception, related to the market timing and commercial feasibility of Virgin Galactic relative to its initial estimates. As Virgin Galactic becomes economically viable and begins paying repeated launch fees, Spaceport America's pie will continue to look more like management phase MARS and then Pacific Spaceport Complex in theory as it moves forward.

Figure 21. Management Phase Funding for Benchmark Spaceports



Maine Space Complex Funding Model

Most FAA-approved spaceports have historically been challenged by profitability. These spaceports are designed around larger, more costly infrastructure for large rockets. They have not diversified their portfolio with other activities like those included in the Maine Space Complex design, such as the data analytic center and the innovation hub, to generate revenue. For these spaceports, operating losses tend to be State/ Federal subsidized. The exception is Alaska's Pacific Launch Complex, one of the few in the United States that can accommodate polar launch. Under the management of the Alaska Aerospace Corporation, the launch complex turns a yearly net operating profit, with $2.6 million in net operating profit in 2020. The Pacific Spaceport Complex is expected to generate a total economic impact exceeding $100 million to the region by 2028.

Maine Space Complex's funding model is based on Alaska's Pacific Launch Complex, which minimized state funds and staged development to start with a minimum viable product and scale growth with demand. Spaceport America in New Mexico is the most expensive spaceport built in the US, while Pacific is the least. Highlights of Alaska's approach are:

- *Alaska's responsible growth and development of its launch site have allowed it to see operational profits as it has reached maturity with limited state appropriations – about $15 million over 20 years compared with $325 million in total revenues during the same period - less than 5% of the project.*
- Alaska utilized a phased approach to its build, justifying each launchpad construction with its marginal benefits and considerations and not building the complex all at once.

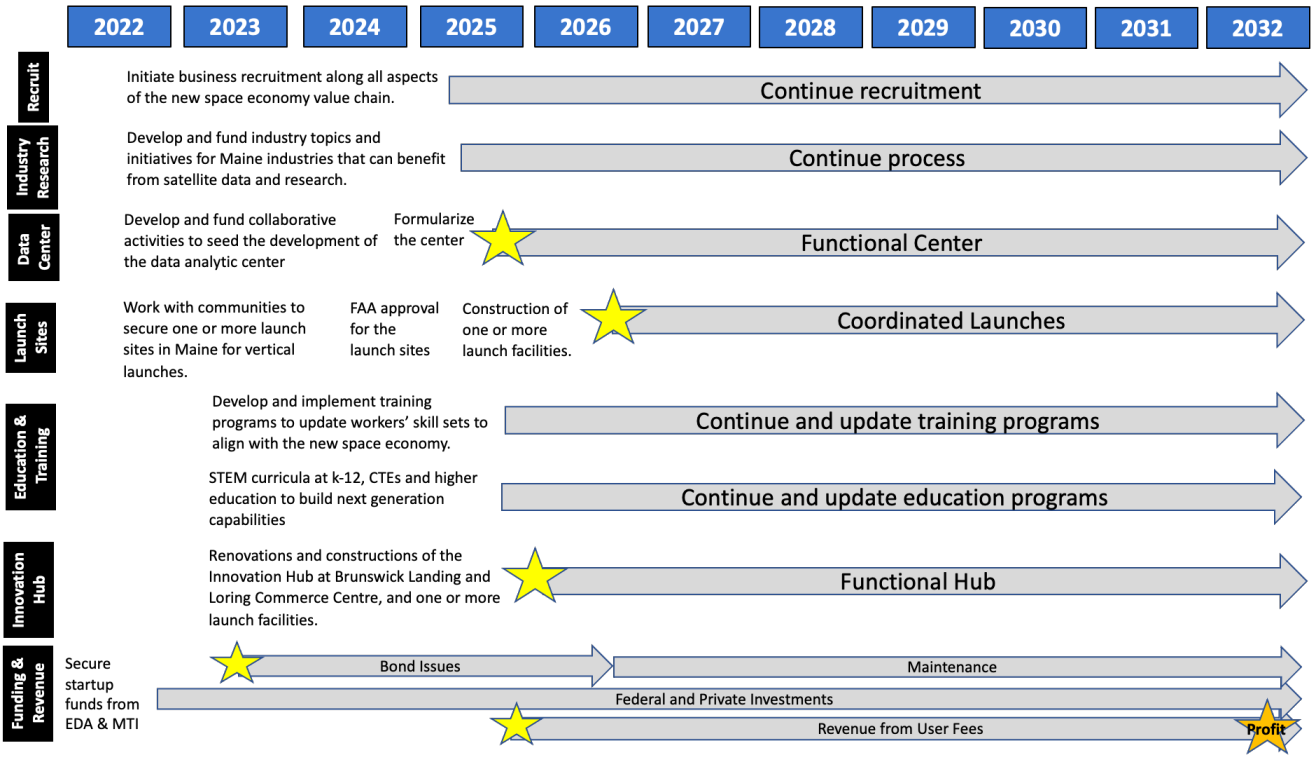
- The complex has a limited presence and has no aesthetic gaudiness or architectural pronunciations. This provided stable income over time, minimizing the state's contribution.
- Most of the planning phase spending for Alaska was from federal funds, as it was seeking to win a competitive bid to be a DoD launching site, beating out a place in the Pacific Northwest.

For these reasons, the strategic plan calls for the Corporation not to seek state appropriations for operations, programs, and infrastructure, and focus attention on positioning the state to secure existing and anticipated future federal funds and private investments for infrastructure, operations, and programs as they become available in the next several months (Figure 22). Financial support would also be realized from fee generation from uses of Complex facilities within ten years. Regarding infrastructure, the Corporation will be able to issue bonds for infrastructure requirements for the Maine Space Complex. In addition to the ARPA infrastructure funds, there is bipartisan support to fund the Department of Commerce Office of Space Commerce and the FAA Office of Spaceports to provide financial support to states with spaceports to support infrastructure, operations, and programs.

Figure 22: Funding Opportunities for the Maine Space Complex

In contrast to the other spaceports, the diverse portfolio of activities of the Maine Space Complex minimizes reliance on the launch sites for revenue generation. Even with this diversity, we expect the Complex to be profitable within ten years once the three business units are fully operational and have time to generate revenue (Figure 23). The Corporation will continue to support the Complex with federal and private investments during this period. For example, the MSGC is working with EDA and MTI to secure financial support for business development activities and for the startup phase of the Corporation.

Figure 23: Maine Space Complex 10-Year Implementation Timeline and Profitability



Economic Impact Projections

A. Statewide Impact

The Maine Space Grant Consortium (MSGC) commissioned the Center for Business and Economic Research (CBER) at the University of Southern Maine (USM) to conduct an economic impact analysis of the proposed Maine Space Complex and business components. The study developed revenue and market share forecasts for space complex business components drawing on several industry sources and experts. Four scenarios were simulated over an 18-year forecast horizon using an economic model developed by Regional Economic Models Incorporated (REMI) and maintained by CBER. The results indicate that a new space economy in Maine could contribute:

- Between $550 million to $1.1 billion per year (in fixed 2022 $) to the state GDP by 2042, and
- Between 2,800 and 5,500 good-paying jobs annually by 2042 while providing a significant source of tax revenues across the state.

Although not a comprehensive evaluation of a space complex development, these simulations represent the *potential* impacts assuming that a new space economy emerges in line with market forecasts and under the various scenarios simulated in this analysis. There are no probabilities assigned to these scenarios.

The development of the Maine Space Complex and the new space economy has the potential for significant economic impacts on the state and regional economies. It is well-aligned with the state's 10-year economic development strategy focused on innovation. The scenarios and forecasts presented in this analysis represent a subset of an industry's potential development paths.

B. Regional Impact

Table 11 provides a geographic breakdown of economic impacts by 2042 across seven regions that are county aggregates that closely align with the state's seven Economic Development Districts (EDDs). The EDD county-based definitions in CBER's REMI model are as follows: Southern Maine EDD – York County; Greater Portland EDD – Cumberland County; Androscoggin Valley EDD – Androscoggin; Kennebec Valley EDD – Kennebec; Midcoast EDD – Sagadahoc, Lincoln, Knox, and Waldo Counties; Eastern Maine EDD – Penobscot, Waldo, Hancock; and Northern Maine EDD – Aroostook and Washington Counties. Based on the locations identified in the market feasibility study, the impacts will primarily be concentrated in a few regions across the state. However, all areas will feel indirect and induced effects across the state. We expect these impacts' relative magnitude and concentration to remain consistent throughout the forecast period. However, some components of the space complex are spatially elastic or footloose. Unlike physical launch and control and command facilities, data analytics and, to a lesser extent, parts manufacturing are more location-dependent - they can be located anywhere. Still, there are strong pull factors for spatial proximity that may draw more of this activity closer to the core to leverage and access labor pools of similarly skilled workers and training networks, to be closer to the buzz and action and knowledge flows, and to be closer to other suppliers that help reduce transaction costs and improves coordination of more nimble launch operations.

Table 12: Geographic breakdown of economic impacts by 2042 across seven regions that are county aggregates that closely align with the state's seven Economic Development Districts.

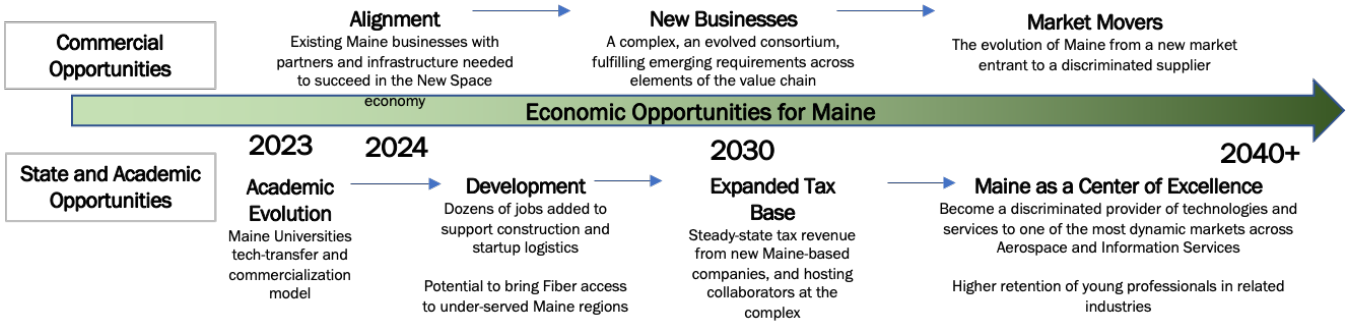
Region	Employment	Wages and Salaries	Gross Domestic Product	Output
		In Millions of Dollars		
Androscoggin Valley EDD - Androscoggin	149	$ 7	$ 18	$ 32
Northern Maine EDD – Aroostook and Washington	339	$ 14	$ 102	$ 158
Eastern Maine EDD – Penobscot, Waldo, Hancock	1070	$ 69	$ 153	$ 293
Greater Portland EDD – Cumberland	1772	$ 154	$ 370	$ 561
Kennebec Valley EDD - Kennebec	85	$ 4	$ 11	$ 18
Midcoast EDD – Sagadahoc, Lincoln, Knox, and Waldo	118	$ 7	$ 16	$ 29
Southern Maine EDD – York	1990	$ 182	$ 414	$ 776
All Regions	**5,522**	**$ 437**	**$ 1,084**	**$ 1,866**

The estimated economic impacts on employment, contribution to GDP, and tax revenues across the state can only be accomplished by state-wide coordination of its assets to realize the potential of the Maine Space Complex. This is the role of the Corporation. No single company can unlock these benefits to the residents of the state of Maine alone. Moreover, creating a monopolistic condition to protect the competitive advantage of a single company will deny other launch providers the opportunity to establish a foothold in Maine and all but eliminate the potential to create and retain jobs in Maine at the scale estimated by the economic impact analysis.

As shown in Figure 24, investment in the new space economy will promote Maine's economic opportunity and growth. As investment and development of the project continue, both commercial and state and academic opportunities will grow as the project matures. Initially, commercial opportunities will focus on aligning existing Maine businesses with partners and the infrastructure needed to succeed in the new space economy. Over time,

new businesses will move to Maine or start here, forming a complex, evolved consortium, fulfilling emerging requirements across elements of the value chain. Maine will grow from a new space economy entrant to a discriminated supplier with maturity.

Figure 24. Timeframe for economic opportunities resulting from investment in a new space economy.



STEM curriculum excellence must evolve in k-12 and higher education institutions to better serve the space and nanosatellites economies. The University of Maine System can emulate technology transfer and commercialization best practices to spur innovation in this sector. State and academic opportunities will begin with K-12 through engagement in space exploration and new space activities via existing space-related challenges developed by educational non-profits to integrate STEM into school curricula.

One segment of the new space value chain that can be strengthened immediately with relatively low levels of investment through private-academic collaboration is the downstream segment of the space economy focused on commercially valuable big data and analytics. Collaboration between higher education and Maine-based private industry on identifying commercial use cases that can be addressed through satellite data and analytics to enhance business decision-making and strengthen the Maine-based industry. As businesses mature, jobs will be added to support construction and startup logistics. These growing businesses and added jobs will expand the state's tax base and assist in the retention of young graduates to build a more robust nationally and internationally competitive economy. Space data will also contribute to the realization of state government policy initiatives such as climate change, fishery research, and management, among others.

Maine could be recognized as a center of excellence in the new space market when the Complex is fully mature. Maine can become a discriminated provider of technologies and services to one of the most dynamic markets across the aerospace and information services sectors. The Complex's proposed investments can promote growth across most technology areas identified by MTI and NASA for Maine, intended economic growth paths for Maine to prioritize.

Contribution to the State's Economic Development Strategy

The proposed Maine Space Complex squarely addresses both overarching goals of Growing Talent and Facilitating Innovation and contributes to the Seven Core Strategies by attracting highly skilled workers to Maine and increasing the average state wage. Specific contributions include:

- The Maine Space Complex is estimated to add between 3,400 and 6,700 high paying jobs by 2040, as projected by an economic impact analysis conducted by USM Center for Business and Economic Research (2020)

- Help train and retain Maine's students and immigrants graduating with aerospace-related STEM degrees (mechanical engineering, physics, computer science, etc.)
- Attract highly skilled workers and their families from out of state
- Develop Maine's workforce to participate in the fast-growing Knowledge Economy.
- Develop a mechanism to facilitate startup growth and spur development in all seven technology sectors
- Facilitate STEM learning opportunities for Maine high school and higher education students
- Increased demand for broadband, quality roads, and housing
- Promote economic aspirations for All Mainers
- Develop globally based applications for both commercial and consumer uses

Community Feedback

Although the MSGC has started and will continue conversations with stakeholders and community members from across the state and more directly in Washington County, community concerns were raised in December 2021 by the citizens of Jonesport-Beals in reaction to bluShift Aerospace's statement regarding its intention to establish a launch facility on Water Island. Among the chief concerns voiced were interference with preexisting fishing and lobstering operations as boats of any kind would be required to stay out of the rocket's trajectory during launch windows. The other concern was the lack of environmental impact detail, which was a big concern to environmentalists, citizens, and those that depend on the areas' natural resources for their livelihoods.

Misconceptions about the Maine Space Complex

While preparing this document, the Legislature's Innovation, Development, Economic Advancement, and Business held a public hearing and a work session on LD 1923, An Act to Establish the Maine Space Corporation. Committee members posed questions about the Maine Space Complex and the Maine Space Corporation. We submitted responses to their questions to eliminate misconceptions about the purposes of the Complex and Corporation. Below are our responses.

1. The Maine Space Complex is more than launching satellites.

The Complex is not only about launching small satellites on small rockers. Launch sites and services, one of the three business units of the Complex, is not a sizeable revenue-generating activity. However, it needs to work in concert with the other two business units to impact the state. The Complex is about applying transferable skills and experiences of businesses and workers in the underlying supporting infrastructure across the new space economy value chain. These skills and expertise include research, precision manufacturing, welding and pipefitting, electrical, design and engineering, engines, computer systems and electronics, data analytics, advanced materials, metals, components supply, telemetry, tracking, and command stations, applications for end-users in the private and public sectors, and products, and services from spin-offs or technology transfer from the space sector. It is about bridging the gap between the growing new space economy and access to resources and technology for Mainers that will:

- Enable Maine industries, such as IT, manufacturing, advanced materials, to diversify and grow.
- Help Maine's natural resource industries mitigate the threats they are confronting.
- Support R&D and commercialization.

- Motivate high school and college graduates to stay in the state and capitalize on employment and business opportunities in the new space economy.
- Enable State government and communities to monitor climate change impacts and mitigation.
- Enable communities to improve their local planning efforts.
- Enable Maine's growing immigrant population to apply their skills in the new space economy and contribute to the growth of the state's economy.
- Support tourism and related support infrastructure.

2. The Maine Space Complex's Business Model DOES NOT rely on state appropriations

- The strategic plan calls for a phased-based approach over 5-10 years to constructing the entire complex, with various options for the Maine Space Corporation to consider during the implementation/ construction phase of the project.
- Based on information from other spaceports, the initial costs for construction could be a minimum of $5.3 million over 3-5 years, primarily for launch facilities. Ongoing management and operational costs would come from user fees and other federal sources.
- A critical element of the Corporation's business model for the Maine Space Complex is to leverage existing physical assets at Brunswick Landing and the Loring Commerce Center. This approach significantly reduces the need for new construction and prioritizes renovations of existing available facilities at these locations.
- We are not requesting state appropriations. Funding sources for facilities will come from leveraging federal and private sector investments. The Corporation will also have the ability to issue bonds.

3. Michigan's and Nova Scotia's Spaceports ARE NOT good comparison models.

Michigan Spaceport (Vertical & Horizontal)

The Michigan Spaceport, led by the Michigan Aerospace Manufacturers Association, envisions vertical and horizontal launch sites, with access to polar orbits and SSO being integral to their plans. A launch site on the Upper Peninsula would allow a vertical launch northward over the great lakes to avoid overhead flight. The horizontal launch is located at the Oscoda-Wurtsmith Airport, a former Air Force base in the Lower Peninsula. The State of Michigan has funded the Michigan Spaceport to the tune of $2 million to undergo the feasibility and site study, hoping that the Michigan Aerospace Manufacturers Association can take the baton and leverage private equity money to build the facility. Operations are expected to begin by 2025. No significant traction has been measured in the plan. The table below describes the differences between Michigan's and Maine's manufacturing sectors for comparison purposes. This comparison shows Michigan's financial power to secure investments and pursue a spaceport. Maine does not have the financial ability to accomplish the same outcome.

Metric	Michigan	Maine
Total Manufacturing Output (2019)	$99.6 billion	$6.4 billion
Percent Share of Total GSP	18.55%	9.46%
Manufacturing Firms (2017)	11,265	1,620
Manufacturing Employment (2020)	568,000	49,000
Percent Share of nonfarm employment	14.32%	8.35%
Average annual compensation (2019)	$82,020	$68,570
Nonfarm businesses (2019)	$50,711	$42,824

Source: National Association of Manufacturers

Michigan Spaceport is still under development and has not proven it can be funded privately and operate successfully. Furthermore, despite the eventual private model status, the state has shown significant buy-in, with $2 million contributed. We are not requesting state appropriations.

Canso Spaceport (Vertical)

The Canso Spaceport in Nova Scotia envisioned and managed by Maritime Launch Services, a private company, has taken the unique approach of privately financing the spaceport infrastructure. In May of 2021, it had secured $10.5 million from a Toronto investment bank and sought to host its first launch in 2023 if construction could move forward as planned. Canso has traction, securing a launch agreement with Nanoracks, a Texas-based commercial payload provider which also offers satellite services to the Canadian Space Agency. Alongside this payload partnership, Canso plans to host the Ukrainian-built Cyclone-4M rocket, which has 877 successful missions under its belt. Canso plans to provide polar-orbit access to small satellites.

Canso Spaceport is unique in that it is the only spaceport in Canada, whereas the U.S. has multiple FAA-approved spaceports. Canada has a national space agency like NASA, with existing large-scale contracts with partners that could be pivoted to Canso Spaceport. For example, Nanoracks is a large-scale partner with the Canadian space agency and has entered into a partnership with Canso Spaceport. The driver behind this shift is one of Spaceport's founders, who is affiliated with the company that builds the Cyclone-4M rocket. Unique to this project is that it would be Canada's first launch site, offering a much higher payoff at the national scale of space programming expenditures. These large-scale pieces in Canso provide a risk profile much different from a proposed commercial launch site in the United States. It would be very difficult for smaller-scale US industry players to raise the necessary capital to fund such a project in the US, with already existing launch options providing a more straightforward operating cost tradeoff to significant capital expenditure.

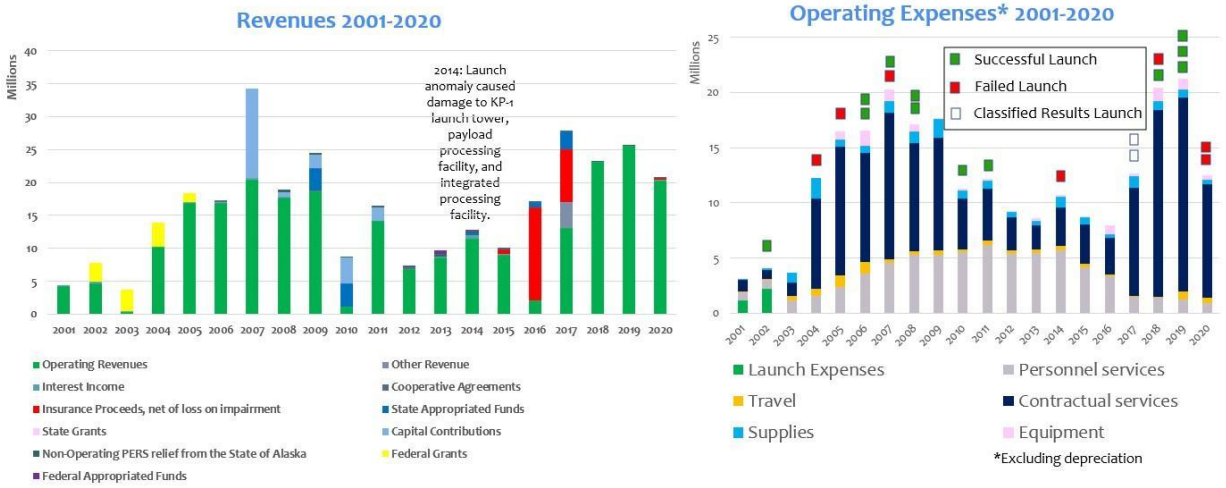
4. New Mexico's Spaceport America IS NOT a good comparison model for Maine

- Maine's business model is based on Alaska's Pacific Launch Complex, which minimized state funds and staged development to start with a minimum viable product and scale growth with demand. Spaceport America in New Mexico is the most expensive spaceport built in the US, while Pacific is the least.

Alaska's Pacific Launch Complex

- Alaska's responsible growth and development of its launch site have allowed it to see operational profits as it has reached maturity with limited state appropriations – about $15 million over 20 years compared with $325 million in total revenues during the same period - less than 5% of the project.
- Alaska utilized a phased approach to its build, justifying each launchpad construction with its marginal benefits and considerations and not building the complex all at once.
- The complex has a limited presence and has no aesthetic gaudiness or architectural pronunciations. This provided stable income over time, minimizing the state's contribution.
- Most of the planning phase spending for Alaska was from federal funds, as it was seeking to win a competitive bid to be a DoD launching site, beating out a place in the Pacific Northwest.

Pacific Spaceport Complex: Revenues and Operating Expenses



Pacific Spaceport Complex: Economic Benefits in Millions

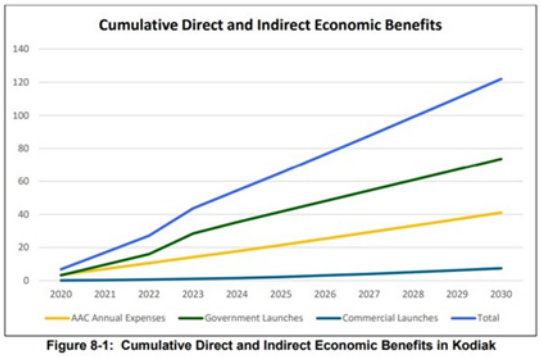
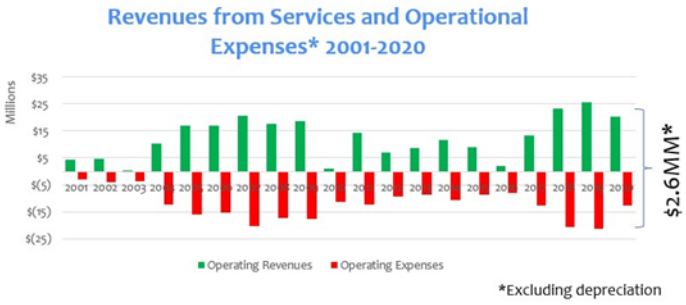
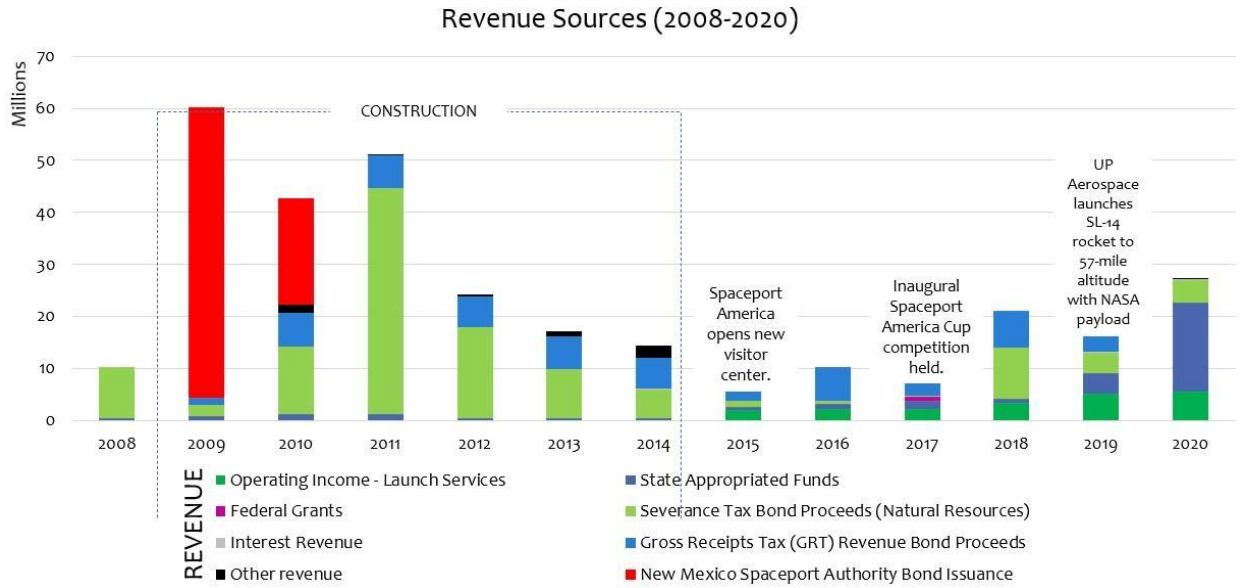


Figure 8-1: Cumulative Direct and Indirect Economic Benefits in Kodiak



New Mexico - Spaceport America

- In contrast to Alaska, Spaceport America, which gained excitement from a blockbuster launch provider, Virgin Galactic, instituted massive amounts of local spending to be an attractive host to that provider.
- This massive investment was eagerly allocated and decided on before Virgin Galactic became a turn-key launch provider. Thus, it created a significant deficit of revenues when it took Virgin Galactic almost half of a decade to make its first commercial launch.
- Spaceport America is perhaps the least experienced and least developed of the four spaceports operating under public-private partnerships both in its track record and management.
- Massive spending was done to create an aesthetically-attractive and luxurious look and feel because Spaceport America's clientele is mainly for human space tourism – a luxury product.
- Spaceport America is a suborbital complex, not orbital like Maine, and this limits its addressable market to only those launch providers that want to go up and come back down all at once.
- Spaceport America is not a similar project to the Maine Space Complex. However, although Spaceport America struggles to turn an operational profit, its economic impact is pronounced and exceeds its budgetary shortfall.



Direct Impact - Spaceport spending creates additional activity in the local economy (i.e. construction of launch pad)

Indirect Impact - Impact of business-to-business transactions indirectly caused by the direct effects (i.e. hotel and hospitality business from spaceport).

Induced Impact - impact of increased personal income caused by the direct and indirect effects.

FIGURE 29: Annual Economic Impacts-Baseline Scenario
FY2016-FY2029 ($million)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2029
NMSA	$7.89	$8.63	$16.33	$10.08	$26.38	$66.73	$23.04	$19.61	$28.99	$27.61
Horizontal Launch Activities	$2.67	$3.79	$10.02	$21.11	$32.90	$57.84	$58.81	$72.50	$65.17	$78.50
Vertical Launch Activities	$0.06	$0.67	$0.89	$1.29	$1.07	$1.08	$1.51	$1.65	$1.77	$3.83
Other Activities	-	$0.01	$0.02	$0.68	$7.32	$8.06	$6.85	$7.09	$7.46	$8.70
Direct Economic Impacts	**$10.62**	**$13.10**	**$27.25**	**$33.16**	**$67.68**	**$133.71**	**$90.20**	**$100.84**	**$103.38**	**$118.64**
Direct and Indirect	$13.16	$16.49	$33.50	$40.74	$81.27	$162.93	$109.27	$122.97	$125.34	$144.99
Direct, Indirect, and Induced	$18.04	$22.69	$44.91	$55.92	$111.61	$215.05	$149.95	$167.68	$171.13	$197.12
Gross Receipts Taxes Generated	$0.41	$0.40	$1.62	$1.88	$4.22	$8.11	$5.77	$6.71	$6.67	$7.77

5. The Corporation WILL NOT prevent or hinder the growth of existing or new companies.

- Startups and established businesses face significant barriers to entering and succeeding in the new space economy marketplace. These barriers include but are not limited to:
    - Supporting infrastructure and facilities to facilitate R&D, manufacturing, and operational elements of their business
    - Access to capital
    - Access to a qualified workforce
- Creating the infrastructure needed for this project is too large a burden and a risk for an individual company to bear.
- Just like an airport is built to serve multiple carriers (Jet Blue, Delta, United, etc.) and not a single one or roads are built to allow commercial and passengers cars to travel throughout the state, the role of the Corporation is to facilitate the development of launch sites to enable companies, both within and outside the state, to access space.

- By maintaining and curating the infrastructure, the Corporation will diffuse the cost of the infrastructure over an ecosystem of use cases and rents and create a positive economic impact on the state as a whole.
- The Corporation will have the flexibility to pursue and secure federal and private sector funds to support the Complex, including construction, maintenance, programs, businesses, researchers, and students, and, at the same time, minimize costs to state government. In addition, it would:
    - Provide better infrastructure solutions than a wholly public or wholly private initiative.
    - Facilitate faster project completion and reduce delays on infrastructure projects by including time-to-completion as a measure of performance and, therefore, profit.
    - Yield greater return on investment than projects with traditional, all-private, or all-government fulfillment. Innovative design and financing approaches become available to a private-public corporation.
    - Minimize risks to state government.
- Most of the Corporation's board members will be from the private and education sectors. This will ensure that the Corporation will support and help coordinate the expansion of business interests in the new space economy while protecting the environment.
- Enactment of the Bill would send a strong message to the business and investment communities inside and outside of Maine that the state supports the development of the Complex and would facilitate agreements with businesses and organizations that want to become anchor tenants and use the Complex's facilities.
- Without the Corporation, progress in realizing the potential of the Complex would be inhibited and cause the state's efforts to fall behind the competition in other states such as Michigan.
- We are already seeing companies prioritizing the quality of life that Maine offers over the incentives provided by other states. Maine provides a relaxing and recreational environment with the ability to plug into much of the cloud-oriented work done in the data and analytics industry. Places like Brunswick Landing are set up with aerospace operators in mind. bluShift cites its ability to conduct engine tests on-site as a significant reason for settling there.

6. The Corporation WILL NOT Prevent or Take Over Private Launch Sites

- LD 1923 provides no authority to the Corporation to prevent a private company from establishing its launch site or exercising eminent domain to take over a privately-owned launch site.
- Just like an airport is built to serve multiple carriers and not a single one or roads are built to allow commercial and passengers cars to travel throughout the state, the role of the Corporation is to facilitate the development of launch sites to enable companies, both within and outside the state, to launch their satellites.

7. Maine Launch Sites will Not be Configured for Single Users

- Launch sites will be configured for multiple uses, meaning that launch providers that have rockets with different configurations would be able to use these sites.

- Several small launch vehicle companies are looking to expand operations and have initial discussions about their interests with the project leadership.
- Creating a monopolistic condition to protect the competitive advantage of a single company will deny other launch providers the opportunity to establish a foothold in Maine. It will all but eliminate the potential to create and retain jobs in Maine at the scale estimated by the economic impact analysis.

8. The Corporation does not have the authority to dictate the location of a launch site

- There are two major determinants of a launch site: FAA and a community.
    - FAA has stringent requirements for licensing launch sites, including population density, population flyover, launch safety, environmental impact, etc.
    - Community concerns about many factors including impact on industries in their location, environmental impact, increasing in tourism, among other concerns.
- The Corporation would invite communities to apply for consideration. Communities would be provided site requirements before applying.
- FAA approval would come after environmental impacts are addressed, and public comments are given.
- Ultimately, the community will decide to accept launch site designation using whatever local approval process at their disposal, including the planning board and a community-wide vote.
- The Corporation does not have the authority to prevent local voting on a launch site.

9. There are several launch site opportunities in Maine

- Due to FAA requirements, in-land vertical launch sites are not considered at Brunswick Landing and Loring Commerce Centre.
- Vertical launch sites can only be located along or off the coast.
- Horizontal launches using airplanes are a consideration at Brunswick Landing and Loring Commerce Centre but must be approved by the FAA.

10. Environmental impacts of a launch site will be shared the public BEFORE any infrastructure development

- The FAA requires full environmental impact assessments before approval for licensing; this report would be shared with the public during the planning stages before any infrastructure development.
- The approach to siting the launch facility will be transparent and open as we understand the impacts and outcomes that affect us all.
- The rocket companies (beyond bluShift) being considered for Maine use fuel classified as non-toxic.
- Sustainability is a value the Maine Space Corporation will prioritize starting with these five areas: carbon emissions mitigation, marine health, space debris recovery, biodiversity, and onsite operations.

11. Launch sites are restricted to commercial, research, and educational purposes, even to the Military.

- Unless the US is in a war situation, the US military cannot take over the state or private lands.
- The US military would not use Maine's launch sites to launch weapons because these require classified locations and are only available in a few places in the country, such as Cape Canaveral and Vandenberg Air Force base.
- The military could use Maine launch sites to launch small satellites only to support scientific research and data gathering.

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Maine Space Complex Leadership Council

The development of the strategic plan was guided by a steering committee that was represented mainly by the private and educational sectors. Committee members include:

- **Sascha Deri,** Founder & CEO, bluShift Aerospace
- **Karl Hoose,** Founder & CEO, VALT Enterprises
- **Lisa Martin,** Executive Director**,** Manufacturers Association of Maine
- **Steve Von Vogt,** Executive Director, Maine Composites Alliance
- **Matt Parker,** Engineering Manager**,** Fiber Materials Inc.
- **Brian Walker,** President**,** Maine Angels
- **Bob Clark,** Executive Director**,** Northern Maine Development Corporation (Washington & Aroostook County)
- **Charles Rudelitch, Esq.,** Executive Director**,** Sunrise County Economic Council (Washington County)
- **Steve Levesque,** Former Executive Director**,** Midcoast Regional Redevelopment Authority
- **Carl Flora,** President/CEO, Loring Development Authority
- **Janet Sorter, Ed.D.,** Vice President, and Chief Academic Officer**,** Maine Community College System
- **Dana Humphrey, Ph.D.,** Dean of Engineering College**,** University of Maine
- **Ali Abedi, Ph.D.,** Professor of Electrical and Computer Engineering & Research Director of CubeSat Mission, University of Maine
- **Jeremy Qualls, Ph.D.,** Dean and Professor, College of Science Technology & Health**,** University of Southern Maine
- **Jason Judd, Ed.D.,** Executive Director**,** Educate Maine
- **Chris Saucier,** Strategic Alliance Development Director, Cybersecurity and Communications**,** Roux Institute @ Northeastern University
- **Gregory Falco, Ph.D.,** Professor at Whiting School of Engineering & Applied Physics Laboratory Research Institute, Johns Hopkins University
- **Nick Livesay,** Director, Bureau of Land Resources**,** Maine Department of Environmental Protection
- **Anthony Ronzio (Governor's office),** Director**,** Governor's Office of Policy Innovation & the Future

Appendices

The appendices are being finalized and will be available in a stand-alone document.

Appendix A: Funding Analysis and Cost Estimates

Appendix B: Maine Aerospace Industry Assessment

Appendix C: Private Sector Incentives Analysis

Appendix D: Research and Development

Appendix E: Education

Appendix F: Economic Impact Assessment

Appendix G: Private Sector Inclusion & Investment

Appendix H: Risk Capital Availability