Testimony In Support of LD 1923, An Act to Establish the Maine Space Corporation

Terry Shehata, Executive Director - February 1, 2022

Senator Curry, Representative Roberts, and distinguished members of the Committee, my name is Terry Shehata. I live in Winthrop, and I am the Executive Director of the NASA-funded Maine Space Grant Consortium, a 501(c)(3), Affiliate-based corporation (see attached overview). I want to take this opportunity to express our extreme gratitude to Senator Daughtry for sponsoring the bill and to Senators Breen, Cyrway, and Hickman, and Representatives Roberts, Dodge, Fecteau, and McCrea for co-sponsoring the bill.

I am testifying in support of LD 1923 to establish the Maine Space Corporation. The Corporation would ensure the Maine Space Complex (see attached overview) contributes to the state's Economic Development Strategy 2020-2029 and the goals of the MaineSpark Coalition, the Maine STEM Council, the Maine Innovation Economy Advisory Board, and FocusMaine by facilitating and enabling:

- Research, entrepreneurship, innovation, startups, and business expansion spur development in MTI's technology sectors to develop globally based applications for commercial and consumer users.
- Maine industries grow and mitigate the threats they are confronting.
- The attraction of highly skilled workers and their families from out of state.
- State government and local communities monitor the impacts of climate change and mitigation.
- Communities' improvement of local planning efforts.
- Maine high school and college graduates to stay in the state and capitalize on employment opportunities in the new space economy.
- Maine's growing immigrant population to grow Maine's economy, and
- Advancement of Maine to a new competitive level in a fast-grow new space economy

The new space economy is a term that recognizes the traditional space economy as we have known it has shifted from the exclusive domain of large government projects to private industry. This shift has led to greater affordability, precipitating a wave of industry innovation and growth in lower-cost satellite driven businesses.

The Consortium is a member of a national network of state-based consortia in all 50 states plus DC and Puerto Rico and is funded by NASA's National Space Grant College and Fellowship Program. Our mission is to invest in Maine's aerospace-related research and education infrastructures in a manner that mutually benefits NASA and the state's research priorities as amplified by the investment priorities of the Maine Technology Institute (MTI). Since 2001, the Consortium has invested over $25 million in NASA funds in Maine's higher education institutions, businesses, and K-12 schools to seed research, internships, fellowships, and curriculum development. These investments have enabled students, researchers, and small businesses to create or expand relationships with NASA and the aerospace industry.

Over the past 16 months, with input from many Maine stakeholders in academic, businesses, local and state governments, community members, and federal agencies, and financial support from the federal Economic

Development Administration (EDA) and MTI, we have engaged in a strategic planning process for the geographically distributed Maine Space Complex and its three business units - data analytics, Innovation Hub and launch sites and services - with proposed locations at Brunswick Landing, Loring Commerce Centre, and Washington County. On February 11, we will release the interim strategic plan to the Governor and the Committee, followed by a public release. If your schedule allows, I am requesting the Committee to grant us the opportunity to provide an overview of the plan before scheduling the work session.

An essential objective in the strategic plan is the creation of the Maine Space Corporation as a quasi-state body to manage the development and growth of the Maine Space Complex and advance a new space economy in Maine that would serve the global market end-users. The Corporation would position Maine to become a more visible national/international industry destination and an authority in launching low-cost small satellites such as CubeSats which are the size of a bread loaf, into polar orbits using small, low-cost launch vehicles 55 feet in length and 3-feet in diameter.

The concept for the Maine Space Complex stems from the fact that Maine has assets it can leverage to engage in the new space economy and to advance Maine's participation in the rapidly growing global satellite market that was valued at $385 billion in 2020. Small satellites 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. 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; close proximity to academic and business centers in the Northeast region; physical and business assets at Brunswick Landing and Loring Commerce Centre; Maine's aerospace supply chain; businesses directly involved in space exploration and development such as VALT Enterprises, blueshift Aerospace, and Fiber Materials; and Maine's entrepreneurial ecosystem support network. The Complex is the aspiring vision and rallying infrastructure for a coordinated effort to leverage these assets to build capability and facilitate growth throughout the new space economy value chain and to position Maine in a leadership role in the emerging and fast-growing market of launching low-cost small satellites into polar orbits using small, low-cost launch vehicles.

In early 2020, preliminary projections of job creation and contribution to the state's GDP from capturing 10% to 30% of the small satellite market by 2040 were estimated by the USM Center for Business and Economic Research (MCEBR). The projections suggest that the Maine Space Complex could facilitate the creation and retention of between 3,400 and 4,500 good-paying jobs per year and contribute between $1 billion to $1.5 billion per year to the state's GDP. MCEBR is updating the economic impact analysis with additional data.

To be clear, the Maine Space Complex is not about only 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 reasons for establishing the Corporation now are:

- **Timing** – With additional federal funds becoming available in the next several months, the Corporation, as a quasi-state entity, would be the best vehicle for applying for these funds. Without a quasi-state entity status, progress in realizing the potential of the Maine Space Complex would be inhibited and cause the state's efforts to fall behind the competition in other states such as Michigan.
- **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.
- **Strong Signal**. 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 Maine Space Complex and would facilitate agreements with businesses and organizations that want to become anchor tenants and use Complex facilities.
- **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.
- **Public Identity** - As the initiative progresses and begins public hearings, it will be essential to align the brand perception to the Maine Space Corporation rather than the Maine Space Grant Consortium, which has been shepherding the development to date.

LD 1923 does not have a Fiscal Note because we are in discussions with EDA and MTI to secure additional funds that would also support the startup of the Corporation. The objectives of the funds are to work with the Maine Composites Alliance on pathways for Maine's advanced materials industry to engage in the new space economy; to develop and implement a business development strategy to recruit businesses to the Complex; and to continue our outreach efforts throughout the state, including Washington County. We are finalizing applications valued at $2.5 million over two years to these agencies within the next couple of weeks and anticipate final decisions before the Legislature's adjournment in April. Based on our discussions with EDA and MTI, we are confident of favorable decisions. We plan to transfer the awards and support staff to the Corporation within a year. At that time, the Corporation would be in a better position to apply for and secure financial support from the federal government, generate revenues from the use of facilities, and the issuance of bonds for infrastructure development. In the future, the Corporation may request state appropriations for nominal operating costs following discussions with the Governor's Office, DECD, and the Legislature.

The bill includes a section titled "Maine Space Complex Job Increment Financing Fund." DECD has informed me that this section is problematic in implementation because it would be duplicative of existing programs at the Midcoast Regional Redevelopment Authority and the Loring Development Authority, locations where elements of the Maine Space Complex would be located. DECD and I agreed to request the Committee to remove this section from the bill during the work session. Removing this section would not impact the Maine Space Complex.

My colleague, Emily Dwinnells, the project director for the Maine Space Complex strategic planning process, will offer testimony that provides more information on Maine's assets and a preview of the interim plan that would be the responsibility of the Maine Space Corporation to implement. She will also share our efforts to engage local communities to solicit feedback on the Complex and address environmental impacts.

Thank you for the opportunity to testify in support of LD 1923, and I ask the Committee to move the bill to Ought to Pass. I would be delighted to answer any questions you may have.

MAINE SPACE GRANT
C O N S O R T I U M



Overview



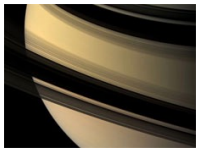
About NASA



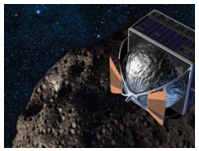
Aeronautics Research: Enables a safer, more secure, efficient, and environmentally friendly air transportation system.



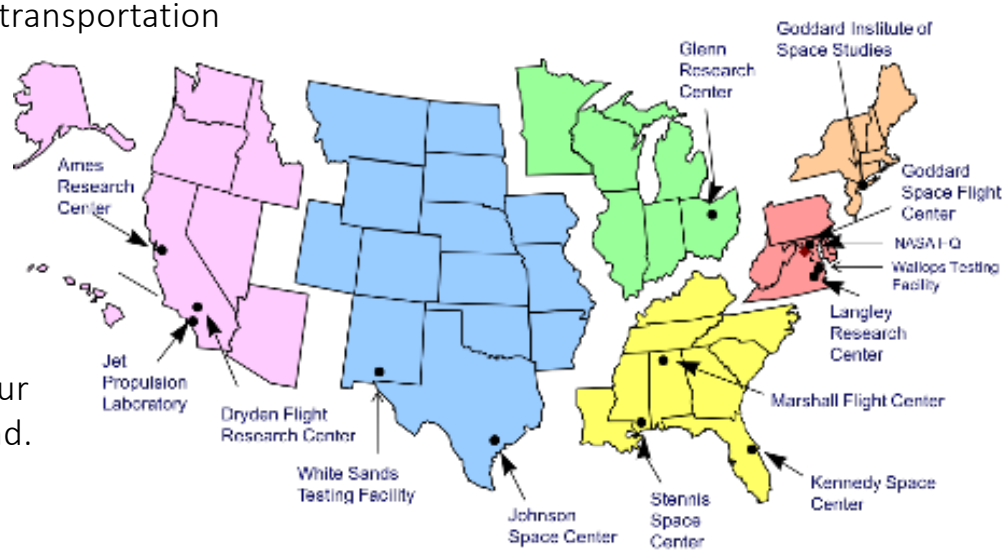
Human Exploration and Operations: Operates the International Space Station and prepares for human exploration beyond low Earth orbit.



Science: Explores the Earth-Sun system, our own solar system, and the universe beyond.



Space Technology: Develops the crosscutting, advanced and pioneering new technologies needed for current and future missions benefitting the aerospace industry and other agencies, and addressing national needs.





National Space Grant College and Fellowship Program

Established by Congress in 1989

National Goal:

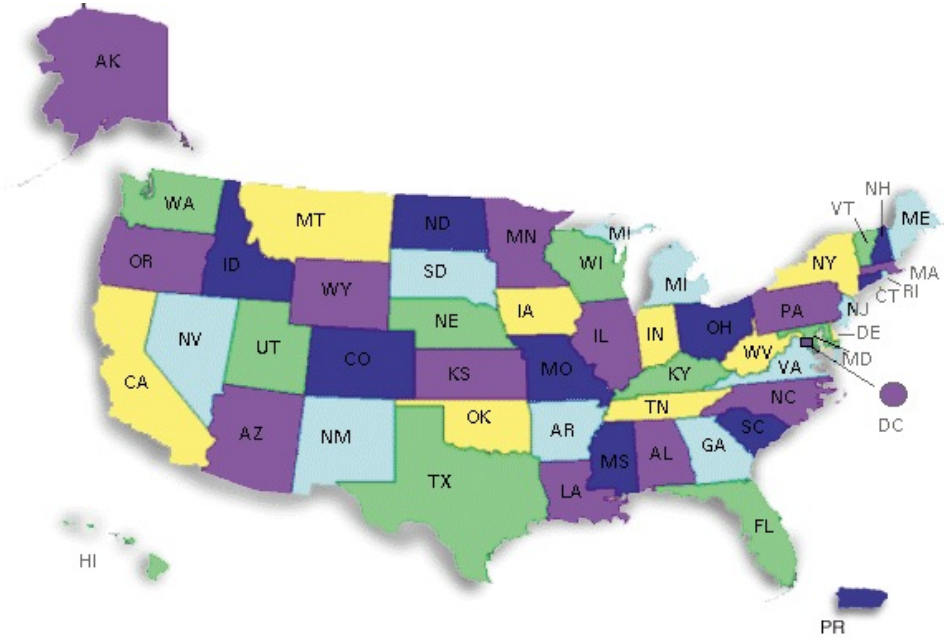
Contribute to the nation's science enterprise by funding education, research and public engagement projects through a national network of university-based Space Grant consortia.

National Objectives:

- Establish and maintain a national network of universities.
- Encourage cooperative programs among universities; aerospace industry; and Federal, state and local governments.
- Encourage interdisciplinary education, research and public service programs related to aerospace.
- Recruit and train U.S. citizens, especially women, underrepresented minorities, and persons with disabilities.
- Promote a strong science, mathematics and technology education base from elementary through secondary levels.

National Network:

The Space Grant national network includes over 850 affiliates from universities, colleges, industry, museums, science centers, and state and local agencies. These affiliates belong to one of 52 consortia in all 50 states, the District of Columbia and the Commonwealth of Puerto Rico.





Maine Space Grant Consortium

- 501(c)(3) corporation
- Member of NASA's Network of National Space Grant College and Fellowship Program in all 50 states plus Washington, DC, and Puerto Rico
- Affiliates

Private 4-Year Institutions
- Bates College
- Bowdoin College
- Colby College
- College of the Atlantic
- University of New England
- Saint Joseph's College of Maine
- Roux Institute

Public 4-Year Institutions
- Maine Maritime Academy
- University of Maine
- University of Southern Maine

Public 2-Year Institutions
- Southern Maine Community College
- York County Community College

Non-Profit Research Institutions
- Gulf of Maine Research Institute
- Bigelow Lab for Ocean Sciences

Non-Profit Educational Institutions
- Maine Math and Science Alliance
- Challenger Learning Center of ME
- ME Mfg Extension Partnership

For-Profit R&D Institutions
- VALT Enterprises, LLC
- Blushift Aerospace
- Lockheed Marti

K-12 Schools
- Me School of Math and Science
- Fryeburg Academy

Board of Directors:
- Karl Hoose, President, VALT Enterprises, Sanford
- Sascha Deri, CEO, bluShift Aerospace, Brunswick
- Stephen Swan, Maine Fab Site Quality Engineering Manager, Texas Instruments, South Portland
- Robert Zeiglaar, President, MainEXPO, Inc., Brewer
- Brian McLaughlin, President, Amplify Additive, Scarborough
- Dana Humphrey, Ph.D. (Chair), Dean of Engineering, UMaine, Orono
- Asli Sezen-Barrie, Ph.D., Associate Professor, College of Education and Human Development, UMaine, Orono
- Shawn Laatsch, Director, Versant Power Astronomy Ctr/the Maynard Jordan Planetarium, UMaine, Orono
- Jeremy Qualls, Ph.D., Dean, College of Science, technology and Health, USM, Portland
- Ashanthi Maxworth, Ph.D., Assistant Professor, Department of Engineering, USM, Gorham
- Janet Sorter, Ph.D., Chief Academic Officer, Maine Community College System, South Portland
- Luke Shorty, Executive Director, Lee Academy, Lee
- Scott Burgess, Science Teacher, John Bapst High School, Bangor
- Nikki Becker, Observing Program Leader, National Weather Service, Gray

- Responsible for Space Grant and NASA EPSCoR
- Since 2001, invested over $25 million in our Affiliates to strengthen the state's aerospace research and education infrastructure by seeding research, internships, fellowships, curriculum development, and K-12 activities.
- Supported research include biomedical science, advanced materials science, high performance propulsion systems; remote sensing applications; marine sciences; climate change; data science and engineering; and sensor technology.



FY2020-2024 Goals, Objectives and Programs

Space Grant Funding

Goals

Goal #1: Expand and diversify Maine's space exploration research capacity that align with the priorities of the Mission Directorates and the Maine Space Entrepreneur and Innovation Complex's Topic Areas.

Goal #2: Broaden exposure of undergraduate students to aerospace career pathways that align with the priorities of the Mission Directorates and the Maine Space Entrepreneur and Innovation Complex's Topic Areas.

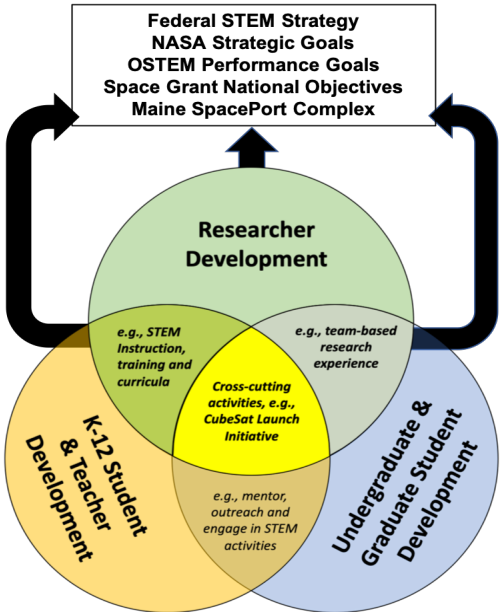
Goal #3: Broaden exposure of K-12 students in formal and informal settings to STEM career pathways that align with the priorities of the Mission Directorates and the Maine Space Entrepreneur and Innovation Complex's Topic Areas.

Goal #4: Increase public awareness and understanding of STEM through connections to NASA.

Programs

- MSG Ideas Lab
- MSG Innovation Seed Fund
- MSG Undergraduate Research Experiences
- MSG Graduate Fellowships
- NASA Center Internships
- MSG Undergraduate Industry Internships
- Curriculum Development
- Maine Student High Altitude Platform
- MSG K-16 CubeSat Program
- Statewide Students for the Exploration and Development of Space (SEDS) Chapter
- MSG Teacher Academy
- MSG K-16 CubeSat Program
- MSG High School MERITS
- STEM4Me
- Support Space Day Maine
- Travel Grants

Maine Space Grant Integrated Portfolio



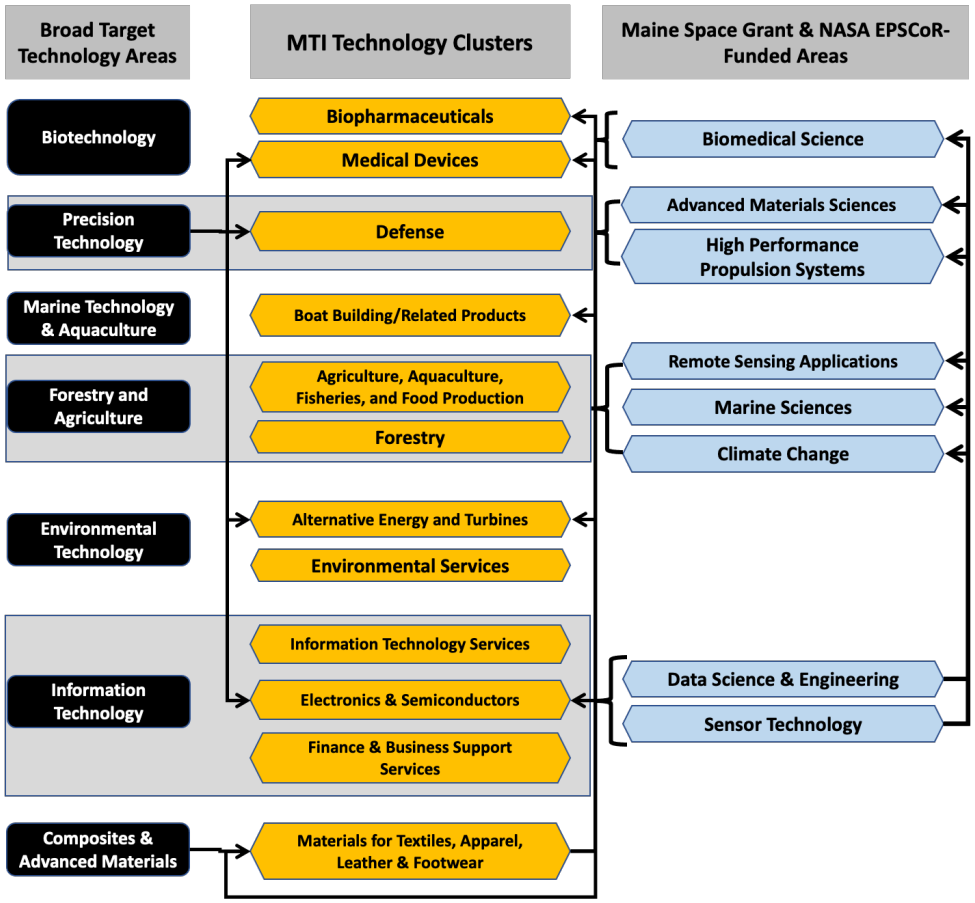


MSGC FY2020-2024 Proposed Outcomes

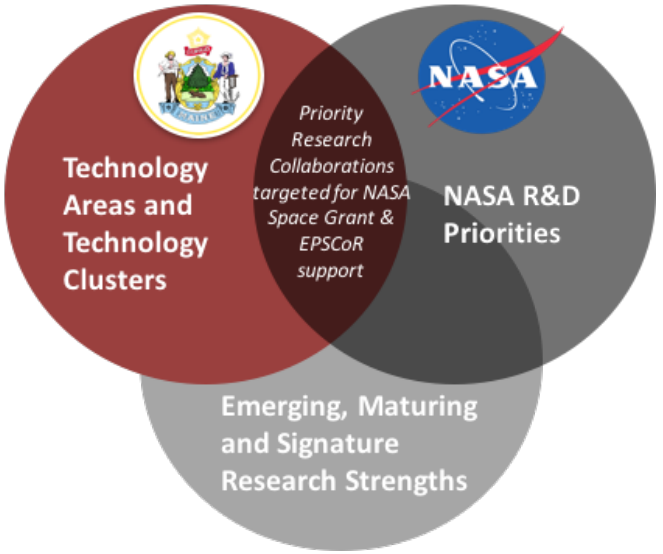
FY2020-2024 Objectives	Activities	Outcomes to Achieve by June 2024
Goal #1: Expand and diversify Maine's space exploration research capacity that align with the priorities of the Mission Directorates and the proposed Maine Spaceport Complex's Topic Areas.		
1. Invest in up to 12 innovative team-based solutions and approaches that address Mission Directorates priorities and have the potential to be foundational R&D and educational anchors for the Complex. 2. Engage 34 undergraduate and 8 graduate students in the research teams that align both with the priorities of NASA Mission Directorates and the Complex's Topic Areas.	• MSG Ideas Lab • MSG Innovation Seed Fund • MSG UG Research Experiences • MSG Graduate Fellowships	1. 50% of supported research teams establish NASA collaborations in high-quality publishable research that serve as the foundational R&D and educational anchors for the Complex. 2. 75% of undergraduate and graduate students engaged in the research teams are inspired to continue their career pathways in aerospace S&T as evidenced by longitudinal tracking. 3. Non-Space Grant/EPSCoR NASA S&E obligations are doubled vs. 2019 baseline. 4. Diversity targets are met.
Goal #2: Broaden exposure of undergraduate students to aerospace career pathways that align with the priorities of the Mission Directorates and the proposed Maine Spaceport Complex's Topic Areas.		
1. Engage 100 undergraduate students in research experiences that align both with the priorities of NASA Mission Directorates and the Complex's Topic Areas. 2. Support four awards to enhance or develop curriculum/coursework focused on space exploration and space technology. 3. Establish a state network of students with interest in aerospace S&T.	• MSG UG Research Experiences • NASA Center Internships • MSG UG Industry Internships • Curriculum Development • Maine Student High Altitude Platform • MSG K-16 CubeSat Program • Statewide Students for the Exploration and Development of Space (SEDS) Chapter • Travel Grants	1. 75% of undergraduate students immersed in NASA missions or research are inspired to continue their career pathways in aerospace S&T as evidenced by longitudinal tracking. 2. Diversity targets are met.
Goal #3: Broaden exposure of K-12 students in formal and informal settings to STEM career pathways that align with the priorities of the Mission Directorates and the proposed Maine Spaceport Complex's Topic Areas.		
1. Train 245 K-12 teachers on how to infuse NASA missions in classroom curricula. 2. Immerse 2,000 K-12 students in curricula with hands-on learning experiences based on NASA missions.	• MSG Teacher Academy • MSG K-16 CubeSat Program • MSG High School MERITS • STEM4Me • Travel Grants	1. 50% of teachers continue infusing NASA missions in their classroom curricula 2 years after initial training. 2. 50% of K-12 students immersed in NASA missions or research aspire to consider STEM career pathways as evidence by surveys.
Goal #4: Increase public awareness and understanding of STEM through connections to NASA.		
Increase awareness of K-12 students of the achievements, benefits and opportunities in the exploration and use of space.	• Support Space Day Maine	• K-12 students have better appreciation of the achievements, benefits and opportunities in the exploration and use of space.



Research Investments by Area since 2001



Alignment of MSGC Space Grant and NASA EPSCoR Funded Research Areas with the State's Seven Broad Technology Areas and Technology Clusters.





Research Capacity Building and Workforce Development Investments by Numbers since 2001

500
Faculty members

1,000
Undergraduate and Graduate Research Fellowships

95
Undergraduate and Graduate Summer Internships at NASA Centers

90
High Students Summer Internships over 8 years

64,000
K-12 students

2,100
K-12 teachers

37% seeking advanced degrees
51% employed in STEM fields
7% seeking STEM employment
5% employed in non-STEM fields

Longitudinal Tracking

49%
Women



Examples of MSGC (Space Grant and NASA EPSCoR) Funded Research Projects

University of Maine
- Crew Health Monitoring Using a Novel Neuro-Cognitive Sensor Network
- Joint leak detection and localization based on fast Bayesian inference from network of ultrasonic sensors arrays in microgravity environment.
- Behavior and Optimization of Hypersonic Inflatable Atmospheric Decelerator Devices for Spacecraft Re-Entry.
- Multi- and hyperspectral bio-optical identification and tracking of Gulf of Maine water masses and harmful algal bloom habitat
- Visionary Workshop for Understanding and Forecasting the Impact of Climate Change on Maine's Forest.
- Experimental Studies of Biosignatures in Serpentinite-Water Systems.

University of Southern Maine
- Non-contact Method for Studying Impending Failure in Mechanical Systems.
- Stellar Outflows from Oxygen-Rich Stars: Effect of Nucleation Models.
- Effects of radiation on neuronal survival, morphology, and function.

Gulf of Maine Research Institute
- Earth System Data Solutions for Detecting and Adapting to Climate Change in the Gulf of Maine.

Bigelow Laboratory for Ocean Sciences
- Learning How to Breathe: What Can We Learn About Antiquity, Biological Iron Oxidation, and Respiration on Oxygen from Modern Fe-Oxidizing Bacteria.

Colby College
- Using High-Resolution Simulations to Inform Observations of Galaxy Structure in the Early Universe.

VALT Enterprises, LLC
- Preliminary Flight Demonstration of a Nanosatellite Launch System.



Overview of the Maine Space Complex

Maine Space Grant Consortium

Maine's Master Economic Development Strategy 2020-2029 & Space Maine Complex

The Maine Space Complex Initiatives can help the State achieve its state vision and goals

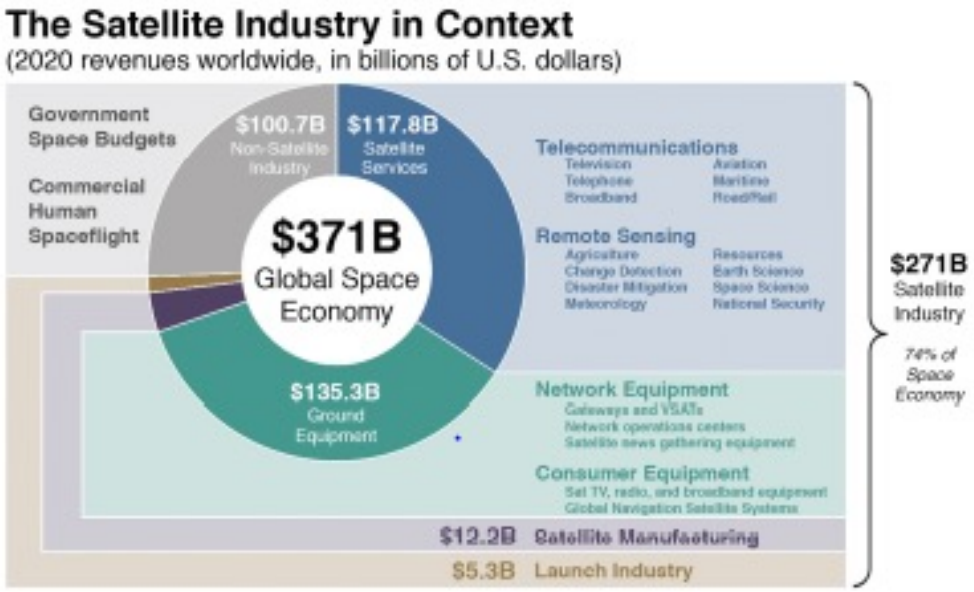
Maine's Economic Development Goals	Maine Space Complex Contribution
INNOVATION	
• Increase R&D Investment levels in Maine • Raise the Investment cap of the Maine Seed Capital Tax Credit Program • Revitalize the Maine Innovation Economy Advisory Board • Promote Exports in Order to Strengthen the climate for startups	• Growing a new and rapidly developing New Space industry in Maine that relies heavily on R&D in areas such as robotics, AI/ML, advanced materials science and 3D printing • Use of preexisting infrastructure at Loring and Brunswick in addition to a launch facility • Developing strategies to compete with space dominant states by growing incentive and talent landscape
TALENT	
• +75,000 to work-force over 10 years • Grow average wage by +10% • Increase value of pdts/svcs sold by +10% • Aim to have 60 – 65% of workers w/credentials • Institute co-op experiences, internships, research experiences, and apprenticeships	• A 2020 economic impact assessment predicted 3,400-6,700 high paying, skilled jobs will be created by the space complex by 2040 • In Maine average aerospace worker earns $77,232 or 77% more than average wage • The Space Initiative is currently sponsoring a coop program in partnership with the Roux Institute • The Space Initiative has introduced K-12 to learners to computer programming using composable satellite kits



MAINE SPACE GRANT CONSORTIUM
An affiliate of the National Space Grant College and Fellowship Program

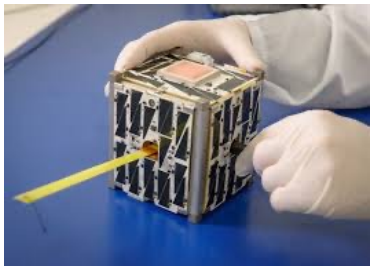
The Space Industry and Market Opportunity

Small satellites addressable by the Maine Space Complex **are among the fastest growing and most dynamic aerospace markets**, attracting a high level of venture capital and federal attention



Satellite Class	Global Market 2018	Global Market 2030	CAGR
Small Satellites	$4B	~$25B	~18%

- Typical cubesat is 1/10th the size of this (to scale)
- Alternatively, this is the size of a 10U cube

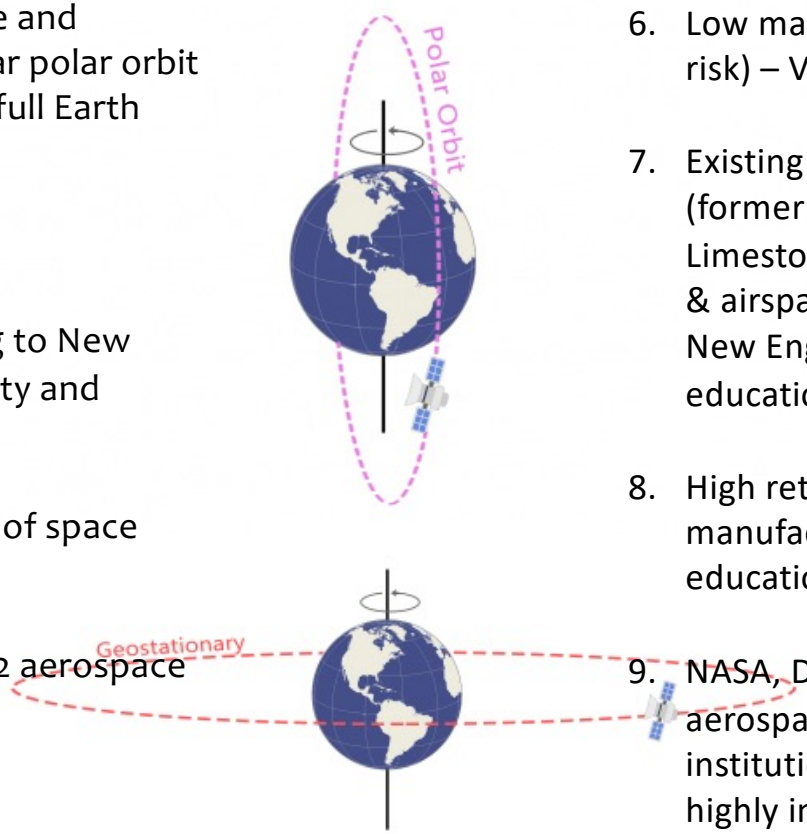




Why Maine?... Why Not Maine?

Maine has a unique geographic advantage that makes it an ideal location for small polar rocket launch.

1. The state's latitude/longitude and coastline offer direct and near polar orbit access for nanosatellites for full Earth coverage as Earth rotates.
2. Very low population density
3. Unique space access offering to New England aerospace community and beyond
4. Maine's growing community of space industry businesses
5. Maine is currently home to 52 aerospace supply chain companies



6. Low market barriers to entry (low cost/low risk) – VALT and blushift
7. Existing resources and infrastructure (former air and naval air bases in Limestone and Brunswick, land, coastline, & airspace, aerospace-related R&D in the New England private sector and higher education institutions
8. High return on investment (high-tech & manufacturing job creation/STEM education)
9. NASA, DOD, several small and large aerospace companies and academic institutions in the Northeast region are highly interested in using launch facilities in Maine

MAINE SPACE GRANT CONSORTIUM

Satellite Orbits Vary Depending on the Mission of its Payload

Nanosatellites typically operate in Low Earth Orbit, where as weather is traditionally monitored from a much higher geostationary orbit

Low Earth Orbit (LEO)

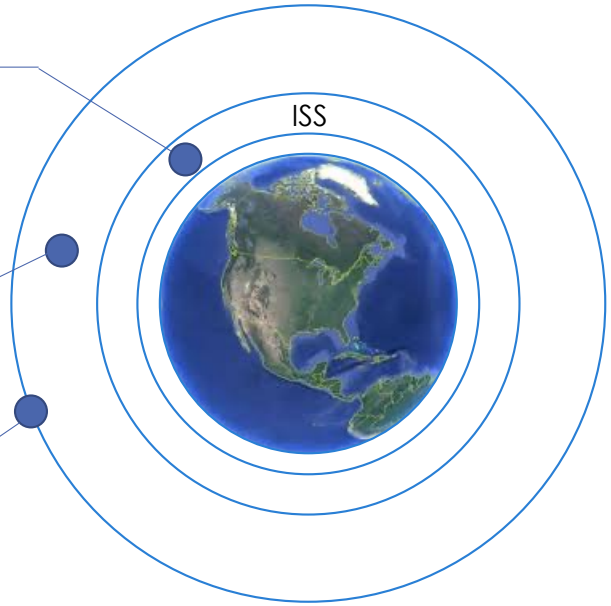
- Operate between 99 – 1242 miles above earth
- Objects at this altitude orbit the Earth between 88 and 127 minutes
- Communications, navigation and scientific satellites
- Nanosatellite have been launched to LEO almost exclusively, with a few recent exceptions going beyond for deep space research

Medium Earth Orbit (MEO)

- Operate between 1242 – 22,236 miles above earth
- Used for navigation and specialty satellites for specific regions

Geostationary Orbit (GEO)

- Operates at 22,236 miles above earth surface
- A geosynchronous orbit follows the rotation of the earth
- Monitoring weather, some communications and surveillance



Other Orbits:

SSO: Sun-Synchronous Orbit, an LEO synchronic with the Sun and very close to being directly around the poles
HEO: Highly Elliptical Orbit
ESC: escape velocity for deep space missions

Launch Vehicles in Perspective

The satellite launch business initially developed to carry payloads of >1000kg into low Earth orbit (LEO) and has only begun to adapt to the growing

Nanosatellite

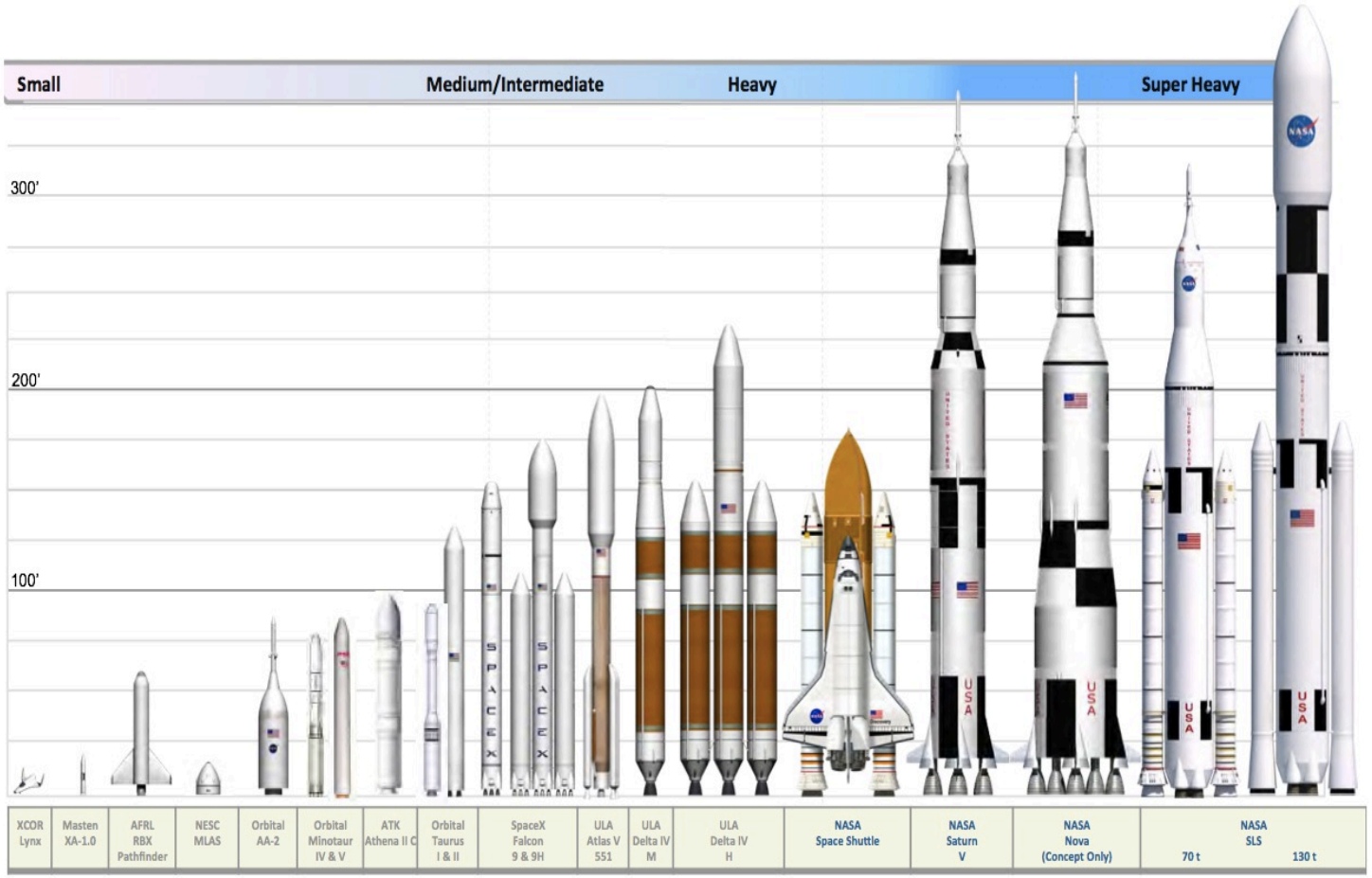
Typical cubesat is 1/10th the size of this (to scale)
Alternatively, this is the size of a 10U cube

Statue of Liberty

Rocket Class for the Maine Space Complex

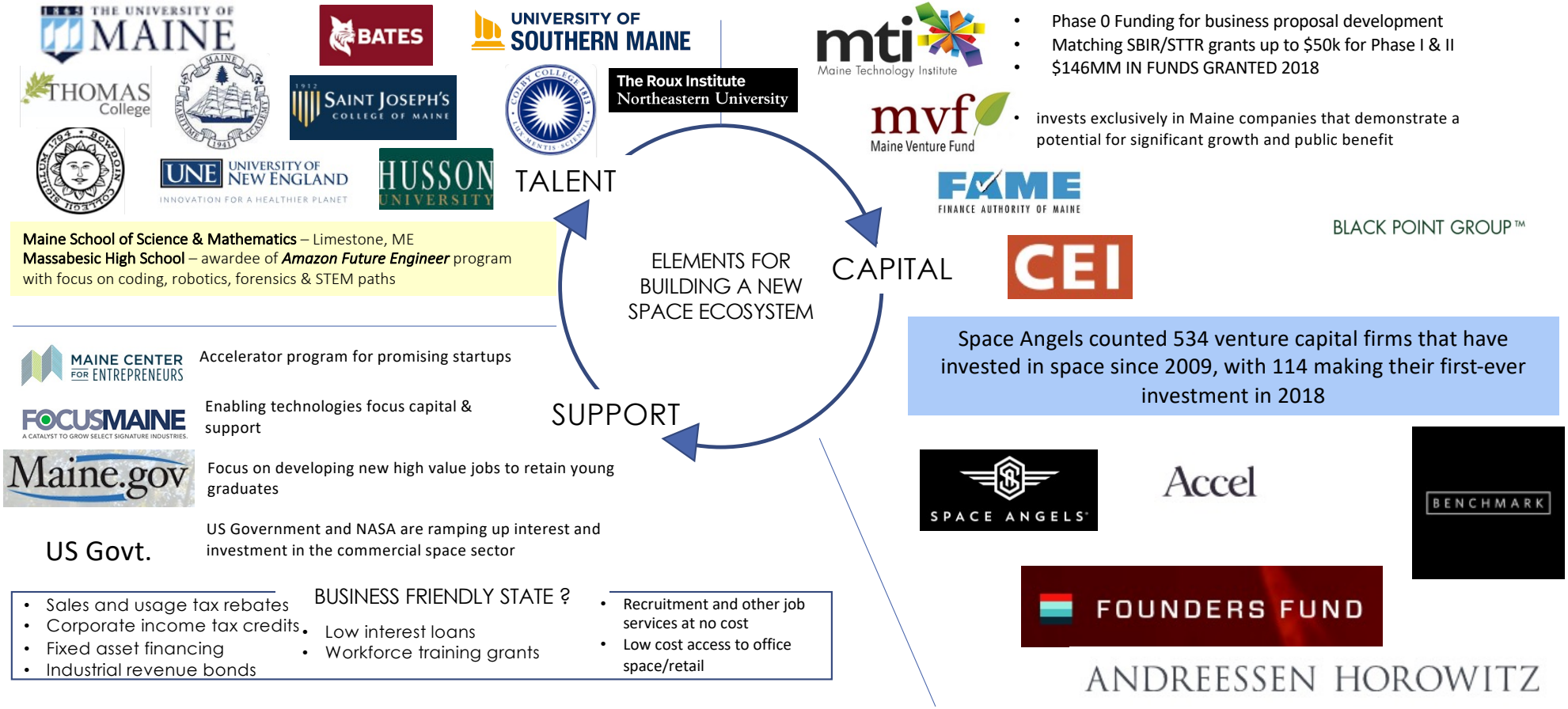
Electron Rocket

- **Size:** 17m x 1m
- **Capacity:** up to 6 cubesats or 150 to 225 kg (330 to 495 lb) payload to a 500 km (310 mi) SSO
- **Use Case**: Suitable for CubeSats and other small payloads



Maine has Some Infrastructure in Place to Create the Talent, Capital & 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



- Phase 0 Funding for business proposal development
- Matching SBIR/STTR grants up to $50k for Phase I & II
- $146MM IN FUNDS GRANTED 2018

- invests exclusively in Maine companies that demonstrate a potential for significant growth and public benefit

Maine School of Science & Mathematics – Limestone, ME
Massabesic High School – awardee of ***Amazon Future Engineer*** program with focus on coding, robotics, forensics & STEM paths

Accelerator program for promising startups

Enabling technologies focus capital & support

Focus on developing new high value jobs to retain young graduates

US Government and NASA are ramping up interest and investment in the commercial space sector

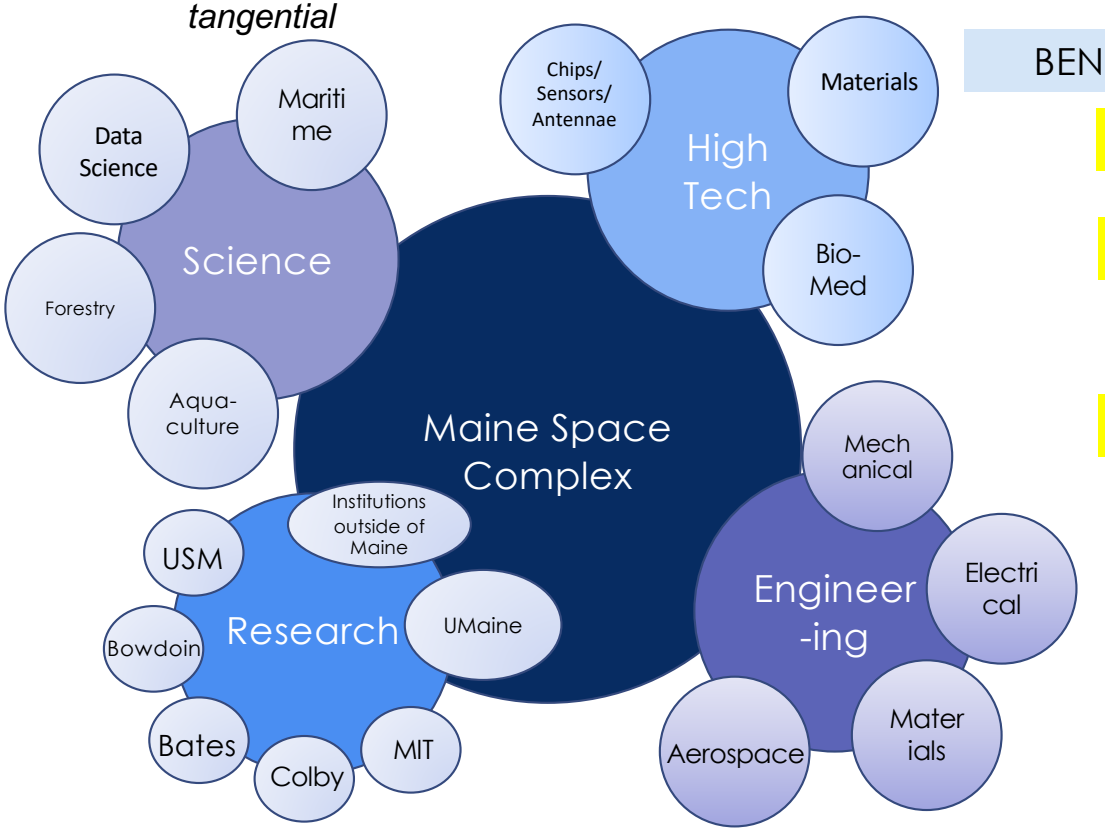
Space Angels counted 534 venture capital firms that have invested in space since 2009, with 114 making their first-ever investment in 2018

BUSINESS FRIENDLY STATE ?

- Sales and usage tax rebates
- Corporate income tax credits
- Fixed asset financing
- Industrial revenue bonds
- Low interest loans
- Workforce training grants
- Recruitment and other job services at no cost
- Low cost access to office space/retail

Market Study: Develop Human Capital and Create Workforce Opportunities

Services and capabilities offered by a spaceport inspires the growth of the commercial space network in tangential



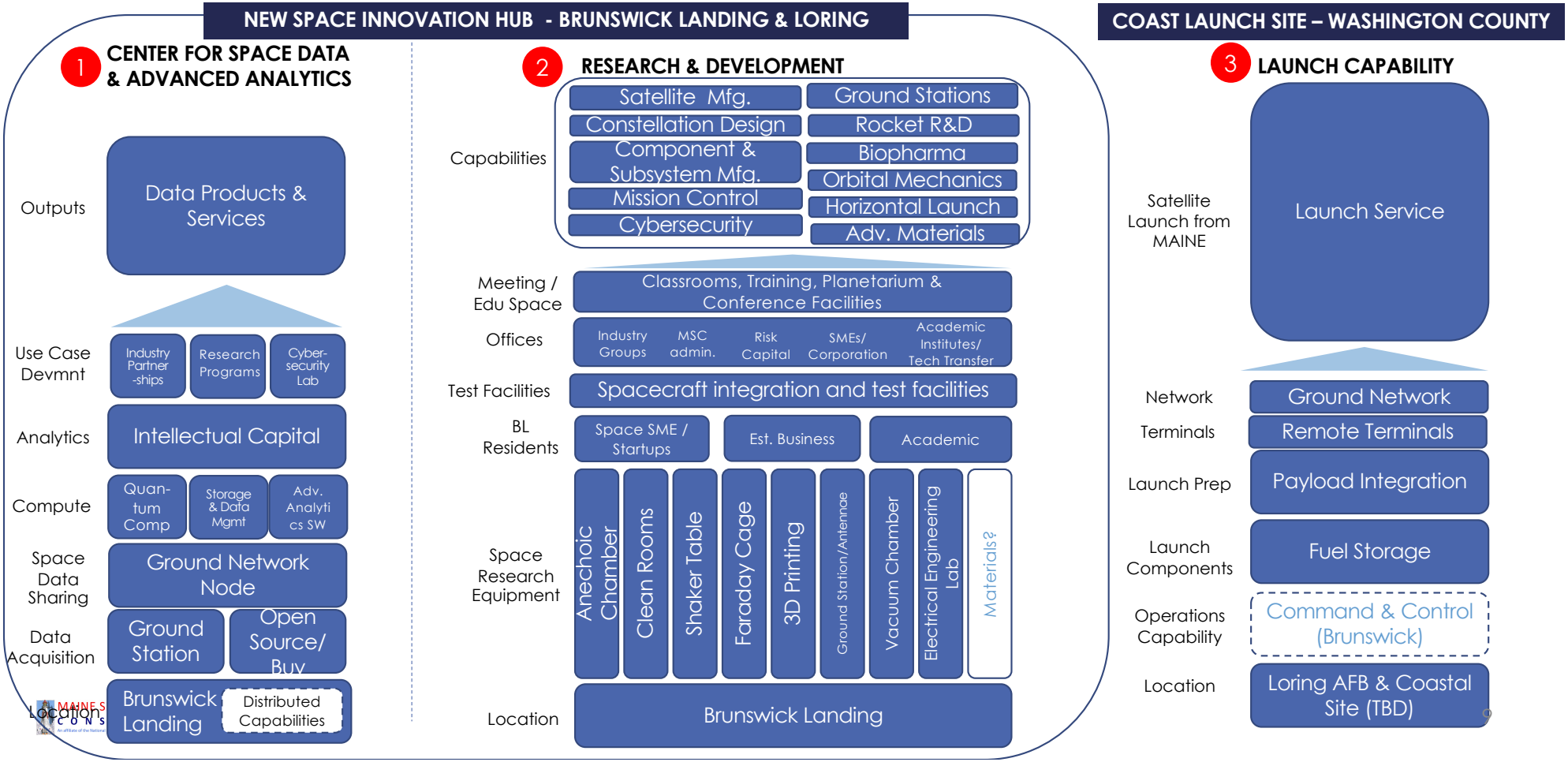
BENEFITS OF SPACE ECOSYSTEM DEVELOPMENT

CREATE HIGH PAYING JOBS	Jobs in high tech, science, & engineering often develop around spaceports
ATTRACT NEW BUSINESS	DOD, NASA & Communications companies are interested in putting satellites into polar orbit for Global Positioning, Telecommunications, Weather Research
GROW LOCAL INDUSTRY	Marshall resources to research and develop new manufacturing techniques, materials, and devices building upon Maine's material science capabilities, revive and position mfg industry for future growth, and develop device/ components ecosystem
DEV STEM in SCHOOLS	Spaceports and related industries can inspire the development of STEM locally through tours, launches & classroom experiences

These manufacturing, integration, and engineering services also may extend beyond the aero-space industry to support research and development for the Department of Defense, universities, and commercial manufacturers.

Proposed Maine Space Complex has Three Business Units

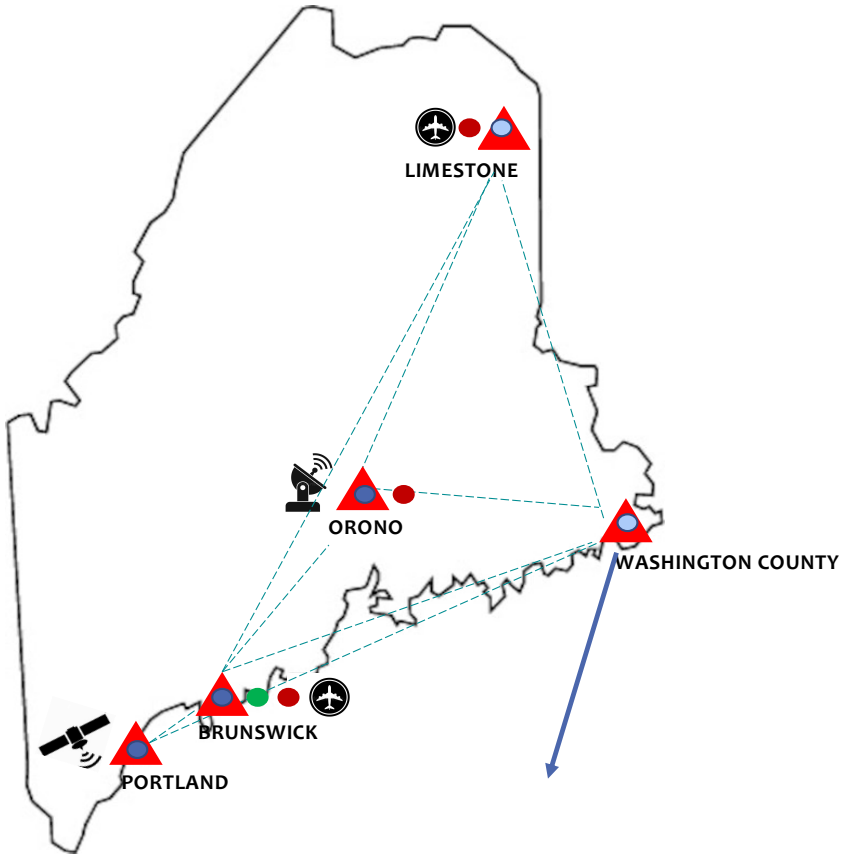
The triplex focuses on upstream manufacturing as well as down stream data analytics



The Maine Space Complex will be Geographically Distributed Bringing Benefit to Multiple Counties throughout the State

Geographically distributed capabilities offer the best opportunity to align with the market demand, and to facilitate growth of Maine space offerings

- Proposed Maine Space Complex Site
- Proposed Vertical Launch Site
  Polar/SSO Orbit Route
- Proposed Horizontal Launch Site
- Proposed Data and Analytics Center
- Proposed Launch Telemetry, Tracking & Control
- Proposed Mission Control TT&C
- Proposed R&D Site
- Nanosatellite Development Site
- Current Site of ISS Ground Station



MAINE SPACE GRANT CONSORTIUM

Satellite Manufacturers and Applications

There are six primary applications for small sats and 5 types of manufacturers

SIX APPLICATIONS OF SMALLSATS:

- **Earth Observation (EO)**: satellites for electro-optical and radar observation of the Earth, and for meteorology, both for operational and Earth-science research purposes.
- **Telecommunications (Satcom)**: satellites for commercial and government operators providing broadband communications.
- **Information**: satellites providing narrowband communications services (IOT & M2M) and collecting data from ground, aerial and atmospheric sensors (e.g. AIS, ADS-B).
- **Security**: satellites for space surveillance and tracking, missile early warning, near-Earth object monitoring, electrical intelligence (ELINT), and space weather.
- **Technology**: satellites, predominantly from government and academia, built to test new technologies (such as sensors and other components); some technology satellites may serve in other application areas on a non-operational basis.
- **Science & Exploration**: satellites for astrophysics and astronomy, planetary science, heliophysics, and solar-terrestrial interactions.

Source: Euroconsult

5 TYPES OF SATELLITE MANUFACTURERS:

> **Large integrators:** also integrator of >500 kg satellite

> **Pure smallsat manufacturer:** purely focused on smallsat

> **In-house:** operator building their own smallsat

> **Academia:** research or education institution mainly integrating COTS hardware

Source: Euroconsult

Data Analytics & Information Services

Data & Information Services Transmission

Turn Data into Intelligence

Productize Data

Earth Observation



Ex. data on Earth's physical, chemical and biological systems from aerial or satellite-based observations gathered through several types of remote sensing incl. optical, infra-red, atmospheric, radar altimetry, synthetic aperture

Precision Agriculture – crop health to detect early warnings of negative conditions in order to plan an intervention and for ordinary management

Environment & Climate Change - evolution of deserts and forests, erosion of coastlines, water temperature over time, measuring water surface height and salinity, detecting chlorophyll pigments in seawater, etc.

Use cloud to productize EO data by dynamically analyzing and packaging insights for sale:

- Pay per product – fixed report or predetermined number of images
- Pay-per-region - pay per area of coverge
- Pay-per-target - based on level of product consumer
- Subscription service – fixed payment for package of services ex. routine observations

Global Navigation Satellite System



Ex. infrastructure that allows users with a compatible device to determine their position, velocity and time by processing signals from satellites
- Enabled by IoT, Big Data & Analytics

Maritime Mobility - helps ships to navigate, used for route planning to improve efficiency and safety and to save time and fuel. Integration with Earth Observation can contribute in the estimation and forecast of winds, waves, currents and propelling.

Autonomous vehicles - GNSS technologies can be used for positioning and navigation of AV in combination with other complex technologies

Location based apps are a product that has resulted from GNSS satellites that are compatible with cell phones.

Examples include Google Maps, car park details, social network apps that include location, and the fitness tracking applications that compute distance and speed of a workout

Satellite Communications



Ex. includes both one-way (e.g. broadcasting of entertainment content) or two-way/multi-way (e.g. voice or conference calls) communications

Broadcasting - Satellites can be used to broadcast content from service providers to the general public via radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general public

Internet Access - it is possible to use satellites to provide internet access to households and businesses. High fixed costs of terrestrial infrastructure make it a non-economically viable option in sparsely populated areas

Subscription Services or Free Services:

- Cable TV
- Radio
- Internet
- Conference calls
- Satellite phones (used for remote areas or disaster zones without terrestrial networks)
- Aviation/maritime/road tracking

*Underlying the **downstream economy** are several core technologies including - **cloud computing** used to store increasing quantities of 'big' unstructured data and provide access to customers through digital platforms; **analytics** including business intelligence and more complex **machine learning (ML) and artificial intelligence (AI)** algorithms to gain actionable insights; **internet of things (IoT)** to deliver data and particularly in GNSS technology understand a point of location.*

Forestry Case Study: Forests 2020

DRAFT

Forests 2020 – a partnership between governments, space sector, academia and non-profit orgs - is leveraging satellite data to slow climate change by restoring 300 million hectares of tropical forests



PROBLEM STATEMENT:

- Forests, which cover 1/3 of earths land surface, are critical to climate regulation, moderating water flows, economic assets (ex. timber, medicinal compounds, etc.) and are experiencing increasing levels of deforestation and degradation in areas near the tropics (Indonesia, Brazil, Colombia, Mexico, Ghana and Kenya)

OPPORTUNITY:

- £152 million program designed to partner UK space expertise (commercial, non-profit and academic organizations) with overseas governments and organizations to use satellite data to identify opportunities for reforestation and areas that were being deforested
- Working with national agencies tasked with tracking forests, local experts in universities, NGOs and forest user groups to improve forest/land management practices and polices

PROJECT IMPACT:

- Improved national, state and local land management strategy across 6 countries, promoted intergovernmental cooperation, facilitated achievement of climate change policy goals

- Maine has joined the U.S. Climate Alliance, a bipartisan coalition of 21 states committed to reducing GHG emissions
- The council will consist of commissioners, key state leaders, science and technical experts, nonprofit leaders, & representatives of climate-impacted industries

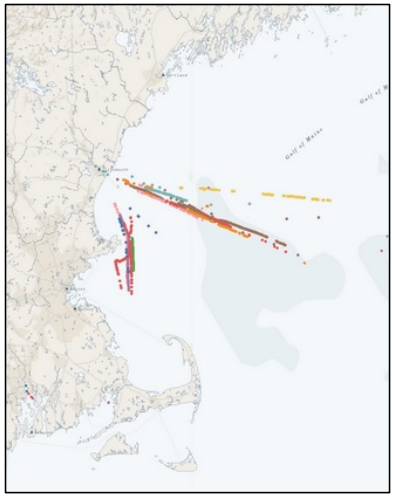
FUNDING	SPACE DATA	CLOUD PLATFORM	DATA ANALYSIS	DATA CONSUMERS
UK SPACE AGENCY, GCRF	esa	ecometrica	carbomap	ACADEMIA: THE UNIVERSITY of EDINBURGH, UNIVERSITY OF LEICESTER; NGOs: pro natura, WRI INDONESIA; GOVT
Led funding of partnership program	European Space Agency sentinel data from Copernicus Satellite using 10 meters from ground special resolutions	Cloud platform operator focused on satellite originated big data & analytics	Analyzing data and developing usable metrics and maps from LIDAR data	

Source:Ecometrica

Maritime Case Study: Predicting Lobster Pricing

DRAFT

In a proof of concept exercise, Spire found that it was able to predict the increase in lobster prices based on geospatial data collected from nanosatellites



PROBLEM STATEMENT:

- While the market price for lobster products in restaurants stays fairly consistent, the wholesale price restaurants pay for lobster can vary dramatically depending on the time of year based on supply
- The lobster season was uncharacteristically slow in 2017 and Spire wanted to determine when supply would increase thereby dropping the price from the $8/lb average in colder months to $4/lb in the warmer months

OPPORTUNITY:

- Spire chose a handful of offshore lobster fishing vessels based out of Portsmouth, New Hampshire to see if the behavior of these boats were a proxy that could be used to predict dramatic price fluctuations
- Using the number of AIS signals emitted from fishing boats Spire correlated the spikes in activity to the moment when the prices will change

PROJECT IMPACT:

- Spire was able to predict could assume that the lobster glut so far this year is now over and that the catch has started to flood the market. That means that the wholesale price is likely to drop significantly closer to the typical $4 per pound

SPACE DATA	DATA ANALYSIS	DATA CONSUMERS (Illustrative)
spire	spire	The Lobster Co. — Seafood wholesalers State of Maine Maine Oyster Company — Restaurants
Spire used their nanosatellite network to gather data about fishing vessel activity in the ME/NH region	Analyzed data in order to predict from ship activity when whole price for lobster would drop	

Source: Spire

Maine Space Complex Job Creation Projection

Total Employment Impacts of Maine Spaceport Complex by Business Component by US Market Share Scenario

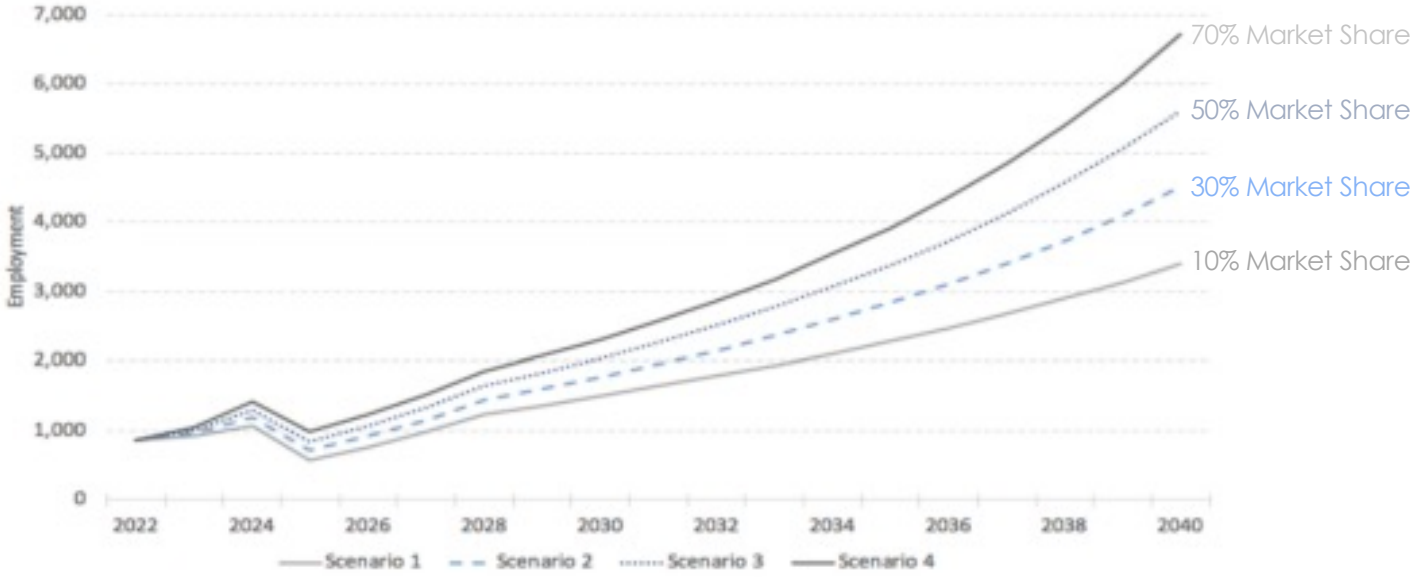
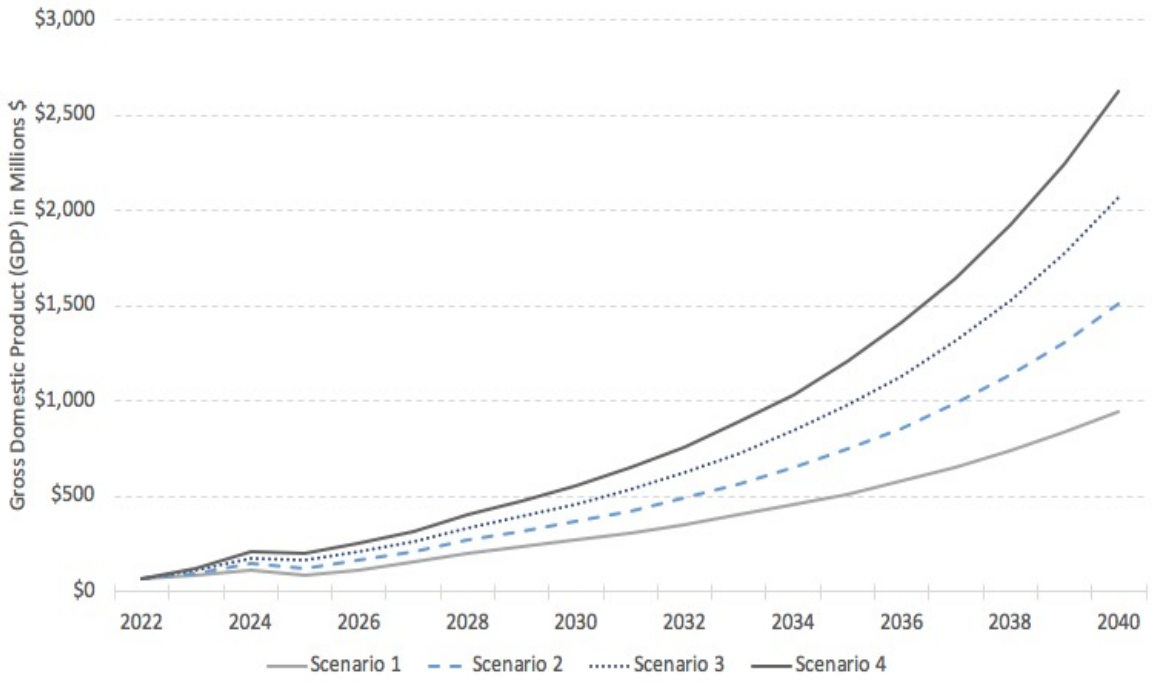


Figure 5: Total Employment Impacts of the Maine Space Complex Under Four Scenarios, 2022-2040. (Source: REMI; CBER.)

https://www.nanosats.eu/
https://www.spaceworks.aero/wp-content/uploads/Nano-Microsatellite-Market-Forecast-9th-Edition-2019.pdf
Ibid.

Maine Space Complex Projected GDP Impact

Total GDP Impacts of Maine Spaceport Complex by Business Component at Each Market Share Scenario



Assumptions:

- Scenario 4 (70% Market Share) shows the largest impacts on state GDP of approximately $500 million in 2029 and peaking at over $2.5 billion in the end years of the forecast period.
- GDP under Scenario 1(10% Market Share) reaches $473 million in 2029 and peaks at just under $1 billion in 2040.
- The distribution of GDP impacts across business components and scenarios are shown in Figures 12 through 15.

https://www.nanosats.eu/
https://www.spaceworks.aero/wp-content/uploads/Nano-Microsatellite-Market-Forecast-9th-Edition-2019.pdf
Ibid.

Developing a Thriving Space Industry Requires Coordinated Action Across the Entrepreneurial Ecosystem to Build Capability and Facilitate Growth

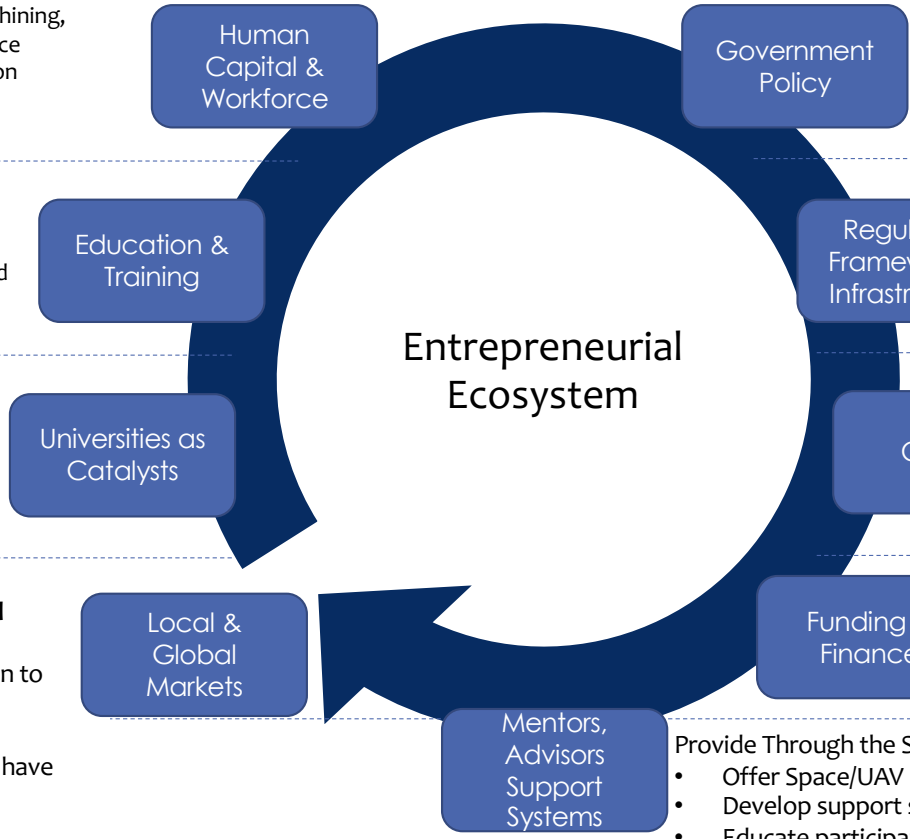
Nascent industries often depend heavily on academic research and resources and government support as they take shape prior to reaching growth stages

Develop Aerospace Talent in State
- Workforce Development in New Space machining, manufacturing, data, ML/AI, materials science
- Educational opportunities K-higher education
- Vocational schools with aerospace focus
- Focus on implementing Industry 4.0

Leverage Space to engage student in STEM
- Develop K-12 STEM & Computer Science curriculum
- Use Spaceport as a platform for growth and hands-on learning

Align Academics & Research Funding to Priority Areas of Growth
- Facilitate the development of Aerospace Engineering programs in state and strengthen connection to those regionally
- Invest in equipment/resources to develop next gen talent i.e. quantum computing

Connect Maine to Regional, National, and International Markets
- Revive Aerospace Industry Association to connect SMEs to regional, national, international industry
- Identify ways for Tier 3 companies to have more insight into aerospace industry demand/needs critical componentry



Encourage Government to Work with Industry for Advancement
- Support Aero/New Space R&D tax breaks particularly collaboration tax breaks for aerospace/tech cluster
- Create state innovation voucher program for small businesses seeking innovation to encourage industry-university collaboration

Evolve regulations to support aerospace & space industry development
- Explore liability policy around launch risk
- Work with industry groups for a national space policy that facilitates growth and competitiveness

Maine is open for Space…
- Execute outreach campaign to improve visibility of aerospace and space sector in Maine consciousness

Create Opportunities / Increase Funding Available
- Develop startup/venture funding for aerospace
- SME development/ redevelopment
- MTI to focus on space as a priority sector for development

Provide Through the Spaceport Support + Growth Structures for Business
- Offer Space/UAV Incubator and Accelerator
- Develop support structures for industry certification
- Educate participants/adjacents on incentives and tax breaks in state

Terry Shehata
Maine Space Grant Consortium
LD 1923

My written testimony includes two attachments with additional information - one is the overview of the Maine Space Grant Consortium, and the other is an overview of the Maine Space Complex.