Puget Sound Regional Council

THE WASHINGTON STATE SPACE ECONOMY: 2022 UPDATE

BERK Consulting Inc.

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Executive Summary

The central Puget Sound region is positioned to be a leader in commercial space exploration and development into the future, given longstanding activity in the aerospace sector, high-tech manufacturing resources, information technology assets, and a strong pool of talent. However, promoting successful competition in areas of the space economy will depend on a regular review of assets, strengths, challenges, and gaps in the field.

This report is intended as an update to a study published in 2018 by the Puget Sound Regional Council (PSRC) that examined the regional and statewide space sector. Even over the past four years, there has been considerable change across the regional space economy and providing a revised outlook on the regional landscape can help to guide future efforts in supporting businesses involved in the space economy in the region.

An update to the assessment of the regional economic impacts of space-related activities conducted using the IMPLAN package suggests that core activities in the field resulted in a total economic impact of about **$4.6 billion in economic activity** in 2021. This supports a total of **13,103 jobs** and **$1.6 billion in labor income** overall. It is also estimated that for every job in a core space-related business an additional 1.26 jobs would be created across the regional economy.

Additional conclusions can be drawn from the research in this supplement that buildings on the findings from the 2018 report:

- **There has been a considerable increase in employment and activity in the space economy of the central Puget Sound region, doubling since 2018.** Over the past three years, there has been a dramatic expansion of regional space-related businesses. While the development of launch vehicles and related activities by Blue Origin has been one source of growth, the advancement of satellite manufacturing and satellite-related services by Starlink, Project Kuiper, LeoStella, and other firms has also been a major source of new regional employment. Significant amounts of office, industrial, flex, and warehouse space are now being taken up in the region to support these activities.
- **New startups in the region are focusing on a diverse range of space-related offerings and are supported by a strong local pool of talent.** Although Blue Origin, SpaceX, and Amazon are employing the most workers in the industries examined in the analysis, there are a range of other smaller businesses that are attracting funding and looking to provide innovative solutions in the field. For example, efforts by Radian Aerospace, STOKE Space, and Wave Motion to explore alternative launch systems could have considerable long-term growth potential for the region if these technologies are successful. These businesses have been built on the foundation of an evolving regional talent pool in the space industry and related tech activities.
- **Businesses in the region are currently taking part in activities related to commercial human spaceflight, and this will be expanded over the coming decade.** Blue Origin is now offering opportunities for commercial spaceflight, focusing first on space tourism with existing launch vehicles and moving towards the development of the Orbital Reef commercial space station by the mid-2030s. In addition to the potential for further expansion of local operations of Blue Origin, this also has the potential to support other activities in this field in the region and state.

- **Future development of the regional space economy would benefit from support for regional entrepreneurship, workforce development, and venture capital funding.** While there is the potential for certain space-related activities to become more decentralized and businesses to locate in other places, maintaining and expanding regional talent in space-related fields and providing support for regional entrepreneurship with space-related activities will be essential in maintaining and enhancing the role that the region can play in the space economy.

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Introduction

The central Puget Sound region is positioned to be a leader in commercial space exploration and development into the future. Over the past five decades, the region has evolved from early aeronautical and astronautical research, development, and manufacturing to support the US space program, to a diverse population of local and international companies dedicated to providing a range of products and services related to space. Today, the combination of high-tech manufacturing resources and information technology assets across the region provides a significant foundation for future growth in this internationally competitive sector.

Promoting successful competition with other regions, both nationally and internationally, will depend on the state, region, cities, and other organizations recognizing and bolstering the assets and strengths provided to space-related industries, and addressing any gaps that may impact the region's long-term viability as a location for these activities. It is essential on an ongoing basis to assess the current state and regional resources available to the sector and identify the strengths, opportunities, and gaps necessary to strengthen them.

To this end, the Puget Sound Regional Council (PSRC) completed a study of the regional and statewide space sector in 2018. This study provided an overview of the space economy and major global trends, local and statewide economic impacts, a competitive analysis against other regions, and an assessment of potential strategies to bolster the strength of the state and central Puget Sound region in this area.

This supplement updates the 2018 report and provides additional information to support ongoing efforts to inform decision-makers about options to support the space sector. This includes:

- A summary of the space sector overall, drawn from the previous report.
- A review of current trends with regional space firms since the 2018 report, including recent efforts by major private space companies in the central Puget Sound region.
- Updating the assessment of local employment in the space sector, including estimates of employee counts in the region.
- Evaluating the overall impacts of the space sector on the local economy and updating estimates provided in the 2018 report.
- Providing conclusions and recommendations for future actions by local partners.

Overview of the Space Economy

The modern economy supports a range of different activities associated with space, primarily activities in Earth orbit. Products and services such as telecommunications, earth observation, satellite TV and radio, internet, and GPS navigation are supported with satellites, spacecraft, launch vehicles, and related space-oriented infrastructure. In the future, commercial space businesses are also expected to be involved in other space-related activities, such as asteroid mining, zero-g manufacturing and research, space tourism, and human colonization.

Spacecraft, satellites, and other space-related goods and services are developed through a complex web of activities across the entire economy. One list produced by the US Department of Commerce[1] consists of the following general market segments in space-related products and services:

- Spacecraft & launch vehicles
- Propulsion systems & fuels
- Navigation & control
- Communications systems
- Space survivability, environmental control/monitoring, and life support
- Payload instruments & measurement tools
- Ground systems
- Non-earth-based surface systems
- Power sources & energy storage
- Electronic equipment
- Computer hardware & robotics
- Software
- Materials, structures, and mechanical systems
- Manufacturing tools & specialty equipment services
- Research & development

Overall, projections of the future value of these activities in the economy have been produced by multiple organizations. UBS and Morgan Stanley have pegged the value of the space economy to reach $900 billion to $1.1 trillion by 2040[2], and others have suggested that these figures may be even higher[3]. Much of this growth has been linked to a substantial increase in satellite broadband internet service providers, which are expected to dominate space-related services over the next 20 years.

With respect to the space economy, activities include production and supply chains, as well as the downstream products and services that rely on access to space. Firms that can be considered active in the space economy can be divided into five major categories based on the uses and consumers of their outputs, as shown in Exhibit 1.

[1] US Department of Commerce, 2014, *US Space Industry "Deep Dive" Assessment: Employment in the US Space Industrial Base.*

[2] UBS, 2018, *Longer Term Investments – Space.*; Morgan Stanley, 2020, *Investing in the Final Frontier*. Morgan Stanley, 2017, *Space: Investment Implications of the Final Frontier.*

[3] Goldman Sachs Global Investment Research, 2017, *Profiles in Innovation: Space, The Next Investment Frontier*.

Exhibit 1. Major elements of the regional space economy supply chain.

LOWER-TIER SUPPLIERS

UPPER-TIER SUPPLIERS AND OEMS

SPACE LAUNCH SERVICE PROVIDERS

SPACE-RELATED GOODS AND SERVICES

SPACE-SUPPORTED BUSINESSES

DESCRIPTION

Lower-tier suppliers provide key raw materials, parts, and services that are used for space-related applications. These suppliers may not be exclusive to the space and defense industries.

Upper-tier suppliers create the major assemblies, components, and systems for spacecraft, launch vehicles, and satellites, and **Original Equipment Manufacturers (OEMs)** provide the final manufacturing and assembly of these products.

Space launch services (public and private) provide for the launch of spacecraft and satellites, and their ongoing management and operation.

Space-related goods and services are provided directly by firms via operating spacecraft, satellites, and other space-based equipment.

Space-supported businesses incorporate the output of satellites and spacecrafts into a range of goods and services.

ACTIVITIES

- Power systems
- Communications systems
- Structural components
- Machined parts
- Support services

- Launch vehicle engine manufacturing
- Structural assemblies
- Spacecraft manufacturing
- Satellite manufacturing

- Launch facilities
- Private launch services
- Spacecraft / satellite mission management

- Global Positioning Systems (GPS)
- Satellite internet/communications
- Earth observation
- Space exploration
- Asteroid mining
- Space colonization

- Satellite TV
- Weather forecasting
- Vehicle fleet tracking and management
- Space-supported research
- Defense applications

LOCAL EXAMPLES

Electroimpact, Inc. in Mukilteo manufactures composite materials and machined parts for satellite fixtures, containers, and trailers, as well as other aerospace and related products.

Blue Origin in Kent is currently developing the BE-4 rocket engine for the United Launch Alliance and the *New Glenn* orbital launch vehicle for future spaceflight services.

Spaceflight Industries in Seattle provides satellite launch and mission-related services, including transportation and "ridesharing" of payloads on commercial launch vehicles.

Starlink in Redmond is a service provided by SpaceX that will provide satellite internet access across most of the Earth. As of 2022, Starlink is coordinating a beta version of their services.

Zonar Systems in Seattle provides fleet tracking and management services, in part relying on GPS and satellite services.

Source: BERK, 2022.

These categories include:

- **Lower-tier suppliers.** At the initial stages of the supply chain, lower-tier suppliers produce the constituent materials and parts for spacecraft, satellites, and launch vehicles. These suppliers include businesses like metal and plastics manufacturers, machine shops, instrument manufacturers, and electronics producers. Many of these firms also produce materials used for other applications, such as aircraft, maritime, or automotive manufacturing.
- **Upper-tier suppliers and original equipment manufacturers (OEMs).** Upper-tier suppliers include businesses that develop major assemblies and systems for these products, including communications, power, engine, and structural systems. Original equipment manufacturers (OEMs) provide the final development and assembly of spacecraft, satellites, and launch vehicles. While some of these businesses may include manufacturers providing some goods and services to other fields, these firms are more focused on space-related applications.
- **Space launch service providers.** Businesses and organizations that manage the launches of spacecraft and satellites into space are critical to the space economy. This includes not only the launch facilities themselves, but also the coordination of spaceflights, mission management, ground support of spacecraft, and ongoing operations of satellites. While this was a service provided by US government agencies in earlier periods, businesses have increasingly relied on commercial launch service providers to access space.
- **Providers of space-related goods and services.** As opposed to companies that create or launch products that are destined for space, there are other firms dedicated to using the goods and services directly provided by these activities. This most often involves telecommunications (including internet, TV, and voice communications); and Earth observation and mapping systems (including both capturing images of the Earth's surface and providing navigation through global positioning systems, or GPS). However, this can also include other research activities, space tourism, defense applications, and other space-dependent applications.
- **Businesses supported by space activities.** In addition to goods and services that rely specifically on space-related platforms, there are other cases where space-related technologies improve the quality and functionality of existing products. This can include such things as TV and radio services, weather forecasting, asset tracking systems, and personal wayfinding systems. These are becoming much more commonplace in the market over time.

Note that businesses in the space economy can be in more than one role. For example, SpaceX, currently an OEM and launch service provider, is also working to provide global internet services through its Starlink satellite broadband service.

Competitiveness of the central Puget Sound region

With respect to the development of local space industries, the central Puget Sound economic cluster is positioned to compete against other regions. Competitive advantages for the regional space industry include the following:

- **Long-term investment in commercial aerospace supply chains.** In the central Puget Sound region, a broad network of suppliers has been developed to support the needs for commercial aircraft manufacturing, primarily with Boeing. This foundation has also supported the rise of new, smaller startup companies in aerospace as well, as new businesses in the region can rely on many of these suppliers as well.
- **Significant support from major private investors.** Although the Seattle metro area supports a broad range of technology and aerospace firms, one of the most important drivers for the local sector has been significant investment by local interests. Early activities in the field by Paul Allen, Jeff Bezos, and others led to significant local investment in talent and facilities, and ongoing investment by Blue Origin, SpaceX, and Amazon have continued to shape the regional space industry.
- **Interconnections with local tech industries.** Given the reliance of the space sector on the information technology sector for such activities as communications, data processing, and use of end products, both established tech businesses and emerging startups are natural partners with businesses in the space sector. As such, colocation of these types of businesses in the Seattle metro area can present strong opportunities for collaboration on joint projects.
- **Strong overall labor pool.** The University of Washington and Washington State University are strong educational resources in both the training of talent for the sector, and the development of innovative technologies related to the space economy through research and collaboration with industry. This includes training in aerospace engineering and related fields, as well as other fields of interest for space-related businesses, such as earth sciences and computer sciences and engineering.

There are some competitive challenges that are faced by the central Puget Sound region as well:

- **Access to launch facilities.** One major limitation in the region is the lack of local launch facilities for satellites and space vehicles. This is due in part to the latitude of the region being less favorable for space launches than locations closer to the equator. This has meant that companies like Blue Origin have relied on launch facilities in Texas and Florida, and over the long term there are large-scale manufacturing activities that will be more efficient to site closer to these locations.
- **Competition from traditional space clusters.** While the central Puget Sound region has made significant strides in competing in the space economy, other regions also have significant long-term investment in aerospace, often in activities that are more related to space-related activities. Launch facilities in the Space Coast in Florida and related manufacturing facilities in the southeastern US were tied to the US Space Race, while large space-related clusters have developed from government and military-related investment in the Washington, DC, and Los Angeles areas. These areas still maintain significant local labor pools and investment in local infrastructure.
- **Decentralization of space-related activities.** Although competition from large existing clusters can be one issue in competition, another major driver is the opposite: the decentralization of business activities in space-related manufacturing and services. Large-scale manufacturing of launch vehicles,

for example, will still require specialized facilities and significant investment. However, development of other types of space-related products such as commercial satellites may be manufactured in other, smaller facilities. Space-related services, such as Earth observation data, may also be managed without the need to be co-located with production or communications facilities. While a strong labor pool can be an important draw for these businesses, space-related firms are less tied to traditional centers than in the past, and smaller centers can now also draw these companies as well.

Recent Developments in the Regional Space Economy

Since the initial PSRC report in 2018, there have been several developments which have had an impact on the regional landscape for space-related firms. These trends have pointed to an optimistic long-term outlook on the role of the central Puget Sound region in the national and international space economy.

Global and National Economic Activity

Estimates of the global space economy provided by the Space Foundation indicate that these activities resulted in about $447 billion of activity in 2020.[4] While government space spending fell by 1.2% from 2019 levels, there was a significant shift towards commercial space activity, which grew by 6.6% during the same period. Military space spending decreased globally in 2020, but US expenditures in this category increased by 6.1% and now constitute over 80% of the world's total.

Increasing Pace of Commercial Space Operations

Ongoing technology improvements in launch vehicles pioneered by private companies such as Blue Origin, RocketLab, and SpaceX hove advanced significant innovations in areas such as reusable rockets and mass production methods. Combined with improved logistics, this progress in the field has allowed for lower costs and greater scalability for space-related products and services over time.

In 2021, there were 145 orbital launch attempts overall, with 11 unsuccessful launches.[5] As can be seen in Exhibit 2, this exceeded the previous record of 143 launches set in 1967 during the height of the Space Race and were driven primarily by China (55 launches), the US (51), and Russia (24). Overall, commercial missions made up 38% of this total, including about 61% of launches from the US.

Satellite Manufacturing and Operations

The increase in orbital launches in 2021 has been primarily driven by the deployment of new constellations of broadband internet satellites into orbit. Several companies are focused on providing these services:

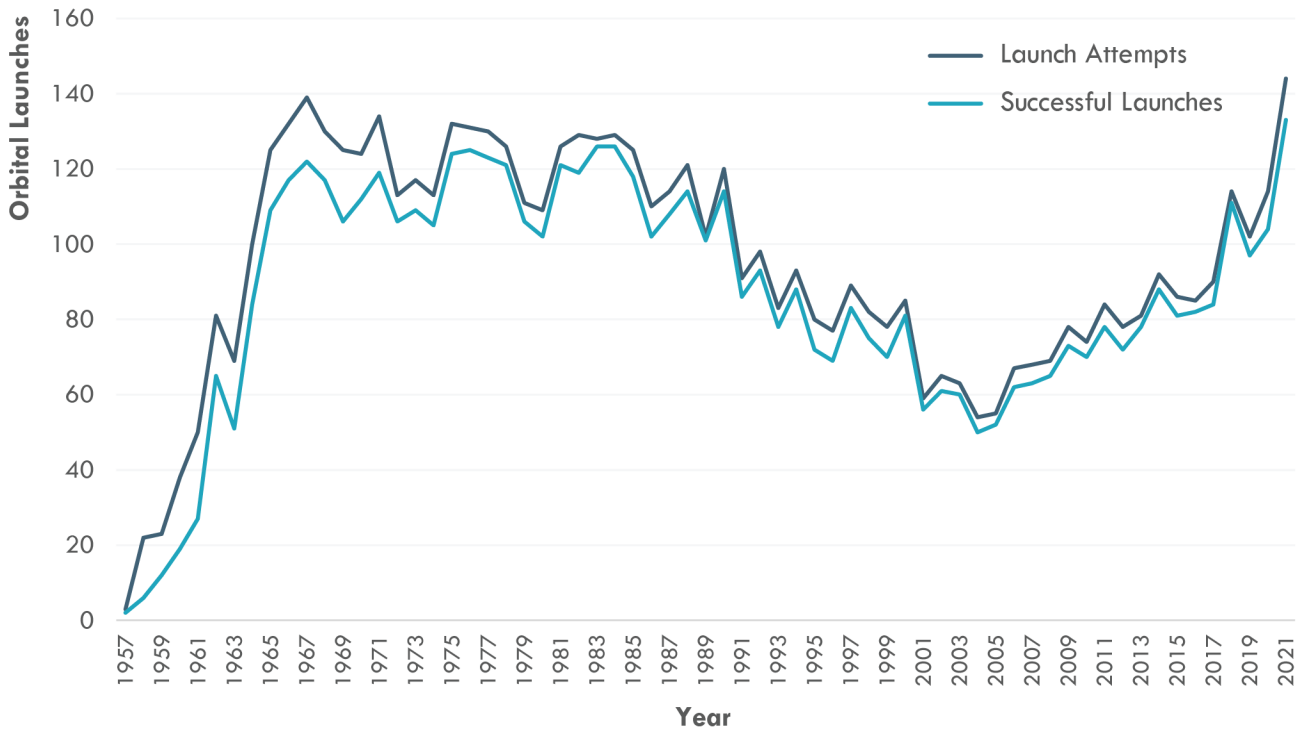
- Starlink, a system operated by SpaceX with manufacturing facilities located in Redmond, currently includes a constellation of over 2,000 satellites.[6] They currently offer a beta service of their satellite internet service and are expecting to conduct an average of one launch per week in 2022. Over the long term, this system may include up to 30,000 to 40,000 satellites in low-earth orbit.

[4] Space Foundation, 2021, "Global Space Economy Rose to $447B in 2020, Continuing Five-Year Growth", press release.

[5] Space Foundation, 2022, *The Space Report: 2021 Q4*; Kyle, E., 2022, Space Launch Report.

[6] Mann, A., Pultarova, T., 2022, "Starlink: SpaceX's satellite internet project", *Space.com*, January 7, 2022.

Exhibit 2. Successful worldwide orbital launches, 1957–2021.



Source: Space Foundation, 2022.

- Project Kuiper is a Redmond-based subsidiary of Amazon created in 2019 which is planning to send a constellation of 3,236 satellites into orbit, with half to be launched by 2026. Two prototype satellites are expected to be launched by Q4 2022 in partnership with ABL Space Systems.[7]
- OneWeb, a firm from the United Kingdom, began test launches of satellites from Russia for a 648-satellite network starting in February 2020.[8]

These constellations amount to about 81% of the non-geostationary orbit (NGSO) communications satellites that have received approval from the Federal Communications Commission.[9]

Other local space companies have also been involved in expanding the role of the region in satellite production and operations:

- LeoStella in Tukwila has created a constellation of 12 Earth observation satellites for BlackSky, as well as for companies such as Loft Orbital Solutions of San Francisco. The satellites for Loft Orbital Solutions have been developed to accommodate a variety of payloads, with a satellite delivered in

[7] About Amazon, n.d., "Project Kuiper announces plans and launch provider for prototype satellites", accessed January 2022.

[8] Clark, S., 2021, "OneWeb surpasses 200 satellites with Soyuz launch", *Spaceflight Now*, May 28, 2021.

[9] Nall, M., 2021, "Puget Sound region emerging as a satellite capital amid shift to mass production." *Puget Sound Business Journal*, September 4, 2021

June 2021 providing a demonstration for the Defense Advanced Research Projects Agency's Blackjack program and an Internet of Things payload for Eutelsat.[10]

- Starfish Space in Kent is working to develop technologies related to managing active satellites and cleaning up space debris through its Otter space tug technology and Cephalopod software for satellite operations. In 2021 it closed a $7 million funding round to support these activities.[11]
- Spaceflight Inc., a satellite rideshare launch provider in Seattle, has coordinated rideshare payloads with SpaceX, Rocket Lab, and other providers, and announced the development of the Sherpa family of next-generation orbital transfer vehicles to improve its abilities to deliver satellites into orbit.[12]
- Xplore, a startup intending to build both satellites and interplanetary spacecraft, recently located to a 22,000 square foot facility in Redmond (formerly occupied by Planetary Resources) that will allow for the construction of 20 spacecraft per year.[13]

Launch Vehicles

Launch vehicle manufacturing in the region is dominated by Blue Origin. Ongoing production of New Shepard reusable suborbital launch vehicles at its Kent production facility are ongoing and are currently being used as part of passenger flights as of 2022.

However, production and deployment of the New Glenn orbital launch vehicle has been delayed to late 2022. This has been linked in part to Blue Origin not being selected for a major procurement contract for launch services by the US Space Force in 2020, which resulted in an adjustment to the expected production schedule. While the manufacturing of the New Glenn launch vehicle was planned for Blue Origin facilities in Alabama and Florida, this does impact company-wide planning for long-term operations.

In addition to Blue Origin, however, other firms in the region have been exploring the potential for building new launch systems to support space operations. Examples include the following:

- Radian Aerospace, based in Renton with test facilities in Bremerton, has been exploring the potential for a reusable, rail-launched "space plane." This winged single-stage-to-orbit craft would provide opportunities for horizontal takeoff and landing, and would be focused on quick turnarounds between launches. It has recently raised $27.5 million in seed funding for development.[14]

[10] Daily Journal of Commerce, 2021, "LeoStella", June 30, 2021.

[11] Nall, M., 2021, "Starfish Space raises $7M to develop in-orbit space tug technology", *Puget Sound Business Journal*, September 20, 2021.

[12] Spaceflight, Inc., n.d., *Sherpa Program: New Orbital Transfer Vehicles Launch Smallsats to Custom Orbital Destinations*, accessed January 2022.

[13] Nall, M., 2021, "Xplore plans hardware buildout as space industry grows in Redmond", *Puget Sound Business Journal*, December 3, 2021

[14] Wall, M., 2022, "Radian Aerospace raises $27.5 million for new orbital space plane", *Space.com*, January 20, 2022.

- STOKE Space from Kent raised $65 million in venture capital in December 2021 to develop a fully reusable vehicle for low-cost launches with quick turnaround times. The expectation is that a prototype of the second stage rocket will be completed and flight-tested by the end of 2022.[15]
- Wave Motion Launch Corporation in Everett is developing barrel-less impulsive launcher for space launches, which will provide an alternative, low-cost approach for space launches.

Commercial Space Stations

One primary area of advancement in planning has been with the development of plans for commercial space stations. Although the International Space Station is expected to operate until at least 2030, multiple joint ventures are being planned for building new long-term stations in orbit for different applications.

While two planned stations are under development by the Chinese and Russian governments, NASA created the Commercial LEO Destinations (CLD) project in 2021 to support the development of these platforms in orbit.

Planned commercial space stations include the following:[16]

- Orbital Reef, a platform to be managed by Blue Origin and Sierra Space of Colorado, and including partners such as Boeing and Redwire Space. This would be deployed in the mid-2030s.
- Starlab (Nanoracks), which will be developed from a single launch payload in 2027.
- Gravity Ring, a space station planned by Orbital Assembly Corporation for operation by 2023.
- A Northrup Grumman station with no planned launch date.

Additionally, Axiom Space is designing a segment for the ISS that is planned to be separated as its own station after the ISS is retired.

Over the long term, the economic potential for space stations in orbit is considerable. Potential applications include:

- Earth and space observation
- Satellite launch platforms
- Microgravity research
- Microgravity manufacturing and industrial processes
- Space tourism

Although vehicle manufacturing and launch facilities to support the Orbital Reef station for Blue Origin are expected to be in Florida and Alabama, there will be considerable opportunities for engineering, research, design, and operations activities in the central Puget Sound region.

[15] Foust, J., 2021, "Stoke Space raises $65 million for reusable launch vehicle development", *SpaceNews*, December 15, 2021.

[16] Space Foundation, 2022, The Space Report: 2021 Q4, pg. 3.

Space Tourism

For space tourism, major milestones were set in 2021. Although space tourism is not new, no tourists have entered space since 2009, when Guy Laliberté visited the ISS aboard a Soyuz spacecraft. In 2021, however, twenty space tourists traveled to space on Soyuz spacecraft as well as craft operated by Blue Origin and SpaceX. This included a Russian film crew sent to the ISS for a film shoot, Blue Origin founder Jeff Bezos, actor William Shatner, and TV personality Michael Strahan. In fact, so many tourists traveled to space in 2021 that the US Federal Aviation Administration stopped a program to award astronaut's wings to any civilians that traveled into space.[17]

Future developments are expected to expand both the offerings and availability of space flights for civilians. Blue Origin and SpaceX are planning to expand their offerings, and Virgin Galactic is also planning for a suborbital trip with several minutes at an elevation of 50 miles. Space Adventures, coordinated through Roscosmos, is also coordinating planned trips of around 10 days to the ISS, and expects to increase Soyuz production to meet demand.

Regional Development

Since 2018, the emergence of new firms and the expansion of existing operations has led to a significant expansion of both employment and facility space in the central Puget Sound region. The greatest change has been with Blue Origin. The company formally opened the O'Neill Building in 2020, a new 232,885 square foot facility in Kent which can accommodate an additional 1,500 employees.[18] The company has also leased warehouse space in the Pannatoni Business Center in Kent, amounting to an additional 210,000 square feet of warehouse space, and the company has been rumored to be looking for further space for expansion in the future.[19]

Aside from this new development, other companies have also worked to expand their operations in different ways. Notable examples include the following:

- Project Kuiper, which is involved with developing satellite-based broadband internet, coordinated plans in 2019 to move its R&D operations to a new 219,000 square foot facility in Redmond.[20]
- SpaceX has leased a new 125,000 square foot building in Redmond Ridge Business Park in 2021 to expand its Starlink facilities in Redmond.[21]
- Radian Aerospace coordinated a lease agreement with the Port of Bremerton to develop a rocket engine on a half-acre parcel at the Bremerton Airport in 2017.[22]

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[17] Space Foundation, 2022, The Space Report: 2021 Q4, pg. 35.

[18] Boyle, A., 2020, "Blue Origin takes one giant leap across the street to space venture's new HQ in Kent." *GeekWire*, January 6, 2020.

[19] Hunter, S., 2022, "Kent-based Blue Origin leases warehouse space for further expansion", *Kent Reporter*, January 11, 2022.

[20] Boyle, A., 2019, "Amazon is moving Project Kuiper satellite operation to huge Redmond facility." *GeekWire*, December 18, 2019.

[21] Boyle, A., 2021, "SpaceX leases new 125,000-square-foot complex in Seattle area as Starlink satellite operation grows", *GeekWire*, April 7, 2021.

[22] Boyle, A., 2017, "Report: Stealthy Radian Aerospace gears up for rocket engine testing in Bremerton." *GeekWire*, December 4, 2017.

- LeoStella opened a satellite manufacturing factory in Tukwila in 2019. This facility, including a 10,000 square foot production floor and clean room, is designed to scale up to produce up to 30 small satellites per year at full buildout.[23]
- In 2021, Xplore occupied production space in a 22,000 square foot facility in Redmond to produce both satellites and spacecraft for deep space.[24]

Regional Coordination

Efforts to support and promote the space economy in the state and region have been supported by the Washington State Space Coalition (WSSC). WSSC began in 2013 when the Governor's Director of Aerospace coordinated a group of industry and community leaders to help support initiatives with the space industry, and it was officially launched in 2014.

In 2018, the need for greater private sector involvement and more direction for the group led to the transfer of its administration to the Aerospace Futures Alliance (AFA). Under this management, WSSC focused its efforts on becoming an industry-led consortium of space companies across the supply chain, with additional partners involved from R&D, education, government, and the public sector.

Since 2018, WSSC has worked to provide additional support for the local space industry though opportunities with market development, industry collaboration, shared innovation infrastructure, entrepreneurship, attracting and retaining talent, and other initiatives. Building local infrastructure can help to increase the health of the regional space cluster and improve the ability for local firms to receive funding, attract and retain talent, identify, and attract a customer base, tap into local suppliers, and improve the competitiveness of the region and state as compared to locations such as California, Colorado, Florida, and Washington, DC.

[23] Foust, J., 2019, "LeoStella looks for more customers as it opens satellite factory". *SpaceNews*, February 17, 2019.

[24] Boyle, A., 2021, "Xplore reveals its plans to open satellite manufacturing facility in Seattle area", *GeekWire*, May 12, 2021.

Impacts of the Space Economy

Overview

From a national and international perspective, the central Puget Sound region has emerged as a growing location for major space-related businesses. Building from the traditional foundations of the aerospace sector, private space companies have increased their activities in the region related to space, and local employment in the space economy has grown.

To determine the overall effects of the space industry on the regional economy, we rely on an assessment carried out with the IMPLAN economic modeling package, using the 2019 model in 2022 dollars. This package relies on the US Bureau of Economic Analysis Benchmark Input-Output Accounts as a basis for models of impacts, with proprietary adjustments made to account for additional sectors and shifts in the economy over time.

This analysis includes the following assumptions:

- **Industries included in the analysis.** This analysis assumes the "core" space economy includes upper-tier suppliers, OEMs, launch providers, and direct suppliers of space-related goods and services as noted in Exhibit 1 above. Industries examined in this analysis include the following (as defined by NAICS codes):
  - **Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing** (NAICS 334220), which includes satellite manufacturing.
  - **Space Vehicle Manufacturing Propulsion Units and Parts for Space Vehicles and Guided Missiles** (NAICS 336414 to 336419), including the development and manufacture of rocket engines and major spacecraft components.
  - **Nonscheduled Chartered Freight Air Transportation** (NAICS 481212), which includes private space launch services and launch-sharing coordination.
  - **Satellite Telecommunications** (NAICS 517410), focusing on businesses that provide telecommunication services to other industries, including resellers of these services.
- **Lower-tier suppliers and users of services are excluded from this analysis.** Although parts suppliers earlier in the supply chain form an integral part of the regional space economy, many of these businesses may have other customers outside of the space industry. As these elements may be difficult to disentangle, and some of the effects from suppliers can be accounted for as part of the indirect economic impacts, these firms are removed from the direct assessment. Downstream companies that use space-related services in their business are also excluded from consideration, as determining the inputs drawn from space-related firms versus other companies would also be difficult to separate.
- **Government research excluded from the analysis.** Note that government-related space research and technology (NAICS 927) could also be considered part of the local space sector, but this industry is not strongly represented in the central Puget Sound region or the state overall, and information is not available about total employment.

- **Impacts are based on estimated employment.** Because of the nature of the space industry in the region, it is challenging to identify the full impacts of spending between companies, especially those that are currently coordinating prototype development and scaling up production while supported by diverse types of venture capital. Because of this, the analysis reviews the impacts associated specifically with estimated employment levels across the different firms and industries identified in this report.
- **Certain firms may be excluded based on number of employees and availability of information.** As employment figures from certain firms may not be public information and can be subject to change, the estimates used in this analysis are based on the best information that can be acquired. Additionally, beyond the firms identified as part of the analysis, there may also be smaller startups and individual consultants operating in this sector that would be challenging to identify. Any firms that do not have 10 or more employees were removed the from analysis.

Employment Estimates

Exhibit 3 provides a list of the firms in the region identified as part of the core space economy, with estimated employment included by firm. Overall, these estimates indicate that the core space economy currently includes over 5,800 employees, divided between the identified industries and firms.

We identified the businesses in Exhibit 3 from a review of available data for businesses in the listed NAICS industries listed, an evaluation of membership in the Washington State Space Consortium regional trade group. We also used other available news sources on the regional space economy to identify employment levels as needed. Companies with fewer than 10 local employees were not included on this list.

Exhibit 3. Estimated employment in the core space economy, central Puget Sound region.

NAICS	Industry	Direct Employment (est.)
334220	**Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing (302)**	
	SpaceX/Starlink	900
	Amazon/Kuiper Systems LLC	800
	LeoStella	60
	Xplore	20
	TOTAL	**1,780**
336414–336419	**Propulsion Units and Parts for Space Vehicles and Guided Missiles (358)**	
	Blue Origin	3,000
	Boeing Defense, Space & Security	500
	Aerojet Rocketdyne	400
	Radian Aerospace	40
	STOKE Space Technologies	40
	Wave Motion Launch Corporation	10
	TOTAL	**3,990**
481212	**Nonscheduled Chartered Freight Air Transportation (414)**	
	Spaceflight Industries	30
	TOTAL	**30**
517410	**Satellite Telecommunications (435)**	
	RBC Signals, Inc.	10
	TOTAL	**10**
	Overall direct employment in core activities of the space economy	**5,810**

Sources: Dun & Bradstreet, 2021; Washington State Space Consortium, 2020; BERK, 2022.

Regional Economic Impacts

Based on estimates of local employment provided in Exhibit 3, calculations for the economic impacts of the core space economy in the central Puget Sound region are summarized in Exhibit 4. These impacts are divided between the following categories:

- **Direct impacts** from the businesses themselves.
- **Indirect impacts** from across the supply chain for the businesses identified.
- **Induced impacts** from the household spending derived from labor income.

The findings indicate the following:

- **Overall economic impacts from core space economy business.** Over the entire regional economy, this analysis indicates that core businesses contributed about **$4.6 billion in 2021 dollars** to the regional economy, supporting a total of **13,103 jobs** and **$1.6 billion in labor income** overall.
- **Employment multipliers.** This analysis also highlights that an additional 1.26 jobs are created across the entire economy for every job created in a core space business, with 0.45 jobs created from indirect impacts on suppliers, while 0.81 jobs are created from induced impacts from consumer spending.
- **Economic and labor income multipliers.** The results also indicate that every dollar spent by core space businesses leads to 1.54 dollars of total economic activity, including 0.55 dollars of regional labor income.
- **Changes from 2018 impact estimates.** The estimates noted in this report present slightly higher multipliers than the 2018 report, as the employment multiplier increased from 2.13 to 2.26, and the economic multiplier increased from 1.51 to 1.54. While changes in the model do have a role to play in this, there could also be an increase in connections with local suppliers, as well as increases in household income associated with more numerous and higher-paying positions available in the local market.

Exhibit 4. Estimated 2021 economic impacts from the core space economy (in millions of 2021 dollars).

Type of Impact	Output ($ millions)	Employment	Labor Income ($ millions)
Direct	$2,963	5,810	$1,058
Indirect	$684	2,602	$258
Induced	$919	4,691	$320
TOTAL	**$4,566**	**13,103**	**$1,636**

Sources: IMPLAN, 2022; BERK, 2022.

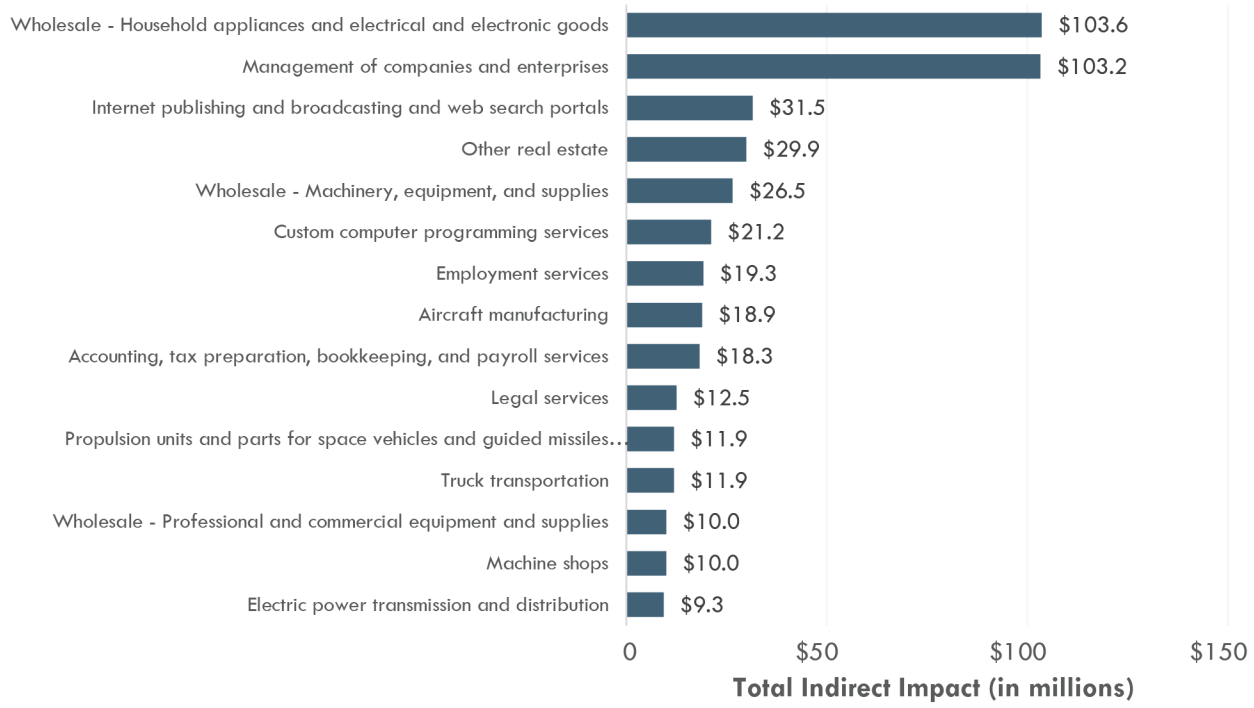
Indirect and Induced Impacts

The components of indirect and induced demand are provided in Exhibits 5 and 6, respectively. These results are reported based on the 546-sector aggregation used in the IMPLAN modeling platform.

For the indirect inputs described in Exhibit 5, these outputs highlight estimates of the required inputs across the supply chain necessary to support the activities of core businesses in the regional space economy. Note that in addition to goods such as electrical equipment, machinery, and space vehicle components, these activities also require significant inputs of services, including management services, computer programming, legal services, and other professional services.

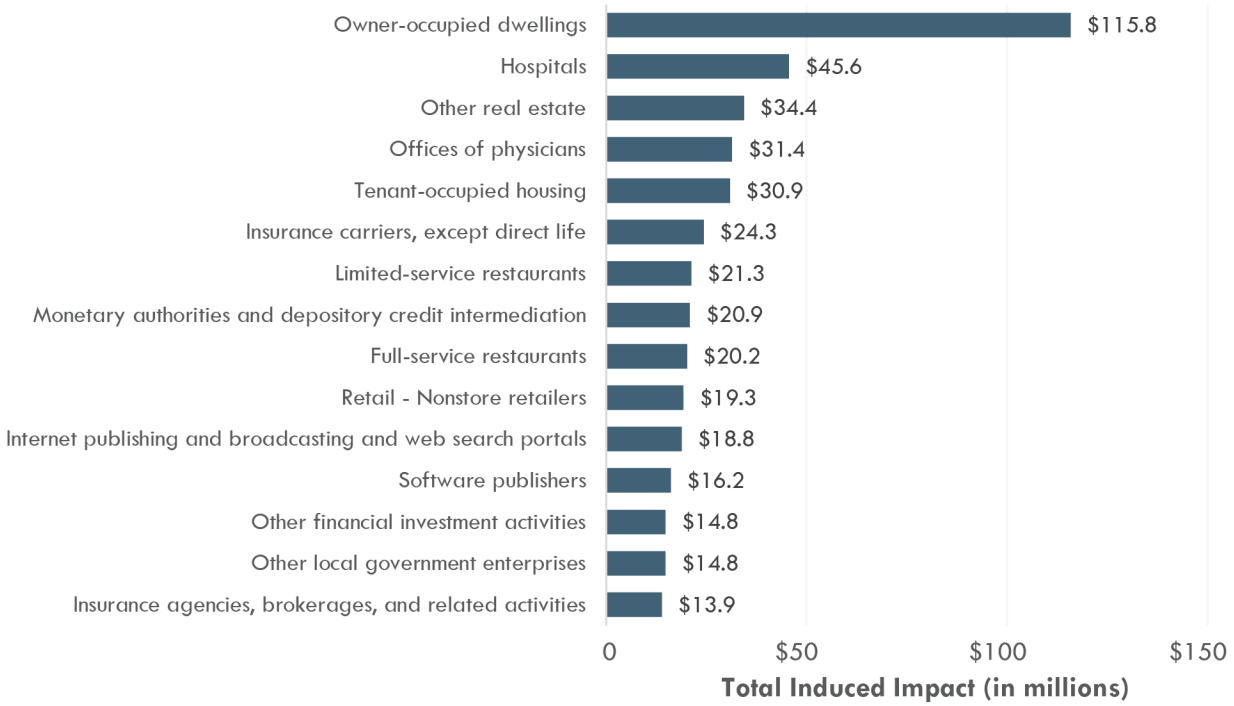
The estimates of induced demand by industry given in Exhibit 6 highlights the range of household spending supported by labor income from increased direct and indirect economic spending across the local economy. This does include a range of retail expenditures and personal services expected for households, such as restaurants and healthcare. What is also noteworthy is that almost 20% of the $919 million in induced impacts is associated with real estate expenditures of some kind, including both owner- and tenant-occupied housing.

Exhibit 5. Total indirect impacts by IMPLAN industry (in millions of 2021 dollars).



Sources: IMPLAN, 2022; BERK, 2022.

Exhibit 6. Total induced impacts by IMPLAN industry (in millions of 2021 dollars).



Sources: IMPLAN, 2022; BERK, 2022.

Tax Effects

In addition to overall economic impacts, the estimated effects of this activity on federal, state, and local tax receipts are provided in Exhibit 7. The tax impacts in this table are divided according to the jurisdictions receiving benefits and whether the taxes apply to direct, indirect, or induced economic impacts.

Exhibit 7. Estimated 2021 impacts of the core space economy on tax receipts (in millions of 2021 dollars).

Type of Tax	Federal	State	County	Cities	Special Districts	TOTAL
Direct	$224.4	$19.8	$1.3	$2.0	$2.6	**$250.1**
Indirect	$55.3	$19.4	$2.2	$3.2	$4.4	**$84.6**
Induced	$71.2	$40.5	$4.9	$7.1	$9.6	**$133.2**
TOTAL	**$350.9**	**$79.7**	**$8.5**	**$12.3**	**$16.6**	**$468.0**

Sources: IMPLAN, 2022; BERK, 2022.

Overall, these results highlight the following:

- **The regional space economy has a considerable impact on government tax receipts.** The space economy contributes about $80 million to the state in taxes, with about $37 million provided to county and local governments (including special districts). Note that the most tax revenue from the identified activities are received by the federal government, in part due to the high employee compensation received in this sector and the greater dependence of federal tax receipts on income taxes.
- **Household spending plays a key role with expanding state and local tax revenue.** One important note for local tax revenue is that while induced economic impacts are not as sizable as direct impacts, the tax receipts from induced economic activity make up a majority of state and local tax revenue. This is specifically related to the importance of sales taxes for tax receipts, and indicates that for the local space economy, the greatest boost to government revenue is linked to high-wage jobs and associated household spending.

Conclusions

Several conclusions can be drawn from these findings that can supplement the findings from the 2018 report:

- **Core businesses in the regional space economy had an impact of about $4.6 billion in 2021.** This estimate is based on an analysis developed in IMPLAN, with the core businesses of the region focused on satellite and launch vehicle manufacturing. Across the entire economy, 13,013 jobs are dependent on the activity in this sector, including both indirect employment across the supply chain and induced employment from increased household spending. This corresponds to every job in core businesses of the space economy leading to an additional 1.26 jobs created across the region, and one dollar of economic activity in the sector corresponding to 1.54 dollars of total economic activity.
- **There has been a considerable increase in employment and activity in the space economy of the central Puget Sound region, doubling since 2018.** Over the past three years, there has been a dramatic expansion of regional space-related businesses. While the development of launch vehicles and related activities by Blue Origin has been one source of growth, the advancement of satellite manufacturing and satellite-related services by Starlink, Project Kuiper, LeoStella, and other firms has also been a major source of new regional employment. Significant amounts of office, industrial, flex, and warehouse space are now being taken up in the region to support these activities.
- **New startups in the region are focusing on a diverse range of space-related offerings and are supported by a strong local pool of talent.** Although Blue Origin, SpaceX, and Amazon are employing the most workers in the industries examined in the analysis, there are a range of other smaller businesses that are attracting funding and looking to provide innovative solutions in the field. For example, efforts by Radian Aerospace, STOKE Space, and Wave Motion to explore alternative launch systems could have considerable long-term growth potential for the region if these technologies are successful. These businesses have been built on the foundation of an evolving regional talent pool in the space industry and related tech activities.
- **Businesses in the region are currently taking part in activities related to commercial human spaceflight, and this will be expanded over the coming decade.** Blue Origin is now offering opportunities for commercial spaceflight, focusing first on space tourism with existing launch vehicles and moving towards the development of the Orbital Reef commercial space station by the mid-2030s. In addition to the potential for further expansion of local operations of Blue Origin, this also has the potential to support other activities in this field in the region and state.
- **Future development of the regional space economy would benefit from support for regional entrepreneurship, workforce development, and venture capital funding.** While there is the potential for certain space-related activities to become more decentralized and businesses to locate in other places, maintaining and expanding regional talent in space-related fields and providing support for regional entrepreneurship with space-related activities will be essential in maintaining and enhancing the role that the central Puget Sound region can play in the space economy.

Sources

About Amazon, n.d., "Project Kuiper announces plans and launch provider for prototype satellites", accessed January 2022.

Boyle, A., 2021, "Xplore reveals its plans to open satellite manufacturing facility in Seattle area", *GeekWire*, May 12, 2021.

Boyle, A., 2021, "SpaceX leases new 125,000-square-foot complex in Seattle area as Starlink satellite operation grows", *GeekWire*, April 7, 2021.

Boyle, A., 2020, "Blue Origin takes one giant leap across the street to space venture's new HQ in Kent." *GeekWire*, January 6, 2020.

Boyle, A., 2019, "Amazon is moving Project Kuiper satellite operation to huge Redmond facility." *GeekWire*, December 18, 2019.

Boyle, A., 2017, "Report: Stealthy Radian Aerospace gears up for rocket engine testing in Bremerton." *GeekWire*, December 4, 2017.

Clark, S., 2021, "OneWeb surpasses 200 satellites with Soyuz launch", *Spaceflight Now*, May 28, 2021.

Daily Journal of Commerce, 2021, "LeoStella", June 30, 2021.

Foust, J., 2021, "Stoke Space raises $65 million for reusable launch vehicle development", *SpaceNews*, December 15, 2021.

Foust, J., 2019, "LeoStella looks for more customers as it opens satellite factory". *SpaceNews*, February 17, 2019.

Goldman Sachs Global Investment Research, 2017, *Profiles in Innovation: Space, The Next Investment Frontier*.

Hunter, S., 2022, "Kent-based Blue Origin leases warehouse space for further expansion", *Kent Reporter*, January 11, 2022.

Kyle, E., 2022, Space Launch Report.

Mann, A., Pultarova, T., 2022, "Starlink: SpaceX's satellite internet project", *Space.com*, January 7, 2022.

Morgan Stanley, 2020, *Investing in the Final Frontier*.

Morgan Stanley, 2017, *Space: Investment Implications of the Final Frontier.*

Nall, M., 2021, "Xplore plans hardware buildout as space industry grows in Redmond", *Puget Sound Business Journal*, December 3, 2021.

Nall, M., 2021, "Starfish Space raises $7M to develop in-orbit space tug technology", *Puget Sound Business Journal*, September 20, 2021.

Nall, M., 2021, "Puget Sound region emerging as a satellite capital amid shift to mass production." *Puget Sound Business Journal*, September 4, 2021.

Space Foundation, 2021, "Global Space Economy Rose to $447B in 2020, Continuing Five-Year Growth", press release.

Space Foundation, 2022, *The Space Report: 2021 Q4*.

Spaceflight, Inc., n.d., *Sherpa Program: New Orbital Transfer Vehicles Launch Smallsats to Custom Orbital Destinations*, accessed January 2022.

UBS, 2018, *Longer Term Investments – Space.*

US Department of Commerce, 2014, *US Space Industry "Deep Dive" Assessment: Employment in the US Space Industrial Base.*

Wall, M., 2022, "Radian Aerospace raises $27.5 million for new orbital space plane", *Space.com*, January 20, 2022.