AEROSPACE

State of Play

SMALLSATS GO BACK TO THE FUTURE

And How Small Launch, Rideshare, and Space Tugs Bring It

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The Big Picture

Rockets go to space usually to put something there, like a camera or a radio housed in a satellite. This helps people see things or talk to other people around the world. Starting in about 2000, it became increasingly easy to make very small, inexpensive satellites which could "rideshare" into space as part of a larger satellite launch. The price was right. Companies were dreaming of constellations, but the destination orbit was generally off. So the market produced destination-specific rides on smaller launchers. Eventually, it became possible to reposition a satellite in space using new and better onboard thrusters or by getting a tug to reposition it. This has led to a renewed interest in ridesharing, which now offers more frequent launches to the right orbit at a good price. So the questions are: Who's involved? What does it mean for other industry players? What's next?

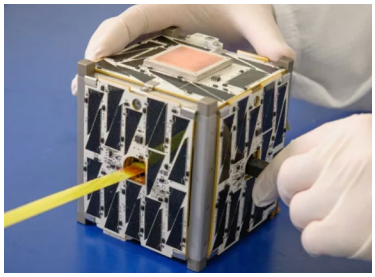

Image: NASA/Ames Reseach Center

Dedicated Launch Providers

As small payloads matured into operational commercial and government systems, they needed to get to their own orbits on their own schedules and were willing to pay a bit more for that. The market responded with companies offering destination flights for small payloads, and we saw growing interest in privately owned launchpads, air-launched systems, and mobile and stationary launch platforms designed to support the custom small launch market. The small launch providers have now created a market segment, and several companies are highlighted below. Overall, there are over 148 different small dedicated launchers in development worldwide. Dedicated launch demand and ready venture capital funding has facilitated this, but not all will survive.

Virgin Orbit uses a rocket launched from a Boeing 747 to deploy smallsats into space. This Virgin Group company was formed in 2017 and is based in Long Beach, California. On January 17, 2021, Virgin Orbit launched their air-launched rocket LauncherOne, which reached low Earth orbit and deployed 10 cubesats for NASA, among other payloads. Through its subsidiary VOX Space, Virgin was awarded a $35 million contract for three launches of 44 cubesats for the United States Space Force. The first launch is expected in October 2021. In April 2021, Virgin Orbit was one of the companies selected by the Brazilian Space Agency to launch from the Alcantara Launch Center in Brazil. Virgin Orbit also plans to launch space flights from Spaceport Cornwall in partnership with the U.K. Space Agency.

Photo courtesy of Virgin Orbit

Rocket Lab is headquartered in Long Beach, California and operates a small orbital rocket, called Electron, for dedicated launches for small satellites. The company has now successfully launched more than 100 smallsats for government and commercial customers, and is working on booster reusability. In March 2021, Rocket Lab announced that it will be going public via a special purpose acquisition company (SPAC) before the end of the year.

Enter the Space Tugs

Space tug technology is gaining real-world credibility and could be one factor that reshapes the smallsat rideshare market. Space tugs provide last-mile "taxi" services that place small cargos in preferred custom orbits. There can be a cost advantage for small cargos to ride on large launchers, depending on the mission. Several companies are highlighted below.

Northrop Grumman kicked off the "age of tugs" with their landmark in-orbit servicing achievements when, in 2020, the company's Mission Extension Vehicle-1 (MEV-1) lifted the Intelsat IS-901 satellite out of the GEO graveyard orbit and back into service. In April 2021, the Mission Extension Vehicle-2 (MEV-2) docked with Intelsat's 10-02 spacecraft to extend its life.

Seattle-based **Spaceflight** deployed 15 spacecraft from its debut flight of the Sherpa-FX space tug in January 2021. The company launched two Sherpa tugs on the SpaceX Transporter-2 mission in June 2021, one of which had electric propulsion from atomic fusion. Spaceflight expects to fly their next generation Sherpa-LTC on a different SpaceX mission later this year. Each Sherpa can be stacked and launched with other Sherpa modules for later separation and independent free-flying.

The SpaceX Transporter-2 mission launched two Sherpa tugs in June 2021. Photo courtesy of SpaceX.

Italy's **D-Orbit** actually demonstrated the world's first commercial last-mile delivery service in October 2020, using its **In-Orbit Now (ION)** vehicle to deliver 12 Planet SuperDove satellites to orbit. It is working on space debris solutions as part of its future development.

Exolaunch is a German company that brokers rideshare missions. It plans to conduct flight tests for its Reliant tugs next year. In 2023, Exolaunch plans to flight test a Reliant Pro configuration that can make finer adjustments to custom orbits post-launch, such as a satellite's orbit inclination. It is also working on space debris solutions and is expected to compete with D-Orbit in this trade space in the future.

Momentus is a commercial company that provides last-mile, in-space delivery for small satellites with what is claimed to be a novel, water-based propulsion system. Their family of space tugs move satellites dropped off at a common orbit to custom, highly precise orbits for specific space-based applications. The company has experienced recent turbulence in their technology and their public offering through a SPAC, and the outlook appears to be cloudy.

One creative advance in space tug technology is the use of ESPA rings with an added propulsive capability. **The United States Space Force** is developing a rapid launch capability for small satellites and hosted payloads using an ESPA ring equipped with just such a power and propulsion system. The Space Test Program 3 mission, scheduled to launch in late 2021, will carry the first **Long Duration Propulsive ESPA (LDPE)** payload. The EELV Secondary Payload Adapter (ESPA) used will be Northrop Grumman's ESPAStar bus, equipped to carry payloads to final orbit after launch. Three LDPE missions will be launched in the next 18 months, and then the capability will transition to a program called **Rapid On-orbit Space Technology Evaluation Ring (ROOSTER)**. Two contracts will be awarded for ROOSTER missions in the near future.

Moog has developed the Orbital Maneuvering Vehicle (OMV), a propulsive tug for secondary payload deployment based upon the Moog NSSL EELV Secondary Payload Adapter (EPSA) ring. The OMV can be used to disperse and position small satellite constellations, act as a hosted payload platform, or deliver a single spacecraft to its ideal orbit.

Starfish Space, a Washington-based company, was founded in 2019 to launch an all-electric tug called Otter by 2023. Otter is a smaller tug than its competitors. This allows Starfish to operate a network of the tugs in space, providing on-demand satellite servicing.

Tokyo-based **Astroscale** intends to demonstrate capabilities required for debris removal, including client search, inspection, and both tumbling and non-tumbling rendezvous docking.

Back to the Future—Rideshare and Beyond

PSLV's then record-breaking launch of 104 smallsats in 2017 may have helped reinvigorate rideshare, but three factors now combine to create a long-term market. These include the growing market for smallsat launch itself, more frequent launches, and the tugs that can deliver the orbit accuracy needed.

The at-scale performance and cost of in-space tugs remains to be seen. If successful, it will at minimum slow the growth of small launch business as cost-conscious, less time-sensitive small-payloads opt for rideshare. Notable in 2021 is the January SpaceX's rideshare mission that released 143 satellites (breaking the PSLV record), followed by a second dedicated rideshare in June that released another 88 satellites. SpaceX's rideshare program is said to be putting downward pressure on prices for small satellite launches generally. Tugs alone cannot account for this trend, but given the foundational technology on which tugs are built, we may see growth for tugs in adjacent areas, such as in on-orbit servicing, assembly, and eventually on-orbit manufacturing, as well as more exploratory missions in cislunar space, to and around the moon, and beyond. The recent spate of space SPACs attests to considerable excitement in the space domain not confined to space tourism. What remains to be seen is whether these are solid bets or a case of irrational exuberance.

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