When it comes to launching satellites, there’s a very limited provider pool to pick from: Arianespace and SpaceX dominate the market, while China Great Wall Industry Corporation (CGWIC), Eurockot Launch Services, Indian Space Research Organisation (ISRO), International Launch Services (ILS), Mitsubishi Heavy Industries, Orbital ATK, and United Launch Alliance (ULA) deliver more niche services for customers in specific regions or vertical markets. Blue Origin, Rocket Lab and Virgin Galactic are set to enter the market in the coming years, each with their own take on next-generation launch services.

While we’ve seen small advancements in launch capabilities over the years, including dedicated small satellites launches, new fuels and electronic propulsion, major steps have been few and far between until now. Reusable rockets have gone from science fiction to science fact.

Reusing launch vehicles

The concept of reusing satellite launch vehicles is not a new one by any means. Discussed at length since the 1960s, and with projects planned or attempted and then shelved, reuse is expected to afford a meaningful solution to tackle high launch costs and the time and resources it takes to build launch vehicles.

But is there really a need for it? Some say not, and that reusability is simply a vanity project. Satellite Evolution spoke to Jacques Breton, Senior Vice President of Sales and Business Development at Arianespace, who opined that, for some, reusability is a must, while for others, it is unnecessary: “SpaceX is moving towards reusability because they’re
looking at a huge number of launches each year; they have this huge market in the US, and they intend to launch a constellation with thousands of satellites. For them, reusability is a must just to keep up. Our launch rate is more modest, and when you have such a launch rate, reusability might not be economically interesting, because when you want to reuse a stage, you need to use propellant to bring it back and you need built-in landing capabilities and so on, which means using mass that is not useful for the initial launch.”

Demonstrating reusability
It’s one thing to talk about re-using launch vehicles, but it’s an entirely different matter to actually achieve it. What’s particularly interesting to note is that neither of the two most prominent companies exploring reusability technology are traditional satellite launch providers; Blue Origin founder Jeff Bezos and SpaceX founder and CEO Elon Musk are both heavily invested in a wide range of next-generation technologies, each with their own vision of providing consumers access to space.

“We are building Blue Origin to seed an enduring human presence in space, to help us move beyond this blue planet that is the origin of all we know,” wrote Bezos in a blog post. “We are pursuing this vision patiently, step by step. Our fantastic team in Kent, Van Horn and Cape Canaveral is working hard not just to build space vehicles, but to bring closer the day when millions of people can live and work in space.”

Blue Origin has been working on its launch technology since 2000 and plans to use the New Shepard vehicle for sub-orbital space tourism and as a microgravity science laboratory. The company made history in November 2015 when it launched the New Shepard rocket to 329,839 feet and then recovered it at the launch pad using eight drag brakes, fins fitted outside of the vehicle, and the BE-3 engine. The New Shepard crew vehicle also landed safely with the aid of parachutes.

Jeff Bezos commented in a blog post after the achievement: “Rockets have always been expendable. Not anymore. Now, safely tucked away at our launch site in West Texas, is the rarest of beasts; a used rocket. This flight validates our vehicle architecture and design.”

A further four launches and recoveries of the same vehicle have taken place since then, and the company is on track to start trialling its new heavier rocket, the New Glenn, for which it has already agreed launch contracts with Eutelsat for 2021-2022. The New Glenn will come in two or three-stage versions, both with a reusable first stage powered by seven BE-4 engines.

Speaking at the CASBAA Satellite Industry Forum 2017 in Singapore, Clayton Mowry, Vice President of Sales, Marketing and Customer Experience at Blue Origin, stated that, for the first re-flight of the New Shepard, the engine was not removed, thus the time between launches was only a couple of months. The New Glenn has been designed to enable the same capabilities. “The engines are designed for 100 uses; we’re trying to design and build the system so that it’s robust, so that there’s not a lot of work needed. Right now, we’re thinking we could have a couple of weeks between flights,” said Mowry.

SpaceX, too, has invested heavily in recent years to make reusable launch vehicles a viable option for satellite operators, as well as to further its own commercial interests towards cost-effective access to Mars. Shortly after Blue Origin achieved the first recovery of its New Shepard vehicle, SpaceX achieved the same with the Falcon 9 in December 2015. To date, the company has recovered 10 boosters, six on drone ships and four on land.

In March 2017, SpaceX made history with the first ever successful launch of a satellite on board a flight-proven (reused) SpaceX Falcon 9 rocket. SES-10 was launched from NASA’s Kennedy Space Centre in Florida and is today operating as expected, while the flight-proven Falcon 9 first stage was recovered for a second time on a drone ship in the Atlantic Ocean. According to SpaceX, the company is working on a final iteration of Falcon 9, due for debut later this year, which will be capable of achieving around 10 launches.

“We are thrilled to have achieved the successful launch of a flight proven Falcon 9. This is an historic milestone on the path to complete and rapid reusability,” said Gwynne Shotwell, President and COO at SpaceX, after the successful launch. “We are pleased to have accomplished this milestone with SES, which has been a strong supporter of SpaceX and innovation over the years.”

Advancing its programme further, SpaceX is currently nearing the final stages of development for the Falcon Heavy, a reusable launch vehicle able to carry 63,800kg to low Earth orbit (LEO) or 8,000kg to geostationary transfer orbit (GTO).
The first stage of the two-stage Falcon Heavy will consist of three Falcon 9 nine-engine cores, while the second stage features the same Merlin engine utilised on the existing Falcon 9. In March 2017, Elon Musk said on Twitter that he might attempt to recover the second stage of the Falcon Heavy as well as the first stage to enhance reusability.

Jonathon Hofeller, Vice President of Commercial Sales at SpaceX, outlined SpaceX’s plans for the Falcon Heavy at the CASBAA Satellite Industry Forum 2017: “Moving beyond reusability, we’re going to start launching human test flights next year, following testing the Falcon Heavy vehicle this year. To reuse the Falcon Heavy, we’re looking to recover three boosters on drone ships or two of the boosters on land and one on a drone ship.” He added that the refurbishment time for all reusable launch vehicles needs to be reduced to a matter of days or even hours to be a viable option. “We’re taking the data from the SES-10 flight and learning how to do it better. We’re trying to cut down the refurbishment time,” said Hofeller.

Different strokes for different folks?
History has definitely been made in 2017 as far as reusable launch vehicles go, and we can certainly expect to see more flight-proven launches in the coming years as capabilities are refined and technology further advanced.

Whether reusable launch vehicles will be required to keep satellite launch companies competitive remains uncertain.

SpaceX and Blue Origin aren’t only pursuing reusable launches for economic reasons, given the bold plans to make transport to sub-orbit and even Mars affordable for the general public with reusable launchers, so do other launch providers necessarily need to follow suit?

Jacques Breton explained that reusable launch vehicle capabilities are not a priority for Arianespace: “The direction we chose was to develop Ariane 6, which is a simpler launch vehicle compared to Ariane 5; it’s simpler to design and to build, and therefore, less costly. We think that with Ariane 6, we’ll be able to stay competitive on the market, while retaining our reliability and quality of service. Of course, we have technical activities running in parallel to look at future reusability; we’re looking at the building blocks for evolution, looking at a new engine using liquid oxygen, but this will come after Ariane 6.”

For SpaceX, however, which plans to launch a constellation of 4,425 satellites into orbit, in addition to its longer-term space exploration plans, reusability is key. “With these reusable launch vehicles, there’s going to be an abundance of vehicles. We’re still producing one every couple of weeks, and we have an entire fleet available. The way I see the future is that we’ll have a tonne of vehicles on standby, ready to launch for customers, in addition to our own constellation. We have three launch pads right now, which are capable of launching every two weeks, and soon we’ll have another launch pad operational,” explained Hofeller.
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