Waiting for the new generation of small launchers

INSIDE

- Tech’s ‘Valley of Death’
- Smallsats, big data
- BlackSky seeking more than imagery

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ABOVE: Planet, which just nabbed a fresh $14 million satellite-imagery contract from the National Geospatial-Intelligence Agency, captured this picture in April of Utah’s Brigham Canyon Mine, “the largest excavation in the world, producing more copper than any other mine.”

ON THE COVER: Rocket Lab’s Electron rocket undergoes preparations for its May 25 maiden launch.

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Intelsat-33e in the factory.

$65M
Speedcast is buying an American satellite network operator in a bid to enter the U.S. defense market. Australia-based Speedcast said it is acquiring UltiSat, a Maryland company that operates a teleport in Denmark, for at least $65 million. UltiSat’s customers include the Defense Information Systems Agency.

$78M
The amount of Intelsat’s insurance claim for reduced service life on Intelsat-33e, a Boeing-built satellite that had a thruster malfunction and required additional time to reach orbit using a backup system. Intelsat filed the claim in March, some seven months after the satellite launched aboard an Ariane 5 rocket. Intelsat Chief Financial Operator Jacques Kerrest said July 27 that the operator is collecting cash from the claim, but is only at the beginning of the process.

$14M
Planet won a second contract from the National Geospatial-Intelligence Agency to provide satellite imagery. The one-year contract valued at $14 million replaces a seven-month, $20 million pilot contract that just ended. NGA said no other company could provide global imagery with a high revisit rate for both humanitarian and intelligence needs.

Sierra Nevada Corp. will launch its first two Dream Chaser cargo vehicles on Atlas 5 rockets. The company said July 19 it signed a contract with United Launch Alliance for two Atlas 5 launches, in 2020 and 2021, of Dream Chaser spacecraft flying cargo missions to the International Space Station. The Dream Chaser will launch on an Atlas 5 552, a version of the most powerful Atlas 5 variant with a dual-engine Centaur upper stage. The selection of the Atlas 5 was expected, as Sierra Nevada previously planned to launch a version of Dream Chaser developed for NASA’s commercial crew program on an Atlas 5 as well.

A Dream Chaser cargo vehicle sits atop a ULA Atlas 5 rocket in this artist concept.

Commercial crew test flights are still on track to begin within a year, according to both NASA and the two companies developing those spacecraft. NASA released schedules July 20 that included two test flights for SpaceX’s Crew Dragon next February and June, and for Boeing’s CST-100 Starliner in June and August. Both vehicles are well behind the original schedules announced when they won NASA contracts in 2014, but executives with the two companies said they’re confident they can maintain their current schedules.

DLR plans to fly microgravity experiments on Blue Origin’s New Shepard vehicle. A DLR official said at the ISS Research and Development Conference in Washington July 18 that the German space agency had two experiments it expected to go on a New Shepard suborbital test flight later this year. DLR currently uses sounding rockets for suborbital research payloads, but those opportunities are expensive and infrequent. New Shepard test flights are expected to resume this year as Blue Origin prepares to begin commercial service as soon as 2018.
QUICK TAKES

ASTROBOTIC TO LAUNCH ITS FIRST LUNAR LANDER ON ATLAS 5

ASTROBOTIC, A COMPANY DEVELOPING COMMERCIAL LUNAR LANDERS, announced July 26 that it will launch its first spacecraft to the moon on a United Launch Alliance Atlas 5 in 2019.

Pittsburgh-based Astrobotic said it selected ULA to launch its Peregrine lunar lander, carrying 35 kilograms of payloads from a number of customers to the lunar surface. The companies did not disclose the terms of the deal.

“Astrobotic is thrilled to select a ULA launch vehicle as the means to get Peregrine to the moon,” John Thornton, chief executive of Astrobotic, said in a statement. “By launching with ULA, Astrobotic can rest assured our payload customers will ride on a proven launch vehicle with a solid track record of success.”

The announcement offered no technical details about the launch. Astrobotic spokesperson Carolyn Pace said July 26 the lander will fly as a secondary payload on an Atlas 5 launch. She did not identify the primary payload for that mission.

Astrobotic unveiled the Peregrine lunar lander concept in June 2016. The lander will be capable of carrying up to 265 kilograms of payload to the lunar surface on future missions. Airbus Defence and Space is providing engineering support for the lander’s development under an agreement announced last year. Under a separate agreement, DHL serves as the official logistics provider for the company. The company has signed up 11 deals from six nations to carry payloads on the initial Peregrine lander. This includes an agreement announced in June with Atlas Space Operations to carry a laser communications terminal on the lander.

CAMERAS ON TESS SLIGHTLY OUT OF FOCUS

Cameras on a NASA exoplanet spacecraft to launch next year will be slightly out of focus. The agency said July 26 that testing found that the focus of the cameras on the Transiting Exoplanet Survey Satellite (TESS) will drift when the spacecraft cools to operating temperatures after launch. The agency said that, despite being slightly out of focus, the cameras will still be able to achieve their science goals. TESS is designed to look for planets around the nearest and brightest stars by measuring dips in brightness as planets transit in front of them, similar to the Kepler mission. Some astronomers are still concerned about the effects of the focus shift, according to discussion at a NASA Advisory Council committee meeting last week. “The TESS team thinks there will be a 10 percent cut in terms of the number of planets that they expect to be able to detect,” Alan Boss, an astronomer with the Carnegie Institution, said at the meeting.

“In short, there are mind-bogglingly vast quantities of alcohol in outer space. But since it is dispersed over truly enormous distances, the drinks companies can rest easy.”

—ALEXANDER MACKINNON, SENIOR LECTURER IN ASTROPHYSICS AT THE UNIVERSITY OF GLASGOW, EXPLAINING THAT, WHILE ASTRONOMERS HAVE DETECTED ALCOHOL MOLECULES IN INTERSTELLAR SPACE, IT IS VERY WIDELY DISPERSED.
GERMANY’S HEINRICH HERTZ SATELLITE NOW EXPECTED TO LAUNCH IN 2021

The German space agency, DLR, signed a delayed but long-expected contract with satellite builder OHB Systems for an experimental telecommunications satellites that will be used by Germany’s armed forces. OHB received a study contract for the Heinrich Hertz satellite in 2011, at which time the spacecraft was planned for launch in 2016. Under the $362 million contract signed this month, the satellite is expected to launch in 2021 to test a number of advanced technologies while also carrying a military communications payload.

Right: The Heinrich Hertz satellite will carry around 20 experiments, along with a military communications payload.

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A spending bill approved by the Senate Appropriations Committee July 27 would restore funding for several NASA Earth science missions slated for termination by the administration as well as a satellite servicing program.

The Commerce, Justice and Science (CJS) appropriations bill offers $19.529 billion for NASA overall and reveals different priorities from those reflected in the House version of the bill and the original White House request.

The Senate bill provides $1.921 billion for NASA’s Earth science program, identical to what it received in fiscal year 2017. The White House’s proposal sought a cut of $167 million in the program, while the House deepened that cut by an additional $50 million.

The Trump administration’s proposal sought to cancel four missions under development or in operation: the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) satellite, the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder and the Orbiting Carbon Observatory (OCO) instruments for the International Space Station, and Earth-viewing instruments on the Deep Space Climate Observatory (DSCOVR). All four are specifically funded in the Senate report.

The Senate also supported a fifth project slated for termination, the Radiation Budget Instrument (RBI), with conditions: NASA must report on whether RBI can be ready for inclusion on the Joint Polar Satellite System (JPSS) 2 spacecraft and stay within budget. If so, NASA can continue working on RBI using reprogrammed funding.

While Earth science received a large increase in the Senate bill, planetary science was cut: the Senate bill offers $1.612 billion, versus the administration’s request of $1.93 billion and the House bill’s $2.12 billion.

Senate appropriators included $660 million for NASA’s Mars exploration program, but unlike the House bill, does not specify any funding for planning missions beyond the Mars 2020 rover. As in past years, the Senate bill also does not specify any funding for the Europa Clipper mission or a follow-on lander, which is explicitly mentioned in the House bill at levels higher than the original request.

There were few changes in NASA’s astrophysics or heliophysics divisions, or for the James Webb Space Telescope. Senate appropriators allocated $150 million for the next flagship astrophysics mission, the Wide Field Infrared Survey Telescope, about $25 million above the NASA request.

Another major difference between the Senate bill and both the original request and the House bill is in satellite servicing. The administration sought to restructure the Restore-L program, a mission that would refuel the Landsat 7 satellite, into a more generic satellite-servicing program that would receive $45 million. The House bill provided a similar amount, but under the Restore-L name.

The Senate bill, by contrast, provides $130 million for Restore-L, the same amount as it received in 2017. While critics of Restore-L had argued it duplicated a DARPA project for geostationary orbit satellite servicing, the Senate rejected that claim. “By focusing on low-Earth orbiting satellites, it avoids competing against industry and holds the potential to save money by allowing government satellites longer operational life,” the report stated.

In other areas, the Senate is more closely aligned with the House. They provide $2.15 billion for the Space Launch System and $1.35 billion for the Orion spacecraft, both above the administration’s request. Both also reject the administration’s proposal to close NASA’s Office of Education, with the Senate offering $100 million, the same as 2017, and the House $90 million.

Senate leadership has not indicated when these or other appropriations bills will be taken up by the full Senate.

The fiscal year 2018 appropriations process is unlikely to be completed until well after the fiscal year begins Oct. 1, requiring one or more short-term continuing resolutions to fund the government at 2017 levels. SN

Jeff Foust
RUAG Space specializes in the development and manufacturing of products for both satellites and launchers – including high-precision electronics. Over 300 on-board computers have been launched, successfully steering the rockets into orbit. In order to further reduce cost and increase performance, RUAG Space investigates the use of commercial components (COTS), to be qualified and applied for space.
A small launch vehicle company that ran into financial problems last year and appeared to be all but dead has found new life under a slightly different name while working on a slightly different vehicle.

Last September, Texas-based Firefly Space Systems furloughed all its employees after a funding round fell through. In March, virtually all of the assets of the company were sold at auction by a creditor.

Thomas Markusic, who had been chief executive of Firefly Space Systems, said in a July 26 interview that the company took out loans to keep the company running while trying to find new investors. That effort failed. “We essentially became in default of these loans, and the creditors who held the secured debt foreclosed this spring,” he said.

One of those creditors, he said, was Noosphere Ventures, which then bought the assets at the March auction. “After they acquired the assets they started a new company, called Firefly Aerospace,” he said. They then started hiring people, including bringing back Markusic as president of the new company.

In the public auction notice last spring, the secured creditor was identified as EOS Launcher. Its president, Maxym Polyakov, is also a managing partner in Noosphere Ventures.

Noosphere Ventures owns 100 percent of the new Firefly Aerospace, Markusic said. “We’re back executing the Firefly Space Systems business plan,” he said. “These guys believe in the need for the Alpha launch vehicle.”

The Alpha launch vehicle previously under development was designed to carry about 200 kilograms into a sun-synchronous orbit. Firefly Space Systems had a contract for one launch, through NASA’s Venture Class Launch Services program, scheduled for early 2018, and said it had letters of intent from other customers for more than 40 additional launches.

Markusic said Firefly Aerospace is now working on “version 2.0” of Alpha that will have a significantly higher payload capacity, able to place up to 1,000 kilograms into a 200-kilometer low Earth orbit if launched from Cape Canaveral. That shift, he said, was based on both an assessment of the technical issues encountered during earlier development of the rocket as well as its competitiveness in the overall market.

The larger Alpha vehicle, with a projected price of $10 million a launch, is designed to be more competitive with India’s Polar Satellite Launch Vehicle, which has become a major provider of small satellite launch services. “I see the PSLV as kind of an existential threat to all of the domestic small launchers,” he said. “I wanted to be sure we could take that vehicle on head-to-head.” He expects the vehicle to be ready to enter service by mid-2019.

Firefly Aerospace now has about 60 employees and is continuing to hire, including both former Firefly Space Systems personnel and new people. Markusic said he expects the company to grow to about 100 employees to take the company through the first launch. At the time of the furloughs last fall, Firefly Space Systems employed more than 150 people.

The company is keeping a low profile for now, Markusic said. “We really just have our heads down trying to rebuild the company,” he said. The new owners, he added, have sufficient capital to support the company through the development of Alpha without outside investment, although he said he did not rule out raising funds for “capital efficiency.”

Firefly Aerospace is also, for now, not actively selling Alpha launches. Markusic said he expects to hear from potential customers later this year, after the company releases a payload users guide for the new Alpha. “We’re not going to be PR-heavy. We’re not in a big fundraising mode,” he said. “We’re in a ‘race to space’ mode.”

The new Firefly, he argued, was on a much better footing than the original company. “I think that, at the end of the day, bad things happen,” he said, “but given that we have complete financial stability now and we’re going to field a vehicle that I think is even more competitive than the original Alpha, I think we’re going to be better off in the long run.” SN

JEFF FOUST

Firefly employees pose for a photo last September, shortly before all 150 were furloughed.
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Building bridges to span the Valley of Death

Funding basic R&D is often easier than sending technology into space for the first time. NASA and the Air Force aim to change that.
microgravity, it carries the type of cost and schedule risk program managers are trained to avoid.

“TRL doesn’t capture the complexity of the system and it forces you to adopt obsolete technology with spaceflight heritage,” said Tomas Svitek, president of Stellar Exploration Inc. Instead, managers should evaluate the design and make a qualified judgement call on which parts require spaceflight heritage and which ones don’t. “Every bolt does not need spaceflight heritage,” he added.

**New Millennium**

The problem is longstanding. For decades, both NASA and the Air Force have worked to bridge the Valley of Death. NASA’s most ambitious effort was the New Millennium program, which began in 1994 as a dedicated effort to demonstrate cutting-edge technologies in flight. New Millennium’s first mission, the Deep Space 1 probe, took off >
in 1998 chock-full of technologies flying for the first time, including sensors, autonomous navigation and electric propulsion.

“We all knew electric propulsion worked on the ground and would be a great way to get around in space because it was so efficient. Yet no one could propose it for a space mission because it had never flown,” Martin said. “As soon as it flew, everyone started using it.”

Another New Millennium mission, Earth Observation-1, launched in 2000 flying a hyperspectral imager, phased-array communications antennas, lightweight solar panels and a Teflon-coated pulsed plasma thruster for attitude control.

Joseph Cassady, then an engineer of Aerojet’s pulsed plasma thruster, traveled to NASA Goddard Space Flight Center to see the thruster fire in orbit for the first time. When NASA retired EO-1 in 2016, the thruster, affectionately known as Sparky, was still working, said Cassady, now Aerojet Rocketdyne’s executive director for space.

**Failure should be an option**

Not all of New Millennium’s missions fared well. In 1999, NASA lost communications with two Deep Space 2 probes designed to search for ice on Mars’ South Pole.

NASA flew four New Millennium missions laden with technology demonstrations from 1998 to 2006 before cancelling the program in 2009.

“Sometimes, it’s hard to continue those high-risk, high-expense kinds of programs,” Martin said. “Even though people know the technologies are high risk, they get mad at you when they don’t work.”

In the wake of New Millennium, NASA established new programs including the Commercial Reusable Suborbital Research program, later renamed Flight Opportunities, which offers promising technologies rides in commercial launch vehicles, high-altitude balloons and parabolic aircraft.

NASA also sets up public-private partnerships through Tipping Point for technology like ExoTerra’s Hall thruster that’s on the verge of a breakthrough that would benefit government and commercial space activities. To receive a Tipping Point award, companies cover at least 25 percent of the program’s cost.

“We are an example of NASA’s public-private partnership efforts getting technology over the Valley of Death,” VanWoerkom said.

Another initiative, NASA’s Game Changing Development program, ushers lab-proven concepts through component or breadboard testing in a relevant environment, like microgravity.

“We like to focus on high-risk, high-reward technologies, taking the concept or prototype and maturing it and nurturing it to do a ground demonstration or flying to the space station to do testing in a relevant environment,” said LaNitra Tate, NASA’s program executive for Game Changing Development.

“One of the biggest challenges in moving from the Valley of Death or mid-TRLs, from a prototype to demonstration to infusion, is just the cost. We always try to look for avenues where we can
WHERE THE GROWTH IS

MANY YOUNG ENTREPRENEURS RAISING CAPITAL FOR SMALL-SATELLITE STARTUPS AND TESTING NEW TECHNOLOGIES ON CUBESATS have never heard of the space technology Valley of Death. “That’s great. People shouldn’t know about it,” said Gary Martin, a NASA veteran who served as an assistant associate administrator for advanced programs in 2000 and NASA space architect in 2002. “At that time, it was very hard to get through the Valley of Death. There was a huge amount of frustration especially when you could see the innovation out there.”

Some innovative technologies are starting to skirt the Valley of Death thanks to cubesats, suborbital flights and commercial rides to the International Space Station, which are all combining to reduce the cost of sending something into space.

Some of the credit goes to Bob Twiggs and Jordi Puig-Suari, the university professors who invented the cubesat standard in 1999. As of mid-July, 679 of the tiny satellites had been launched, giving university, government and industry researchers a chance to test their inventions in microgravity.

“The key thing about cubesats is your investment to build something for flight is small enough you can afford to take a risk,” said Joseph Cassady, Aerojet Rocketdyne’s executive director for space. “You don’t need a dedicated launch. That has enabled us to test new propulsion systems.”

Suborbital research flights are another piece of the puzzle as new companies entering the market bring down the cost, Martin said.

In addition, entrepreneurs are turning to NanoRacks to help them gain spaceflight heritage by testing technology onboard the International Space Station or launching it on cubesats ejected from the orbiting outpost.

“We have allowed people with a dream and a business plan to show investors, ‘Look it works in space,’” said Jeffrey Manber, NanoRacks chief executive.

Since NanoRacks was established in 2009, it has arranged for more than 180 cubesats to be launched from the space station.

Some startups are raising money by simply showing investors a letter from Manber that affirms they have paid their deposit, are slated to travel to orbit and that NanoRacks engineers believe their technology will pass NASA’s rigorous safety review.

“I feel good about that,” Manber said. “These people are able to realize their ambitions and raise capital because NanoRacks makes space access so easy.”

Inexpensive spaceflight can do more than prove whether new propulsion or communication technologies work in orbit.

“The way I picture the future is how the internet blossomed,” Martin said. “Once they got the infrastructure in place, people could see how easy it was to create an app or to access data in a new way.”

A similar cycle is occurring in the space industry. “When costs fall, people can launch innovative technologies that will piggyback on one another and build new capabilities you can’t even perceive,” Martin said.
mature the technology to meet NASA’s needs, but also to produce products that are affordable and reliable for our applications,” she added.

To achieve those goals, Tate’s office focuses on collaboration with other government agencies, NASA mission directorates, academia and companies.

For example, the Game Changing Development program worked with NASA’s Human Exploration and Operations Mission Directorate, the International Space Station program office and NASA Small Business Innovative Research program to send a 3-D printer developed by the Silicon Valley startup Made In Space to orbit for testing. When those tests showed the printer worked, Made In Space continued developing the technology which astronauts now use to make tools and parts.

The Game Changing Development program had similar success with new ablative materials NASA plans to use for compression pads between the Orion Multipurpose Crew Vehicle’s crew and service modules, and with composite cryogenic fuel tanks Boeing included in its advanced design of the XS-1 experimental spaceplane for the U.S. Defense Advanced Research Projects Agency.

“Our engineers worked very closely with Boeing engineers to develop this great technology you see being implemented by industry and another government agency,” Tate said.

Collaboration is key, said Debra Facktor Lepore, Ball Aerospace vice president and general manager for strategic operations and a veteran of entrepreneurial space startups.

“A lot of people talk about the Valley of Death from the perspective of technology, but the real gap is how you get the idea into the real world where it can be adopted and implemented and used.”

Making that happen requires the right timing, cultural understanding and a successful handoff between transition partners, she added.

By any other name
Matt Fetrow, Air Force Research Laboratory technology engagement lead, doesn’t like the term “Valley of Death,” but agrees technology handoffs can be tricky and said the Air Force begins focusing on transitions long before they occur.

“One way to get through this 'Valley of Death' is to make sure early in the process we begin talking with groups in the [Air Force] acquisition arms and in industry that are going to be taking our technologies and using them for the future products the Air Force needs,” Fetrow said. “There are many handoffs that have to occur and a bunch of different players become involved so there is a risk for things getting dropped or misunderstandings to occur.”

That strategy is proving successful with oscillating heat pipes, a technology AFRL has been developing for years to cool high-power processors and electronics on future Air Force spacecraft.

“We are working with industry to make sure they are involved in the development of that technology,” Fetrow said. “The big primes are following the progress so they are poised to adopt the new technology and put it into systems rapidly, avoiding this ‘Valley of Death’ where technology might lay fallow while the acquisition community and industry figure out what to do with it.”

Oscillating heat pipes, which were tested in an airborne microgravity flight in 2012, are scheduled to make their spaceflight debut this year. Once that testing is completed, the Air Force and its industry partners will have enough confidence to adopt the technology, Fetrow said. SN
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May 25 marked the start of a new era in access to space for small satellites. Perhaps.

On that day, from a launch pad on New Zealand’s North Island, an Electron rocket lifted off for the first time. The rocket, developed by U.S.-New Zealand company Rocket Lab, is designed to place payloads weighing up to 150 kilograms into sun-synchronous orbit. Although there was a problem with the rocket’s upper stage that kept it from reaching orbit, the company still considered the test flight a success.

“On this first flight we’re well ahead of where we needed to be,” Peter Beck, the chief executive of Rocket Lab, said in a call with reporters hours after the launch. “We’ll go into the second test flight with a lot more confidence.”

Beck said at the time that he expected the second launch to take place in about two months. The rocket for that flight, he said, was already in the company’s New Zealand factory.

Rocket Lab, though, has said little about that launch, and its future plans, two months after that test flight. In a mid-June update published on the company’s website, Beck wrote that the company had a “strong understanding” of what went wrong on that launch.
“As soon as we’re ready, we’ll look to make more details publicly available,” he stated. Rocket Lab has not provided an update since, and company spokesperson Catherine Moreau Hammond did not respond to requests for comment on the status of its next launch.

That uncertainty describes the mood of the small launch vehicle industry, and its potential customers, today. There’s a mix of anticipation that vehicles offering more frequent and less expensive access to space for smallsats are finally becoming available, tempered by questions regarding when, or even if, they’ll finally enter service.

State of the small launch industry
Rocket Lab might be at the forefront of this new generation of small launch companies as the first to reach space, if not all the way to orbit, but it’s hardly alone. In recent years dozens of ventures, in the United States and elsewhere, have announced plans to a variety of smallsat launch vehicles.

Three weeks before Rocket Lab Electron’s took off, Vector launched a prototype of its Vector-R small launch vehicle from a test site in California’s Mojave Desert. It didn’t go very high — the planned altitude, the company said, was less than two kilometers — but it met the test objectives of that flight.

James Cantrell, chief executive of Vector, said the company has a campaign of up to six test launches, culminating in an orbital test flight that Rocket Lab tried on its first launch. “It’s an incremental development approach that gradually adds more and more complexity and performance to the vehicle as we go along,” Cantrell said in May.

At that time, Cantrell said a second test flight, going a little higher and a little faster, was planned to take place in about two months. As of late July, that launch was scheduled for early August — three months after the first flight — from the future site of Spaceport Camden on Georgia’s Atlantic coast.

While Rocket Lab and Vector plan to launch their vehicles from any number of different sites on land, others are slowly taking to the skies. Virgin Galactic announced plans for a small launch vehicle, LauncherOne, at the Farnborough International Air Show five years ago. At that time, the rocket was designed to launch from the same WhiteKnightTwo plane developed for its SpaceShipTwo suborbital vehicle.

LauncherOne has undergone many changes since, including a switch to a Boeing 747 Virgin Galactic acquired in late 2015. Modifications of that plane are nearly complete, said David Caponio, mission manager at Virgin Orbit, the part of Virgin Galactic spun off earlier this year to focus on LauncherOne, at the Small Payload Rideshare Symposium in June at the Applied Physics Laboratory in Laurel, Maryland.

The company has also completed an initial “pathfinder” version of LauncherOne. “That’s the vehicle we’ll take underneath the wing of our 747 as we take it through flight test and some other ground tests,” he said. Like its suborbital sibling, though, Virgin Orbit has shied away from providing specific dates for when orbital launches will begin.

That 747, though, is dwarfed by Stratolaunch’s aircraft. The company rolled out the giant plane, whose 117-meter wingspan is the largest in the world, at the end of May from its Mojave, California, hangar. The company said it is planning months of ground tests before the planes make its first flight. “Stratolaunch is on track to perform its first launch demonstration as early as 2019,” chief executive Jean Floyd said in May.

Stratolaunch, backed by Microsoft co-founder Paul Allen, originally planned to use the plane to launch a medium-class rocket. “We started to see trends in what’s happening in the space market: this real blossoming of the smallsat industry,” said Steve Nixon, vice president for strategic development at Stratolaunch, at a June 21 panel session at the Center for Strategic and International Studies (CSIS) in Washington. “We’ve shifted our thinking.”

Stratolaunch, unlike the other companies in this market, is not developing a new launch vehicle, at least for now. It signed an agreement last year with Orbital ATK to use the venerable Pegasus XL rocket, a small launcher that in recent years has flown only sparingly, primarily for NASA. Stratolaunch says its plane is big enough to accommodate three Pegasus rockets on a single flight.

Small rockets, big budgets
Many other small launchers are also in development, with a wide range of technical approaches. CubeCab plans to develop a very small rocket, designed for launching individual cubesats and deployed from an F-104 fighter. CloudIX (as in “cloud nine”) wants to launch small rockets from high-altitude balloons. Interorbital Systems is working on a series of rockets called Neptune intended, appropriately enough, to launch from the ocean.

The biggest differentiator among the various small launcher concepts is not how they’ll be launched, or what propellant they’ll use, or other innovative technologies they’ll incorporate. Instead, it’s how they’ll be funded, since even small rockets aren’t cheap.
Increasing competition has become a major provider with its opportunities on larger vehicles. India in particular has become a major provider with its Polar Satellite Launch Vehicle, launching from more secondary payload opportunities on larger vehicles. India in particular has become a major provider with its Polar Satellite Launch Vehicle, launching primary competition than ever. And yet, as these new vehicles get closer to entering service, they will face more competition than ever. It’s tough to compete with a billionaire.

Growing competition
For years, an affordable small launch vehicle has been the Holy Grail of a smallsat industry starved for access to space. And yet, as these new vehicles get closer to entering service, they will face more competition than ever. That competition comes primarily from more secondary payload opportunities on larger vehicles. India in particular has become a major provider with its Polar Satellite Launch Vehicle, launching 30 smallsats on one PSLV in June and more than 100 on a February PSLV.

Most recently, Russia has entered the rideshare market. Glavkosmos, a subsidiary of Russian state space corporation Roscosmos, launched 72 smallsats as secondary payloads on a Soyuz launch July 14. Glavkosmos plans to launch 40 more smallsats on two Soyuz launches in December.

Another form of rideshare is the International Space Station. For those willing to place their satellites into ISS-like orbits, hitching a ride to the ISS on a cargo ship and deploying from an airlock in the Japanese module has become an attractive option.

Nanoracks, the company that has arranged most of the ISS smallsat deployments to date, is doubling down on this market with its commercial airlock. Scheduled to be attached to the station in December, the airlock will be able to deploy more cubesats at a time than the Japanese module airlock, according to Brock Howe, Nanoracks airlock manager, in a presentation at the ISS Research and Development Conference July 20.

Small launch vehicle developers have criticized rideshares, arguing that it gives smallsat developers limited choices about launch schedules and orbits. Yet those developers, attracted by the affordability and availability of rideshare options, have used them for everything from one-off spacecraft to Planet’s constellation of nearly 200 cubesats.

“There’s an extreme price sensitivity in the market,” acknowledged Richard DalBello, vice president of business development and government affairs at Virgin Galactic, during the CSIS panel.

DalBello said Virgin assumes that, as small launch vehicles enter service, they will attract new customers who place a greater emphasis on controlling when they launch and to what orbit. “We’ll see a maturation of this marketplace, and we’ll see people migrating towards our services,” he said.

There’s also potential demand from the U.S. government, which is working on a growing number of smallsat programs but is largely restricted from taking advantage of foreign rideshare opportunities.

Stratolaunch in particular appears to be targeting the national security market, emphasizing its ability to perform multiple launches on a single flight. “There might be very strong attraction to that kind of thing in the national security market,” Nixon said. In July, U.S. Air Force Secretary Heather Wilson toured the company’s Mojave factory to see how the company “is developing an air-launch platform to make space more accessible,” she tweeted.

Two shakeouts are thus coming to the small launch vehicle industry. One is separating those with the funding and technology to successfully build small rockets from those that lack either or both. The second will be finding those companies who can close their business case with some combination of commercial and government customers. Only then will we know if that new era in space access for smallsats has really arrived. SN
BlackSky is preparing to launch its first four Global high-resolution Earth imaging satellites by the end of the year, but Scott Herman, BlackSky’s vice president for product development, says it would be a mistake to focus on the spacecraft.

“Rockets and satellites are a means to an end,” Herman said. “When we sell to a Fortune 50 company, they don’t care about satellites and sensors. They want to know, ‘What are my competitors doing? How do I build a hedge bet? Are my employees in danger? Is there a labor strike or supply disruption that will impact me?’”

BlackSky, a subsidiary of Seattle-based Spaceflight Industries, plans to answer those questions with the help of its own satellites, other space-based, airborne and shipborne sensors, plus social media and news media.

“Those data sources feed into the engine but they are not the output,” Herman told SpaceNews. “The output is insight and answers about real business problems.”
To provide that insight, BlackSky needs space-based sensors that are inexpensive to operate and can provide the firm with quick access to multiple daily observations over most of the world. Because that type of constellation did not already exist, BlackSky is building it with 60 Global satellites, which weigh about 50 kilograms, to capture imagery of most places in the world every 15 to 45 minutes. The first four satellites are scheduled to launch within the year.

“The Global constellation will be our premier data sources but not the only data source,” Herman said. “Think about BlackSky not in terms of the plumbing but in terms of what we are going to offer: activity monitoring, site monitoring, risk management, threat assessment.”

BlackSky has not yet revealed how it will launch its constellation, but the firm has access to rides through Spaceflight, its sister company and launch broker. In 2016, BlackSky launched the first prototype for its constellation, Pathfinder-1, on an Indian PSLV rocket. The firm planned to launch Pathfinder-2 on a SpaceX Falcon 9 rocket, but scrapped the plan in the wake of multiple launch delays.

“We could keep prototyping or get in the game with revenue-generating satellites,” Herman said.

BlackSky will operate the satellites at various inclinations with the exact plan evolving based on customers and demand. “In general, we’ll be in an inclination where we are flying against the rotation of the Earth, which gives us intra-day revisit over facilities,” Herman said.

The company could obtain multiple daily images with a smaller constellation, but with 60 satellites BlackSky will serve more customers and offer an on-demand service Herman calls “coin-operated tasking,” where a construction foreman, hedge fund manager or infrastructure analyst who wants to know what’s going on at a distant oil refinery could point to the location on a mobile phone and obtain an image with supporting analytics within 90 minutes.

BlackSky would like to offer that 90-minute service for about $90, Jason Andrews, Spaceflight Industries chief executive, said in March at the Satellite 2017 conference in Washington.

BlackSky plans to pay for its constellation through a combination of investment and income generated from ongoing operations.

“Our goal is to use venture capital and other capital to build the first 20 revenue-generating satellites,” Herman said. “At that point, they should be generating enough revenue to fuel the continued build out of the constellation and the maintenance of that constellation.”

To date, BlackSky has raised $53.5 million through its parent company, Spaceflight Industries.

BlackSky already operates an on-demand imagery service called Spectra that gives customers access to archival imagery and the ability to task sensors on high resolution satellites operated by France’s Airbus Defence and Space, South Korea’s SI Imaging Services, China’s Twenty First Century Aerospace Technology Co. and UrtheCast of Canada.

To date, the U.S. government has been BlackSky’s largest customer. “The intent is that we will become more commercially focused over time and while the government will continue to be a very important anchor customer for us, the way they buy our services will change.”

For example, U.S. government customers like the National Geospatial Intelligence Agency will buy subscriptions or purchase BlackSky products and services through the General Services Administration, Herman said.

Chris Quilty, president of Quilty Analytics, agreed the commercial imagery market will overtake the government market. “Given the fact that government spending represents about 85 percent of all [Earth-imagery] spending today, it will take several years for commercial to take the lead,” Quilty said by email. “But eventually, yes, commercial has much greater long-term potential.”

BlackSky’s new enhancement process brings details of this Asian airport into sharper relief. BlackSky combines satellite imagery, social media, news and other data feeds to create timely and relevant insights.
BRIDGESAT, a startup company that spun out from Allied Minds, a Boston incubator focused on commercializing government research projects, has started construction on a network of 10 laser communications ground stations for low-Earth orbit satellites to dump their data at the speed of light, so to speak.

The first such ground station is being built in California, with completion timed for later this year. BridgeSat’s Network Operations Center is under construction in Denver where the company’s headquarters will also be located.

Satellites today communicate with ground terminals using designated radio-frequency (RF) channels. So far, space agencies have executed the largest space-focused laser communications demonstrations. Japan’s Kirari satellite linked in 2005 with Europe’s Artemis satellite and NASA’s Lunar Atmosphere and Dust Environment Explorer carried an experimental payload that beamed data from its orbit around the moon in 2013. Now a rising number of companies are crafting business plans around the technology’s potential.

ESA has two European Data Relay System laser nodes in space today, and wants industry partner Airbus Defence
BridgeSat is counting on LEO satellite operators equipping their satellites with laser modems capable of transmitting data to BridgeSat ground stations at 10 Gbps.

and Space to commercialize the “laser-comm” service.

Analytic Space in Boston is building a network of lasercomm cubesats to optically beam down data collected from remote-sensing spacecraft via RF cross-links; a demonstration satellite is planned for the first half of 2018. LaserLight Communications in Reston, Virginia, which counts the Singapore-owned but Australia-focused satellite operator Optus as a partner, wants to build a constellation of medium-Earth-orbit laser satellites and a large network of ground stations around the world for high-speed internet and data communications.

Leveraging optical communications technology developed by The Aerospace Corp. and Draper, BridgeSat anticipates having all 10 of its ground stations operational by 2019. With that infrastructure, said David Mitlyng, BridgeSat’s senior vice president of business development and strategy, the company will pursue LEO operators as primary customers.

“The target market for us initially is the Earth-observation satellites that are generating a lot of data on orbit,” he said. “[If] they have an imaging payload, [Synthetic Aperture Radar] payload, or a hyperspectral payload — these payloads are generating a lot of data and these companies can’t get that data to the ground.”

At a NASA laser communications workshop July 12, Mitlyng said LEO satellite operators tend to be more tolerant of risk, making them willing to try new technology to downlink data at a faster rate.

“With our ground network of 10 sites around the world, [and a] 10 Gbps lasercomm modem on that satellite, those operators can get two-plus terabytes of data per satellite, per day to the ground,” he said at the conference. “If you have S-band, you are probably getting 50 to 100 Mbps to the ground even when using one of the larger RF ground networks. So this is really being embraced, particularly by the LEO observation guys starting off.”

Unmanned aerial vehicles are another market BridgeSat will pursue, Mitlyng told SpaceNews.

BridgeSat is flying a lasercomm terminal on a multimission demonstration satellite from York Space Systems, expected to launch by year’s end, in order to evaluate the technology smallsat operators will need to have on their spacecraft. Mitlyng said the company intends to deliver spacecraft terminals to customers to enable its business, but that supplying terminals is not a core focus.

“The primary focus for us at BridgeSat is the ground network,” he said. “We are procuring the lasercomm terminals as part of a turnkey contract that we are offering to satellite operators.”

Mitlyng said most of BridgeSat’s ground stations will be located at high latitudes in order to ensure Earth-observation satellites — whose orbits are typically polar — will pass over at least one station during their orbit. Optical lasercomm is extremely sensitive to weather — clouds will block signals — so BridgeSat is building stations in low-cloud areas where the skies are clear at least 50 percent of the time, Mitlyng said.

“Statistically, one of those sites should be clear so that they can do their downlink and get their data to the ground,” he said.

When formed in 2015, BridgeSat initially planned to field a constellation of interlinked relay satellites to route smallsat traffic to accessible ground stations, but Mitlyng said the company scaled down those plans in favor of just the ground network.

Competitor startup Analytical Space is building a network of LEO relay satellites based on the conviction that Earth-observing smallsats will prefer to use idle time over oceans and seas to downlink their data, rather than devote time to downlinking over land areas that could be of interest to customers. David Payne, Analytical Space’s vice president of government and regulatory affairs, declined to comment for this article.

In May, BridgeSat raised $6 million from investors for its network in a Series A financing round, and in July hired Barry Matsumori from Virgin Galactic as chief executive. Mitlyng said the company is preparing for a Series B round, but declined to say how much capital BridgeSat will pursue. SN
31ST ANNUAL CONFERENCE ON SMALL SATELLITES

SMALL SATELLITES

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KEYNOTE

MR. ROBERT CARDILLO
Director of the National Geospatial-Intelligence Agency

CONFERENCE REGISTRATION INCLUDES:
PRE-CONFERENCE WORKSHOP • TECHNICAL SESSIONS
POSTER SESSIONS • STUDENT COMPETITION • EXHIBITS
CONFERENCE LUNCHES • SOCIAL EVENTS
Investment opportunities accelerating in the smallsat and big data arena

It’s rare to witness an industry change in a matter of months. In the case of small satellites and the big data they generate, however, this is exactly what’s happening.

Since writing about the forces driving the “Mega-set” in these pages last August, the smallsat industry has seen increased merger-and-acquisition activity, a substantial increase in spacecraft launched, a myriad of new startups and a wave of new capital. I expect these trends to continue, if not accelerate, for the remainder of 2017 due to three primary drivers:

1. SPACE INVESTMENT
While space investment has been trending upward for the past few years, mainstream venture capitalists are now taking notice. As announced in June, Sequoia was the lead on the Series A round by launch startup Vector. They were joined by Lightspeed Venture Partners and Shasta Ventures. Perhaps more than any single investment in 2017, this signals a milestone moment in the industry, as Sequoia is generally regarded by many as the smartest money in Silicon Valley.

Having two other top-tier venture capital firms as co-investors reinforces just how mainstream space investment has become. Coupled with recent merger-and-acquisition activity, including Planet’s acquisition of the Skybox assets from Google and EagleView’s acquisition of data-and-analytics firm OmniEarth, it also signals the industry is maturing to the point where companies can achieve scale and ultimately provide exits in the public markets. With space having increasing cache in the investment community, and the confluence of smallsats and big data being perhaps the biggest investment opportunity, I expect capital flows to continue to accelerate.

2. OPTIMIZATION OF DOWNLINK
Another trend is the increase in downlink capacity. RBC Signals and Atlas are competitors in the so-called “Uberization” of ground stations and the optimization of the downlink network. Using on-board signal processing and machine-to-machine communications built into the smallsats, downlink can be further optimized.

New startups such as Analytical Space are looking at laser-based downlink technology. These startups are contributing to removing the constraint of getting massive amounts of data to ground in a timely and actionable fashion. As downlink capacity increases, this should further accelerate the industry’s growth and development.

3. SPACE IS WINNING THE PURPOSE BATTLE
Ultimately, capital and people are the forcing functions of smallsats and big data. As the flow of capital continues to increase, the limiting factor has now primarily shifted to the human resources side. In hotbeds for talent such as the San Francisco Bay Area, Seattle and Los Angeles, competing for top talent — especially in the software-related roles — has become every bit as competitive as it was during the tech bubble of the late 1990s.

Here, though, the space industry has an edge. Many of the younger software engineers openly seek positions that are purpose oriented; they are looking for employers that are doing ambitious and bold work that is impacting the world. For many job seekers, purpose really is a needle mover. Millennials, especially, are seeing space as just that opportunity.

Smallsat and big data investment opportunities are the leading edge of a wave that should generate billions of dollars of commerce in the medium term. As mainstream venture capital investors continue to realize this and new models emerge to facilitate the success of the industry, capital flows to the sector will continue to increase. This will lead to more company formations, more merger-and-acquisition activity, public company exits, and ultimately a vibrant and successful industry that has the potential to change the world.

DYLAN TAYLOR IS A LEADING ANGEL INVESTOR IN NEWSPACE COMPANIES, INCLUDING OMNIEARTH, PLANET AND WORLDVIEW.
Sleepwalking away from Mars

As international exploration of Mars heats up, the U.S. may be unintentionally walking away from its leading role at the red planet

The United States is close to sleepwalking through a major decision regarding its robotic Mars exploration plans — a decision that would depart from decades of commitment to exploring the red planet and potentially undermine 20 years of focused taxpayer investment. And this could occur just as NASA is ready to attempt some of the boldest (and scientifically important) Mars missions yet.

NASA’s Mars Exploration Program is one of the agency’s most successful initiatives in recent history. Created in 2000 in response to the twin failures of the Mars Climate Orbiter and Mars Polar Lander missions, this program provided centralized management, a common workforce, and a single organizing principle (beginning with “follow the water”) for an unprecedented campaign of robotic exploration of Mars. The program has overseen seven missions to the red planet — every one a success. The program is now working on an eighth, the Mars 2020 rover, for launch in 2020 (InSight, a stationary lander which launches to Mars in 2018, is managed by NASA’s Discovery Program). Mars 2020 addresses the top recommendation for large-class missions in the current Decadal Survey for planetary science: in addition to in-situ science to seek signs of life, it will prepare a carefully curated selection of drilled samples, store them in advanced sample containers, and deposit them in various “cache depots” on the surface for future retrieval and return. It is the first step of a Mars sample return campaign, one of the most important and enduring goals of the planetary science community, and...
The Mars Atmosphere and Volatile EvolutioN (MAVEN) probe launched in 2013. No new missions have been announced (one mission in development at a time) to a serialized process (multiple missions in various stages of development) to a parallel process (multiple missions in various stages of development) to a serialized one (one mission in development at a time). No new missions have been announced since 2012 — the longest drought in new Mars missions in decades — meaning NASA has no official plans to retrieve the samples it is spending billions of dollars to collect and no official intention to re-fresh its science and telecommunications orbiter network, which is critical for the successful operations of Curiosity, Mars 2020, and any future surface missions.

A new start for a science and telecommunications orbiter is particularly pressing. Twice every Martian day, the Mars Reconnaissance Orbiter (MRO) and Mars Odyssey spacecraft pass over the Curiosity and Opportunity rovers, receiving and then relaying hundreds of megabits of data back to Earth at a very high rate. While the exact rate varies over the year, it is on average thousands of times faster per second than what is possible via the rovers’ direct-to-Earth antennae. These orbiters also provide critical communications coverage during the risky entry, descent, and landing phase of both NASA and European Space Agency spacecraft, and MRO provides peerless high-resolution imaging necessary for selecting safe landing sites for robotic and future human missions.

Both Odyssey and MRO are operating far beyond their intended design lifetimes. Odyssey lost the use of a reaction wheel in 2012, and the loss of its backup would mean the rapid end of its mission. NASA is carefully managing MRO to operate through 2023 to cover the prime mission phase of the Mars 2020 rover, at which point the spacecraft would be 18 years old (it was designed to last five years). NASA does have emergency backup options with its MAVEN spacecraft and ESA’s Trace Gas Orbiter, but both spacecraft are in suboptimal orbits that would greatly complicate operations planning and science return. MAVEN’s orbit could be improved, but at great cost to its science mission. And neither spacecraft can replace the high-resolution imaging capability provided by MRO or be guaranteed to support future sample return efforts.

The director of the Mars Exploration Program, Jim Watzin, declared last year that a new start for a replacement Mars orbiter in fiscal year 2017 was essential. No new start came. The FY 2018 budget request for NASA, while overall very good for planetary science, conspicuously neglected to request a new start, too, going so far as to reduce funding for future Mars missions to a paltry $2.9 million. This amount is down from the $20 million Congress had just allocated for 2017. NASA leadership is understandably hesitant to commit to new projects absent political appointees at the agency. Orbital mechanics, however, do not wait for politics, and this is not a controversial topic.

A new orbiter must launch by 2022 to ensure that data-relay capability is present at Mars by 2023, which would support ongoing operations of Mars 2020 as well as future sample return missions. That’s less than five years away. Absent a new start in FY 2018, a new start request in FY 2019 would leave NASA a mere three years to prep a new orbiter or wait until the 2024 launch window, at which point the spacecraft would arrive at Mars a full two years after the prime mission of Mars 2020. MRO would be 20 years old, should it still be operating. A 2024 launch would also likely push back sample return missions to 2026, if not later.

The highest-priority science goal is to retrieve the samples collected by Mars 2020 later in the decade. There are only a handful of launch opportunities remaining...
that have a realistic chance to reach Mars in time. Yet the FY 2018 budget request proposes to slash the Mars Technology budget line that should otherwise be advancing critical components such as a low-cost, reliable Mars Ascent Vehicle needed to launch the samples into orbit for rendezvous and return to Earth.

The success of NASA at Mars since 2000 has been so total, so absolute, that it is easy to forget how much of our current knowledge of Mars is due to the investments in this program. More than 2,300 peer-reviewed articles have been published using the data generated by these missions. These data confirmed the extended presence of fresh and salty water on ancient Mars. We now know that the planet was once habitable for life as we know it, and how it lost its atmosphere to become a dry, cold world. NASA missions provide unique data for human exploration by measuring radiation levels in transit and on the surface, capturing detailed information during entry, descent, and landing, and mapping out potential resources for use by human explorers. All of this with a program that has never accounted for more than 5 percent of NASA’s total budget.

Congress can take steps in the FY18 appropriations process to address these problems. It can direct NASA to begin formulation activities for a new Mars orbiter and provide proper Phase A funding. Similar support for the Mars program and its science goals could be expressed in a new authorization bill as well. Quick action by Congress this year would give NASA a fighting chance to make the 2022 launch window and help ensure continuous high-speed communications for Mars 2020 and future missions.

Compellingly, there is ample opportunity to leverage the work done for the now-defunct Asteroid Redirect Mission by utilizing solar electric propulsion (SEP) on a new Mars orbiter. The orbital flexibility provided by this technology would advance the Mars sample return campaign while at the same time providing communications coverage, excellent science, and technical experience using SEP in the Martian system. Congress should also direct additional funding into technology maturation efforts related to sample return, particularly for a Mars Ascent Vehicle, in order to lower the risk and future costs.

House appropriators in mid-July took an important step by adding $62 million for a Mars orbiter in support of a 2022 launch date. The Senate should embrace this bipartisan action in the House, as well as support critical technology investments for sample return.

An unprecedented fleet of spacecraft from international space agencies is poised to launch to Mars in the 2020s. Europe, China, the United Arab Emirates, India, and Japan are all working on Mars missions slated for the early 2020s. China has also expressed interest in pursuing sample return from Mars in the late 2020s. The United States should not cede its global leadership at Mars during this burst of activity. Instead, we should continue to lead in our scientific exploration while leveraging our international relationships to help enable and support this worldwide fascination with the red planet.

With every passing day, the 2022 launch window for Mars grows closer, as do the launch windows for 2024, 2026, and 2029. The United States, through inaction and distraction, risks sleepwalking through a major decision on its robotic Mars program. Congress, the new presidential administration, and NASA must work to ensure proper scientific return on decades of taxpayer investment.

Decisive action now could mean the difference between a decade of breathtaking scientific discoveries or the sad public spectacle of watching NASA’s Mars fleet slowly die of old age while precious samples atrophy on the surface, waiting for a trip home that may never come. SN

Treating space policy as a team sport won’t get us there any faster

Recently had the opportunity to participate in a great panel session discussing the role of commercial space in returning America to the moon. The panel was part of the International Space Development Conference, hosted by the National Space Society. The NSS crowd was enthusiastic and clearly many of them were excited by the visions of Elon Musk, Jeff Bezos and other NewSpace entrepreneurs. I share that enthusiasm and look forward to an active future in space that only a truly competitive market can bring. However, my recent service on President Donald Trump’s transition team at NASA has led me to understand that treating space policy as though it were a team sport will not get us there. The future is complex and challenging and we will need the amazing capabilities and scale of the traditional players to get there. In that spirit, I’d like to offer some unsolicited advice to friends in both camps.

It’s great that NASA appears to be surviving this year’s government budget cutting unscathed. The House Appropriations Committee in July recommended a nearly $19.9 billion budget for NASA for 2018, about $800 million more than the Trump administration requested and nearly $300 million more than Congress approved for 2017.

Assuming NASA ultimately gets the $19.9 billion, that isn’t the sort of increase that will take us back to the moon and get us to Mars via traditional methods. Doing bigger and bolder things with nominally fixed NASA budgets will require greater use of commercial tools like Other Transaction Authority (OTA) agreements and milestone-based prizes. The Trump administration clearly recognizes that and has called for sustaining America’s leadership in space via public-private partnerships.

MARKET INCENTIVES

Nobody can deny any longer that well-managed commercial partnerships deliver the goods. NASA’s Commercial Orbital Transportation Services (COTS) program, designed to produce options for International Space Station resupply, produced wondrous results. We got two great ISS resupply systems and something more. SpaceX’s aggressive pricing and launch cadence is recapturing a large portion of the international commercial launch business for America. Just as importantly, this effort spurred incumbent United Launch Alliance to reduce costs and develop innovative new designs. The visionary commercial plans that ULA CEO Tory Bruno has laid out are nothing short of revolutionary.

What makes a program truly “commercial” isn’t simply the nature of the company or how NASA or the Defense Department pays them; commercial is when we end up with a self-sustaining market after the program is complete. Competitive markets drive efficiency improvements that continue to reduce the space agency’s operating costs without additional capital investment. The $800 million

America’s future in space is both commercial and traditional

NASA’s proposed Europa Lander is a good example of the kind of science-driven missions only governments can currently pursue.
outlay for COTS has unleashed forces that will save NASA, DoD and the National Reconnaissance Office, many billions of dollars over the next decade.

While that’s impressive, success in space also requires making better use of our incumbent players and improving our traditional contracting tools. There are many important science, exploration and defense missions that simply lack post-mission commercial potential. The search for life on Europa is a perfect example. It’s potentially the most game changing scientific investigation in history, but the distance to Jupiter’s icy moon and the challenging radiation environment on its surface make this a unique and extremely risky mission.

NOT EVERYTHING CAN BE COMMERCIALIZED

There are no commercial analogs to this task and no market demand. The development process for the one-off Clipper orbiter and Europa lander is so fraught with unknowns that setting a fixed price and demanding matching private investment would only drive away vendors. Private investors are rightly focused on promising economic opportunities on more accessible worlds: the moon, Mars and near-Earth asteroids.

Europa is a mission we should do and we will be able to count on NASA’s Jet Propulsion Laboratory to design the vehicles and work with their traditional vendors to deliver the goods. JPL’s reputation is well earned and a major reason for their success has been the Federally Funded Research and Development Center (FFRDC) model they operate under with the California Institute of Technology. CalTech is able to recruit the brightest scientists and engineers and move them between programs in a way that traditional NASA centers, bound by tortuous federal rules and labor contracts, cannot. While FFRDC isn’t perfect for every application, it’s worth looking for additional applications of this model.

Many NewSpace advocates chose not only to promote commercial solutions but to also attack large traditional programs that compete for space funding. They have been particularly aggressive with NASA’s next-generation launch vehicle, the massive Space Launch System. As with most space projects, the SLS flight schedule keeps slipping (much like those commercial space tourism vehicles we are eagerly awaiting). The cost-plus contracting mechanism it enjoys has also allowed SLS to run over budget (like nearly all military aircraft in recent memory).

All that said, nothing in our current rocket livery can throw the Europa Clipper directly to Jupiter the way SLS could, saving years on gravity-assist visits to Venus and Earth. The Europa lander is going to be so big and requires so much fuel to slow down and land on a distant, airless moon that even ULA’s Delta 4 Heavy rocket apparently can’t do the job. So, while SLS is expensive, it has unique applications and provides America with unrivaled launch capacity. We can maximize our investment in SLS by utilizing it to its fullest capacity. Increasing the launch cadence and finding ways to utilize its facilities and personnel between launches could reduce the otherwise burdensome fixed costs of this massive project.

The commercial folks will rightly point out that really big heavy-lift vehicles from Blue Origin and SpaceX are in the works. SpaceX’s Falcon Heavy is set to fly this year. The traditionalist will then retort that it is also well behind schedule and that SpaceX’s promised 65-ton LEO lift capacity comes in at about half that of a fully configured SLS Block 2. The
commercial folks will respond that SLS’s Exploratorium Upper Stage and the Advanced Boosters required to give the Block 2 all that power don’t exist yet; the Block 1 SLS uses an existing Delta 4 upper stage and five-segment boosters derived from the space shuttle’s solid rocket booster design. And, of course, the traditional folks have good explanations for that and so it goes.

This back and forth was a really fun conversation the first half dozen times, but at some point, it became a needless distraction and then unfortunate source of ugly conflict among Americans who all share a vision of humankind’s future in space. There is a way to get beyond this argument.

TEACHING ELEPHANTS TO DANCE

The first step in solving a problem is admitting it exists and I’d ask the traditional players to stop dismissing the achievements of upstart NewSpace entrepreneurs. It’s obvious that they are facing serious, determined, brilliant and well-funded competitors. Companies like SpaceX, Virgin Orbit and Blue Origin are attracting the best and brightest young minds. Many of my finest students at the University of Southern California have turned down higher paying jobs from Google, Apple and big traditional space firms to work long hours under demanding conditions at these NewSpace startups. Stability, great benefits and generous retirement plans are no longer the source of competitive advantage in recruiting — inspiration is.

The execs at the traditional firms should all be required to read Lou Gerstner’s “Elephants Can Dance,” the story of how that visionary IBM chief executive reinvented a great American firm in the face of Silicon Valley disruption. History has repeatedly demonstrated that the worst possible strategy for incumbent firms facing market change is to live in denial, attempt to stop time and to attempt to defend their turf based on past achievements. This defensive posture produces a dangerous culture of entitlement and inevitably fails. When the Silicon Valley folks and their disruptive business model show up in your market, you must adapt; ask your taxi driver about Uber or your video rental store about Netflix. To survive and flourish during disruption incumbents must recapture the innovation that made their firms great, shake up management, reduce costs in meaningful ways, and show more vision. Traditional space already has the perfect model for all that in Tory Bruno, whose visionary new ULA is still a joint venture of Boeing and Lockheed Martin.

FAN BOYS AND DINOSAURS

For the commercial firms and their raucous fan boys, let me suggest that they stick to what is clearly working so well. Be humble when you succeed, quickly fix things when you fail and stop worrying about what you think the other team is doing wrong. We understand why you believe that you’re the young mammals of the Cretaceous Period and the traditional folks are the soon to be extinct dinosaurs. That may indeed be the case, but let me remind my friends that it was the environment that selected the dinosaurs out. Tyrannosaurus rex was not eaten by those little mammals, who wisely scurried from its path. So, please stop poking the dinosaurs; they may take my advice and evolve. I’ve seen an eagle swoop out of the sky and seize a rabbit; a stunning reminder to us mammals that the theropods never really vanished.

In the end, the American taxpayer expects our investment in space to deliver awesome science, bold achievements in human exploration, unbeatable national security and technological spinoffs that make their lives better. For 50 years, America’s space program and the amazing companies that built it have delivered on that promise. With the introduction of new blood, fresh ideas and more intense competition our future in space will only be brighter. Enough with the infighting, together we can go!

### AUGUST

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### OCTOBER

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<td>2-3</td>
<td>Satellite Innovation Symposium</td>
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<td>Women in Aerospace Awards Dinner</td>
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<td>Space Tech Expo Europe</td>
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### NOVEMBER

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<tr>
<td>7-9</td>
<td>19th Annual Global MilSatCom</td>
<td>London, UK</td>
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<td>A New Space Age</td>
<td>Seattle, WA</td>
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**A sample list of the 30+ speakers attending**

- Tarr, CEO, DigitalGlobe
- Francois Lombard, SVP, Head of Intelligence Business, Airbus Defence and Space
- David Belton, General Manager, MDA Geospatial
- Massimo Comparini, CEO, e-Geos
- David Soloff, CEO and Co-Founder, Premise Data
- Philip Briscoe, Coo, Rezatec
- Peter Platzer, CEO, Spire
- Jason Andrews, President & CEO, BlackSky
- Andy Wild, CRO, Planet
- Wade Larson, President & COO, UrtheCast
- Bobby Machinski, CEO, Hera Systems
- Emiliano Kargieman, CEO, Satellogic
- Martyna Galkowska, Deputy Head of Remote Sensing Center, Institute of Geodesy and Cartography (Poland)
- Abd-Alla Gad, EU-SUDSIE Project Coordinator, Environmental Studies & Land Use, Egyptian Authority For Remote Sensing And Space Science (NARSS)
- Dr. Ho-Pen Chang, Program Director of FORMOSAT-5, National Space Organization of Taiwan (NSPO)
- Mathilde Royer, SVP, Earth Observation, Navigation & Science, Airbus Defence & Space
- Debra Facktor Lepore, VP & GM, Strategic Operations, Ball Aerospace
- Steven Krekel, Unit Manager Remote Sensing, VITO – Flemish Institute for Technological Research
- Pascal Legai, Director, European Union Satellite Centre
- Peter Volk, CEO, OAF AG
- Rolf Skatteboe, CEO, KSAT
- Christopher Richins, CEO, RBC Signals

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**View the full program and register at:**

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What do Target, Tupperware and Michael J. Fox have in common? Since you’re reading this in SpaceNews, you’d likely assume that they are, in some unforeseen way, linked by space. And you’re right: the department store, housewares company and the actor — specifically, his foundation — are all among the latest, and increasingly diverse, organizations doing research on the International Space Station.

Of the three, it’s the Michael J. Fox Foundation that is perhaps the most traditional user of the station. The foundation, which supports research into Parkinson’s disease, is funding a protein crystal growth experiment that will fly to the ISS in August. The experiment will attempt to grow crystals of LRRK2, a key protein linked to the disorder, to allow researchers to better understand its structure and develop treatments for it.

Tupperware is a little less obvious a fit. “Tupperware is a brand not normally associated with the space industry,” admitted David Kusuma, vice president of product development at the company, during a panel at the ISS Research and Development Conference in Washington July 19. While Tupperware is best known for its wide range of food containers, it is involved with a project called Passive Orbital Nutrient Delivery System (PONDS), a next-generation greenhouse for the station. Tupperware is working with aerospace technology company Techshot on PONDS, and is responsible for fabricating hardware for it using its experience with making “food-safe” plastics.

Tupperware, as it turns out, is not new to space. Kusuma said it supported a European experiment that flew on the ISS a decade ago, but PONDS is its biggest project to date involving space research.

Target, though, is a newcomer to space. At the conference, the Center for the Advancement of Science in Space (CASIS), the organization that manages the portion of the ISS designated a national laboratory, announced that Target was sponsoring a new Cotton Sustainability Challenge. This competition will support ISS experiments that could result in better ways to grow cotton on Earth that require less water or other resources.

But why Target?

“Target is such a good partner from a social responsibility standpoint,” said Cynthia Bouthot, director of commercial innovation at CASIS. “What Target is doing is looking out at their whole supply chain from a sustainability standpoint, trying to learn something through this challenge on the space station and bring it back down here on the Earth for that more sustainable production.”

CASIS highlighted all three of these space station users at the conference as evidence of the growing interest in using the station for an ever-expanding array of applications. That interest, CASIS argued, is growing, based on the size of the conference. More than 1,000 people attended this year’s event, although that may have been due to its star power: Kusuma’s panel, for example, was wedged between talks by Robert Bigelow and Elon Musk, who each spent little time talking about ISS research itself.

But, just as the appearance of Bigelow and Musk drew people to the conference, the ability to do research on the station has a novelty of its own that can be a selling point for companies that otherwise aren’t associated with space. After all, if Tupperware can fly hardware on the station, its food containers can probably handle your leftovers. And Target can argue it’s willing to go to extreme lengths — to space — to help ease any guilt you might have about the environmental impact of the inexpensive clothes you buy at their stores.

Ultimately, though, research on the ISS or any future space stations must stand on its own benefits, not the short-term publicity it generates. If it can, perhaps, lead to treatments for Parkinson’s or other diseases, there will be plenty of attendees at future ISS research conferences, regardless of who’s speaking. SN
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  Head Biophysics Group, Radiation Biology, German Aerospace Center- DLR, Institute of Aerospace Medicine

- **Joshua Brost**
  Director of Government Business Development, SpaceX

- **Ariane Cornell**
  Head of Astronaut Strategy & Sales and Head of North American New Glenn Sales, Blue Origin

- **Wayne Hale**
  Director of Human Spaceflight & Energy Services, Special Aerospace Services

- **Bjarke Ingels**
  Founding Partner and Creative Director, Bjarke Ingels Group (BIG)

- **Fred Kennedy**
  Deputy Director, Tactical Technology Office, Defense Advanced Research Projects Agency (DARPA)

- **Mark Sirangelo**
  Corporate Vice President, Sierra Nevada Corporation’s Space Systems

- **Jeffrey Smith**
  Chief, Science and Technology Projects for Exploration Division at NASA KSC

- **Andrew Zolli**
  Vice President of Global Impact Initiatives, Planet, Inc.

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