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- **Government Leader (Civil) of the Year** - Bill Gerstenmaier, NASA Associate Administrator
- **Government Leader (Military) of the Year** - Heather Wilson, U.S. Air Force Secretary
- **Unsung Hero of the Year** - Tom Mueller, SpaceX rocket designer and founding employee
- **Deal of the Year** - U.S. Air Force divides $2.3B in LSA awards among Blue Origin, Northrop Grumman and United Launch Alliance

2121 Crystal Drive, Suite 800, Arlington, Virginia, 22202 USA
T: +1 (703) 414-5300  E: CAES.BD@cobham.com
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**ON THE COVER:** SPACENEWS ILLUSTRATION THIS PAGE: SPACENEWS ILLUSTRATION

**PUBLISHING NOTE:** Our last issue of the year comes out Dec. 17 and will feature the return of the SpaceNews wall calendar. Our first issue of 2019 will be published Jan. 21.
NASA SELECTS NINE COMPANIES FOR COMMERCIAL LUNAR LANDER PROGRAM

NASA announced Nov. 29 the selection of nine companies eligible for future contracts to transport payloads to the moon. The companies, ranging from Lockheed Martin to small startups, were selected for NASA’s Commercial Lunar Payload Services (CLPS) program, under which NASA will buy payload space on commercial landers these companies will develop for scientific instruments and other payloads. While the maximum value of all the contracts is $2.6 billion over 10 years, for now each company will receive only a small amount of funding to develop a payload users’ guide, and will then be eligible to compete for task orders under CLPS to fly those payloads.

PSLV PARTY BUS

The Nov. 28 launch of India’s PSLV rocket gave a boost to several Internet-of-Things (IoT) satellite companies. Thirty small satellites flew as secondary payloads, including satellites from Kepler Communications, Fleet, and Hiber, who are all targeting the IoT market. Hiber’s first satellite was on this launch, and the Dutch company plans to deploy a constellation of dozens for IoT connectivity. Fleet and Kepler are planning constellations of 100 or more, and the two companies now have a combined five satellites in orbit.
SPACEX COMMERCIAL CREW DEMO COULD SLIP, NASA WARNS

NASA Administrator Jim Bridenstine is skeptical SpaceX will fly its first commercial crew demonstration mission in January as originally planned. Bridenstine said that the uncrewed mission could slip until spring because of issues with the spacecraft’s parachutes. Despite the potential delay, he said he still expected SpaceX and Boeing to be able to perform their uncrewed and crewed test flights before year’s end. Bridenstine also says he personally ordered the safety reviews at Boeing and SpaceX revealed Nov. 20. He said the appearance by SpaceX’s Elon Musk on a podcast where he briefly smoked marijuana and drank whiskey “was not helpful, and that did not inspire confidence.” He added, though, that he planned to seek a safety review even before the podcast, saying safety issues in general were on his mind after reading the accident investigation reports for Apollo 1, Challenger and Columbia.

NASA astronauts (from left) Bob Behnken, Doug Hurley, Mike Hopkins and Victor Glover pose for a portrait in front of the SpaceX Dragon Commercial Crew vehicle mock up at NASA’s Johnson Space Center in Houston in August.

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NASA's InSight spacecraft successfully landed on Mars Nov. 26, completing a journey of nearly 500 million kilometers and starting a mission to study the planet's interior.

The Lockheed Martin-built spacecraft touched down on Elysium Planitia near the Martian equator at 2:52:59 p.m. Eastern. Telemetry from the lander, relayed by a pair of cubesats called Mars Cube One (MarCO) passing by the planet, confirmed that the lander had made it safely to the surface. It transmitted an X-band “beep” seven minutes after touchdown, as planned, confirming it was operating. NASA announced about seven hours after landing that InSight had deployed its two solar arrays.

“Once we get to the surface, InSight is a slow-motion mission,” said Tom Hoffman, InSight project manager at the Jet Propulsion Laboratory, during a news conference a little more than two hours after landing, but noted he didn’t have the precise location yet of where the spacecraft touched down.

“We got very close to the bullseye” in terms of the landing site location, said Tom Hoffman, InSight project manager at the Jet Propulsion Laboratory, during a news conference a little more than two hours after landing, but noted he didn’t have the precise location yet of where the spacecraft touched down.

The landing site features level terrain with very few rocks, the topography sought by project scientists in order to most effectively be able to deploy the spacecraft’s main instruments. “We’re at less than 2 degrees of tilt,” said Bruce Banerdt, principal investigator for InSight at JPL. “It makes our job very easy to do. It’s time to get going.”

With the landing, InSight will begin a prime mission scheduled to last two years to study the composition and structure of the planet’s interior. The spacecraft is equipped with two instruments, a seismometer and a heat flow probe, to carry out those measurements.

However, it will be several months before InSight starts collecting data from those instruments because of the time required to identify the best locations around the lander to place the instruments, and then to install them in those locations.

“Once we get to the surface, InSight is a slow-motion mission,” Banerdt said at a briefing Nov. 25. “We take our time getting our instruments down. It’ll probably take at least two, probably more like three months, maybe even longer to get our instruments down. It’s going to us take a month or so to get them all calibrated.”

He said it would take nearly the full primary mission to get answers, depending on how many “marsquakes” the seismometer is able to measure. “The more marsquakes, the better,” he said. “The more shaking it does, the better we can see the inside.” Problems with the seismometer, provided by the French space agency CNES, caused InSight to miss its original launch window in March 2016. The instrument was redesigned and completed in time to allow InSight to lift off on an Atlas 5 from Vandenberg Air Force Base in California May 5.

InSight has an unusual degree of reliance on international partners for a NASA science mission. In addition to the seismometer, the heat flow probe was provided by the German space agency DLR. Those international contributions accounted for about $180 million of the mission’s overall cost, including launch and operations, of nearly $1 billion.
MarCO’s Insight landing assist validates use of cubesats on deep space missions

The success a pair of cubesats achieved in relaying telemetry from NASA’s InSight Mars lander demonstrates that such spacecraft can play increasing roles in future deep space missions, spacecraft designers believe.

The twin Mars Cube One, or MarCO, cubesats launched as secondary payloads with the InSight spacecraft in May and flew by Mars as InSight landed on the planet. The cubesats, intended primarily as technology demonstrations, were designed to provide a real-time relay of telemetry from InSight during landing, without which it would have been hours before controllers knew if the spacecraft had landed successfully.

Although NASA emphasized the experimental nature of the cubesats prior to the landing, the MarCO spacecraft performed as intended, receiving the UHF telemetry from InSight during its entry, descent and landing phase and rebroadcasting it at X-band frequencies received by NASA’s Deep Space Network.

“MarCO was there to relay information back from InSight in real time, and we did that extraordinarily well,” said Andy Klesh, MarCO chief engineer. “We had no dropped frames, no dropped data along the way.”

In addition to the InSight telemetry, one of the cubesats, MarCO-B, returned an image of Mars taken shortly after the Nov. 26 landing, as the spacecraft was passing 6,000 kilometers from the planet. The MarCO primary mission lasts about two weeks beyond the landing. The two spacecraft will return other data collected during the flyby, including telemetry about the health of the cubesats themselves and potentially other images of Mars taken during close approach.

The MarCO-A cubesat also indirectly performed science during the flyby as its radio signals were occluded by the planet as it passed behind Mars. Measurement of the changes in signal as it passed through the planet’s atmosphere just before and after being blocked by the planet itself could provide information about atmospheric conditions. “With that, we’re actually doing atmospheric science as we’re passing by Mars, and we’ll be digging through that data as well,” Klesh said.

The success of MarCO demonstrates that such small satellites — each MarCO satellite is a six-unit cubesat — can perform useful missions beyond Earth orbit, opening up new opportunities for such spacecraft in the future. “This team of really mostly part-timers on the project has proven the technology we were trying to demonstrate with this mission, being able to support a large craft like InSight,” he said. “We can take a smaller, focused, more riskier mission out into the solar system and take advantage of new opportunities.”

NASA has increasingly shown an interest in using cubesats and other small satellites for a variety of science missions, initially in Earth science and heliophysics but now also astrophysics and planetary science. NASA hasn’t committed to a MarCO-like mission for its next Mars lander, the Mars 2020 rover, but Klesh said the success of MarCO has opened the door to that and other uses of smallsats in deep space.

“We’ve shown that this type of craft can support these types of missions, should that be needed,” he said. “We’ll be working on opportunities as we go to see where they’re necessary and how well we can support them in the future.” — Jeff Foust

Engineer Joel Steinkraus uses sunlight to test the solar arrays on one of the Mars Cube One (MarCO) spacecraft that relayed Insight telemetry.
Four hours after the Camp Fire broke out Nov. 8, one of Planet’s Dove satellites captured an image of the deadly Northern California blaze, not because it was tasked to observe the area or detect fire but because the company gathers daily, global Earth imagery with more than 130 satellites.

The California Office of Emergency Services noticed the image Planet tweeted and immediately contacted the San Francisco company. Within 24 hours, Planet employees were in the agency’s mission control center, providing access to medium-resolution imagery from Planet’s shoebox-size Doves as well as high-resolution and near-infrared imagery from its dorm-room-refrigerator-size SkySats.

Now, Planet and California’s Office of Emergency Services are drafting a contract. Emergency managers may opt for a paid subscription during California’s fire season, said Robbie Schingler, Planet co-founder and chief strategy officer.

That’s how Planet’s customer base grows. Planet or a prospective client spots a new application for the company’s data. Customers then sign up for subscriptions.

“That way, we sell one thing again and again, which then decreases the cost per user and expands the number of people who can actually afford it,” Schingler said. “We are playing a long game of building a subscription business, which is predictable, recurring revenue to build a resilient organization that can continue to invest in products two or three years in the future.”

It’s a far cry from the traditional remote...
sensing business, dominated by government agencies tasking large satellites to capture scenes of particular places on specific timetables. Instead, Planet draws on cloud computing and machine learning to create data products that, in many cases, include no pictures at all.

Agriculture customers, for example, may prefer to see changes in the health of crops on graphs instead of false-color imagery created by the Normalized Differential Vegetation Index, an indicator of plant health based on the way plants reflect light in different wavelengths.

"Every industry has indicators like this," Schingler said. "It tells them something is about to happen and it helps them make a better decision."

As a private company, Planet holds financial information close to the vest. Interviews with employees, customers and investors paint a picture of a company growing steadily while seeking to dramatically expand the market for data captured via satellite.

Not content to fight for a share of the existing $5 billion geospatial information services market, Planet is introducing data products to individuals, businesses and government agencies around the world who never consumed geospatial data before.

"The real opportunity is to deliver insight in a way that helps anyone make a better decision," Schingler said. "That's when we will evolve this smaller industry, which is about a $5 billion addressable market, to be part of the business-to-business information services economy, a $100 billion, $200 billion industry. That's what we're focused on."

Since it was founded in 2010, investors have poured $300 million into Planet, a startup that dispensed with aerospace traditions, favoring consumer electronics and agile development to radiation hardening and flight heritage.

"They are the poster child for the new way of doing aerospace," said Steve Jurvetson, one of the first venture capitalists to back Planet and SpaceX. "As one of the earliest investors, I was investing when Planet was valued in the single digit millions, now it’s in the billions. Just like SpaceX, there has never been a reversal in Planet’s price per share."

Planet employs 422 people around the world, including 191 in San Francisco, where its move Nov. 26 into spacious headquarters brings its management, engineering, sales and testing operations under one roof for the first time.

Planet won’t reveal annual revenues, but Trevor Hammond, chief of staff, says 2017 sales were twice those of 2016. The firm completed 180 agreements in the third quarter of 2018, including new deals and expansion of previous contracts.

Agriculture is Planet’s largest market segment. "We essentially have a contract with every major agriculture company," Schingler said. "They keep renewing and upselling."

Next largest is the firm’s government business. Civil, defense and intelligence agencies comprise about 70 percent of the market for Earth observation data. Planet has sales agreements with government agencies in Japan, Germany, Canada, the Netherlands, Australia, Thailand and Brazil.

"It’s hard to get those contracts initially," Schingler said, "but once you do, there are quite a few things you can do together."

In Europe, for example, Planet joined an Airbus-led consortium supplying high-resolution imagery through the Copernicus Earth observation program, an ambitious European Commission campaign to offer a wide array of free data. Planet then won additional contracts to supply data to Copernicus Emergency Management, Land Monitoring and Security programs.

In late September, NASA’s Earth Science Division announced agreements to purchase data from Planet, DigitalGlobe and Spire under contracts with a maximum value of $7 million over five years. A few days later, the National Geospatial-Intelligence Agency announced a $5.9 million six-month contract for Planet data. The contract, which includes an option for another six months, is Planet’s third NGA deal in three years.

To make inroads in smaller countries, Planet’s business development team is working with a country in the Middle East.
which it declined to name, to demonstrate the value of its data products.

“Rather than a large initial contract value, we’re doing a three- to six-month pilot engagement that includes training to fully empower them and show the return on investment,” Schingler said. “The goal is to prove that return on investment in a month so it turns into an enterprise contract. We do those for people we believe will become enterprise customers for anywhere on the order of a decade.”

Not all of the deals revolve around imagery. Increasingly, Planet customers subscribe to spatial information feeds, updates on objects in specific areas of the world. A government agency could, for instance, track ship movement in the North Sea.

Through machine learning algorithms, Planet keeps tabs on roads, buildings, ships and planes globally. Energy customers subscribe to alerts showing new roads near Oklahoma’s Cushing Oil Field. Brazilian forest managers get alerts when roads appear, an early indicator of illegal logging.

“The first thing that goes in is an illegal road,” Schingler said. “They start thinning trees from there.”

No one would task a satellite to find roads in Oklahoma. Since Planet’s algorithms highlight road changes anyway, it’s an easy product to offer, Schingler said.

Planet alone can’t come up with all the possible applications for its imagery even as it expands its sales and marketing staff.

“The most exciting part is discovery,” Jurvetson said. “What if I can see every water reservoir in the world or every new housing start? What can I do with that data?”

Partners build spatial information products on top of Planet’s data to serve specific markets.

“We see ourselves as helping to enable companies to go further up the value chain to come up with products or information feeds that are specific to the needs of the customers in a particular market vertical,” Schingler said. SN

Forecasts call for rapid growth in Earth observation market

Two consulting firms anticipate strong demand for commercial Earth observation products and services in the next decade as satellite constellations offer an increasing array of optical, radar, hyperspectral and video imagery and data.

From 2017 to 2027, Northern Sky Research (NSR) expects annual demand for Earth observation data and services to rise from just over $3 billion to $6.9 billion. By 2027 small satellites will claim 24 percent of the revenue compared with 11 percent in 2017, according to “Satellite-Based Earth Observation, 10th Edition” by Cambridge, Massachusetts-based NSR.

“Earth observation revenues are growing, due to high-volume imagery sales and a growing focus on analytics from high-resolution and medium-resolution imagery,” NSR said in the report published Nov. 19.

NSR expects sales of imagery and data to expand only slightly while revenues from analytics and big data products and services jump fourfold over the decade.

Euroconsult reached similar conclusions in “Satellite-Based Earth Observation: Market Prospects to 2027,” although it sees data and services as two distinct markets.

“The commercial Earth observation data market could reach $2.4 billion in 2027, driven by a mixture of defense and new commercial markets and supported by the arrival of new constellation operators,” according to the report released Oct. 19 by the Paris-based consulting firm.

Meanwhile, the market for value-added services, such as crop forecasts or disaster monitoring, will top $5.7 billion under Euroconsult’s conservative forecast or grow to $9 billion in an “upside scenario” that envisions the new supply of space-based data prompting customers to adopt Earth observation for jobs like high-frequency change detection.

Demand for imagery with resolution better than 1 meter will grow far more quickly than demand for lower resolution data products, according to Euroconsult. By 2027, the market for this very-high-resolution imagery will be worth nearly $1.7 billion, compared with $938 million in 2017, according to Euroconsult. — Debra Werner

“The real opportunity is to deliver insight in a way that helps anyone make a better decision,” said Robbie Schingler, Planet co-founder and chief strategy officer, shown above speaking at GEOINT 2017 in San Antonio, Texas. “That’s when we will evolve this smaller industry, which is about a $5 billion addressable market, to be part of the business-to-business information services economy, a $100 billion, $200 billion industry. That’s what we’re focused on.”
Amazon-Lockheed venture casts shadow on ground station startups

A joint effort by Amazon and Lockheed Martin to provide ground station services to satellite startups could pose a competitive threat to other startups offering similar solutions.

During a presentation at the AWS re:Invent conference Nov. 27 in Las Vegas, Amazon Web Services (AWS) announced a partnership with Lockheed Martin to provide satellite ground stations as a service, similar to other cloud computing applications it offers to its customers. The AWS Ground Station service will use a network of ground stations called Verge developed by Lockheed.

The creation of AWS Ground Station was based on feedback from customers who use other AWS cloud computing services, such as storage and processing, for satellite data. “What these customers tell us all the time is that it’s not so simple dealing with satellites if you actually want to be able to upload and download data,” said Andy Jassy, chief executive of AWS, during the presentation.

Jassy described AWS Ground Station as the “world’s first fully managed ground station as a service,” accessible to AWS customers in much the same way as other services. Customers can schedule communication passes through the system, paying for only the services they need.

While the network today consists of just a handful of S-band antennas in the Denver area, the system will expand globally and include X-band frequencies. The ground stations will be closely tied to AWS data centers, allowing access to data downlinked from satellites within seconds, Jassy said. “It’s a total game-changer in how people can interact with satellites.”

The new service pits AWS against a number of major operators of satellite ground stations. However, it may be a more competitive threat to some startups offering similar services but without the resources of Amazon or Lockheed Martin.

One such company, Seattle-based RBC Signals, offers satellite customers access to more than 60 antennas in over 40 locations around the world at a variety of frequencies. The company’s network includes antennas from a group of partners, taking advantage of excess capacity on them, along with its own ground stations, such as one the company completed in September in Alaska.

Christopher Richins, chief executive of RBC Signals, saw the AWS Ground Station announcement more as a confirmation of its own business model than as a competitive threat. “This is a wonderful validation of the magnitude of the opportunity in managed ground station services for satellite operators,” he said in a statement to SpaceNews the day of the announcement.

RBC Signals is an early-stage company and is currently raising a Series A round of undisclosed size. In October, the company hired as president and chief operating officer Ron Faith, a former executive with companies working in the cloud computing and communications fields.

Tokyo-based Infostellar is another startup that offers ground station services to satellite operators, using a cloud computing platform to link those operators with a network of ground stations with excess capacity. The company raised $7.3 million in a Series A round in September 2017.

“This announcement from Amazon spotlights the necessity of our business,” said Kazuo Ishigame, chief operating officer of Infostellar, in a Nov. 29 statement to SpaceNews. “Until now, the ground segment has been relatively overlooked.”

However, he acknowledged that the new AWS venture will be a competitor. “From a customer perspective, we will definitely be competing with them. In terms of business model, we’re taking a different approach,” he said. “Infostellar’s unique offer is a ground station sharing platform that provides satellite operators with various ground station use options.”

Richins held out the possibility of some kind of partnership with AWS Ground Station or the Verge network of antennas. “As with all ground station owners, we would be pleased to add AWS Ground Stations to the RBC Signals network and look forward to collaboration in the future,” he said.
SpaceNews established these awards to honor the well-known champions and the unsung heroes shaping the global space industry. We endeavored to celebrate headline-grabbing breakthroughs as well as outside-the-limelight innovations.

The winners recognized in the pages ahead were chosen by the SpaceNews editorial team after an open nomination process that concluded with a reader poll.

This year, we are also identifying the Readers’ Choice for each award to recognize the top vote-getters in each category. More than 12,000 SpaceNews readers voted for this year’s slate of winners.
It remains to be seen whether there’s a lot of money to be made in the emerging small launch vehicle market. One company, though, has demonstrated that it’s possible to raise a lot of money for small launch vehicles.

Rocket Lab announced Nov. 15 that it has raised $140 million in its latest funding round, from investors as diverse as venture capital firm Bessemer Venture Partners and the Accident Compensation Corporation of New Zealand, the country’s leading insurer. The company has now raised $288 million, valuing the company at more than $1 billion — a unicorn in the lingo of Silicon Valley.

That new funding round came less than a week after Rocket Lab performed the first commercial launch of its Electron rocket, placing into orbit several small satellites for customers like Fleet, GeoOptics and Spire. More customers are waiting in the wings, including NASA, who has a contract for a launch of a collection of smallsats as soon as December.

With the Electron having demonstrated its capabilities, and with the new funding in hand, Rocket Lab is ready to pick up the pace of operations. In October the company opened a new 80,000-square-foot factory in Auckland, New Zealand, that will be used to assemble the Electron, with the ability to produce one Electron a week. Days later, the company announced it will build a second launch site at the Mid-Atlantic Regional Spaceport on Wallops Island, Virginia, that will be ready to host launches in the third quarter of 2019. The company said its new funding round will allow it to build additional launch pads at its existing New Zealand launch site as well, while also supporting unspecified research and development projects.

Rocket Lab is hardly alone in the small launch vehicle field: dozens of other vehicles are in development around the world, including some soon to begin flights. Virgin Orbit is planning a first launch of its LauncherOne vehicle in early 2019 while Vector, which raised $70 million in October, is planning its first Vector-R launch in the coming months.

With all those vehicles in development, but uncertain demand from smallsat companies, some in the industry predict there will be a shakeout in the coming years. If so, Rocket Lab, with an operational launch vehicle and a war chest of funding, is well positioned to be one of the companies that survives that shakeout. Its investors certainly believe so. SN
Sometimes it takes a while for a breakthrough to, well, break through. Fortunately for SpaceX and its customers, the Falcon Heavy finally delivered.

When SpaceX Chief Executive Elon Musk formally announced plans for the Falcon Heavy at an April 2011 press conference, he said the vehicle would be delivered to the company’s launch site at Vandenberg Air Force Base in California in late 2012 “with liftoff to follow soon thereafter.” Those dates, though, slipped and slipped in the following years, as the company faced development problems with the rocket and competing priorities from other programs.

At last, on Feb. 6, the Falcon Heavy took off from Kennedy Space Center’s Launch Complex 39A, which previously hosted the shuttle and the Saturn 5. The rocket soared into space, and its twin side boosters made dramatic side-by-side landings back at Cape Canaveral. The rocket’s payload featured a mix of whimsy and panache characteristic of SpaceX and Musk: a Tesla Roadster electric sports car, with a spacesuit-clad mannequin at the wheel. It broadcasted live video for hours, attracting hundreds of thousands of viewers, before the upper stage boosted the car on a trajectory that took it out beyond Mars.

Musk admitted after the successful launch it almost didn’t happen. “We tried to cancel the Falcon Heavy program three times at SpaceX because it’s like, ‘Man, this is way harder than we thought,’” he said, estimating the company spent more than half a billion dollars on its development.

What sort of return will SpaceX get on that investment? The market for Falcon Heavy may be limited, as upgrades to the Falcon 9 now allow it to carry payloads that previously would have required the Falcon Heavy. SpaceX also has its next-generation reusable rocket under development — formerly known as Big Falcon Rocket but recently renamed Super Heavy and Starship — with far greater performance than the Falcon Heavy.

But in the months since the Falcon Heavy made its debut, SpaceX has lined up new customers for it, attracted to a vehicle that offers to place eight metric tons into geostationary transfer orbit for just $90 million. Several commercial satellite operators have signed contracts for Falcon Heavy launches, and the U.S. Air Force certified the vehicle for national security payloads, awarding SpaceX a contract for a classified mission.

For those customers, and for SpaceX, it appears that Falcon Heavy was worth the wait. SN
This year, Iridium put to bed concerns about its future, working with SpaceX to launch most — and potentially all — of its second-generation satellite constellation in a span of two years. Iridium’s legacy constellation has been in space for two decades, nearly three times as long as it was designed to operate. The company’s future hinged on getting the $3 billion Iridium Next constellation in orbit and in service before the older satellites expired.

As of early December, 65 of a planned 75 Iridium Next satellites are in orbit, with the vast majority of Iridium’s telecom traffic running through the new fleet. The eighth and final batch of 10 satellites are due to launch in the coming weeks.

Iridium, meanwhile, is deorbiting legacy satellites as they are taken out of service, setting a good example of responsible orbital stewardship for the many new companies proposing large constellations of their own.

And as Iridium Next takes off, so is Iridium’s revenue. The company reported $135 million in revenue for the three months ending in June, setting a personal record it beat by $2 million during the following three months. Whereas doubts about Iridium’s business model plagued the company around the launch of its first-generation system in the late 1990s, the atmosphere around Iridium today is one of technical and financial optimism. Iridium’s stock, worth $11.60 at the beginning of 2018, has nearly doubled in value as investors shed fears about constellation deployment and look toward a future where Iridium’s expertise in machine-to-machine satellite communications evolves to serve a growing Internet of Things market.

This was also a major year for Iridium in maritime, where a five-year effort paid off with the company finally achieving a key safety certification from the United Nations. The certification means Iridium is the only company besides rival Inmarsat that can provide Global Maritime Distress Safety System services that are required for most ocean-going vessels on international trips.

In aviation, Aireon — the flight-tracking startup Iridium founded to help finance its constellation — raised $69 million this spring and began paying Iridium for hosting its sensor network onboard its satellites.

Once Iridium’s final batch of Iridium Next satellites is in orbit, Iridium will shift focus to its next big challenge: deleveraging. Iridium is poised to enjoy a capital expenditure holiday lasting at least a decade as it pays down the $2.1 billion debt it incurred deploying the second-generation constellation it’s now just one launch away from completing.
The European Space Agency overcame enormous technological challenges to launch two ambitious missions in 2018: BepiColombo’s voyage to Mercury and the Aeolus wind-sensing satellite.

BepiColombo began its seven-year journey in October with its European and Japanese orbiters mounted on an ESA transporter. The launch was the culmination of nearly two decades of work on a $2 billion program that was nearly derailed by the complexity of its ion-electric propulsion system and the challenge of finding materials durable enough to withstand lengthy exposure to temperatures as high as 450 degrees Celsius.

ESA persevered with help from more than 30 companies in 12 of its member states. In many cases, the firms had to invent technology for the mission that project manager Ulrich Reininghaus compared to flying into a pizza oven.

If by comparison Aeolus seems almost easy, it wasn’t. Program managers struggled for more than a decade with the satellite’s Atmospheric Laser Doppler Instrument (Aladin), the first space-based instrument capable of measuring wind in cloud-free atmosphere. Aladin combines an ultraviolet laser and large telescope with an extremely sensitive receiver to provide the first global vertical wind profiles. Prior to Aeolus, wind in cloud-free atmosphere was “the largest data gap in meteorology,” said Josef Aschbacher, ESA’s director of Earth observation programs.

Although both missions took far longer than expected and blew through initial cost targets, ESA persevered and ultimately succeeded with the type of daring missions only a leading space agency could attempt.

Also in 2018, ESA continued to produce state-of-the-art Earth observation and navigation satellites. In April, Eumetsat and the European Union launched Sentinel-3B, a sophisticated ocean-monitoring satellite for the Copernicus constellation. ESA and the European Union sent four Galileo global navigation satellites into orbit in July. Then, Eumetsat completed its ESA-built constellation of MetOp polar-orbiting weather satellites in November.

On the launch front, it was a rough start. In January, the ESA-backed ArianeGroup’s Ariane 5 rocket sent SES-14 and Al Yah-3 short of their intended orbits. With subsequent Ariane 5 and Vega launches, though, the ArianeGroup and Avio vehicles proved dependable.

ESA, ArianeGroup and Avio also made steady progress on their next-generation rockets: Ariane 6, a rocket slated to fly for the first time in 2020, and Vega C, the light-lift launch vehicle scheduled for initial takeoff in 2019. SN
NASA’s human spaceflight programs have experienced enough changes over the last decade to give someone whiplash, from the Vision for Space Exploration’s return to the moon to an emphasis on Mars and, now, back to the moon again. Those efforts have had one constant, though: the person in charge.

William Gerstenmaier — known universally within and outside NASA simply as “Gerst” — became associate administrator for space operations at the agency in 2005, and took on his current role as head of NASA’s human exploration and operations mission directorate in 2011 when NASA merged space operations with exploration. It’s the culmination of a NASA career that started as an engineer at the Lewis (now Glenn) Research Center in 1977 and included leadership positions on the shuttle and International Space Station programs.

In his position, he has oversight of all of NASA’s human spaceflight activities: the ISS, the Space Launch System and Orion, commercial crew and planning for human missions beyond Earth orbit, each with its set of technical and programmatic challenges. Moreover, during his tenure NASA’s overarching plans for human spaceflight have undergone changes, from the Obama administration’s “Journey to Mars” to the Trump administration’s renewed focus on the moon. The Asteroid Redirect Mission has come and gone, but the lunar Gateway is now taking shape. Even a long-running program like the ISS has seen its share of issues, like the October Soyuz launch abort and ongoing debate about ending federal funding of the station in the mid-2020s.

Through all these challenges, large and small, Gerstenmaier has provided stability and continuity, giving confidence to the agency’s workforce and reassurances to industry and Congress. He’s embraced changes, though, such as the greater use of partnerships with the private sector. He’s backed plans to take a more commercial approach to the Gateway’s first module, the Power and Propulsion Element, which will be based on a commercial satellite bus. “We don’t need a unique spacecraft design. We don’t need a unique bus,” he said at an advisory group meeting this summer, countering the agency’s tendencies to develop unique vehicles.

His endorsement of those Gateway plans at that meeting quieted skepticism from some committee members: when Gerst speaks, people listen. That leadership has been, and will continue to be, essential as the future of NASA’s human spaceflight program takes flight in the next few years with the first SLS/Orion and commercial crew missions. **SN**
U.S. Air Force Secretary Heather Wilson would be one of the first to admit that no one really knows whether President Trump’s call for a Space Force will result in a full-fledged sixth branch of the U.S. military or something more like a Space Corps that would be part of the Department of the Air Force the way the Marine Corps is part of the Navy.

“We support the president’s proposal,” Wilson said in September. “But none of this can happen without Congress’ involvement, obviously.”

As a former member of the House Armed Services Committee, she understands that only Congress has the authority to establish a new military service to stand alongside the Army, Air Force, Navy, Marines and Coast Guard. As an Air Force Academy graduate and doctor of international relations who served at the White House National Security Council during the collapse of the Soviet Union, she knows as well as anyone in Washington what’s at stake for the United States and its allies in the unfolding ‘great power competition’ with its geopolitical rivals.

Wilson possesses a sophisticated understanding of both the technical and political challenges involved in defending against counterspace threats posed by China, Russia and other potential adversaries.

Well before the president’s Space Force fixation threw the Pentagon for a loop, Wilson had already made it her mission to transform the way the Air Force organizes and equips its air, space and cyber forces to prevail in the 21st century’s inevitably multi-domain conflicts.

Specific to space, Wilson championed SMC 2.0, a long-overdue reorganization of the Space and Missile Systems Center to empower smarter and faster delivery of vital capabilities such as a new generation of missile-warning satellites.

Air Force space modernization efforts are well funded heading into 2019, thanks to Wilson getting the White House to request a 20 percent spending increase Congress largely honored this fall. Next year’s budget battle promises to be much tougher as the Pentagon strives to balance the president’s demand to stand up a Space Force with his call for five percent across-the-board cuts.

Regardless of how the Space Force debate unfolds in the months ahead, the Air Force is fortunate to have a leader as savvy, steady and well-respected as Heather Wilson at the helm.

As one SpaceNews reader put it: “Wilson understands the loudest person in the room does not always bring forth the best ideas but instead leverages critical thinking skills of a team to build the most productive answers to our nation’s hardest challenges.”  

**SN**
The only thing more shocking than Intelsat’s pitch to let cellular networks use the satellite industry’s prized C-band spectrum for 5G was that Intelsat also got three of the world’s largest satellite operators to join it.

C-band spectrum is globally employed for satellite television broadcasts and other telecom services, being favored in particular for its signal strength during rainstorms. Cellular companies have for over a decade sought to wrest those frequencies away from satellite operators to use in their own networks.

Satellite operators have stood their ground against this front in the past, so Intelsat’s proactive move, with chipmaker Intel, to relinquish some C-band spectrum was unprecedented. Instead of preparing for regulatory fisticuffs as per norm, Intelsat under the leadership of CEO Stephen Spengler offered an olive branch, and one that could draw in billions of dollars to boot.

Initial industry reactions varied from circum-spect to severe. Eutelsat CEO Rodolphe Belmer first described Intelsat’s move as one that had “taken everyone by surprise.” One regional operator called it a “disaster for the whole industry.” Telesat this spring was poised to “oppose it vigorously.”

Since then SES, Eutelsat and Telesat, the three operators besides Intelsat with the most at stake in the U.S. where Intelsat’s plan is focused, have all backed that plan through a group they formed called the C-Band Alliance.

It remains too early to tell how effective the C-Band Alliance will be in persuading the U.S. Federal Communications Commission to accept their plan, which involves allowing mobile networks to use 180 megahertz (36 percent) of satellite C-band, while using a 20-megahertz guard band to protect nearby satellite signals from interference. That Spengler led a sea change in industry thinking that united the world’s biggest satellite operators on a highly controversial topic is clear as day, however.

That leadership has catapulted Intelsat’s stock from $3.64 on Jan. 2 to over $37 a share this October. The C-band plan aligns with important pillars of the U.S. Federal Communication Commission’s proposed rulemaking, which positions it well to be the agency’s go-forward strategy when it decides how to reallocate C-band in 2019.

Though it is early days, the success of the Intelsat-led plan has the potential to generate cash flows that can drastically reduce the company’s weighty $14.3 billion debt load. As a highly leveraged company, Intelsat has admitted it is not able to make industry-leading moves the way it would like. The C-Band Alliance, however, is one such move. **SN**
One of the clearest signs that the Space Coast region of Florida has rebounded economically from the end of the shuttle program is that there is now space commerce on Space Commerce Way.

The two-lane road had for years connected two highways just outside the gates of the Kennedy Space Center, with visions of a large business park developing there. But other than a single building, there was little activity along the road, which became primarily a shortcut by tourists going to KSC’s visitors center.

It’s a different story today. Earlier this year Blue Origin opened a 750,000-square-foot factory along Space Commerce Way that the company will use to manufacture its New Glenn rocket, which will launch starting in 2020 from Launch Complex 36 at nearby Cape Canaveral. Across the street, OneWeb Satellites, the joint venture of OneWeb and Airbus, has built a factory designed to produce the hundreds, and eventually thousands, of satellites planned for OneWeb’s broadband constellation.

Those facilities are among the biggest, but not the only, signs of a revitalization and diversification of the region’s space industry. When the shuttle program ended in 2011, bringing with it the loss of thousands of jobs, some wondered if the region would ever be able to recover. Some companies closed facilities, other businesses shut down entirely and people moved away.

One reason for the turnaround is Space Florida, the state space development agency. It offered economic incentives to attract companies like Blue Origin to the region. It’s also taking a bigger role in launch activities there, receiving an FAA spaceport license in November for the Shuttle Landing Facility runway that could host air-launch companies like Stratolaunch and Virgin Orbit.

KSC has also played a major role in the region’s turnaround. The center’s leadership has sought to turn KSC into a “multi-user spaceport” rather than serving only the needs of NASA. It worked to sign agreements to lease unneeded facilities to private companies, stimulating commercial activity while getting maintenance of them off the center’s books. Now, Boeing is building its Starliner commercial crew vehicle in a former shuttle hangar while SpaceX is launching rockets from the same pad that sent Apollo 11 to the moon.

That increase in launches by SpaceX and others has stimulated tourism in the region as well, in some cases causing traffic jams outside KSC. So, one of the projects on the drawing board is a widening of Space Commerce Way to four lanes. SN
In a year of major investments and acquisitions, the most influential deal of the year involved a set of awards by the Air Force that sets the stage for a potential realignment of the U.S. launch industry.

The Launch Service Agreement (LSA) contracts awarded by the U.S. Air Force in October to Blue Origin, Northrop Grumman Innovation Systems and United Launch Alliance are intended to support the development of a new generation of launch systems, providing improved access to space and ending reliance on the Atlas 5 and its Russian main engine.

For two of the companies, the LSA awards were likely make-or-break. It’s unlikely that United Launch Alliance would have been able to continue the Vulcan Centaur without the financial support in the form of nearly $1 billion from the Air Force. Northrop Grumman would have almost certainly dropped plans to develop OmegA had it not secured an LSA award valued at nearly $800 million.

It’s a different story for Blue Origin, though: the company, backed by Amazon.com founder Jeff Bezos, would have continued development of its New Glenn rocket regardless of any Air Force funding. However, the $500 million it received will go toward specific capabilities, including a launch site at Vandenberg Air Force Base in California, needed to be able to support national security space missions but which it might otherwise not have developed.

The LSA awards are also a major deal because of who didn’t win: SpaceX. While the company was widely considered a front-runner for an award, it came away empty-handed. SpaceX presumably sought LSA funds to help finance its next-generation launch system, until recently called Big Falcon Rocket (BFR). The Air Force may not have seen value from investing in BFR, even as it relies on SpaceX’s existing rockets.

The LSA awards mirror the Air Force’s last major effort to develop new launch vehicles. Like the Evolved Expendable Launch Vehicle program, the LSA program expects companies to invest their own money alongside Air Force funds to develop those vehicles. The EELV program was a technical success but a business failure, as the commercial markets expected in the late 1990s to be able to support two vehicles didn’t materialize.

This time both the Air Force and industry hope the market is different. But even if it is, not all competitors are guaranteed to succeed. The Air Force plans to select only two companies for phase 2 of the LSA program, a future “block buy” of launch services. SpaceX, despite not winning an LSA award, will be eligible for this competition, a high-stakes race that will shape the future of the American launch industry. SN
Every word uttered by Elon Musk makes headlines around the world. Far less attention focuses on SpaceX’s propulsion chief technology officer, Thomas Mueller. Without Mueller’s expertise, though, it’s hard to imagine SpaceX succeeding in slashing the cost of space access or producing reliable, reusable rockets.

Mueller, who worked his way through college as a logger, holds bachelor’s and master’s degrees in mechanical engineering. Before helping start SpaceX as one of Musk’s original hires, he spent 14 years at TRW, an American corporation known for automotive parts as well as satellites, space-based observatories and rocket engines. Long before TRW sold its space business to Northrop Grumman in 2002, the company produced the Lunar Module Descent Engine for the Apollo program, the first engine for human spaceflight that could be throttled. At TRW, Mueller carried forward the throttling concept, with TR-106, a powerful, throttleable booster engine fueled by liquid oxygen and liquid hydrogen.

Not content to leave work at the office, Mueller was building a 36-kilogram rocket engine in his garage when Musk invited him to help found Space Exploration Technologies in 2002.

Sixteen years later, Mueller remains at the Hawthorne, California, company where he developed engines for the Falcon and Dragon spacecraft. Mueller-led teams invented the Merlin 1A and Kestrel 4 engines for Falcon 1, the first privately operated liquid rocket to reach orbit. Then, they turned their attention to Falcon 9’s Merlin 1C, 1D and Vacuum engines, the keys to the booster’s reusability.

In recent years, Mueller has devoted his attention to Raptor, a family of reusable liquid oxygen, liquid methane staged-combustion engines for the booster and upper stage of Starship, the launch vehicle SpaceX is building for interplanetary transportation.

“That rocket is going to be the real game-changer,” Mueller told New York University’s Astronomy Club in 2017 via Skype. “I would say that the Falcon 9 is evolutionary; a reusable rocket that greatly reduces the cost of access to space... We want a hundred or more reduction in costs. That’s what the Mars rocket’s going to do.”

In the early 2000s, it was popular to dismiss bold predictions from SpaceX. With 18 launches in 2017 and 18 more completed in the first 11 months of 2018, including the first flight of the Falcon Heavy, claims by the company’s propulsion chief are harder to discount. SN
2018 WINNERS & FINALISTS

★ **Startup of the Year**: Rocket Lab  
**Readers’ Choice**: Rocket Lab  
**Other Finalists**: Blue Canyon • Capella Space • Kepler Communications • Relativity Space

★ **Breakthrough of the Year**: Falcon Heavy  
**Readers’ Choice**: Falcon Heavy  
**Other Finalists**: ICEYE X-1 SAR smallsat • NASA’s MarCO cubesats • ESA’s RemoveDebris mission

★ **Company of the Year**: Iridium Communications  
**Readers’ Choice**: Lockheed Martin  
**Other Finalists**: SpaceX • United Launch Alliance

★ **Agency of the Year**: European Space Agency  
**Readers’ Choice**: NASA  
**Other Finalists**: Defense Advanced Research Projects Agency • U.K. Space Agency • UAE Space Agency

★ **Government Leader of the Year (Military)**: Heather Wilson, U.S. Air Force  
**Readers’ Choice**: Heather Wilson  
**Other Finalists**: Mike Griffin, OSD • Betty Sapp, NRO

★ **Corporate Leader of the Year**: Stephen Spengler, Intelsat  
**Readers’ Choice**: Tory Bruno, United Launch Alliance  
**Other Finalists**: Bob Smith, Blue Origin • Matt Desch, Iridium Communications

★ **Turnaround of the Year**: Florida’s Space Coast  
**Readers’ Choice**: Florida’s Space Coast  
**Other Finalists**: Aerojet Rocketdyne’s AR-22 • Firefly Aerospace • Iridium Communications

★ **Deal of the Year**: Launch Service Agreements  
**Readers’ Choice**: Lockheed Martin wins $7.2 billion GPS 3 contract  
**Other Finalists**: Northrop Grumman acquires Orbital ATK • Mid-Atlantic Regional Spaceport signs Rocket Lab as tenant

★ **Unsung Hero of the Year**: Tom Mueller, SpaceX  
**Readers’ Choice**: Tom Mueller  
**Other Finalists**: Steve Volz, NOAA • Dan Rasky, NASA • Delta 2 rocket • Space Angels

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On its 13th successful launch in a row the Arianespace light-lift vehicle Vega lofted the MOHAMMED VI - B satellite, developed for the Kingdom of Morocco by Thales Alenia Space and Airbus, on November 20th. Unsurpassed in its class, the Vega is the preeminent choice when small payloads need access to space. A more powerful new variant, the Vega C, will be introduced in 2019 and will serve as the complement to the heavy-lift Ariane 6.
IoT smallsats: Ready for launch?

Total satellite M2M/IoT market revenues, by region 2027*
North America is expected to generate 40 percent of satellite machine-to-machine (M2M) and Internet of Things (IoT) revenue by 2027. *Includes both GEO-based and smallsat constellations

In recent years, there has been a boom of announcements for satellite constellations comprising satellites weighing as little as 3 kilograms to address a growing market of machine-to-machine (M2M) and Internet of Things (IoT) via satellite. Traditionally, this market has been serviced through combinations of Ku-band Very Small Aperture Terminals (VSATs), and mobile satellite services (MSS) including Orbcomm and Globalstar. NSR found that at end of 2017, there were approximately 3.5 million in-service MSS/ VSAT terminals addressing this need, and this total will grow to approximately 6.3 million in 2027.

However, NSR also tracks several up-and-coming small satellite constellations, including:
- Kepler Communications
- Hiber
- Eutelsat ELO
- Fleet Space
- Xingyun
- Myriota
- Astrocast
- Fleet Space
- Helios Wire
- Blink Astro
- Analytical Space
- Sky and Space Global
- Hongyan

Funding for these new constellations has increased significantly, including $15 million for Myriota, $4 million for Astrocast, $5 million for Kepler Communications, and more. The assumption for funding is based on the premise that 10s, 100s or 1,000s of millions of devices will become internet-connected over the coming decades, terrestrial networks only cover around 10 percent of the Earth’s surface, and there will be enormous demand for anywhere-on-Earth connectivity for low cost — so low a cost that one might as well deploy a terminal for satcom connectivity on virtually anything that moves.

With that said, the main unique value proposition of smallsat IoT constellations is the single global network, low cost, and IoT connectivity outside of cellular coverage. However, the proportion of devices that need to be connected outside of the footprint of terrestrial networks is limited. Use cases that fit into this category exist in the maritime sector, including fishing
aggregation devices, buoys, fishing and recreational vessels. New types of use cases may also be attracted to smallsat IoT services, including connected life jackets for instance, or find-my-device functionality, similar to services that many mobile phones sold today feature. Transportation use cases – where vehicles and trucks move in and out of terrestrial networks, are also excellent candidates for smallsat IoT services. Agriculture, civil government, and energy markets can also use such low-cost services for remote, but non-critical, applications.

Pricing is a key consideration for demand, so the question begs: just how low could pricing get? Hiber expects to offer its services beginning at just a few euros per month plus terminals costing around $40. However, NSR expects the entry-level pricing of this business model to be a loss leader, as if all customers were on this lowest plan, operational expenditure costs for constellation replenishment alone, which is in the order of $3 million to $8 million, won’t be covered. The model is to attract customers with low cost, one-data-packet-per-day services, and then upsell to more frequent (and for most applications, significantly more valuable) use cases, and additional value-added services – a feasible proposition.

However, this field is rife with competition. Not only are the smallsat constellations vying for market share, but there is also established MSS/Ku-band service available plus GSM/5G cellular and Low Power Wide Area (LPWA) terrestrial networks. These networks, such as Sigfox and LoRa, are specifically designed for low-cost IoT services, with payloads limited to around 12 bytes. This provides the main form of competition, with similar price points and value proposition offered. When LPWA networks are available, customers are unlikely to choose smallsat satcom solutions.

One key reason is because on LPWA networks, terminals can be lower in price – around $20 — and have lower servicing cost. Sigfox charges between 1 euro and 14 euros per year, depending on the number of messages sent. Sometimes one year of free service is also included, although many of these accounts won’t be renewed. More benefits include the fact that up to 140 messages can be sent per day, and it also has a service-level guarantee that 98 percent of data latency is under 60 seconds (although is typically under 45 seconds). By comparison, in the early phase of smallsat IoT launch, latency exceeds 20 hours due to only having 1-2 satellites in a single plane. Although, at full launch, latency can decline below 20 minutes depending on the constellation.

Due to the reasons outlined above, NSR expects smallsat IoT to primarily become the network of last resort and will therefore take many years to begin turning a profit. After all, with the above price points, millions of devices will be required to relay data every month for this to happen. Further, reliability, antenna performance, and value-chain infrastructure and not yet ready for deployment – this will take some years to iron out. For real, critical demand of industry, cargo tracking, government, military and energy, larger satellites, which are already deployed, will be primarily relied upon from both MSS and VSAT networks.

Because NSR forecasts only approximately 3.7 million smallsat M2M/IoT in-service connections by 2027, due in part to the extremely high levels of competition and inevitable launch delays, this means there is limited opportunity for four constellations to succeed, let alone 10 or more. The result is most constellations currently proposed will either merge, never launch, or change system architecture to provide more than the most basic IoT services, to generate enough low average-revenue-per-user income to cover launch, renewal, service and maintenance costs.

**Bottom line**

The competitive M2M and IoT space is heating up, with many new entrants vying for a potentially large terrestrial IoT market, and a relatively small satcom market. These constellations will have a role to play in the overall IoT ecosystem; however, they will have to compete with better options in terms of pricing, latency and bandwidth. The sole advantage remains availability (and pricing compared to MSS networks). Thus, the fact that terrestrial solutions will meet most customer needs, combined with limited demand outside of said footprints, will result in uncertain times ahead for smallsat IoT operators and investors. **SN**

**ALAN CRISP** is a senior analyst at NSR Hong Kong and a member of the Research and Consulting Firm’s Fixed Satellite Services group. He is the co-author of NSR’s annual M2M and IOT via satellite report.
DoD needs a new space procurement agency. Sound familiar?

The Pentagon is moving to establish a Space Development Agency as early as next year. According to Deputy Defense Secretary Patrick Shanahan, the SDA will field new capabilities faster, capture technologies from the commercial space industry and consolidate overlapping research projects across DoD. The agency is one pillar of a broader plan to reorganize space forces and programs under a new military branch.

Greater efficiency and innovation in space programs seem worthy goals. But why is a new agency needed to do that?

In the view of one military procurement expert, the Space Development Agency is a shortsighted response to deep-rooted problems that have plagued defense procurement for years.

“I support and encourage every effort we can make to improve space acquisition, but fixing space acquisition has very little to do with why we need a separate space service or space agency,” said retired Lt. Gen. James “Kevin” McLaughlin, former deputy commander of U.S. Cyber Command.

McLaughlin led Air Force space units and worked at the National Reconnaissance Office before becoming Cyber Command’s No. 2. He also served on a blue-ribbon panel — known as the Rumsfeld Commission — that in 2001 delivered a massive report recommending management and organizational reforms in national security space.

McLaughlin saw firsthand what happened when DoD more than a decade ago also decided that a new organization was the answer to sluggish procurement and lackluster performance in space programs.

“My experience as the first director of the Operationally Responsive Space Office left lasting impressions,” he said. DoD stood up the ORS office in 2004 because Pentagon leadership was convinced the Air Force Space and Missile Systems Center was broken. “I’m hearing the same statements from senior leaders today when they say that Air Force space acquisition and the industry that supports the Air Force is too expensive and takes too long,” he said.

The ORS office was conceived to tap into then-emerging technologies — such as smaller satellites and techniques like hosting military payloads on commercial satellites — to reduce the cost and expedite the fielding of military capabilities.

“I don’t think we were very successful then or have been since then,” said McLaughlin. He cites three reasons: First, a shortage of experienced personnel. Second is the convoluted defense procurement process and rules that govern all DoD procurements, not just space. “You need very short chains of command and exemptions from most of the Pentagon and service bureaucracy to achieve radically reduced costs and shorter acquisition timelines.” Third are budgets. Spending on space at the time was getting squeezed to fund other military priorities.

To the Air Force’s credit, it still managed to produce world-class satellites and launch vehicles. “I have to say that while I’m not an apologist for the Air Force, SMC, or the industry that supports them, you have to understand those organizations have structured themselves in a manner aimed at not failing in critical space missions and in complying with oversight and compliance rules dictated by the Pentagon and the Congress.”

If DoD wants improvements in space acquisitions, McLaughlin said, it should give existing organizations experienced people, eliminate complex chains of command and wasteful bureaucracy, and increase the budgets of high-priority programs before any new agency is added to the mix.

McLaughlin favors the establishment of a separate military branch for space, but for reasons that have nothing to do with procurement. He worries that there is a rush to fund new agencies before there is a clear answer on what problems need to be solved. “Creating a new U.S. Space Command or a Space Development Agency doesn’t really fix the core problems.”

Whether space remains in the Air Force or is moved to a Space Force, DoD must ensure that the service is organized to develop skilled space officers, with the knowledge and expertise to tell SMC or the Space Development Agency what they should buy in order to prevail in a future space war. They also are the leaders that would be needed to fill the ranks of U.S. Space Command.

“Combatant commands and acquisition organizations don’t create deeply experienced and expert service cultures that provide the units and people required to write doctrine, define requirements, develop and acquire advanced space capabilities, and execute space operations,” said McLaughlin. “Military services do that.”

The Rumsfeld Commission 18 years ago called for the Air Force to restructure its personnel system to better support the space career fields, increase promotion opportunities and strengthen the space culture within the Air Force. McLaughlin laments that the Air Force did not do that and consequently missed an opportunity to develop a new generation of space warriors, setting the conditions for the current movement to take space out of the Air Force.  

ON NATIONAL SECURITY Sandra Erwin
COMMENTARY Joan Johnson-Freese and Sahana Dharmapuri

U.S. President Donald Trump’s recent announcement of a Space Force to “degrade, deny, disrupt, destroy, and manipulate adversary capabilities” — specifically Russia and China — is one approach to the question of how to protect substantial American interests in space. But sustainability of the space environment is also a key objective of space security, as emphatically stated in a 2017 interview with Air Force Gen. John Hyten, commander of U.S. Strategic Command, currently responsible for U.S. space security. Yet, maintaining the sustainability and stability of the space environment — important for all countries — is perhaps more at risk now than ever before.

Beyond discussion regarding the creation of a U.S. Space Force and Russian warnings of a “tough response” to such a force, discussion of limited war in space, satellite “safe zones” and potentially the overt weaponization of space are indicative of the escalation of risk regarding space security issues. The complexity of the problems of space security requires that alternative approaches be offered and considered by global decision-makers.

As Victoria Samson, Washington director for the Secure World Foundation, explained in 2018, what we need is:

"an understanding of maintaining security, stability, and economy depending on space not just for the U.S. but also for the world. Part of this is a response to the changing space domain, which is the playing field for not only the established spacefaring nations..."
COMMENTARY Joan Johnson-Freese and Sahana Dharmapuri

but also the non-state actors and new entrants from around the world. And part of it is admitting that the way the U.S. military space acquisition was built was for a world that no longer exists and therefore has to evolve in order to meet the existing demands and allow for future requirements.”

In fact, there is an acute need for new perspectives and approaches to long simmering and now escalating issues.

The Women, Peace and Security (WPS) agenda offers such an alternative perspective, and is in accordance with the 2017 Women, Peace and Security Act that President Trump signed into law last year and is also supported by more than 70 countries that have adopted National Action Plans to implement the Women, Peace and Security agenda. That agenda offers both a different perspective on problem-solving and a different approach to achieving durable security that focuses on collaboration, diplomacy and maintaining peace — concepts which are by no means foreign to space security policy and decision-makers.

Disruption and destruction in space

Skeptics and experts alike acknowledge that space security is fraught with suspicion, opaque decision-making, ambiguous threats and classified acts, largely due to the dual-use nature of most space technology. Consequently, the “stalker” co-orbital anti-satellite that China developed and the moribund Chinese weather satellite that the Chinese military shot down in 2007 created significant international tension. So, too, did Operation Burnt Frost in 2008, when the U.S. military shot down the decaying spy satellite US-193, using modified missile defense technology, as well as ongoing classified U.S. spaceplane, the X-37B.

Current levels of distrust and opacity can lead to dangerous miscalculations, and the international community is badly in need of expanded policy options.

This is where the Women, Peace and Security agenda and the issues of space security intersect.

Globally, the Women, Peace and Security agenda, first codified in UNSCR 1325 (2000), offers a framework of legal and policy architecture to support policy alternatives in the hard security arena. The 2017 Women, Peace and Security Act builds on these efforts and mandates that U.S. defense, development and diplomacy agencies implement the increase in women’s participation in decision-making and the use of gender analysis. Furthermore, asking questions like, “how do we degrade, disrupt and destroy our adversaries in the realm of space security?” implies being on the defensive, and suggests weakness. However, there is an option to change the question and ask, “How is a cooperative environment maintained where all countries can maintain, use, and benefit from the space environment, in accordance with the 1967 Outer Space Treaty?”

The case for a gender lens in space security: the evidence

There are numerous examples of how a gender perspective improves the operational effectiveness of peace and security operations that are highly relevant to the challenge of space security. In particular, the WPS agenda advocates specifically for the use of dialogue, participatory engagement and decision-making, international cooperation, consultative mechanisms and non-violent approaches to mitigating and resolving conflicts. There is a robust and growing body of evidence that shows the application of a gender perspective and an increase in women’s participation in decision-making results in more durable peace agreements, increased trust and collaboration across political agendas, and more comprehensive and
nuanced information gathering to better inform decision-making.

Examples regarding warfare and operational readiness, taken from a recent meta-study conducted by Our Secure Future: Women Make the Difference, evidence the impact of WPS on the effectiveness of international peace and security policymaking. Studies have found, for example, that a 5 percent increase of women in a legislature decreases the state’s overall likelihood to use violence by nearly five times, and that greater state gender equality leads to a lower level of likelihood to use military action to settle international disputes. Furthermore, when at least 35 percent of the legislature was female, it both reduced state likelihood to go to war and reduced the likelihood of a state relapsing into civil war to virtually zero.

Similarly, examples of the application of the WPS agenda to hard security in international instruments are found in the 2013 Arms Trade Treaty and the International Nuclear Test Ban treaty of 2018. The Arms Trade Treaty, the first treaty to regulate the international transfer of conventional arms and ammunition, aims to regulate the flow of weapons around the world by requiring governments to assess all arms transfers against a set of criteria, including the risks of gender-based violence, before the transfer is authorized or denied. The Nuclear Test Ban Treaty, which was negotiated and supported by 130 states, recognizes the importance of “equal, full and effective participation of both women and men” for promoting peace and security, as well as the engagement of women in nuclear disarmament. These two treaties are significant advancements in the application of the WPS agenda to hard security problems and provide a precedent for use with other hard security issues, including space.

Collaboration, trust, transparency in space: an entry point for Women, Peace and Security

In July 2011, a Group of Government Experts (GGE) from 15 countries, including the five members of the U.N. Security Council, were directed by the U.N. General Assembly to study and develop transparency and confidence-building measures (TCBMs) for space activities to avoid misunderstandings and misjudgments. The final report was approved by consensus in 2013. It first gives an overview of global space activities and of the attention paid to the need for TCBMs in space.

Section 3 of the GGE report provides the general characteristics and basic principles of TCBMs, and explains the nature and purpose of TCBMs, stating:

“in general terms, transparency and confidence-building measures are a means by which governments can share information with an aim of creating mutual understanding and trust, reducing misperceptions and miscalculations and thereby helping both to prevent military confrontation and to foster regional and global stability.”

The GGE report stresses the value of continuing dialogue between agencies, governments, organizations and through various U.N. forums.

Currently a second GGE has been charged by the U.N. General Assembly “to make recommendations on substantial elements of an international legally binding instrument on the prevention of an arms race in outer space.” In July 2018, a first introductory workshop was held in Beijing. Of the 22 participants listed as governmental experts, only two were women, from Japan and France. Yet almost half of the states represented have adopted National Action Plans for WPS and/or Regional Action Plans. Unfortunately, the U.S. failed to even show up at this meeting — a lost opportunity to help set the agenda.

How, or if, the Women, Peace and Security agenda will be included in these meetings remains to be seen. Will they include consultations with those who benefit from a stable space environment (telecommunications, disaster management, tele-education/health, climate monitoring, etc.)? How will continued dialogs be set up? Clearly, women’s representation in space policy and decision-making (even within countries which ascribe to the Women, Peace and Security agenda) is low, whether intentionally or simply by benign neglect.

Merely having women present at meetings does not inherently signify that a
gendered perspective will be offered, much less acted upon. However, when attention to both women’s representation in decision-making and the use of a gender perspective is applied in domestic or international conflict management, the Women, Peace and Security agenda increases the effectiveness of almost every policy and program it is married with. This is not a “women’s issue;” this is a peace and security issue. The evidence mentioned earlier shows that the WPS agenda increases operational effectiveness, is more collaborative rather than competitive, and produces more constructive outcomes for disputing parties.

**Toward a more stable outer space**

A Space Force without the complimentary effort of diplomacy and confidence building would be a recipe for incalculable escalation of unnecessary tension between states. Instead, decision-makers would fare better with more policy tools to choose from. In fact, having multiple and complimentary options for action is imperative in a complex world. Chairman of the Joint Chiefs of Staff, Gen. Joseph Dunford, Jr., has said future conflicts will be transregional, multidomain and multifunctional. The Women, Peace and Security agenda offers options to complex conflict issues shown to yield positive results. The demand – even by, and perhaps especially by, the military – to protect the security and sustainability of the space environment requires that collaboration be employed in conjunction with other approaches.

There are small, yet hugely impactful steps that the space security communities can take. For example, leverage section 3 of the GGE Report, which underscores the importance of confidence building, and use the WPS strategy of participatory engagement and decision-making. The call for transparent consultation is a hallmark of the WPS agenda, and the report’s insistence on continued dialogue amongst and within agencies, governments, and organizations lays the groundwork for this concept to become mainstreamed within space security processes and procedures. Increased dialogue leads to better, more comprehensive information, which will shed light on formerly opaque decision-making processes, inevitably lowering suspicion.

A lack of diverse viewpoints limits the boundaries of just how much peace and security actors are able to achieve. Asking questions about deterrence and how to maintain space security as well as the space environment is a rather empty endeavor if the answers never change. Ultimately, working toward creating a more cooperative environment in space will not exclude military efforts. Indeed, a strong defense is important, including deterrence, resilience, hedging, mission assurance and perhaps even a “space force.” But pursuing confidence building and nonviolent collaborative approaches should be welcomed rather than neglected. Adhering to and capitalizing on international and national commitments already established on Women, Peace and Security will provide another avenue in the global pursuit of a more stable and sustainable space environment.

### ON THE HORIZON

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**International Academy of Astronautics**

**3rd IAA Latin American CubeSat Workshop**

03 - 07 December, 2018

Ubatauba, Sao Paulo, Brazil

For NASA’s return to the moon, a little something to cheer about

When NASA announced its Commercial Lunar Payload Services program earlier this year, there was some question at first about how to pronounce its vowel-less acronym, CLPS. The consensus soon was to insert an imaginary “i” in the middle, so that it sounded like “clips.”

Maybe, though, it should be pronounced “claps.” There was certainly a lot of clapping at NASA Headquarters Nov. 29 when NASA announced the nine companies it selected to participate in CLPS. Clapping when representatives of the companies were paraded onstage. Clapping for a promotional video that kicked off the event. Clapping for NASA astronaut Stan Love who, on a video link from the Johnson Space Center, bounced across a floor wearing a harness to simulate the moon’s one-sixth gravity. Clapping even for a Mars spacecraft, InSight that landed on the planet three days earlier. (“We’re still on that Mars high,” quipped Thomas Zurbuchen, NASA associate administrator for science.)

The result was a spectacle that was an unusual way to roll out a new commercial initiative. Students from local FIRST Robotics teams got more air time during the event than the companies winning contracts, and more opportunities to ask questions of NASA leadership than the journalists in the room or on the phone. “Personally, a happy day, but what an odd event,” remarked a representative of one of the winning companies afterward.

The cheering children overshadowed the fact that, for now, the CLPS awards are a little underwhelming. While the agency said the contracts have a total value of $2.6 billion over 10 years, that is a maximum value for those indefinite delivery, indefinite quantity awards. For now, each company gets only a token amount to produce payload users’ guides, with no guarantee they’ll get any more.

The companies will now have to compete against each other — and potentially additional companies in the future — for task orders to fly individual payloads, which NASA is still in the process of identifying. The companies also have to raise money for, and build, their landers: by and large what they offered were concept art and mockups, with designs still no further along than the critical design review level of maturity.

But even though the announcement lacked much substance, the program is still an important one for NASA and industry. Some companies noted after the event that the awards will help them raise money from investors by demonstrating that they have a real, and potentially lucrative, customer for their vehicles. The absence of such customers during the now-defunct Google Lunar X Prize competition made it difficult for many companies to fund their landers and thus attempt to win the prize.

NASA sees CLPS as a way to achieve low-cost science at the moon, including work identifying resources that could support future human exploration. More importantly, though, it acknowledges that CLPS is a risky endeavor, with many companies likely to suffer technical or financial failures. NASA Administrator Jim Bridenstine compared the class of CLPS companies to a venture capitalist’s portfolio: only a few need to make it for the overall program to be a success.

And if it is a success, CLPS could go a long way toward achieving that “sustainable” return to the moon that has been NASA’s mantra since the signing of Space Policy Directive 1 nearly a year ago. Even as many other aspects of NASA’s lunar plans remain uncertain or, in the case of the Gateway, subject to criticism, helping establish a commercial means of going to the moon — one that could be expanded over time to support larger, more complex payloads — could go a long way toward ending the past decades’ stop-and-go efforts to get back to the lunar surface.

If CLPS achieves that, it will certainly be worth a round of applause. SN
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