FEATURES:

2  SMC 2.0: A Challenge to Industry

4  Getting More Value from SmallSats

6  Pushing the Boundaries of Space Antenna Technology

8  Conquering Big Data

10 A Technology Trailblazer for GPS

12 Clear Pictures from Space

On The Cover:
SpaceX successfully launched the United States Air Force’s first Global Positioning System III space vehicle December 23, 2018. Harris technology has been on every GPS satellite ever launched.

Photo Credit: SpaceX

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Mission Confidence: Increased resiliency, rapid response, managed risk

Harris is a technology-driven company with industry-leading investments in independent research and development and a highly differentiated portfolio, making us a top provider of responsive mission solutions. In the space domain, these solutions are now essential, as U.S. government officials and potential adversaries call space the “American Achilles heel,” recognizing that disruptions in space pose a serious threat to national security.

Ensuring that our nation is protected and has the freedom to access and operate in space drives our efforts at Harris, as we work in partnership with Department of Defense and Intelligence Community agencies to advance national security missions and enhance mission confidence in an affordable, sustainable way. This issue of Insights for a Better World focuses on the three Rs of mission confidence that we strive for: increased resiliency, rapid response, and managed risk.

SMC 2.0: A Challenge to Industry discusses ways that industry can help the Air Force Space and Missile Systems Center evolve to bring better capabilities into the hands of warfighters faster. Success depends on adopting nontraditional approaches that drive innovation and speed up design and development.

Small satellites will deliver all three Rs of mission confidence. Getting More Value from Smallsats provides insight into Harris’ smallsat research and development journey, which includes 3 on-orbit systems and 17 more in the pipeline.

Pushing the Boundaries of Space Antenna Technology shares Harris’ actions to address critical satellite communication needs while reducing costs, shortening production schedules, and meeting volume constraints for space antenna reflectors. Conquering Big Data recommends tools that can enable analysts to glean useful information faster and more effectively from a deluge of sensor data. And A Technology Trailblazer for GPS features the new experimental mission of Navigation Technology Satellite – 3 for improved positioning, navigation, and timing resiliency.

We close our publication with Clear Pictures from Space, a look back at our 60-year partnership with NASA and a look ahead to the innovations that enable us to meet demands for more resilient imaging systems, faster deployment, and reduced production costs.

By focusing on the three Rs of mission confidence, working in creative partnership with our customers, and making the right research and development investments, Harris is doing our part to protect our nation and ensure America’s superiority in space.

When it comes to national security, the winds have shifted. Adversary nations have replaced terrorist groups as our top national security concern. The United States 2018 National Defense Strategy warns that “America’s military has no preordained right to victory on the battlefield.” And space is no longer an advantage for our nation.
From conference podiums to congressional meetings, Air Force leaders have been sharing their concern about the challenges to U.S. superiority in space posed by our adversaries. In response, the Air Force is transforming the nation’s premier developer of space capabilities, the Space and Missile Systems Center (SMC), through an initiative dubbed “SMC 2.0.”

SMC Commander, Lt. Gen. John F. Thompson, succinctly described the factors driving this transformation at MILCOM 2018:

“The Space and Missile Systems Center must adapt in order to maintain our nation’s superior space technical capability. …We’ve got to work better as an enterprise, and we have to be able to shift our cultural mindset. We’ve got to strengthen our partnerships with allies and you, the U.S. space industry. Above all, we’ve got to move faster, and we have to keep our adversaries backpedaling. We’ve got to do more innovative things, and we’ve got to do them more quickly.”

EMBRACING THE CHALLENGE

As a former military member at SMC and now the leader of Harris’ Space Superiority and Global Positioning System Programs, I have a strong connection with both the center and its mission. I am excited to see how SMC is addressing the initiatives of EPIC Speed—enterprise, partnership, innovation, culture, and speed—to do things quicker and with more industry collaboration.

I also recognize that for there to be true success, industry must be fully on board. And there are some key ways that we can make this partnership successful.
Remove our own stovepipes. One of the goals of SMC 2.0 is to create an overarching enterprise architecture that eliminates stovepipe programs in favor of an integrated portfolio of systems. Through this approach, SMC will reap the speed, cost-savings, and innovation benefits that come from leveraging economies of scale, fostering resource and knowledge sharing, and promoting collaboration.

Companies have their own stovepipes, created by organizational structures and factors like geographic locations, profit centers, customer types, and capabilities. We must find ways to look across our enterprises to fully understand the breadth of our own capabilities, and we must be able to work across stovepipes to create opportunities for our technical experts to brainstorm and collaborate. This will enable us to bring the best of our capabilities to bear for SMC and deliver innovative approaches to the most difficult space superiority challenges.

Accept more risk without being reckless. Space-related programs are generally highly complex. Yet media, politicians, and government accounting functions have not been tolerant of cost overruns, schedule slips, and system failures. Industry, like SMC, has learned to be extra conservative—building more time into schedules and taking additional steps to make sure we get everything perfect the first time.

But speed has now entered the mix. We must move quickly to get missions and assets into space and space capabilities into the hands of our warfighters. If SMC is willing to accept more risk by developing prototypes and accepting solutions that are “good enough” for today, then those of us in industry must do so as well. Risk management rather than total risk avoidance should be our focus.

Approaches like DevOps and Agile development enable us to develop and deliver in incremental releases. New techniques for collaboration among program team members and among contractor and customer should be explored to reduce the time between concept and completion. We also can be smarter about how we invest our research and development dollars, homing in on where our customers need it most.

We must consider emerging, less-proven production strategies and materials with the potential to deliver both cost savings and new or enhanced levels of performance. We need to look at what is already available in the commercial marketplace and incorporate it where it makes sense.

Go fast. For industry, speed also means having established rapid and repeatable processes for activities like proposals and rough order magnitude development. Aligning ourselves with the tenets of the Space Rapid Capabilities Office as it takes shape will ensure we are in lockstep with SMC when it comes to expediting the acquisition process.

The ability to go fast is also affected by the time it takes to onboard and grow new talent. One of industry’s most formidable hurdles—and one that has significant impact on our customers—is the slowness of obtaining security clearances, even for experienced, previously cleared personnel. We must be proactive on this matter and work with our customers to find solutions that protect classified information while enabling us to move rapidly on work assignments.

Accept the nontraditional. Through the use of other transactional authorities like the Space Enterprise Consortium (SpEC), SMC 2.0 shakes up the traditional cadence of Air Force acquisitions and breaks down barriers for new players to engage in SMC programs. It also streamlines the contracting process. The recent Navigation Technology Satellite-3 contract, managed by SpEC, went from white paper to proposal to contract award in only six months.

Collaborative organizations, like the Catalyst Campus for Technology & Innovation, present another nontraditional avenue for industry engagement. Catalyst Campus brings together small businesses, workforce trainers, startups, and others within Colorado’s established aerospace and defense industry to, in their words, “create community, spark innovation and stimulate business growth.” Traditional defense contractors can sponsor these types of organizations, assign committed professionals to serve as liaisons, and establish mentoring relationships with members to further the goals of these organizations and benefit SMC.

WELCOMING CHANGE

One of humanity’s greatest thinkers, Albert Einstein, said, “nothing happens unless something is moved.” For those of us who serve the space superiority mission, SMC 2.0 has lifted boundaries, changed rules of engagement, and significantly altered the pace of how we respond and deliver the space capabilities that will protect our way of life. Our response to the Air Force? Bring it on!

Chris Forseth is vice president and general manager of Harris’ Space Superiority and Global Positioning System Programs business. Harris provides the full spectrum of enterprise architecture solutions needed to gain, maintain, and exploit space superiority.
Smallsats, or satellites that weigh less than 1,100 pounds (500 kilograms), have been around longer than most people realize. The oldest artificial object orbiting Earth to this day is actually a smallsat. NASA’s Vanguard I, launched on St. Patrick’s Day in 1958, is just over six inches in diameter and weighs slightly more than three pounds. About a third of the satellites launched over the last 20 years could also be classified as smallsats.

In just the past few years, smallsats have really taken the spotlight. Market researcher Euroconsult reports that 330 smallsats were launched in 2017 and forecasts that more than 7,000 will be launched over the next decade. This number represents more than five times the number of smallsats that were launched in the previous decade.

DRIVING FACTORS
Driving the smallsat industry are two very basic needs: cost and speed to market. The recent emergence of privately developed launch systems has dramatically reduced launch costs, creating more launch opportunities for smallsats. The application of new and maturing technologies, such as 3D printing, is delivering efficiencies in satellite production as well.
Today’s dynamic geopolitical environment is dictating a need to deliver much more responsive and flexible solutions. Rogue states and terrorist threats warrant credible capabilities in orbit much quicker than traditional acquisition timelines allow. Actionable intelligence in a timely fashion is no longer a luxury—it is a necessity.

Increased speed and reduced cost is particularly crucial as space becomes more of a contested environment. Gen. John Hyten, commander of U.S. Strategic Command, has referred to large, exquisite satellites as “big, fat, juicy targets.” While these exquisites provide capability we cannot do without, they were designed for benign environments.

Smallsats, when deployed in constellations, enable not only greater mission resiliency, but also more persistent coverage. However, many question whether these smaller satellites can meet the performance requirements previously provided by larger systems. At Harris, we believe they can. While there will always be a tradeoff between cost and capability, we have been improving our solutions for large satellite systems in parallel with adapting our world-class technologies in sensors, structures, and ground systems to address smaller form factors.

**A PROOF OF CONCEPT**

Last year, Harris launched our own demonstration smallsat, called HSAT, which was developed entirely using Harris internal funds. HSAT is a 6U-sized cubesat, with 1U representing a 10 x 10 x 10 centimeter cube. At 6U, HSAT is about the size of a personal briefcase. HSAT publicly showcases what we call our end-to-end, or turnkey, smallsat solution.

We designed and built HSAT to be affordably launched as a “rideshare” with other satellites on the same launch vehicle. Since its launch last November, Harris has been successfully operating HSAT from a scalable ground system that we designed and installed at our facilities in Florida. From this ground system, we have the ability to provide advanced processing services and deliver data analyses that, if applied to a mission, would aid in effective and timely decision making.

One of the chief reasons for this initiative was to reduce risk for our customers. Industry estimates indicate the failure rate for cubesats to be 80 percent or greater. HSAT provides lessons learned that significantly improve success rates of future systems.

An equally important aspect of HSAT is the demonstration of technologies that deliver real mission value. For example, we are demonstrating an advanced, miniaturized technology on board HSAT that enables smallsat missions to be reprogrammed on orbit. This technology is based on our Harris AppSTAR™ hosted payload architecture, which is on board the new Iridium NEXT constellation and currently serving multiple missions, including maritime ship and airplane tracking.

**NECESSITY PROVIDES UTILITY**

At Harris, mission focus has been our approach since the beginning. We have developed a mission-ready, 6U smallsat called HyperCube™ that has been built around our proven hyperspectral sensing technology. Harris’ SpaceView™ product line includes smallsat-compatible imaging technology that is capable of capturing 1-meter resolution images. Our High Compaction Ratio Reflector Antenna can unfurl from smallsats to support high data rate communications. With these types of electro-optic and radio frequency capabilities, smallsats can indeed be a viable option for many defense and intelligence missions.

Given that the pace of technology advancement continues to increase, it is hard to say if smallsats are the result of an evolutionary process or a revolutionary one. The next few years will be telling. But one thing is clear: when it comes to protecting our nation, the ability to anticipate mission needs and respond with valuable and innovative solutions—for large systems and small ones—remains essential.

**Murali Krishnan** is vice president and general manager of Harris’ Intelligence, Surveillance, and Reconnaissance (ISR) business. Harris is applying new ideas and perspectives to develop game-changing technological breakthroughs for ISR solutions that are more affordable and have lower size, weight, and power requirements.
From the television programs we watch, to our cell phone conversations, to the internet we access for business and personal use, the world relies on satellite-based antenna systems receiving continuous streams of big data and reflecting them back to locations on Earth reliably and quickly.

Nearly 50 years ago, Harris made a commitment to advancing satellite communications with innovative space antenna solutions—in particular, lightweight reflectors that pack up tightly inside rockets for launch and then unfurl in space once the satellite is in its proper orbit. We started with a radial rib design (something like the classic umbrella) and graphite composite materials for the frame. We developed a unique, highly reflective mesh material that we “knit” ourselves to serve as the reflector surface. And we constructed what is still the world’s largest dedicated assembly, integration, and test facility to be able to produce quality mesh reflectors in quantity.

Over the decades, our space antenna reflector business has grown rapidly in alignment with the demand for more and better satellite communications, and Harris is now recognized as the most experienced unfurlable mesh reflector manufacturer in the world. But leadership has its challenges, not the least of which is remaining relevant and competitive in a marketplace that is rapidly changing.

So today, Harris is once again pushing the boundaries of space antenna reflector technology. We are answering the call for higher signal throughput, frequency reuse, faster production, and decreased mission risk with an expanded portfolio of reflector solutions that includes revolutionary new approaches to achieving low-stowed volume constraints, increasing the mission value of smallsats, and reducing costs to satellite owners.

EXPANDING OUR PORTFOLIO

Harris’ Radial Rib Reflector, with deployed apertures ranging from 3.5 meters to 9 meters in diameter, has been a tried-and-true top performer for satellite communications and broadcast systems working in frequencies from UHF to Ka band. Compared to conventional solid reflectors in the 2-meter to 3-meter class, Harris’ Radial Rib Reflector provides more spot beams for more efficient frequency reuse and greater capacity.
Our Folded Rib Reflector design—think of the compact foldable umbrella that fits in your briefcase—followed the Radial Rib Reflector. With deployed apertures as large as 18 meters, it stows in even less space for launch. Available for satellite applications from UHF to S band, these larger reflectors serve high-gain missions and accommodate smaller handheld radios on the ground. These workhorse antennas are still vital, particularly for the mobile-satellite service market and science missions.

A few years ago, Harris introduced another lightweight alternative to bulkier, larger solid reflectors: the Fixed Mesh Reflector. “Fixed” refers to the rigid reflector structure, which stores as-is for launch. Spaceflight-qualified versions of the Fixed Mesh Reflector in sizes up to 3.5 meters fit neatly into today’s generation of rockets. Recent improvements enable this reflector to meet V-band requirements. It is the first mesh reflector to operate through 50 GHz. Recently we designed a 5-meter version of the Fixed Mesh Reflector to fit into the large fairing of the next-generation heavy-lifting launch system, New Glenn, to enable future ultra-high-throughput satellites.

INTRODUCING THE PERIMETER TRUSS MESH REFLECTOR

Demand for even more accurate, compact, and lighter reflectors prompted Harris to design the Ka-band Perimeter Truss Reflector. Introduced in late 2018, the Perimeter Truss Reflector offers a stowed height that is 30 percent shorter than today’s state-of-the-art reflectors and has 50 percent less mass than heritage reflector designs. Scalable from 3 meters to 22 meters, the Perimeter Truss Reflector will support the most technically challenging communication, science, and synthetic aperture radar missions.

A HIGH-QUALITY ANTENNA FOR SMALLSATS

When configured as constellations, smallsats have the potential to deliver significant benefits to mission owners, like improved mission resiliency and affordable, persistent coverage. Harris’ new Ka-band High Compaction Ratio Reflector Antenna brings big value to smallsats.

Our 1-meter reflector and feed can fit into a smallsat with a 2U stowed volume, approximately the size of a box of tissues. And yet it is powerful, enabling high data transfer rates typically only available with large-aperture reflectors. By applying the same fabrication and surface-shaping processes as our heritage antennas, we minimize development risk for our customers.

The High Compaction Ratio Reflector Antenna design can be scaled up to 5 meters in diameter, a size that neatly fits into a quarter of an Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) class satellite.

REDUCING RISK, SCHEDULES, AND COSTS WITH BUILD TO PRINT MODELS

Most big-dollar projects must weigh desired features and capability against cost, and this generally requires trade-offs. Harris is enabling mission owners to get more for their dollars through a “build to print” selection of some of our most successful reflector designs. With their foundational designs completed and with manufacturing facilities and processes already in place, these solutions not only reduce design costs, but also reduce risk for our customers through their proven performance, and they accommodate fast turnaround production schedules.

Our build to print models meet a wide range of needs, including low-stowed volume and low-mass requirements, and they support UHF to V-band applications. These designs use Harris’ patented, highly reflective mesh surfaces and proven structures for reliable, precision deployment. We streamline manufacturing time and costs by using additive manufacturing and off-the-shelf components when possible—but we never cut corners when it comes to quality. Our reflectors are still manufactured in-house following proven processes and rigorous testing regimes.

BEYOND DESIGN

Staying relevant and competitive in the fast-paced space industry is never easy. And when it comes to specialized technologies like space antenna reflectors, it takes more than just interesting new designs to be successful over the long haul. I believe that the not-so-secret ingredient to maintaining our leadership position is our highly experienced team of engineers and technicians. These 300 committed men and women work daily behind the high-bay doors of our factory, using proven facilities, following strict processes to the letter, and performing together as a well-oiled machine to deliver reflectors that reliably deploy in space, perform to specification, and advance the state of the art for our customers and their users.

Tom Campbell is general manager of Harris’ Space Antennas and Structures business. Harris is the number-one provider of large, high-accuracy reflectors, with more than 90 lightweight, mesh antennas on orbit.
Every minute, sensors of all types are collecting data to support national security missions. Unprecedented quantities of signals intelligence, measurement and signature intelligence, geospatial intelligence, image intelligence, and open source data are pouring into ground systems for processing and mission incorporation.

Estimates reveal that today’s imagery analysts spend 80 percent of their time searching for the right data to answer critical questions. This leaves only 20 percent of their time to do actual analysis. Adding more staff does not have to be the solution. As a premiere provider of content management tools and custom data solutions, Harris suggests four valuable tools that will make managing the big data influx easier, assure data quality, and enable analysts to get to real intelligence more efficiently and effectively.

**TOOL #1: CONTENT CURATION**

Picture the museum curator dusting his prized artifact. He knows its value and proudly displays it for others to enjoy and learn from. Like the artifact, data has value and history. When we know where it came from and how it got to us, we can assign a level of confidence to it. Just as that prized artifact at the museum can be replaced with something even more spectacular, data can be replaced with something more current or useful.

Harris is modernizing data management with curation tools to monitor data’s value as it passes through time. Through curated data labeling, analysts can understand data’s origin and know what has been done to standardize it for insertion into big data storage systems. When the analyst knows the data’s origin and timeliness, there is less risk involved in applying it to missions, easing the task of providing actionable intelligence to the warfighter with better intelligence at faster speeds.
TOOL #2: DATA VIRTUALIZATION

Virtual data systems connect and integrate disparate data silos without changing the original location of the data, reducing costs and risks associated with moving data from system to system. Data from the individual siloed systems is indexed, enabling the various dissimilar data sources to be accessed from a single point. This not only provides a convenient “window” into the possible data opportunities, but also ensures that the best, validated information is available and accessible to all users. Organizations gain a complete, more accurate picture of operations faster.

Whether systems are located on premise or in the cloud, virtual databases are proven to successfully bridge the gaps between multiple data systems. Harris is implementing secure virtual data systems as the way of the future to efficiently meet mission needs without extensive on-premise equipment.

TOOL #3: QUALITY ASSESSMENT, CONFLATION, AND LABELING

To effectively utilize data in big data environments, search, discovery, and retrieval tools aim for speed to identify query results. Of equal importance to speedy results is the quality of results. High-quality query results save time and reduce risk by providing fit-for-use results that enable faster analysis with increased confidence.

Search and discovery tools rely on metadata labeling that shares key information about what the data is. However, not all sources accurately label the data, and the labeling descriptions often are not consistent. At Harris, we resolve these shortcomings with tools that automate metadata labeling, greatly reducing time spent manually labeling. Our automated processes identify relationships or links between the attributes of the different data sets and apply rule-based, business-specific tagging and classification to standardize the metadata, which enables faster data discovery and retrieval for analysis.

We also reduce the time-consuming manual practices of data quality testing by employing scientific algorithms and automated workflows to keep accurate information, remove conflicting data, and provide trusted data of higher quality for the analyst. We employ tools to automate data set conflation, making it easier to accurately combine data from multiple system configurations.

TOOL #4: ENTERPRISE-WIDE GROUND OR VIRTUAL GROUND PROCESSING

As more data comes in from the expanding number of sensor systems, ground processing tools must keep pace. Organizations managing multiple concurrent programs in silos incur higher overall operational and maintenance costs due to duplication in facilities, infrastructure, and personnel resources for the separate systems. We achieve efficiencies by enhancing enterprise-wide ground systems with shared processing, workflows, and mission-specific algorithms.

Comprehensive enterprise ground architectures integrate multiple programs and connect multiple mission command and control operators with a unified interface. The latest cloud-based satellite control and ingest tools, for example, are reducing ground station investment by enabling command and control and downlink ingestion for new satellite constellations.

While there will always be missions with unique products and needs, a single infrastructure that eliminates duplicate hardware and software and reduces the number of operations personnel pays off significantly in increased efficiencies and cost savings. Even more benefit comes when those enterprise-wide ground systems are designed to allow the rapid insertion of new sensor missions and incorporation of new algorithms that find meaningful patterns in data or sort and process data into more useful information pieces.

A COMPETITIVE ADVANTAGE

When it comes to getting real intelligence from big data, improving data management and streamlining ground processing functions can give organizations a competitive advantage. Tools like those discussed here enable fast, high-quality search results, so that analysts can focus their time where it counts most—analyzing data to put confident intelligence into the hands of the warfighter.

Jackie Schmoll is director of Government Geospatial Systems within Harris’ Geospatial Solutions business. Harris provides data processing, advanced analytics, and content management solutions that turn data into trusted information to detect, analyze, predict, and respond to events around the world.
During the final days of NATO’s two-week Trident Juncture military exercises in late 2018, reports of Global Positioning System (GPS) signal interruption across Norway and Finland began coming in from commercial airline pilots. Finland Prime Minister Juh Sipila quickly commented that interference was “almost certainly deliberate,” and a subsequent announcement from Norway pinpointed Russia as the source of the jamming.

The incident was a sobering reminder of the vital importance of U.S. positioning, navigation, and timing (PNT) capabilities to millions of civilians, as well as U.S. and allied militaries. It was also not a surprise.

Over the past decade, military leadership and national strategists have shared their concerns about U.S. dependence on GPS for everything from financial transactions to commercial transportation scheduling to precision weapon system guidance. The new generation of Air Force GPS satellites, which began launching in late 2018, marks a significant step toward improving GPS services with three times greater accuracy and up to eight times improved anti-jamming capabilities over the previous GPS satellite block.
Now the Air Force Research Laboratory and the Space and Missile Systems Center are focusing the Department of Defense’s first experimental Navigation Technology Satellite (NTS) in more than 40 years—NTS-3—on initiatives that will demonstrate new tactics, techniques, and procedures to improve PNT resiliency and counter threats to GPS.

**ON-ORBIT TESTBED FOR FUTURE PNT CAPABILITIES**

As a unique satellite that flies outside of the GPS constellation, NTS-3 will host experiments with impact across the PNT user spectrum—military, civil, academic, and commercial. It will explore innovations in atomic clocks, antennas, reprogrammable digital waveform generators, signals, and other technologies.

Harris, the satellite prime contractor for NTS-3, is approaching these mission innovations from the standpoints of responsiveness and resiliency as well as technology advancement. For example, the design will support the simultaneous broadcast of dual-frequency, regional high power, and Earth coverage signals. An agile waveform platform will demonstrate the ability to rapidly develop and deploy new signal waveforms with total flexibility throughout the satellite life cycle. These innovations will allow operation in multiple contested environments, a key to achieving resiliency that can combat electronic jamming, spoofing, and more.

Another strategy is the design of a modular NTS-3 payload that can be reprogrammed in space. Based on open, industry standards and interfaces, the payload will be scalable and can be hosted on diverse platforms and in varied orbits with minimal changes.

NTS-3 will also explore a timekeeping system that uses diverse sources to improve mission stability, anomaly detection, and correction capability.

**A LEGACY OF INNOVATION**

When NTS-3 launches for its planned one-year experimental campaign—anticipated to begin in 2022—it will be the latest in a series of experimental spacecraft that have blazed the trail for the extraordinary technological advances that led to the GPS system we enjoy today.

NTS-1 launched in 1974 as the culmination of the U.S. Naval Research Laboratory’s TIMATION program, which used passive ranging technique and highly accurate clocks to create a revolutionary navigation system. The TIMATION program demonstrated the ability to pinpoint longitude, latitude, and altitude throughout the world, leading directly to the first GPS technology.

NTS-2 launched three years later, building on the earlier technology with a long list of technology upgrades—like cesium frequency standards, nickel-hydrogen battery, radiation dosimeters, and a worldwide network for data acquisition. It is considered the first NAVSTAR GPS Phase I satellite.

Like its predecessors, NTS-3 is revolutionary in its approach, addressing new capabilities and paving the way to more resilient PNT. In the next few decades, NTS-3 will blaze the trail to unfettered access to the vital data GPS provides, even in the midst of a wide variety of new threats.

**COST, RESOURCE EFFICIENCIES**

The NTS-3 mission will be delivered with a heavy emphasis on cost and resource efficiency. The contract was issued by the Space Enterprise Consortium, a U.S. Air Force-led group formed to pave the way for faster innovation in military space programs.

Harris is responsible for the design, development, integration, and testing of NTS-3, including ground mission applications. Having provided the navigation technology for every GPS satellite ever launched, Harris brings unmatched PNT experience and mission knowledge to the job. Other integral players include NASA’s Jet Propulsion Laboratory, satellite bus provider Northrop Grumman, and satellite ground control provider Braxton Technologies.

To provide cost savings, direct resources, and schedule priorities where they will have the most impact, NTS-3 will be built on a commercial off-the-shelf (COTS) platform, and other COTS technology, such as standard processors and SpaceWire Interfaces, wherever possible. New development will be focused on the true innovation needed for mission success.

By targeting innovation and using a space-based testbed environment for real-world demonstrations, NTS-3 promises to be one of the Air Force’s most important experiments in recent decades to address the challenges of an increasingly congested and contested space domain, and technology savvy adversaries.

![Col. Jennifer Moore, USAF (Ret)](image)

Col. Jennifer Moore, USAF (Ret) is director of Rapid Capabilities for Harris’ Space Superiority and Global Positioning System Programs business. The Rapid Capabilities business area identifies opportunities to deliver advanced technology prototypes and experiments to the space community on an accelerated and efficient timeline.
Humanity’s first views of the world from space were modest—grainy images from a video camera strapped to a V-2 rocket launched from the White Sands Missile Range in 1946. But that experimental flight would push back a celestial curtain, proving the capability of space-based imagery and driving the appetite for more and better pictures.

By 1959, the fledgling agency called NASA had taken up the gauntlet and tasked its Explorer 6 satellite with capturing the first images of Earth from orbit. Less than a decade later, NASA was turning the lens away from Earth as the Lunar Orbiter mapped the moon in preparation for the Apollo missions. In the 1990s, we were receiving astounding up-close images of Mars from the Sojourner Rover.

As we mark the 60th anniversary of NASA’s founding, we also observe six decades of Harris working hand in hand with the administration to uncover the vast unknowns of space. Imaging systems have been, and are still, at the forefront of those efforts, providing ever-advancing visuals of places that are largely out of physical reach. Our work over the decades has reflected themes that are still important today—addressing the needs of NASA and other customers while innovating ways to protect space access for responsiveness and resiliency.

**PARTNERING FOR INNOVATION**

Partnering with NASA to meet the increasingly complex system requirements and expectations of its programs—and others inspired by the agency’s exciting missions—has required Harris to push the boundaries of technology. As a result, over the past half-century we have significantly evolved our capabilities in imaging system design, payload manufacturing, and integration and testing. We have provided integral systems on commercial Earth observation satellites, including...
These are two of the most enduring puzzles of the cosmos. WFIRST will take a wide view of the universe, along the lines of a panoramic view of space compared to the telephoto views of Hubble and JWST. WFIRST will also find new exoplanets—those outside of our solar system—and new galaxies and other celestial bodies.

Harris is executing the overall preparation of the telescope hardware to meet exacting mission requirements. That includes the 2.4-meter primary mirror and other optics and structures. Harris developed the hardware to enable the two scientific instruments on WFIRST and successfully carried out mirror cold-temperature testing.

The close partnership between Harris and NASA continues in other ways beyond telescopes. NASA’s new series of manned space missions, the first since the Space Shuttle program ended in 2011, will be taking humans and their imaging technology to the moon, Mars, and beyond. Harris is providing the astronaut audio system for the next human deep space mission, scheduled to launch in 2022 on board the Orion spacecraft.

NEW DEMANDS

Certainly, NASA has come a long way since Explorer 6’s onboard scanning device, and so has Harris—by answering the call for better image resolution and faster delivery.

Today we have imagers that collect pictures of the earth so clear that you can identify plant types on its surface. Soon we will have the technology to collect light from the very dawn of the universe.

By broadening our range of solutions to include innovative, advanced optics, sensors, and manufacturing techniques, Harris is addressing tomorrow’s demands for more resilient imaging solutions, faster deployment, and reduced production costs.

WHAT’S NEXT?

Anticipation is mounting for what is coming in the next wave of universe exploration. The JWST mission will be the next to provide a new generation of science and insights into our universe, but more and different capabilities are on the way. Another program promises to uncover some of the greatest mysteries of the universe. And, again, Harris plays a key role.

The Wide Field Infrared Survey Telescope (WFIRST) will provide the most expansive images of the universe ever taken, a key to learning more about both dark energy and dark matter.
Harris Corporation is a leading technology innovator, solving customers’ toughest mission-critical challenges by providing solutions that connect, inform and protect. Harris supports government and commercial customers around the world. Learn more at harris.com.