SatCom For Net-Centric Warfare May/June 2010

# MilsatMagazine

Mission Assurance Remains Fundamental

MILSATCOM Market Trends

Lt. Col. Collins, SBIRS

Upgrading To Military Grade

U.S.A.F. Space & Missile Center

The "Space Plane"

Hosted Payloads On ComSats

TerreStar-1
Image courtesy of SS/L


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# MILSATMAGAZINE

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## PAYLOAD


*TerreStar-1, photo courtesy of SS/L*

# AFTER 50 YEARS...

## MISSION ASSURANCE REMAINS FUNDAMENTAL

*author: Eric K. Spittle, Vice President Government Program Acquisitions, Space Systems/Loral*
*and*
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Fifty years ago, America launched its first operational communications satellite — ***Courier 1B*** — built by **Space Systems/Loral**. Courier 1B was the world's first transponder satellite, besting the broadcast-only capability of the USSR's ***Sputnik 1***.

The satellite generated an enormous sense of national pride as President *Eisenhower* used the satellite to broadcast his 1960 Christmas message from the White House to the United Nations. Back then, Space Systems/Loral was the ***Western Development Laboratories Division*** of the **Philco Corporation**.

In 1961, **Philco** became a subsidiary of the **Ford Motor Company**. In 1975, the name changed to **Aeroneutronic Ford**, and the next year it was changed to **Ford Aerospace**, a name that was used for more than two decades.

In 1990, **Loral Space and Communications** acquired the company from Ford and renamed it **Space Systems/Loral**. Today the Space Systems/Loral (SS/L) name remains and the company is a subsidiary of **Loral Space & Communications**.

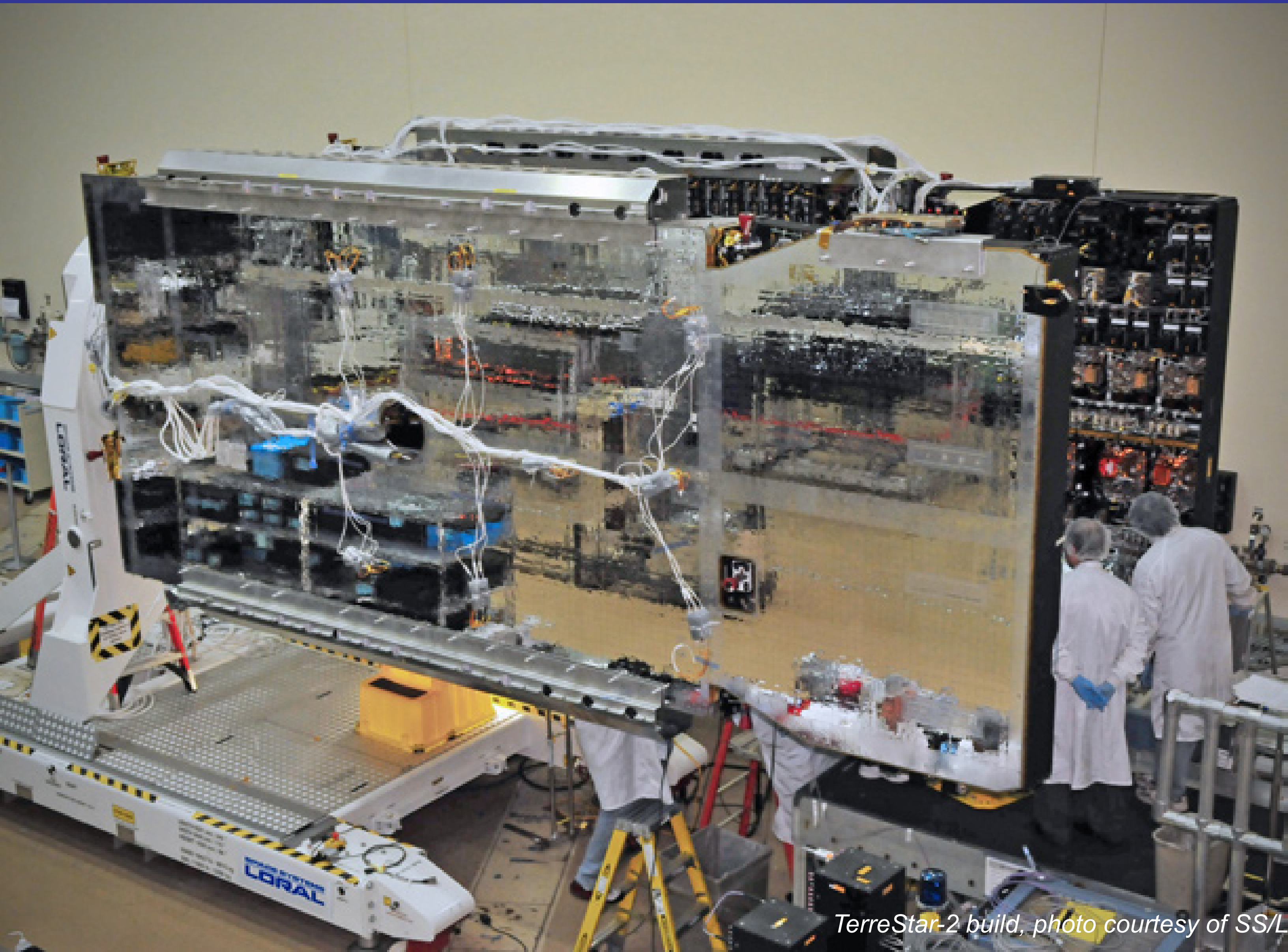
Since 1960, **SS/L** has launched 231 satellites, including 69 using the highly reliable and flexible ***1300*** satellite bus. Today, SS/L is the world's leading manufacturer of high-performance, commercial, geostationary satellite communications systems. Each satellite has been manufactured at the Company's Palo Alto, California campus.

In fact, 2009 was among the busiest at SS/L, with seven successful large satellite launches and seven new awards. How has SS/L been able to amass such an impressive record of performance? To be sure, great people are required. Additionally, an unwavering focus on Mission Assurance is another key to the Company's success.

Space Systems/Loral has always adhered to strict mission assurance processes and procedures based on sound system engineering principals. In the 1980s, SS/L incorporated government military standards and specifications into already robust and proven company procedures. More importantly in the 1990s, when the rest of the aerospace industry abandoned military specs and standards as part of "Acquisition Reform," SS/L did not follow suit.

Similarly, SS/L does not postulate a different mission assurance approach for each satellite build, but proposes and follows the same robust mission assurance procedures on every satellite manufactured in the factory. This approach results in high learning curve yields and low percentage of rework.

SS/L may not yet be a household name, but the Company's customers and their products and services are. Some of the companies that depend on SS/L spacecraft include: **DIRECTV**, **DISH Network/EchoStar**,




*TerreStar-2 build, photo courtesy of SS/L*

**Globalstar**, **Intelsat**, **SES**, **Sirius XM Radio**, **Telesat**, **TerreStar**, and **Wildblue/ViaSat**. SS/L is also currently building two high capacity broadband satellites for service in the U.S. for **Hughes Network Systems** and for **ViaSat.**

Perhaps our most important customer is the **U.S. Department of Defense**. According to industry research firm, **Futron**, the Department of Defense leases roughly 80 percent of its communications from commercial satellite providers. SS/L manufactured satellites carry up to 33 percent of the entire DoD leased bandwidth, which is more than any other commercial manufacturer.

SS/L successfully launched, deployed, and transitioned seven satellites in 2009. The first launch of the year was ***Telstar 11N*** on February 26th for **Telesat** from Baikonur Cosmodrome, Kazakhstan. The second and third launches occurred on separate continents a mere 22 hours apart.

On June 30th, ***Sirius FM-5*** was launched for **SiriusXM Radio** from Baikonur followed by the ***TerreStar-1*** launch for **TerreStar Networks** from Guiana Space Center, French Guiana on July 1st.

***AsiaSat 5*** was launched August 11th for Hong Kong-based **AsiaSat** from Baikonur, followed by the launch of ***Nimiq 5*** for **Telesat** on September 17th, also from Baikonur.


*TerreStar-2 build, photo courtesy of SS/L*

***NSS-12*** was launched for **SES WORLD SKIES** from French Guiana on October 29th. Finally, on November 22nd, the ***Intelsat 14/IRIS*** satellite was launched on an ***Atlas 5*** rocket for **Intelsat** from Cape Canaveral, Florida.

The TereStar-1 and Sirius FM-5 launches demonstrated the depth of resources, capability and strength of the SS/L Mission Operations and launch crews. Two launch crews on different continents simultaneously processed and supported the launch of different satellites on different boosters for different customers, launching just hours apart. Separate mission operations' crews successfully deployed, initialized, calibrated and transitioned for operation two fully capable satellites to delighted customers.

"There is a certain excitement with every satellite launch that I know we share with the Space Systems/Loral team," said *Rob Briskman*, co-founder and Technical Executive of **SIRIUS XM Radio**. "With this very powerful satellite supplementing our existing constellation, we can assure our listeners of the continued exceptional experience that they have come to expect."

SIRIUS FM-5 is the first geostationary satellite in the SIRIUS constellation, which already includes three SS/L built satellites in highly elliptical inclined orbits (HEIOs).

TerreStar-1 is an S-band satellite with the largest unfurlable antenna on a commercial satellite. It was built by **Harris Corporation** for the satellite. After a thorough pedigree and test result review following the April deployment anomaly on a similar satellite built by a different manufacturer, the *Launch Readiness Review* correctly concluded the satellite was clear for launch. TerreStar-1 successfully deployed its 18 meter antenna and transitioned operations to TerreStar on schedule.

"The successful launch of TerreStar-1 marks the start of a new era in integrated satellite and terrestrial mobile services," said *Jeffrey Epstein*, president of TerreStar Networks. "Space Systems/Loral has been an important partner in helping us achieve our vision."

This successful launch was the result of years of dedicated effort. "Over one million hours were spent to design, build, and test TerreStar-1 at Space Systems/Loral alone," said *John Celli*, president and chief operating officer of Space Systems/Loral. "The completion of this highly complex satellite is truly a testament to our skills, hard work, and dedication, and the support of many suppliers around the world."

Fittingly, the seventh and final launch of SS/L's golden anniversary occurred at Cape Canaveral just down ICBM road from where Courier 1B launched a half century earlier. Many changes have occurred at the Cape in the intervening decades, but an absolute commitment to mission assurance has not.

**Air Force Space Command**'s ***45th Space Wing*** oversees launches at Cape Canaveral and Kennedy Space Center. The 45th Space Wing itself compiled a tremendous record of successful launches in 2009, including the November 22nd launch of the SS/L built Intelsat 14/IRIS satellite on a commercial Atlas 5 booster. This launch continued a decade of 100 percent launch success. "Commercial launch processing demonstrates the proficiency resulting from great product, great people and great standardized processes," said Brigadier General *Edward Bolton* Jr., 45th Space Wing former commander. "Frequent repetition of this formula yields successful results: high mission assurance coupled with cost and schedule savings. This commercial paradigm has great applicability to the government. I am implementing this proficiency model here at the 45th Space Wing and finding similar results. The busier the Eastern Range, the better we perform and the more efficiently we perform."

Throughout its 50 year history, Space Systems/Loral has partnered with the government and commercial industry to provide highly reliable and capable satellite communications capabilities, because commercial and US Government space programs have identical mission success goals. The ability to support DoD in the defense of the nation is a source of pride at SS/L. With as many as 33 percent of the DoD's commercial satellite usage being received and transmitted through SS/L manufactured satellites, that's a lot of performance and a source of pride. It is also a huge responsibility. As impressive as 99.999 percent availability is, the men and women of SS/L are driven daily to improve the performance and reliability of the next generation of communications satellites using our time-proven Mission Assurance approach.

"Employees don't just have a job at SS/L, they have responsibilities," states *John Celli*, president of Space Systems/Loral. "We invite the government to visit the Palo Alto campus where we design, develop and build the next generation of communication satellites. If the past 50 years is any indication, it's likely that a large percentage of future DoD communications traffic will depend upon communications satellites manufactured by Space Systems/Loral.

## About the authors


**Lt. Col. Eric K. Spittle, USAF (Ret.) is the Vice President of Government Program Acquisitions and works out of the company's Washington D.C. office. Prior to joining SS/L, Mr. Spittle worked in all lifecycle phases of weapon system acquisitions throughout his 21-year career in the Air Force, with a majority of his career in space system acquisitions. He held numerous research, testing and program management assignments in human biomechanics, software development, fixed-wing aircraft, satellite development and launch system operations support.**

**Lawrence F. Wray is the Vice President of Product Assurance and Ethics Officer. Mr. Wray has held management positions within SS/L and its predecessor companies for 23 years, including eight years as Director of Assembly, Integration, and Test. He also directed SS/L operations in France for two years and served as Director of Payload Programs. Mr. Wray has 30+ years of industry experience in the development, test and launch of communications satellites, launch vehicle systems, and cruise missiles. He has a broad base of expertise in systems development, systems engineering, satellite assembly, integration and test, launch base operations, program management, international program management, and product assurance.**

## Reader Memo

## Government Use Of Commercial Satellites

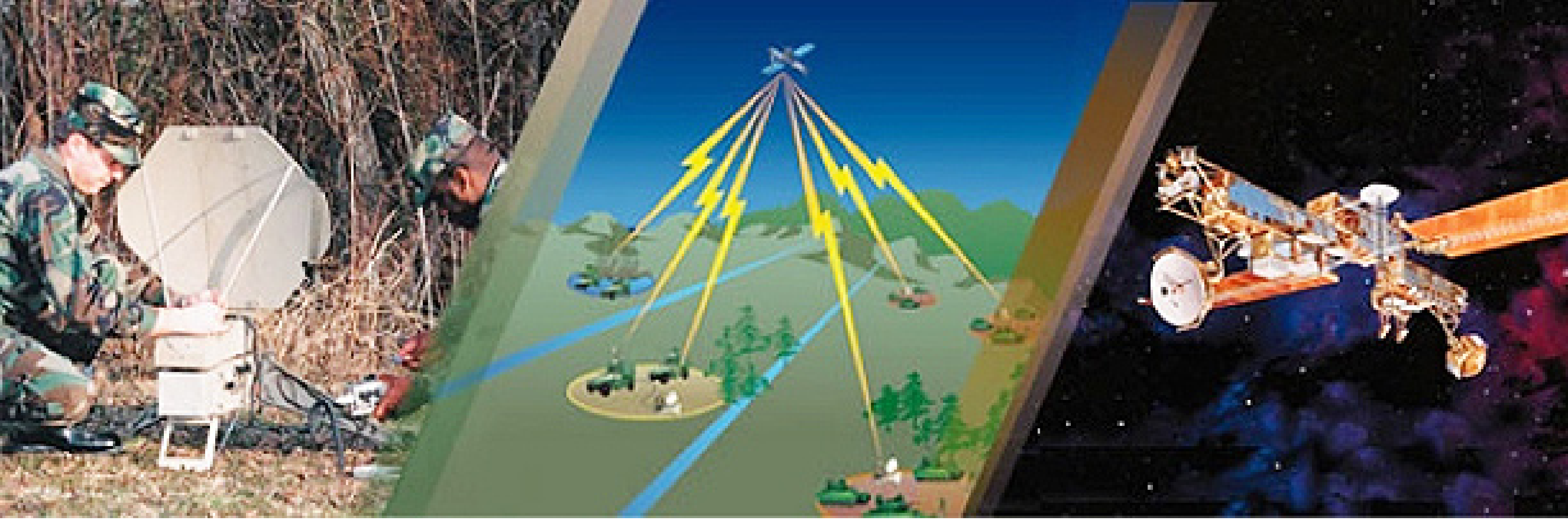
According to *General Steven Boutelle, U.S. Army (Ret)*, who is now Vice President of the Global Government Solutions Group (GGSG) at Cisco Systems, more than 94 percent of military satellite communications used today in the Gulf are delivered via commercial satellites. This fact sheds a positive light on the robust reliability of commercial satellites and commercial satellite manufacturing practices, which are already crucial in serving the military. Now the challenge is for the US Government to develop a space policy that enables government agencies to better leverage the cost and schedule advantages of the commercial industry, beyond annual leasing of commercial transponders already on orbit. With today's lean USG budgets both civil and military agencies are considering how they might benefit from expanded access to the benefits of commercial satellites.

Hosted payloads are one solution that is being seriously studied. With approximately 20 commercial satellites projected to be launched annually for the next five years, there is an opportunity for multiple government payloads to be positioned around the world without the government footing the full bill for spacecraft and launches. In a recent panel discussion at the industry conference, Satellite 2010, Joe Rouge, director of the *U.S. National Security Space Office* (NSSO), commented that every commercial satellite that is launched without hosting a government payload is a "missed opportunity."

Intelsat-14 is host to the IRIS payload
Image courtesy of SS/L

He added, "There is a radical shift in government thinking. The commercial industry has shown to us that they are capable of building capable systems. That was something that we were not ready for. There has been a real shift in this." There will always be technologies and missions that are unique to the government, and will require more traditional government procurement processes. However, if requirements are well understood and the technologies are mature, then commercial satellite manufacturers and operators are well-positioned to team with USG organizations to develop reliable satellite systems. Systems built using rigorous commercial processes can bring much needed capability to the war-fighter rapidly and less expensively, while maintaining or even improving system availability.

Speaking to the commercial manufacturers and operators on the panel, Rouge noted, "It is taking longer and longer for government to launch programs, where the commercial sector is taking less time. We have made this industry unexciting. That is what you bring to us and what we can't do all on our own. We need to learn from your experience."



# MILSATCOM ELECTRONIC MARKET TRENDS THRU 2020

**_A Strategy Analytics Executive Summary_**

*author: Asif Anwar is the Director within the Strategic Technologies Practice at Strategy Analytics*

### Forecast + Outlook Snapshot

A desire for higher bandwidth and networking capabilities in Military Satellite Communications (MILSATCOM) is creating new opportunities for advanced electronic components. Driven by growth in satellite launches and increasingly sophisticated capabilities, the annual market for electronics will grow from $796 million in 2009 to nearly $2.58 billion in 2020.

Communications forms an essential part of the infrastructure required to create a battle plan successful. Satellite-based communications, with their broad coverage areas, allow geographically dispersed users to exchange information quickly and efficiently.

Since the "space race" of the early 1960's, the US government and others have focused on military satellite communications (MILSATCOM) as a vital component for military strategy and national defense. The MILSATCOM market is largely US-centric, with a handful of large OEMs dominating the landscape.

As other countries have recognized the value and devoted resources to MILSATCOM, ***Strategy Analytics*** sees the market growing along two paths: the US and other large military powers will continue to increase the capabilities and sophistication of their networks, while smaller countries will begin establishing capability.

Strategy Analystics believes the desire and need for increased bandwidth capability being experienced in terrestrial communications will reach these military satellites. This will increase the number and sophistication of satellites in constellations with an estimate of 12 satellites launched in 2009 — this will increase to 28 satellites in 2020. Coupled with these increases will be a slight increase in the cost of a satellite and the electronics content to meet the increasingly sophisticated missions.

Driven by all these factors, Strategy Analytics estimates the annual market for MILSATCOM electronics, which was nearly $796 million in 2009, will grow at a CAAGR of 12 percent to reach $2.58 billion in 2020.

To accommodate these increased capabilities, newer satellite programs are incorporating more electronically scanned arrays for communications and much higher levels of processing power — a mix of TWT amplifiers and GaAs T/R modules will continue to enable the communication arrays, with GaN starting to capture share toward the end of the period.

Strategy Analytics estimates that the annual demand for GaAs components was nearly $30 million in 2009 and it will grow to $105 million in 2020. In the same period, we believe TWT content will grow from slightly more than $124 million to nearly $372 million.
Silicon, the primary technology for the processing and control functions, will be the largest contributor to the electronics content. We estimate Silicon content will grow from nearly $340 million in 2009 to slightly more than 1.19 billion in 2020.

This report analyzes the development, technologies and challenges for military communications satellites. A complete military satellite communications (MILSATCOM) network includes the satellites, user terminals and ground control segments. This report will only address the satellite, or space portion of these networks. The remaining segments are rich in electronic content and diversity in their own right and will be the subject of separate reports in the future.

These MILSATCOM satellites are becoming increasingly sophisticated and expensive and they contain a great deal of electronic content. The United States is the largest user and producer of this capability and a handful of US manufacturers dominate the market. Despite this relatively small manufacturer and user community, this market is fostering a lot of innovation as phased array antennas, lighter satellites, *commercial off-the-shelf* (**COTS**) components and more processing power for increasingly sophisticated missions are implemented.

The complete **Strategy Analytics** report examines the basic principles and architecture of satellite communications systems and how they are evolving and also discusses some of the technology and platforms that are enabling this evolution. The report also touches on some of the current and future developments that will affect these often times multi-billion dollar programs. All information in the report and this executive summary was researched using only public domain information.

## Electronic Component Demand Scenarios

Military communications networks provide for the exchange of voice, video and data between geographically dispersed elements of a battle force. These networks consist of user terminals, satellites and a ground network that provides control and interface functions. While all three segments contain advanced electronics content, this report will focus only on the satellite portion.

Military communications satellites range from simple "*bent pipe*" architecture where transponders in the satellite receive a signal and re-transmit it to Earth, to architectures that contain sophisticated on-board processors and link to other satellites in space. The transponders, control and satellite platforms are diverse but high performance semiconductor devices and electronic technologies enable them all. The caveat is these satellites play a vital role in national security, so it is difficult to determine all of the exact details. It is likely that much of this information will remain sensitive for some years to come.

This section uses Strategy Analytics' expertise to analyze the use of advanced electronics and the associated semiconductor component technologies that underpin the transponder/antenna, onboard processing and related systems for representative military communications satellites. This is a growing market with existing users looking to upgrade capabilities and new users realizing the value of communications to national defense.

## MILSATCOM Production Thru 2020

The satellite industry, in general, has weathered recent economic events better than most market segments. MILSATCOM development times are long and their missions are critical for national security, making them more insulated from economic fluctuations. As mentioned, MILSATCOM is a growing market with 12 satellite launches occurring in 2009, to expand to 28 satellites being launched in 2020, for a CAAGR of 9 percent over that time period.

There are several reasons for this growth. For all users, the size of the Earth requires multiple satellites placed in orbit in a constellation to cover the areas of interest. Constellations typically need a minimum of 3 to 4 satellites (and potentially a number of spares) to provide adequate communications coverage and perhaps an order of magnitude more satellites for navigation coverage.

For existing users, upgrade of satellites is not feasible — this means new capabilities are required and aging satellites means new launches with more birds. Additionally, more countries in the world are seeing the advantages of MILSATCOM capabillities and are looking to implement, or expand, their networks.

*Exhibit 1* below shows Strategy Analytics' projections for MILSATCOM platforms from 2008 to 2020.

There are two important trends shown in this forecast. The first is the steady upward trend of satellite launches. The regional and functional contribution to the total will change over the forecast period, but the overall

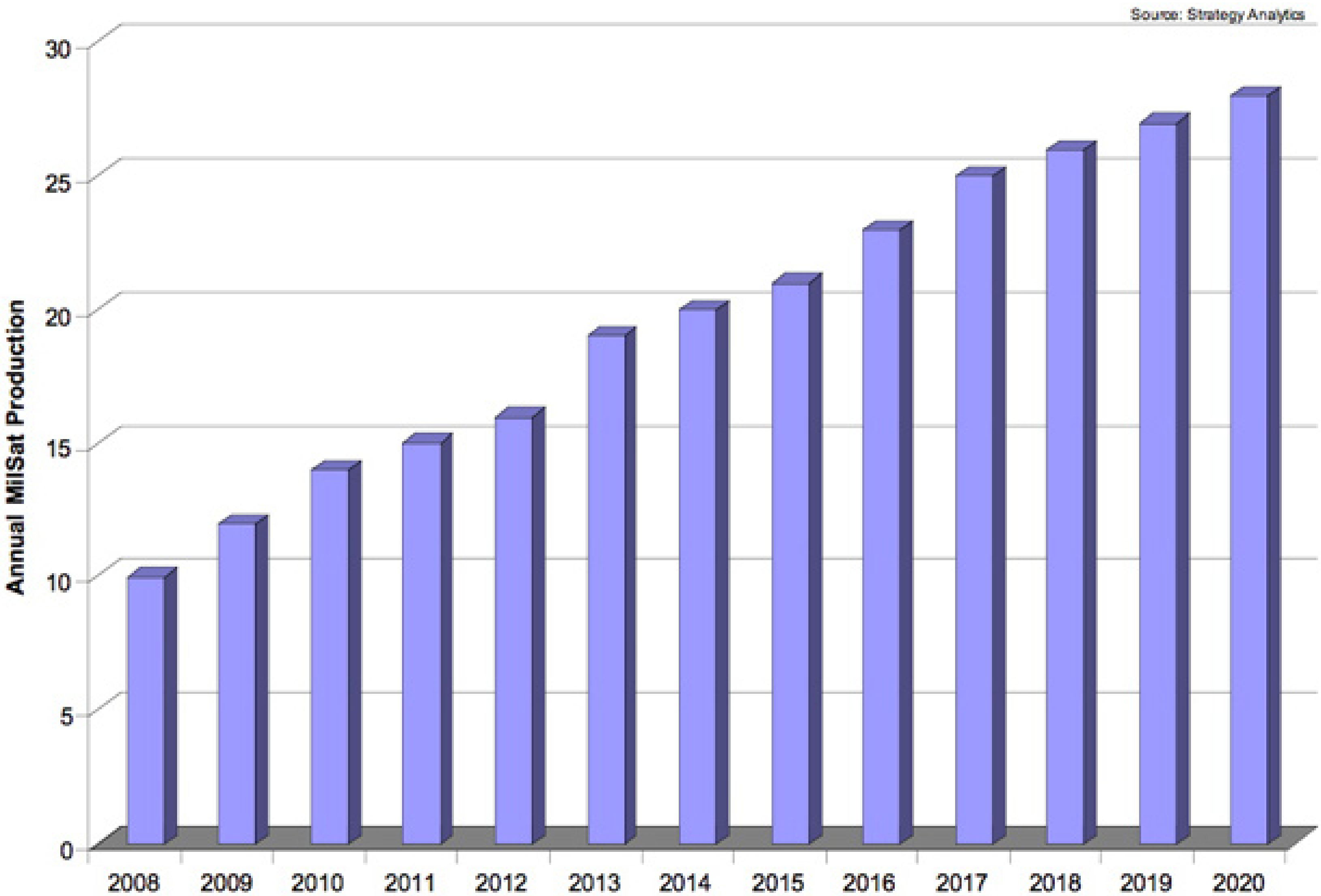



***Exhibit 1 — Annual Military Communications Satellite Production through 2020***

number will continue to increase. The US has been in the forefront of the technologically sophisticated communications satellite activity and this will likely level out as next generation programs have gotten very expensive and are under tremendous scrutiny. To fill this gap, activity from other countries such as Russia, China, India, Japan and Germany will increase as these countries, and others, expand their capability.

The proportion of navigational satellites is likely to increase. Currently, the 30-satellite ***US NAVSTAR*** network is the only fully functional ***Global Navigation Satellite System*** (**GNSS**). This will change as the Russians retrofit and update their ***GLONASS*** network. In addition, there are efforts by Europe (***Galileo***) and China (***Compass***) that will reportedly rival or surpass the size of the US network over time.

The second event of interest is a jump in shipments in the 2013 period. This will be the result of the cancellation by the US government of the highly sophisticated ***Transformational Satellite*** (**TSAT**) program. This satellite constellation was to offer significant improvement for wideband and secure satellite communications. The US is attempting to maintain as much of this capability as possible and one likely scenario is launching additional ***AEHF*** satellites. While these satellites fall short of the specified performance of TSAT, they are among the most sophisticated in the world. Adding additional satellites to the constellation will replace some of the functionality lost through the cancellation and this should occur around 2013.

The US Army is currently developing a nanosatellite that has the potential to alter the dynamics of the MILSATCOM market. This program aims to develop very small, inexpensive satellites to use in a variety of missions. The idea is to simplify the electronics functionality on each satellite and offset this by a dramatic increase in the number of satellites in a constellation. The first prototypes are scheduled for launch in 2010. This forecast does not account for any nanosatellite share in the market because the program is in the early stages and has yet to demonstrate a viable usage model. This development does merit further attention because, if successful, it has the ability to dramatically increase the quantity and reduce the electronics content of satellites.

## Transponder Electronics

On early bent-pipe satellites, the transponder simply received the signal, converted the frequency to a different channel, and amplified it for re-transmission. As data rates and the functionality of the satellite have increased, these transponders have become much more sophisticated. While dish antennas and TWTs are still in use, more satellites are incorporating phased arrays. The advantage is the arrays may be driven to create multiple beams from a single array face.

There are two types of arrays: ***passive*** (**PESA**) arrays uses TWTs to provide transmit power and they contain less solid-state content. ***Active*** (**AESA**) arrays consist of lower power *transmit/receive* (**T/R**) modules typically built using *gallium arsenide* (**GaAs**) compound semiconductor technology. In either case, the transponder feeds the array element and has much more electronic content than early versions.

Strategy Analytics estimates that the total component demand for MILSATCOM transponder electronics was $280 million in 2009. This content will increase to nearly $954 million per platform in 2020 for a CAAGR of nearly 13 period over the period.

Of this total, digital processing represents the fastest growing segment, going from 10% to 13 percent of the total over the period. This reflects the increasing baseband complexity and control requirements for the RF electronics.

## Military Satellite Communications

The mission of a MILSATCOM is simple: provide information to warfighters who may be geographically dispersed. While the mission is straightforward, the implementation is not. The challenge becomes providing more information, at faster rates over greater distances. The challenges of the past and the evolution of military satellites are playing a crucial role in how 21st century conflicts are planned and executed.
MILSATCOM History

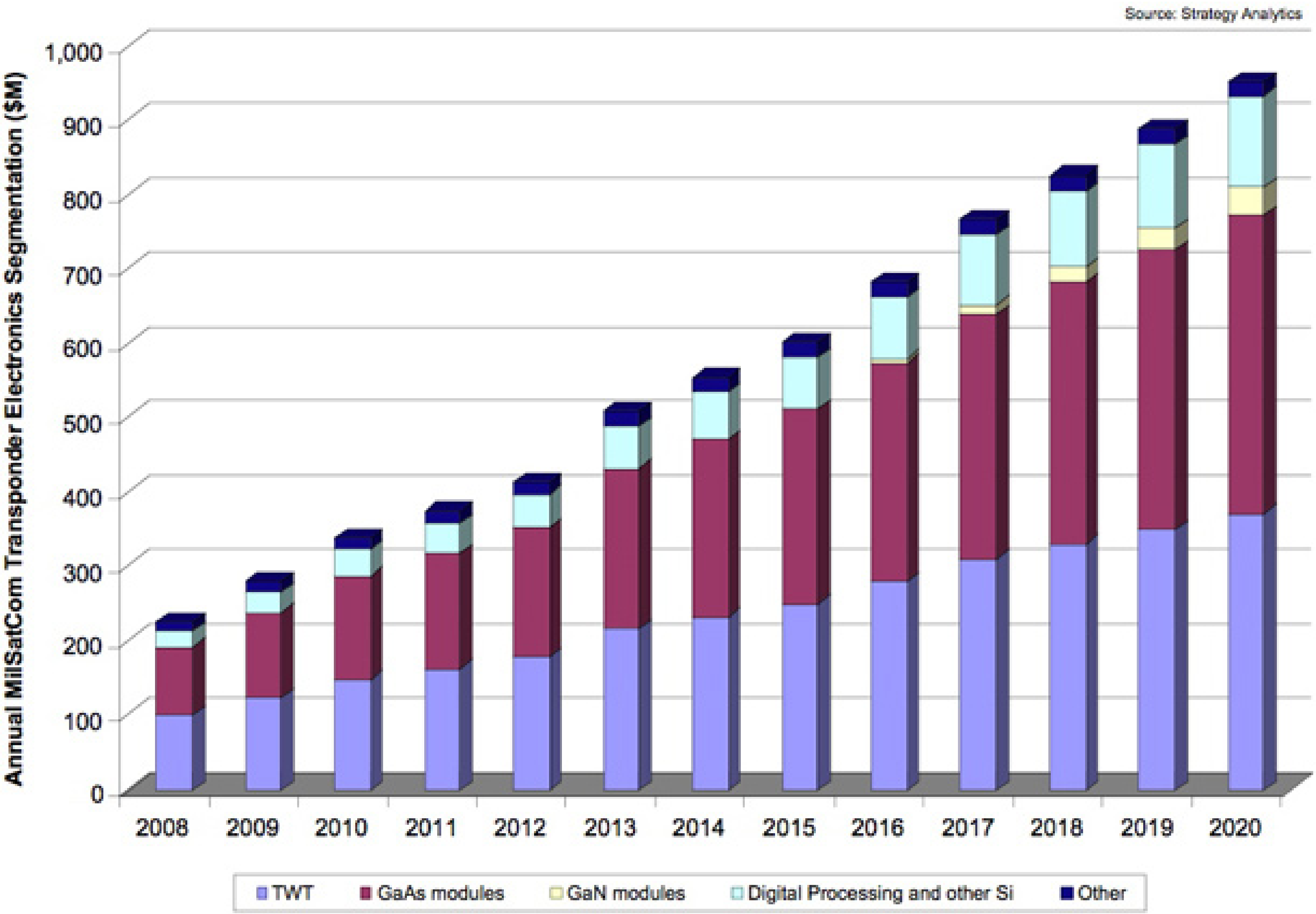



*Exhibit 2 — Annual MILSATCOM Transponder Electronics Market*

The concept of communications satellites only became feasible with the Soviet Union's ***Sputnik*** program of the late 1950's. These series of launches demonstrated that man-made devices could be placed into an orbit around the Earth. Prior to this, the United States had been experimenting with the idea of space-based communications by bouncing radio signals off the moon. In response to the Soviet Sputnik launch, the US space program began in earnest and the "space-race" was on.

The first US military communications satellite launch was in 1958. This device, known as ***Project SCORE*** (*Signal Communication by Orbiting Relay Equipment*), was experimental in nature and used primarily to show that an ***Atlas*** missile could be placed into low-altitude orbit. The secondary objective was to demonstrate the capabililties of two redundant communications repeaters built into the nose of the missile.

Over the next several years, the US launched an array of experimental communications satellites of increasing sophistication. In 1966, the first operational communications satellite was launched as a result of the aptly named ***Initial Defense Communication Satellite Program*** (**IDCSP**).

A total of 28 IDCSP satellites were launched with a mission of strategic communications between fixed or transportable ground stations and ships. These sites were all characterized by large transmit-receive antennas that limited their applicability. The next US MILSATCOM evolution was the ***Tactical Communication Satellite*** (**TacSat**).

The TacSat program was instrumental in driving satellite development along its current path. These satellites were designed with UHF and X-band capabilities to permit operation with a wide variety of smaller Earth terminals. The smaller Earth antenna requirement drove the need for high-power transmitters. This, in turn, necessitated a large solar-cell area to create enough energy for the transmitter and this drove the early enclosure designs. These platforms were part of many of the communications satellites that followed.

## MILSATCOM Architecture

In the early 1970's, the US Department of Defense was satisfied with the benefits provided by satellite communications and set out to define and standardize a MILSATCOM architecture to foster the development of technology and programs to effectively meet military requirements. The first comprehensive MILSATCOM architecture was published in 1976 and still forms the foundation for US MILSATCOM activities. It has three segments: wideband, narrowband (mobile and tactical) and protected (or nuclear-capable). The intent of the activity was to create a common satellite system within each segment that could support a mix of users and programs.

### Wideband

As the name implies, this segment is primarily aimed at moderate to high-data rate applications. Wideband data rates are defined as greater than 64 kbps. The terminals are primarily fixed and transportable land-based with a few on large ships or aircraft. They may be point-to-point or networked systems at distances ranging from in-theater to intercontinental. Examples of wideband systems are the ***Defense Satellite Communication Systems*** (**DSCS**) series and the ***Global Broadcast Service*** (**GBS**) payload on the ***UHF Follow-On*** (**UFO**) satellite.

### Narrowband

Small terminals with relatively low-gain antennas characterize users in the narrowband or mobile-and-tactical segment. These terminals have low to moderate date rates, the original definition being less than 64 kbps and may be located on aircraft, ships or land vehicles. With advances in technology, the data rate of this category is increasing and the cut-off between narrowband and wideband is blurring. These networks connect users at distances typically ranging from in-theater to transoceanic. Examples of narrowband systems are the Fleet Satellite Communications System, the Leasat program, and the UHF Follow-On (UFO) program.

### Protected

The differentiator in this segment of the architecture is mobility. These terminals have very low to moderate data rates and may be used on ships, aircraft, or land vehicles. As a trade-off for the low data rates, these terminals offer considerable protection of their links against physical, nuclear, and electronic threats. Examples of the protected segment are the ***Milstar*** system and the ***Air Force Satellite Communications*** (**AFSATCOM**) and extremely high frequency (EHF) payloads.

## Military Satellite Developments

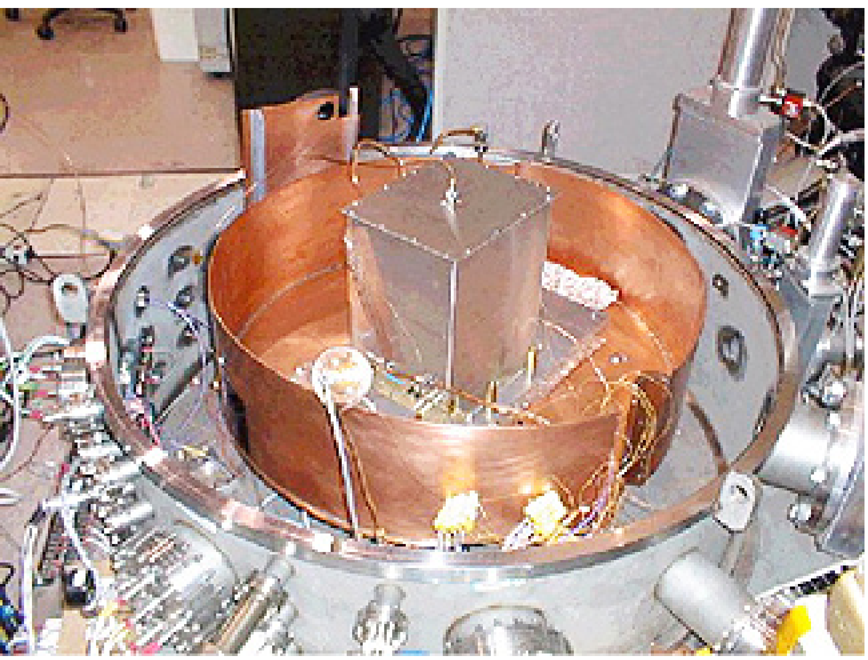
Worldwide, many countries are transforming their military tactics by implementing more network-centric, information-based operational concepts. Improvements in communication capabilities have directly affected the outcomes of conflicts. Tactical use of MILSATCOM plays a pivotal role in providing the interoperable and robust network-centric communications needed for future operations whose needs are increasing dramatically. In the *Desert Storm* conflict of the early 1990's, 542,000 troops occupied nearly 100 Mbps of MILSATCOM bandwidth. At the height of the *Operation Iraqi Freedom* conflict, some ten years later, there were 350,000 troops, but they consumed 3.2 Gbps of MILSATCOM bandwidth, an increase of more than **30x!** A number of technology advances have enabled these increases in bandwidth.

## Phased Array Antennas

Increasingly, communications satellites, for commercial and military uses, are being deployed with phased array antennas. This concept is the culmination of electromagnetic theories that have existed since the 1860's with systems the result of efforts in WWII.

The fundamental idea relies on the principle of interference of radiated signals. This holds that electromagnetic waves from different sources will combine constructively only when the phase of the signals is identical. Anything less than identical phase will cause some amount of destructive interference, reducing the amplitude of the signal.

Phased array antennas contain a number of radiating elements, all in the plane of the array face. The direction perpendicular to the array face is the bore sight and is the direction the beam points with no steering. To steer the beam off bore sight, some signals must travel a greater distance, destroying the identical phase relationship with other elements in the array. If a phase shifter is added into the transmit path of each element, its setting can be changed to ensure the proper phase relationship between antenna elements is maintained. When this occurs, the antenna beam steers off bore sight.



*The X-Band Phased Array Antenna in the Thermal/vacuum chamber at Boeing's Phantom Works in Seattle, Washington. The large, silver box structure is the XPAA hat coupler which absorbs RF energy emitted by the XPAA while under test in a laboratory environment. Image courtesy of NASA.*

Phased arrays can be electronically scanned over their search volume very quickly. All the elements in the array may be used in conjunction to produce a very narrow, high-resolution beam, or a broader, lower resolution beam. In addition, the array elements can be driven in smaller groups to produce multiple beams.

There are two basic designations for electronically scanned arrays: ***passive*** and ***active***. The phased array concepts are identical for both types, but the implementation is different, with the main difference being the transmit power source.

## PESA

The acronym **PESA** stands for ***Passive Electronically Scanned Array.*** In this implementation, a single power source, composed of one or more TWTs, drives all the antenna elements. In this arrangement, the TWT will feed a beam-forming network that distributes the transmit power to the elements. The location of the phase-shifting element will determine the flexibility of the array.

If the phase shifter is between the beam-forming network and the antenna element, each element can be steered individually. If the phase shifter is located at the input of the beam-forming network, all the elements fed by that network will have the same phase relationship. While the individual elements cannot be controlled separately, the "element group" can be phased differently than other element groups. Ultimately, the trade-off is flexibility versus complexity.

PESA-based antenna systems are currently in use in communications satellites. Since the signal propagation theory is identical for both types of radar and the implementation is very similar, the primary decision criteria is how to generate the transmit power.

There are several attractive features inherent in a TWT-based PESA antenna system: bandwidth, peak-power and efficiency. In these areas, TWTs are clearly superior to any other type of amplifier.

While the advantages of TWTs will ensure they maintain a place in the MILSATCOM platform, the disadvantages of the approach have driven development of active arrays. Foremost among the disadvantages is the system architecture. In the PESA approach, the transmit power source is centralized. Depending on the power level, this may be a single TWT or a group of TWTs combined to increased power levels. A TWT is a tube-based device and operates by electron emission. This means there will be a certain failure when the tube's filament can no longer supply electrons. In the best-case scenario, this life span is accurately calculated and the TWT lifespan matches the satellite lifespan. In the worst-case scenario, the TWT undergoes a complete failure. Depending on the system architecture, the entire antenna or a significant portion will also fail, severely compromising satellite performance. This and other concerns have led to the increased interest and development effort in the second type of electronically scanned array.

## AESA

The second type of electronically scanned array is known as **AESA**. The acronym AESA stands for ***Active Electronically Scanned Array***. In this implementation, each element is driven by a transmit/receive (T/R) module. These T/R modules contain solid-state MMICs, typically GaAs for the transmit/receive paths and silicon for the control functions. Similar to the PESA case, the location of the phase shifting element will determine the functionality and complexity of the array.

A typical T/R module contains discrete components, thermal management technology and several MMICs feeding a beam-forming network that feeds a radiating element. As the technology develops, more functionality will be incorporated into the MMICs and the number of MMICs will decrease. The modules come in 'brick' or 'tile' configurations. Bricks have the circuit board perpendicular to the plane of the array. Tiles, with the circuit board in the plane of the array, typically contain four T/R channels with various AESA functions, power distribution, RF distribution, timing and control, implemented in multi-layer circuit boards with layers for T/R modules and antenna radiators.

The MMICs in a T/R module include functions for low noise (receive), high power and driver (transmit) amplification, solid-state switching functions, phase shifting capabilities and a digital attenuator for control. Variable gain amplification is needed to enable antenna aperture weighting. The components are designed to have matched 50-Ohm inputs/outputs to avoid the need for special matching networks.

Current MMIC development effort focuses on low-noise figure receive amplifiers (LNAs) to improve system sensitivity, high power transmit amplifiers (PAs) with high power added efficiency (PAE) to reduce prime power and cooling requirements, integration of digital logic with other functions to reduce complexity and design for higher degrees of automation in assembly and test to reduce costs.

This approach, using many solid-state T/R modules, leverages the rapid development of the semiconductor industry and addresses many of the major issues of the TWT-based PESA approach. In this scenario, each T/R module is a self-contained RF transmit and receive path. The module contains a power amplifier for transmit, an LNA for receive and may contain a phase shifter for element steering. This approach means that the failure of any one module will only degrade the antenna performance slightly. This feature, coupled with the inherently higher MTBF levels of solid-state electronics, reduces the redundancy costs associated with AESA antennas.

While the AESA approach addresses many of the challenges inherent with PESA antennas, it is not without challenges of its own. The primary one may be cost. An AESA antenna may easily contain more than 1000 T/R modules. While this number is large in terms of military electronics requirements, it pales in comparison to commercial quantities This, coupled with potentially stringent space performance requirements, results in costly modules and antenna systems.

A second big concern is thermal management. With lower amplifier efficiency, solid-state arrays generate more heat than tube-based arrays for the same output power. While each module generates far less heat than a TWT, because of reduced power levels, there is still a concern about the distributed heating effect of all the modules.

Satellites have long development times and are very expensive. This, coupled with the fact that a communications network requires several satellites makes reducing cost a top priority.

## About the author

*Asif Anwar is the Director within the Strategic Technologies Practice at Strategy Analytics He develops insights and analysis in the advanced electronics markets through research into key sectors including wired and wireless communications, automotive systems and consumer electronics. For report information, access...*
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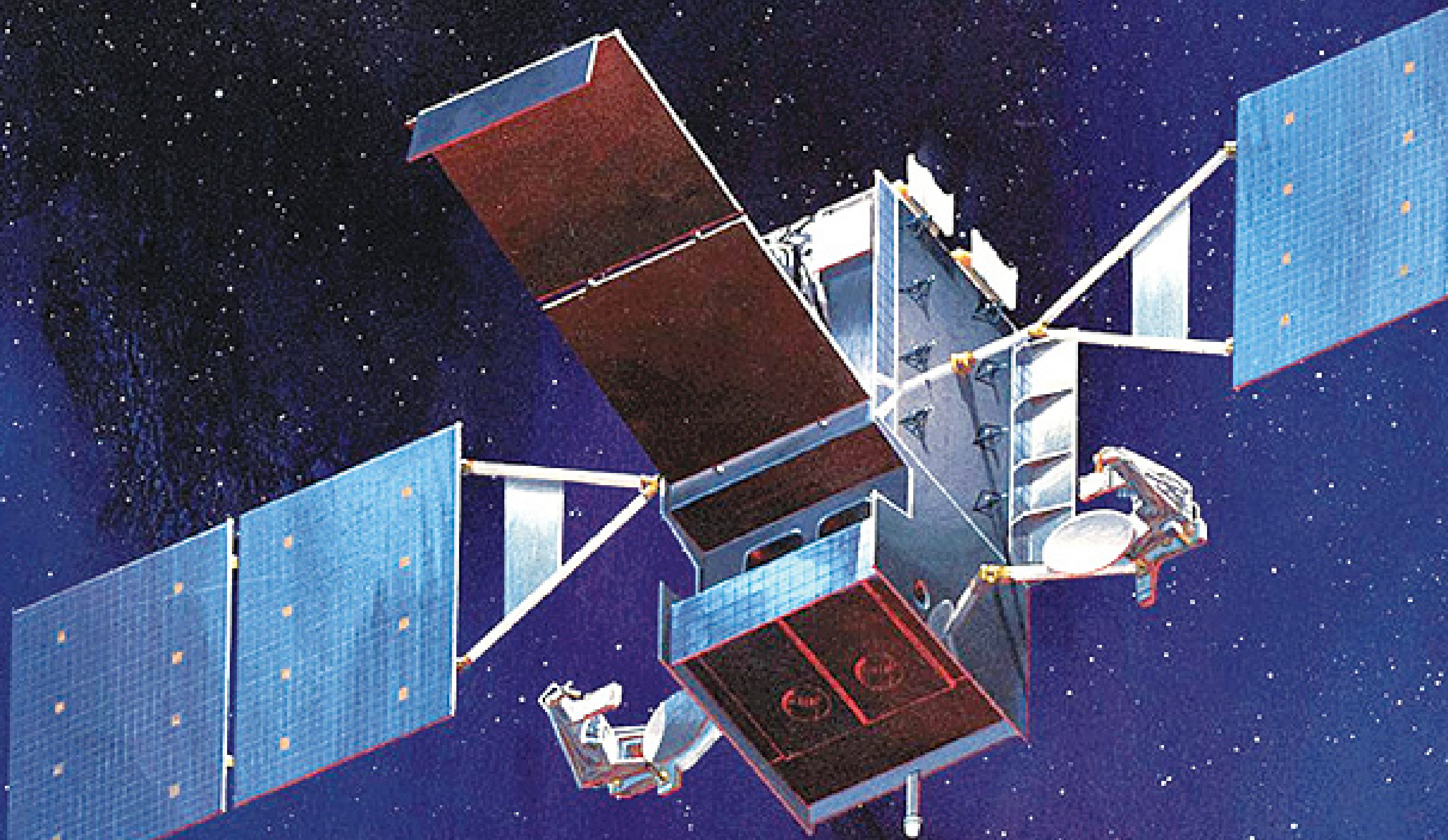
# LT. COL. HEATH A. COLLINS

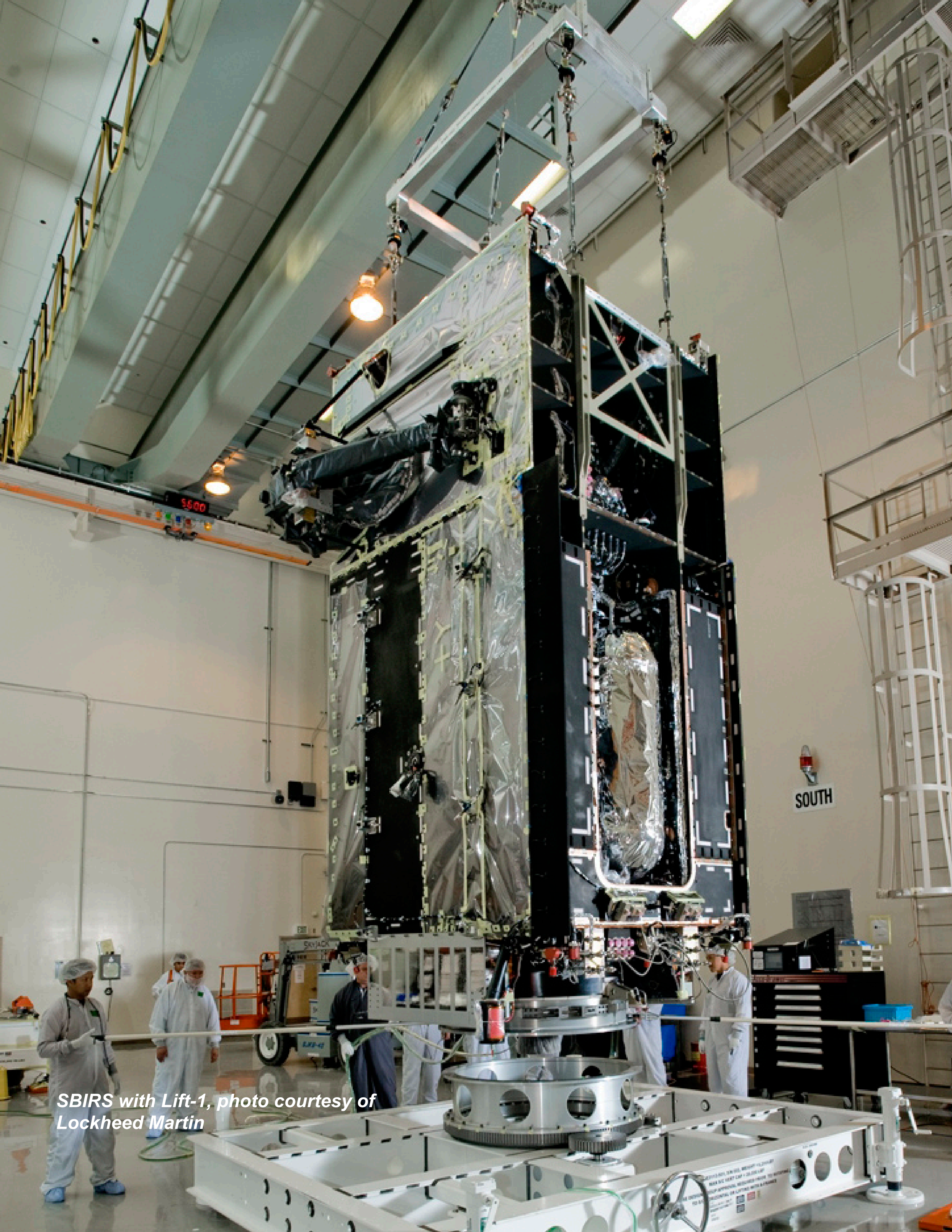
## COMMANDER, SPACE BASED INFRARED SYSTEMS SPACE SQUADRON, L.A.A.F.B



# COMMAND CENTER

Lieutenant Colonel Heath Collins is the Commander, Space Based Infrared Systems Space Squadron, Space Based Infrared Systems Wing, Los Angeles Air Force Base, CA. He leads 52 personnel to develop, deploy, and sustain the nation's space-based infrared detection, targeting, and tracking systems for missile warning, missile defense, battlespace characterization, and technical intelligence. These systems are critical for protection against global and theater ballistic missile attacks against the United States, its deployed forces, and its allies.

Lt. Col. Collins graduated from Clarkson University, and was commissioned a Second Lieutenant in 1993 through the Reserve Officer Training Corps. He has over 15 years of systems engineering, test operations, and program management experience on tactical air-to-air missiles, electronic countermeasures, space, and radar systems. He has worked a number of programs, including the Advanced Medium Range Air-to-Air Missile, Integrated Defensive Electronic Countermeasures Program, the Milstar and Wideband Global Satellite Communications (WGS) satellite communications programs, and two classified intelligence satellite programs.




*SBIRS with Lift-1, photo courtesy of Lockheed Martin*

He has performed duties as the *Lead Air-to-Air Weapons Judge* for two *William Tell Air-to-Air Weapons Meets* in 1994 and 1996, as an *Education with Industry Student* and as the *Initialization Manager* for two classified satellite programs.

Lt. Col. Collins has served in a variety of technical, management, leadership and operations positions such as *Advanced Missile Flight Test Engineer* (**ACC**), *Chief Command and Control Engineer* (**AFSPC**), *Milstar Chief Engineer* (**AFSPC**), *Operations Support Flight Commander* (AFSPC), *Manager, Advanced Satellite Payloads* (**NRO**), and *Chief Vehicle Engineer* (NRO). In the assignment immediately preceding his current command, he held numerous positions in the *Wideband Satellite Communications Group*, *MILSATCOM Systems Wing*, including *Chief, Engineer Wideband SATCOM* systems, *Program Manager, WGS Block I*, and as *Deputy Group Commander* programs' classified intelligence satellite programs.

Lt. Col. Collins received a Master's in Electrical Engineering from the **Florida State University** in 1996 and a Master's in Operational Arts and Science from the **Air University** in 2006. He graduated from **Squadron Officer School** in 1997 and **Air Command and Staff College** as a distinguished graduate in 2006. He completed the *Defense Acquisition University's Program Manager Course* in 2009. He and his wife Julie have two sons, David and Nathan.

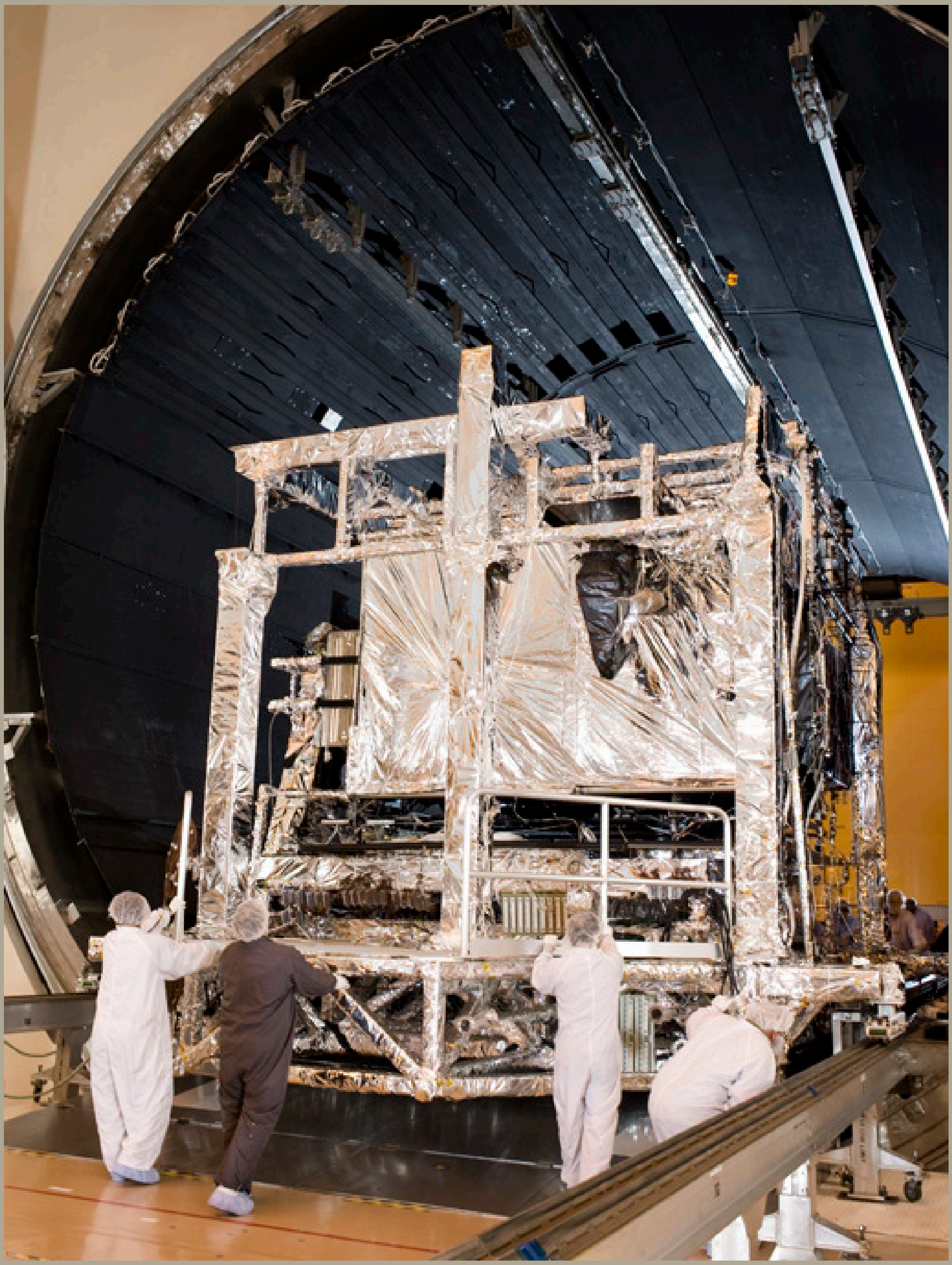
***MilsatMagazine*** had the opportunity to discuss Lt. Col. Collin's command responsibilities and the importance of ***SBIRS*** for our nation.

## MilsatMagazine (MSM)

*Lt. Col. Collins, why did you select the U.S. Air Force as your career choice?*

## Lt. Col. Collins

Growing up just outside Plattsburgh AFB, New York, I was always intrigued by the aircraft (FB-111's and KC-135s) I saw at that base. When it came time to go to college, I immediately looked into Air Force ROTC. From day one in the ROTC program and from my first assignment in 1993, I have been hooked. Now, 17 years later, I've had the opportunity to work in several flight test, space operations, and acquisition related assignments and am thankful for the challenges and rewards I've experienced along the way.



***SBIRS being prepared for final testing, photo courtesy of Lockheed Martin***

## MSM

*You have had a number of highly responsible postings within the U.S.A.F., ranging from the 83rd Fighter Weapons Squadron at Tyndall AFB in Florida, to the Chief of Engineering for the 4th Space Operations Squadron at Schriever AFB, to your present assignment as the Commander of the SBIRS Space Squadron. Which of your assignments has afforded you the most enjoyment?*

## Lt. Col. Collins

I can honestly say that I have enjoyed every one of my assignments. I don't believe I can select any individual assignment as a favorite.

As I mentioned earlier, I've been fortunate enough to have been assigned to unit and missions that offered challenges, obstacles, and opportunities to develop me as an engineer, a program manager, and as a leader. From conducting live air-to-air missile firings, to providing space capabilities directly to the warfighters, to launching first-of-their-kind satellite systems, each has rewarded me with the knowledge that I have made a difference and have been able to contribute to the nation and the Air Force.

### MSM

*What are your primary concerns for the defense of our Nation? Will our technologies manage to sustain our forces throughout the world as we move forward?*

### Lt. Col. Collins

My primary concern for the nation centers on the new and extremely dynamic adversaries we now face. The level of change I have seen in just the last few years rivals the total change I saw the first 15 years of my career. The challenge is to keep up with, and if possible, stay ahead of that ever-changing enemy. As to whether our technologies will sustain our forces going forward, absolutely.

Having worked in the acquisition side most of my career, I have seen the new technologies, the new systems, and the new capabilities that are in development, in testing, and in the field, and they are absolutely the best in the world.

On top of that, we have a force comprised of the finest, most dedicated officers, enlisted, and civilians. They are devoted to the mission, and ingenious in their ability to solve problems, to develop new **CONOPS** (Concept of Operation) and capabilities, and to simply execute the mission when needed.

## MSM

*Lt. Col. Collins, what are the responsibilities of the SBIRS Space Squadron? Why is SBIRS so important to our nation? What role will SBIRS play in defending our nation and our allies?*

## Lt. Col. Collins

The **SBIRS Space Squadron** is responsible for developing and acquiring the SBIRS Geosynchronous orbit (GEO) spacecraft bus, as well as, integrating, testing, launching, and sustaining the GEO satellites. The SBIRS system will perform four mission areas...

- *Missile warning*
- *Missile defense*
- *Battlespace awareness*
- *Technical intelligence*

The system will provide views of targets earlier, longer, and more frequently than other sensors. Its flexible tasking ability provides new ways of collecting mission data, thus enhancing current missions.

## MSM

*What role do you play within this organization and who comprises your staff for this squadron?*

## Lt. Col. Collins

As the Commander of the SBIRS Space Squadron, I'm responsible for executing the assigned mission. This entails setting program priorities, making programmatic and technical decisions, and most importantly taking care of the people assigned under me. This includes a combined 52-person team made up of Air Force officers and civilians, as well as, a number of technical support contractors.

## MSM

*Is this strictly an interface within the Air Force community, or do you interface with a range of external resources as well? If so, who else is involved with your various missions?*

## Lt. Col. Collins

While the program is integrated throughout the DoD, the Services and national agencies, my role keeps me focused on the integration, test, and launch of the GEO satellites. That means my primary interfaces are with the SBIRS prime contractor, **Lockheed Martin**, and the Air Force's launch community, made up of the Launch and Range Systems Wing here at *Space & Missile Center* at **Los Angeles Air Force Base** as well as the launch vehicle contractor, **United Launch Alliance**.

## MSM

*Exactly what do SBIRS spacecraft accomplish? Why do we need them?*

## Lt. Col. Collins

The SBIRS program is the nation's Space Based Infrared System, targeting, and tracking for, missile warning, missile defense, battlespace awareness, and technical intelligence. The SBIRS system is critical for protection against global and theater ballistic missile attacks against the United States, its deployed forces and its allies.

## *MSM*

*Who is building the GEO satellites and when can we expect the first launches of these spacecraft?*

## *Lt. Col. Collins*

The prime contractor for the SBIRS GEO satellites is **Lockheed Martin Space Systems Company** in Sunnyvale, California. The first vehicle, ***GEO-1***, completed its most important and grueling test, thermal vacuum test, in November of 2009. This was the final environmental test to ensure the satellite would survive and operate in the space environment. Once GEO-1 receives the final launch-build of flight software and completes its final testing, we are planning to ship the vehicle to the launch base in Spring 2010.

***GEO-2*** recently completed its first phase of *Baseline Integrated System Test* (**BIST-1**), which is used to generate an initial performance baseline for the satellite. This initial baseline will be compared against downstream test results to verify steady and stable satellite performance throughout the test program. GEO-2 is following GEO-1 by about a year and is scheduled to ship to the launch base in Spring 2012.

## *MSM*

*When discussing the SBIRS Space Squadron, the term Overhead Persistent Infrared satellites is heard over and over* *again. Please inform our readers as to what OPIR satellites' capabilities include and how they apply to SBIRS.*

## Lt. Col. Collins

The SBIRS system will provide 24 x 7 persistent overhead surveillance capabilities that's taskable. *Overhead Persistent Infrared* is across four key mission areas: missile warning, missile defense, battlespace awareness, and technical intelligence. The scanning sensor is for full-Earth surveillance and the staring sensor is for area of interest coverage and provides the key and essential information for combatant commanders.

## MSM

*We are intrigued with your duties as the Lead Air-to-Air Weapons Judge for two William Tell Air-to-Air Weapons Meets in 1994 and 1996. Could you explain what exercise that was and what set of disciplines it was furthering for our armed forces?*

## Lt. Col. Collins

William Tell is an air-to-air weapons meet that dates back to 1954. During the two-week competition, aircrew performance, as well as weapons and tactics use, is tested in air dominance and air sovereignty missions. Additional areas of evaluation included weapons loading, maintenance, and ground control. My duties centered on scoring the air-to-air missile employment scenario.

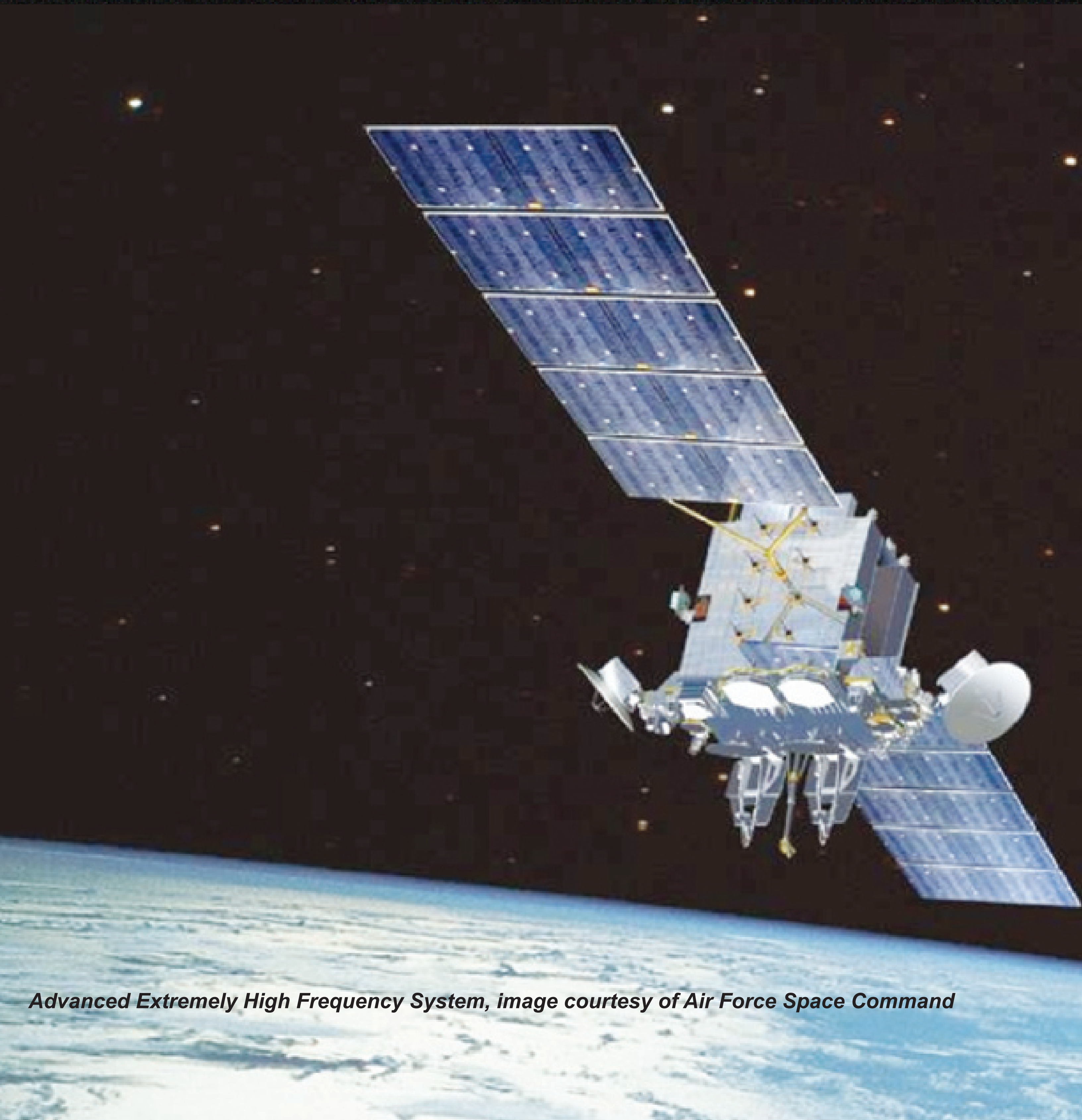
I'd also like to thank your publication for the opportunity to discuss key topics of interest. SBIRS is a major system for the country, with the primary focus on providing missile warning to our combatant commanders as well as providing protection to the nation and our allies. We are receiving positive confirmation each day that, in fact, the SBIRS system is truly making a significant difference on the battlefield.

***Addendum***: It doesn't seem so long ago that Northrop Grumman Corporation delivered the first SBIRS geosynchronous orbit (GEO) payload to prime contractor Lockheed Martin for integration into the spacecraft and final system-level testing. The GEO-1 payload consisted of a scanning sensor and a staring sensor as well as other key spacecraft subsystems and electronics that included a pointing and control assembly (PCA). The scanning sensor is designed for continuous observation and surveillance of traditional intercontinental ballistic missile threats. The staring sensor is designed to detect very low signature, short-burn-duration theater missiles. Together, the sensors contain nearly one million detector elements in their two focal planes.

Northrop Grumman Electronics Systems sector provided the infrared payload, electronics, and ground processing for the mission data processor to the Lockheed Martin-led Space-Based Infrared System (SBIRS) High team. SBIRS High is a series of high Earth orbiting satellites whose sensitive infrared sensors can detect the launch of strategic and theater ballistic missiles from space and pass the time and location of launch to battlefield commanders.

SBIRS High works in conjunction with the Space Tracking and Surveillance System (STSS), a constellation of missile tracking satellites capable of performing missile defense, missile tracking, technical intelligence and battlespace characterization. The company's Aerospace Sector is leading the STSS industry team. Electronic Systems will contribute to the systems engineering, ground segment and algorithms. Plus, the sector will be one of two competitors for the sensor payload and ground station data processing program. The sector also provides space-borne sensing for early warning systems, weather and ground systems that process C4ISR data from space-based platforms for high-priority U.S. government national security programs.

For more than 30 years, Electronic Systems has supplied the sensors for scores of space-based missions, including the Gemini rendezvous radar, the cloud imager for the Defense Meteorological Satellite Program, the infrared sensor for the Defense Support Program and the multispectral/ hyperspectral cameras for the Orb View-3 and Orb View-4 commercial remote sensing program.



*Advanced Extremely High Frequency System, image courtesy of Air Force Space Command*

# UPGRADING TO "MILITARY GRADE"

*author: David Myers, CapRock Government Solutions*

Military and civilian agencies alike depend on advanced satellite services to communicate between forward deployed personnel and command centers outside the area of operations. These communications solutions enhance intelligence gathering and in-field decision making, often creating a competitive advantage in an otherwise hostile environment. The type of information exchange can range from a simple phone call, to something more complex like an encrypted live video feed from an Unmanned Aerial Vehicle (UAV). Either way, it's a communications channel that must be up and running at all times.

### *The MILSATCOM Challenge*

The challenge for many military and government agencies is obtaining access to high reliability reach back communications in a timely and cost effective manner.

With federal budget cuts, many traditional MILSATCOM programs are either under pressure or have been disbanded altogether.

The now cancelled ***Transformational Communications Satellite System*** (**TSAT**) was a $26 billion Air Force program designed to significantly expand government access to broadband satellite communications. With the program's demise last year, U.S. forces must now compete for access to the only other modern large scale broadband military satellite fleet — the ***Wideband Global Satellite*** (**WGS**) program.

Despite its technological advances and unique military frequency X- and Ka-band satellites, the three spacecrafts of the WGS fleet simply can't meet the demand for bandwidth-hungry battlefield applications. Obtaining "mission priority" for MILSATCOM resources can prove

difficult, especially for quick deploy units or logistics support missions. Even when capacity is available, it may take days or even weeks to procure and initiate service on WGS.

For special forces, emergency response teams and other fast moving government units, that process may not support critical mission timelines. In fact, the ***U.S. Space and Missile Defense Command*** (**SMDC**) estimates that military owned and operated spacecraft will only be able to support between 10 and 20 percent of all government satellite bandwidth requirements through the year 2016. As a result, the government must rely on commercially operated satellite services to provide the bulk of its voice, video, and data communications traffic.

### *Military-Grade Features In A Commercial Satellite Alternative*

This dependence on commercial satellite service providers creates a dilemma. Military and government requirements for network security are understandably much higher and more complicated than for traditional commercial customers. The U.S. government is increasingly raising the bar on standards for *Information Assurance* (**IA**) and overall network security. Meeting these standards often requires investments far in excess of traditional commercial teleport capabilities.

There are, however, a handful of qualified service providers who are making the investment in their infrastructures to support growing government demand. These companies are broadening their product portfolios to offer near military-grade services from traditionally commercial sales channels.

This evolution starts by adopting new technologies and implementing a whole host of government standards, such as *Transmission Security* (**TRANSEC**) and *Federal Information Procession Standard* (**FIPS**) 140-2. By upgrading the physical and network security capabilities of their facilities with features such as active intrusion detection, many commercial satellite service providers are able to achieve *Mission Assurance Category* certifications at various levels.

Perhaps more important is the focus on developing managed services that offer true "military-grade" features and options, along with the ease of a commercially available off-the-shelf service.

These features may include the use of:

- ***Military frequency (X-band) commercial satellites***
- ***Electromagnetic Pulse (EMP) hardened satellites and networks***
- ***High security Network Operations Centers (NOCs) for sensitive or classified traffic***
- ***Support for existing WGS certified terminals already in the field***
- ***Options for connection to secure government networks like the Global Information Grid (GIG) and Secret Internet Protocol Router Network (SIPRNET)***

By combining these military-grade features into a commercially available managed service offering, the government customer gets the best of both worlds.

Just to be clear these services are not MILSATCOM. They remain commercial services, but they come with many government-specific features, functionality, and options that field deployed personnel and mission compliance officers demand.

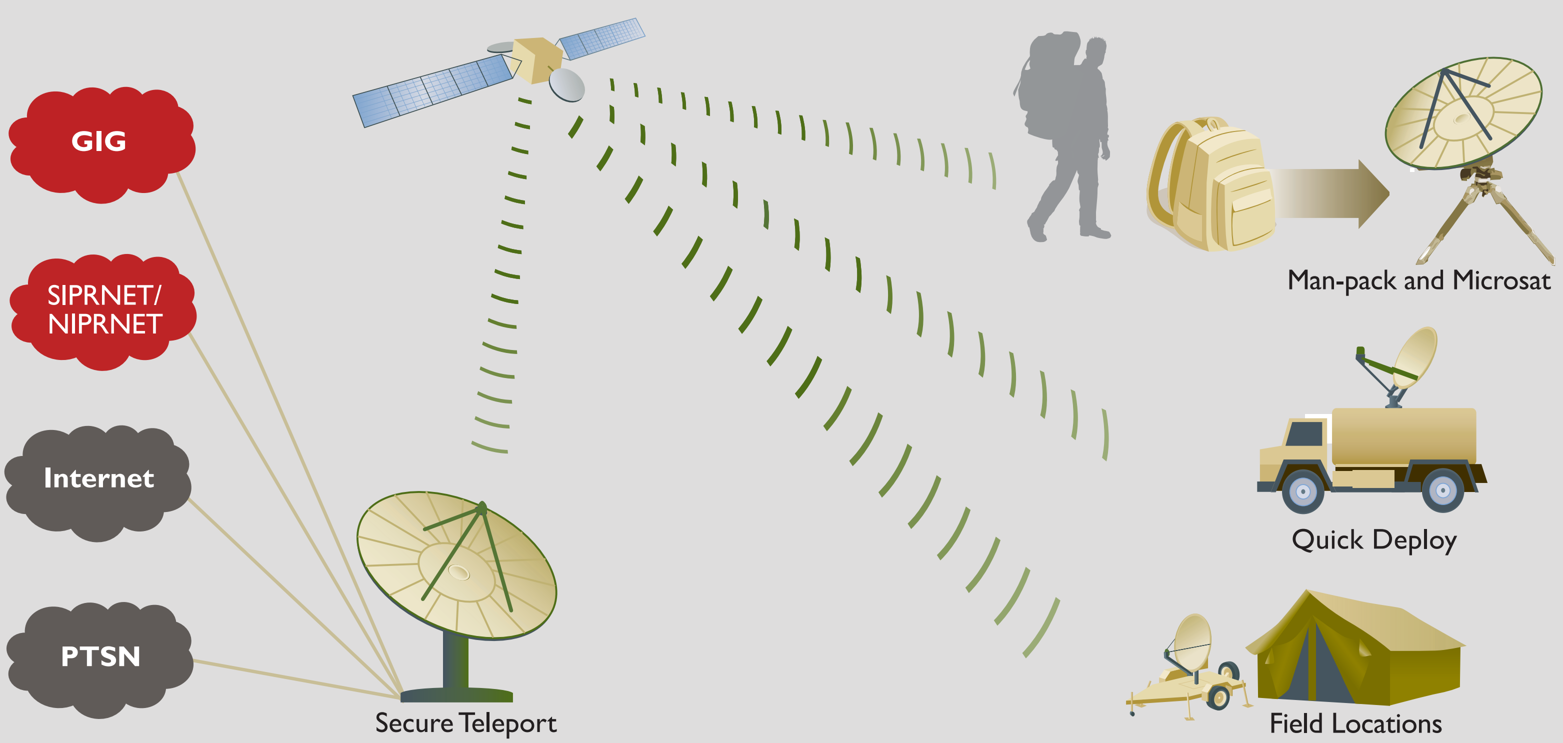
Commercially available military-grade satellite communications services can provide an excellent augmentation to traditional MILSATCOM. These services enable the immediate redeployment of WGS field terminals on an X-band or Ka-band commercial network, even when military space segment is simply unavailable.

### *Qualifying Commercial Satellite Service Providers For Military Applications*

The key to realizing the benefits of these performance-enhancing and cost-saving services is the quality and operation of the network. In recent years, there has been a shift within the military to rely more on contractors to operate many of its mission-critical systems. However, most contractors have elected to forego investment in their own infrastructure, instead outsourcing the services that they provide to multiple third parties.

These "virtual network operators" often face serious quality control issues due to the hands-off approach and lack of visibility into the daily operations of the network. Virtual network operators generally cannot implement the latest bandwidth optimization tools because they don't

**Complete End-to-End Communications Services For Military Applications**



own or control the infrastructure. Many lack the in-house expertise to configure or manage sophisticated remote terminal equipment, like maritime or COTM antennas. And as virtual operators are often several layers removed from the actual network, they are challenged to provide consistent levels of responsive customer service.

Overcoming these challenges requires only that the government customer select an end-to end satellite service provider who has invested in the facilities, infrastructure and security measures necessary to ensure mission success. By partnering with a systems integrator that owns and operates the network service (including multiple 24x7 teleports, network operations centers, in-theatre support centers, a global terrestrial backbone, and cleared in-field personnel), a military or civilian agency can ensure better command, control and communications support for its missions.

### *Future Commercial Satcom Acquisition (FCSA) Model Will Make Procurement Easier*

Ease of deployment and support are some of the primary reasons that government agencies and the military are starting to look to end-to-end service providers to help meet their mission requirements. At the end of the day, the providers that can offer the quickest delivery, installation and support times, while also enabling customization and flexibility in hardware offerings and capabilities, will represent the best customer value.

The recent announcement by the *Defense Information Systems Agency* (**DISA**) and the *General Services Administration* (**GSA**) to realign satellite equipment and service procurement under the new *Future Commercial Satcom Acquisition* program, promises to make procurement easier as well. Fully managed military-grade commercial satellite services will be available off of the ***GSA Schedule 70*** contract.

Government agencies will be able to purchase pre-packaged or customized communications solutions of equipment and services off of standardized rate cards.

Maintaining real-time communications access to the chain of command is a truly mission-critical requirement for today's NETCENTRIC forces. With the new military-grade commercial satellite communications services, government customers will no longer have to compromise between military features and functionality, and commercial availability and ease of procurement.

**About the author**

**David Myers serves as executive vice president and general manager of CapRock Government Solutions. Myers oversees Cap-Rock Government sales and marketing, strategic planning, engineering, and technology and infra-structure functions. Prior to CapRock, My-ers served as senior vice president of marketing and corporate development for Spacenet Inc., one of the satellite industry's largest service providers for Fortune 1000 enterprises. Myers previously served at CapRock Communications, as vice president of marketing & product management.**

### *An Entertaining Environment*

***CapRock Communications has just launched their latest value-added service offering, Crew Infotainment. The fully managed solution supports remote employees across energy, maritime and government services industries.***

***By having a consolidated media console that integrates an almost limitless variety of electronic content, organizations with global operations can achieve increased employee retention, improved Health, Safety and Environment (HSE) standards compliance via distance training and reduced travel costs associated with on-site corporate training requirements. CapRock's Crew Infotainment is a nexgen content distribution solution. Similar to the interface and menus found in hotel television systems, customers can quickly and easily access networked and on-demand content through an intuitive television graphical interface and remote control.***


***The IP-based Crew Infotainment solution is scalable and modular by design to meet the unique requirements of CapRock's diversified customer base and contains enhanced features and functionality not found in traditional analog solutions. Features include trick-play capabilities — pause, fast forward, rewind and seek — quick channel changing, closed caption options and interactive program guides for live TV.***

***Customers can also leverage advantages over analog solutions such as improved remote troubleshooting capabilities and fewer equipment requirements — which reduce maintenance and operational costs — and the solution doesn't require users to switch out equipment when a site moves into a new region. In addition, the on-demand content allows crew members to stay entertained and trained while en-route or outside of a satellite footprint.***

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» DISA Teleports » US Air Force GBS » PM DCATS Army Networks » FBI » NORTHCOM » MBF-I » FRHN » USMC SWAN » PM DCATS Army » AN/TSC-167

» Navy Multi-band Terminal » NATO SGS » AN/TMQ-52 » DISA Teleports » US Air Force GBS » PM DCATS Army Networks » FBI » NORTHCOM

» USMC SWAN » Australian Defence Service Communications » SNAP » Navy Multi-band Terminal » NATO SGS » AN/TMQ-52 » DISA Teleports

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# HOSTED PAYLOADS ON COMMERCIAL SATELLITES

*NSR Report Executive Summary*

**The government vertical has been a stable and growing market for commercial satellite service providers in recent years given the shortfall in internal assets civil and military agencies have at their disposal. In terms of resources to run mission-critical requirements, government entities have always been behind the curve for bandwidth and data resource deployment. Indeed, the commercial satellite industry has been a growing part of governments' strategic planning for current and future requirements for a variety of applications. It is now safe to assume that over the long term, commercial capacity and offerings will be a permanent feature in government planning and procurement practices.**

This has brought the prospect of hosted payloads as a serious alternative or option in addressing internal gaps. The idea of hosted payloads is not new and has been explored and implemented in the past mostly for experimental purposes. To date, there are less than 10 hosted payloads on commercial satellites for use by various government agencies around the globe. However, **as the capability gap grows and as budgets and schedules tighten, discussions and contractual decisions are being undertaken currently to seriously plan for a more permanent and sustainable arrangement as the next generation of satellites for replacements and new programs begin to be built.**

In examining and analyzing the case for hosted payloads for both military and civil government use in the areas of **Communications Services** and **Earth Observation** missions, the compelling benefits of speed, schedule and budget considerations assure the growing role of hosted payload arrangements over the long term. More importantly, **application requirements that are at the core of the hosted payload offering provide government entities with a very attractive option by which to test, deploy and enhance their next-generation plans for a fraction of the time and money they have had to navigate in the past.**

Dual-use programs for use by both commercial and government clients have been in existence for governments and international organizations such as Australia, the European Union, Japan, South Korea and the United States. In the global market for government and military demand, the United

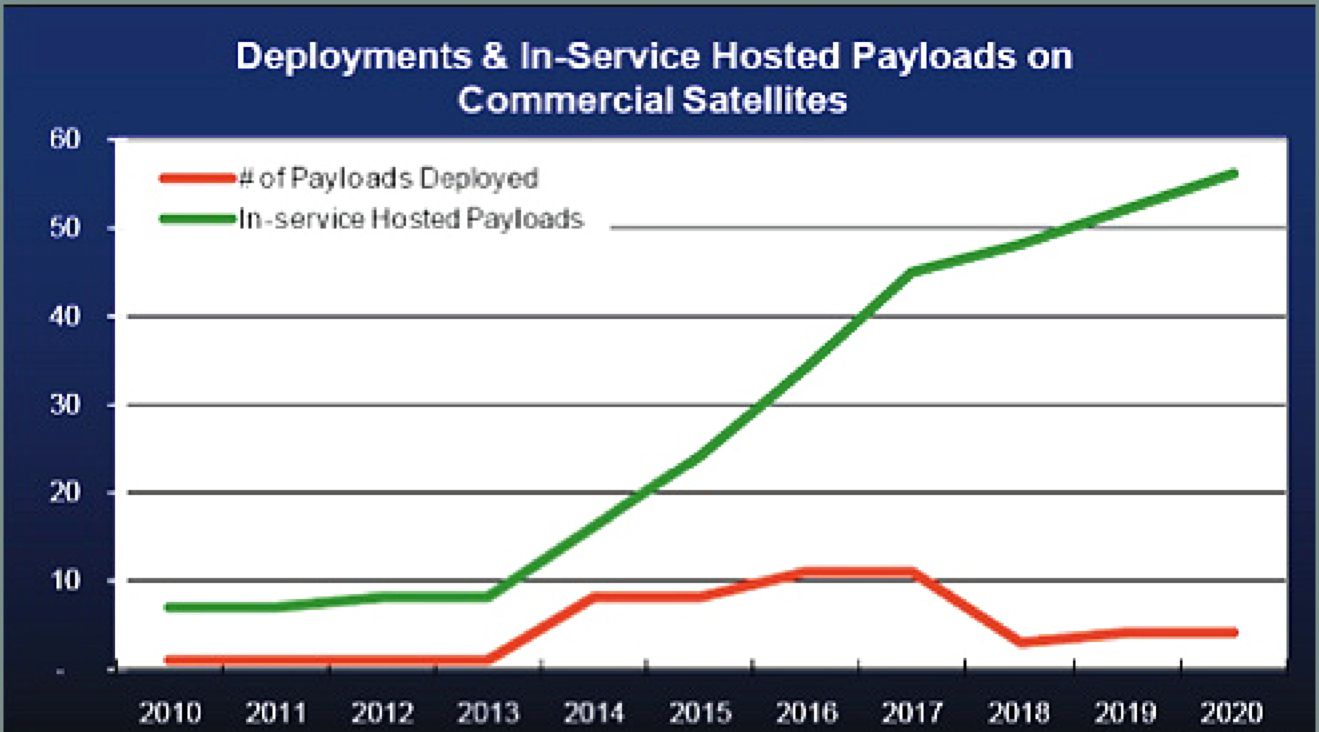


*Figure 1*

States has and continues to account for the vast majority of commercial leases and other satellite-related services. In the emerging area of hosted payloads, a major demand driver is likely to come from the U.S. Government once again. This will likely change the hosted payload market in terms of its place in the overall value chain within the industry. More importantly, the growing role of the United States should likewise lead to changes in the entire process of how commercial satellites are to be built and how military and civil government programs will be planned.

## Primary Research Findings

In terms of the future evolution of the commercial industry as well as the adjustments satellite manufacturers may have to undertake in order to tap this potentially lucrative market, these are already underway. The investment and engineering aspects appear to be minimal relative to the revenue potential.

Governments and military forces have and continue to depend on the commercial satellite sector when looking at solutions. Going forward, NSR expects to see more hosted payload deals taking place. Hosted payload solutions bridge two seemingly disparate propositions in a single offering: **a)** launching a proprietary satellite that is highly expensive with **b)** completely outsourcing services or bandwidth needs to commercial providers.

Alternatives such as launching smaller satellites have been put forward, but that option may still be much more expensive compared to hosted payload arrangements.

Over the next 12 months, the hosted payload environment should develop at a much faster pace compared to the past 2-3 years when hosted payloads came to the fore *(See Figure 1 on previous page)*. This does not mean the marketplace will see many announcements over the next 12 months. Rather, more discussions, negotiations, and various parties coming together to work out deals will take place.

**Currently, there are less than 10 hosted payloads on commercial satellites** and the form by which these have materialized have not yet been ironed out. Compared to current commercial arrangements, for instance, there is still no "templated" contractual formula (so to speak), such as signing a lease or a spot market purchase in drafting hosted payload contracts.

There are also more parties at the table working out deals (including the operator, the manufacturer, and the government client) that enter discussions with different sets of agendas, concerns, and constituencies who may raise various issues regarding hosted payloads for their own reasons. A satellite operator, for example, may have a long-term video client who may appreciate having a hosted payload on the satellite carrying his long-term transponder leases due to the risks associated with that payload.

Yet, the impetus to engage in hosted payloads is a far more serious issue today when compared to the past few years. The contractual scheme is slightly more complicated. Contracts will require more time to close. Due diligence is required on the technical, financial, regulatory, and various other aspects to ensure hosted payload arrangements work smoothly for all parties concerned.

## Deployments & In-Service Hosted Payloads On Commercial Satellites

Input from various players interviewed for this study leads **NSR** to foresee a growing hosted payload market over the next 10 years.

However, apart from growth in hosted payload units being deployed and the number of in-service hosted payloads serving various government agencies (***see Figure 2 below***), trends in the engineering costs

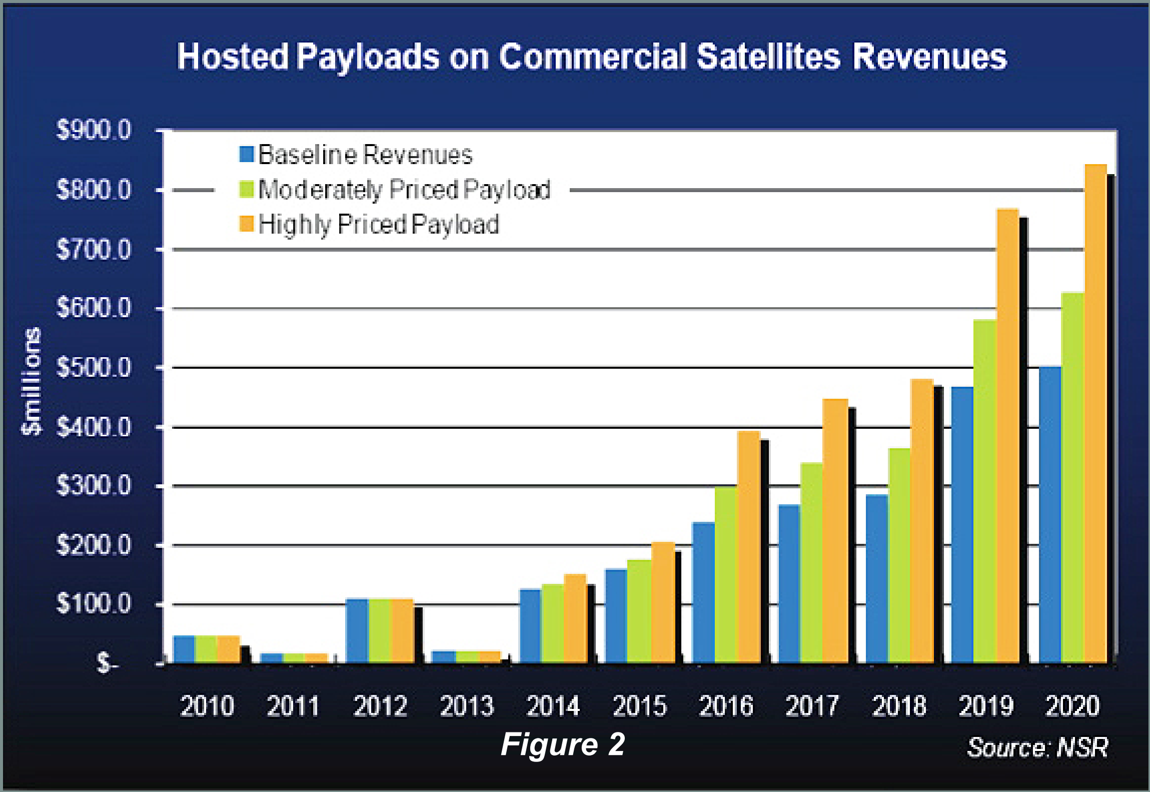


Figure 2

and the expense of the hosted payloads themselves will be difficult to determine.

The only reliable trend is that there will be more hosted payloads in the future. This is a game changer and **a potentially new way to creatively launch capabilities into space**. Other trends continue to evolve. These include where, exactly, demand lies in terms of drivers and payload types whether expensive, simple, or complex. Moreover, engineering methods and costs are all open-ended and cannot be predicted.

LEO payloads, and to some extent, MEO hosted payloads due to limitations in spacecraft size, provide a narrower range of possibilities when compared to GEO hosted payloads.

GEO satellites that have a range of bus size, fuel capacity and other attributes able to support more complex payloads, provide a wide range of payload complexity and this means cost structures will impact revenue streams.

## Hosted Payloads On Commercial Satellites Revenues

Revenues that are driven by the cost of hosted payloads can only be contextualized on a scenario basis. NSR offers a ***Baseline***, ***Moderate Price Payload*** and ***High Price Payload*** scenarios to provide a range of potential revenue streams in the hosted payload market. An important caveat — **the number of scenarios presented are just three out of a possible dozen or more scenarios where different payload types are developed, integrated, launched and operated.**

Revenue forecasts are meant to provide an indication of the revenue potential the market can provide. The "***Baseline Scenario***" provides cumulative revenue opportunities totaling $2.2 billion over an 11-year period. The "***Moderate Price Payload Scenario***" provides a $2.7 billion market opportunity. And the "***High Price Payload Scenario***" provides a $3.5 billion market opportunity form 2010 to 2020.

## What It All Means

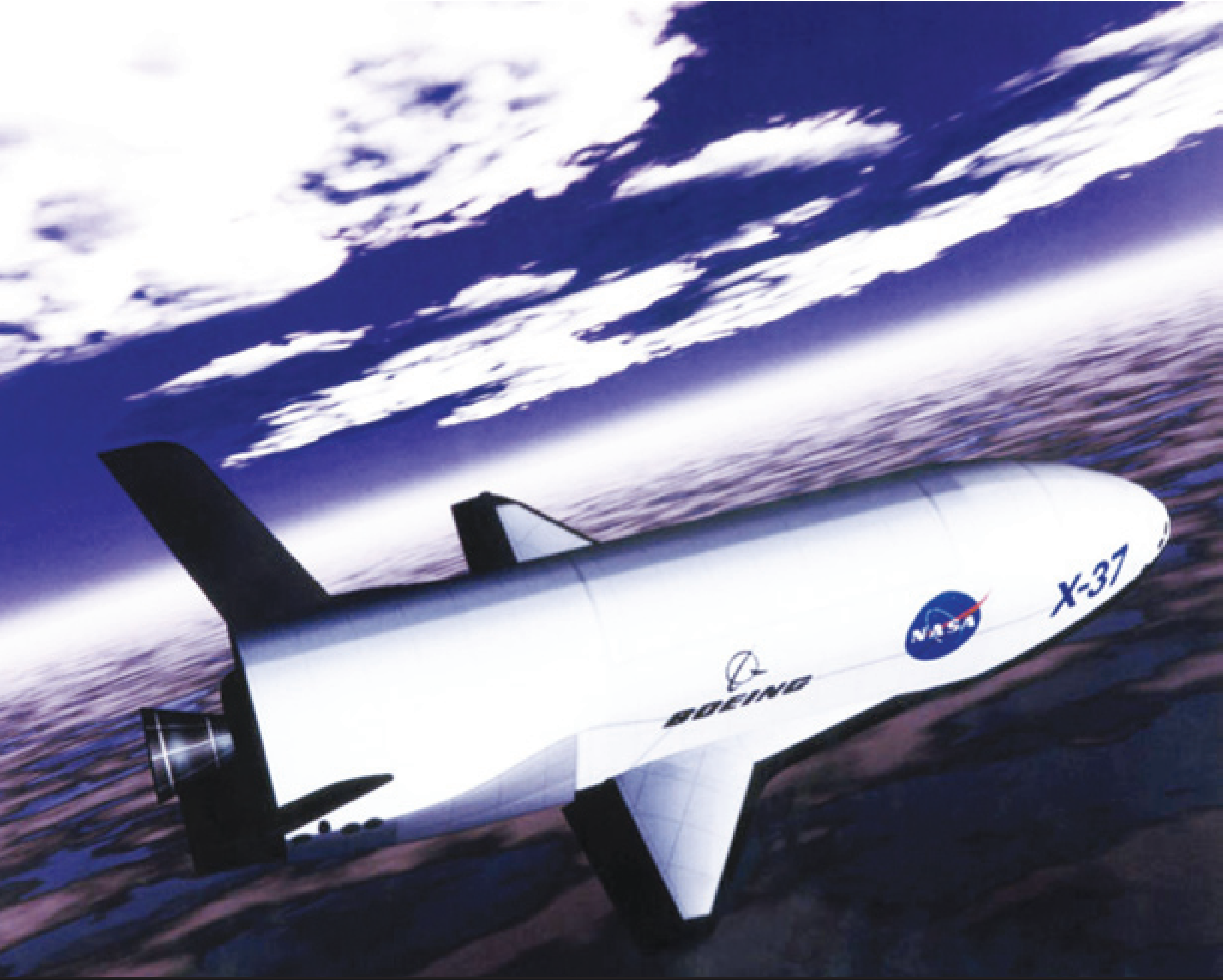
- ***The net effects on the commercial satellite industry, in terms of potential hosted payload revenue opportunities, are enormous.***

- ***Hosted payloads can be a potential game changer and a force multiplier for military and civil use.***

- ***At the writing of this report, the global economic recession was/ is still in force. Moreover, budget constraints due to a multitude of global agendas and concerns that need to be addressed have led to financial challenges in supporting space programs. This has and continues to lead governments to look for more creative solutions when providing bandwidth, communications and Earth Observation/Science solutions to their armed forces and civil arms. And here, hosted payloads provide a compelling option that address*** *not only budget concerns but speed and (to some extent) better solutions compared to launching proprietary assets.*

- ***The old NASA phrase "faster, cheaper, better" is addressed to a large extent by hosted payload arrangements.***

The bottom line is the market is likely to see more cooperative agreements undertaken between the commercial satellite industry and governments where hosted payloads provide a compelling vehicle by which a mutually beneficial partnership scheme ensures a long term and perhaps permanent proposition.


X-37
NASA
BOEING

# MILITARY SPACE PLANES BRIEF

*author: Jos Heyman, CEO, Tiros Space Information*

The United States Air Force (USAF) has always considered space as a logical extension of the air space in which it had its operations and the X-37B automatic space plane is the latest expression of this belief.

Earlier, the USAF conducted programs such as ***Project Bomi*** and ***Dyna Soar*** (**X-20**) while the Space Shuttle was, to a certain extent, a fulfillment of the USAF's wish to have ready access to space. These developments have been discussed in some detail in the author's article ***Military Access To Space*** (*MilsatMagazine*, May 2009).

As a long term replacement for the Space Shuttle as well as an effort to enhance space access capabilities in general, NASA looked at the **National Aero Space Plane** (**NASP**), also known as ***X-30***, which was to provide a single stage to orbit capability. It was envisaged to build two aircraft by the mid 90s and possible contractors included **General Dynamics**, **McDonnell Douglas,** and **Rockwell,** with **Rocketdyne** and **Pratt & Whitney** as engine contractors. The program was cancelled in 1993. There is little doubt the USAF had a significant interest in this development and, if it had proceeded, we could have expected military applications.

In a similar way, we can presume that the USAF was keeping its eye on the abortive **Lockheed Martin *X-33*** and **Orbital *X-34*** space plane developments that NASA undertook in the late 1990s. In the case of the X-33, delays in the program as well as escalating costs led to its cancellation in March of 2001 when the vehicle was 85 percent complete, although sub-scale models had been flown.

In the X-34 program, which was to be a light space plane, the X-34A was a sub-orbital test vehicle and the X-34B an orbital test vehicle.

Two X-34A vehicles were built. The first, designated A1, was initially a hybrid of flight hardware and structural test hardware and was used, in this configuration, to certify the use of the Tristar aircraft as a launch vehicle. The first flight in this configuration took place on 29 June 1999. A2 was the first actual flight article whilst the designation A3 was given to the A1 vehicle after the installation of the remaining flight hardware. In the first year NASA hoped to conduct 27 flights from White Sands and Edwards but the program was cancelled in March 2001 because of excessive costs.

## NASA's X-37A Program

In 1996, **NASA** started the **X-37A** program for an advanced technology flight demonstrator which would provide data in the definition of future space transportation. The vehicle would have tested and validated these technologies in the environment of space as well as test the performance of the vehicle during orbital flight, re-entry and landing. The design had an experiment bay that could carry various instruments. NASA had approximately 41 technologies that could have been demonstrated by the X-37A.

In 1999, NASA contracted with **Boeing Integrated Defense Systems** to design and develop the vehicle, which was built by the California branch of Boeing's ***Phantom Works*** — the first of two orbital flights was expected in 2003 after having been launched on board of a Space Shuttle flight. However, by 2001, the USAF withdrew its support for the project and this led to funding delays.

Nevertheless, in 2002, NASA amended the contract to two instead of only one vehicle. One was to be used for atmospheric drop tests (labelled **Approach and Landing Test Vehicle**, **ALTV**) and one vehicle for orbital tests. By


***The X-37A***

then, the atmospheric tests were scheduled for late 2004, with the first orbital flight, using an expendable booster, was planned for 2006.

However, in late 2003, NASA told **Boeing** to reduce workload on the orbital vehicle — still later, the program was completely placed on hold. In early 2004, NASA stated the X-37 could no longer play a role in the agency's long term agenda, and on September 13, 2004, the ***X-37A*** program was transferred from NASA to the *Defense Advanced Research Projects Agency* (**DARPA**) and became a classified project as part of the independent space policy, which the Department of Defense has pursued since the ***Challenger*** disaster.

Under the DARPA banner, the X-37A made three captive flights (on September 2, 2004, June 21, 2005, and March 24, 2006) with the **Scaled Composites**' ***White Knight*** vehicle before making the first *Approach and Landing Test* on April 7, 2006, when it was released at an altitude of 11.3 km to glide back to **Edwards AFB** in California. During the landing, the X-37A rolled off the runway, damaging the nose wheel. A second flight occurred on August 18, 2006, and the third and final one occurred on September 26, 2006.

The program then moved from Mojave to Palmdale, California, where, again using the White Knight, five or more additional flights were performed. At least one of these flights, which is believed to have been a free flight with a successful landing. The dates of these flights are not known.

The X-37A had a span of 27-feet, 6-inches, and a length of 15-feet, allowing it to fit inside the Space Shuttle's payload bay. On orbit propulsion was to be provided by a **Rocketdyne** ***AR-2/3*** rocket engine, fuelled by **JP-8** jet fuel and hydrogen peroxide.

## The X-40 Program (SMV)

In October of 1996, the **US Air Force Research Laboratory**'s *Military Space Plane Technology* office awarded a contract to Boeing to build a technology demonstrator and a test vehicle for the ***Space Maneuvering Vehicle*** (**SMV**) program.

The SMV was intended to be an unmanned, re-usable spacecraft that could be launched on the Space Shuttle or an expendable booster, spend up to a year in orbit, and then return to Earth to land on a runway just like an aircraft. The tasks foreseen by the SMV were to deliver small payloads to orbit and then undertake remote examination of satellites and orbital reconnaissance.

The technology demonstrator, also named ***Integrated Technology Test Bed*** (**ITTB**) was designated as ***X-40A*** and was a 90 percent scale unpowered version of the SMV vehicle. The vehicle had a span of 11-feet, 6-inches and a length of 22-feet.

The first flight of the X-40A was on August 11, 1998, when it was released from a **UH-60** helicopter over **Holloman AFB**.

The ***X-40B*** designation referred to full scale SMV and would have been fitted with tricycle landing gear and a reusable rocket motor, advanced thermal protection systems, avionics and flight control systems.

In 2000 the X-40A was transferred to NASA for tests as part of the X-37 development. The tests comprised seven drop flights from a CH-47 over Edwards AFB.

The X-40B program was terminated and, it is assumed, was merged with the X-37B program.


***The X-37A With White Knight***

## The X-37B Program

The ***X-37B*** program is based on the X-37A and the X-40A programs and comprises an unmanned space vehicle capable of remaining in space for as long as 21 days before gliding to an autonomous re-entry and landing at the end of its flight, most likely at a lengthy runway modified for the space shuttle at **Vandenberg Air Force Base**. Designed by Boeing and funded by the USAF, it will provide the US military with a testing platform for new space technologies. The X-37B incorporates a number of untested technologies, including new thermal protection tiles underneath and high-temperature components and seals.

The spacecraft, also named the Orbital Test Vehicle, has a wing span of 14’11” and a length of 29’. It is powered by a Rocketdyne AR-2/3, which is fuelled by hydrogen peroxide and JP-8.

The X-37B will serve as a maneuverable test platform for satellites and other space technologies and will be capable to expose satellite sensors, subsystems, components and associated technology to the space environment by opening the doors of its small payload bay. One of the advantages for scientists and engineers is that the OTV returns to Earth and the tested components can be inspected, making the development of better components an easier task.

The first two flights of the X-37B OTV, which are scheduled for April 2010 and 2011 using an Atlas V-501, will more than likely be used to make sure the spacecraft is working in the way it was planned and designed, after which the USAF is expected to commence a program of operational test flights. No details of such an operational program have, as of yet, been published.


***The X-40A***

## Future Developments

Remember that the letter '**X**' in the designation X-37B indicates '*experimental*'. This means it is unlikely that the X-37B vehicle will be put into mass production. Neither does it mean a future operational vehicle would resemble the X-37B except in a very broad manner.

The vehicle will, however, provide the USAF with a basis for developing future operational systems which will be capable of protecting and replacing space assets, the inspection of objects in space, and to also deliver munitions into space, meaning, in simple and unbiased terms, a flexible space based weapons system. Such a system should, however, be complemented by a rapid launch capability. The current absence of such a capability is to be considered as a limitation to the full scale development of an operational derivative of the X-37B.

It is interesting to draw parallels between the Dyna Soar (X-20) of the early sixties and X-37B programs. Both vehicles seem to have the same basic mission objective: to provide military access to space with a return capability. Where they differ is that the X-20 required a pilot whilst the X-37B does not. This difference is a result of the same developments that we see in other military aircraft, such as UAVs — the aircraft does not require a pilot but is, instead, flown by a controller who sits in the comfortable environment of an operations room, far away from the potentially hazardous environment in which the aircraft operates, that being the theatre of war.


*The X-37B*

About the author

Jos Heyman is the Managing Director of Tiros Space Information, a consultancy specializing in information on the scientific exploration and commercial application of space and he is the editor of the TSI News Bulletin.

## *UPDATE*

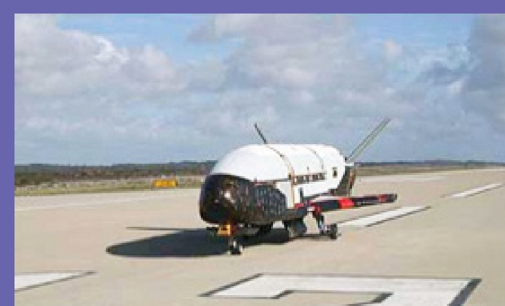
United Launch Alliance successfully launched the U.S. military's X-37B, a prototype space plane also called the Orbital Test Vehicle (OTV) from the Space Launch Complex-41 at Cape Canaveral Air Force Station, Florida. The Atlas V will fly in the 501 vehicle configuration with a five meter fairing, no solid rocket boosters and a single-engine Centaru upper stage.

X-37B OTV-1 (Orbital Test Vehicle 1) is an American unmanned spacecraft, in what is the maiden flight of the Boeing X-37B. It was originally scheduled for launch in the payload bay of a Space Shuttle, however following the Columbia accident, it was transferred to a Delta II 7920. It was subsequently transferred to the Atlas V following concerns over the spacecraft's aerodynamic properties during launch.

This is the 21st Atlas V launch in program history. This space mission has much secrecy associated with it, including the unpiloted military space plane. The spacecraft will be placed into low Earth orbit for testing, then it will be de-orbited for landing.

While the launch took place in Florida, the landing is to occur on a runway at Vandenberg Air Force Base, California with Edwards Air Force Base as the alternate site. The duration of the mission has not been announced, although an Air Force spokesperson has said the vehicle has a requirement to be on-orbit for up to 270 days.

In 1999, NASA selected Boeing Integrated Defense Systems to design and develop the vehicle, which was built by the California branch of Boeing's Phantom Works.



The X-37B space plane prototype is seen on a runway during flight tests in this undated photo released by the U.S. Air Force. Credit: USAF.

The X-37 was transferred from NASA to the Defense Advanced Research Projects Agency on September 13, 2004. The program has become a classified project, though it is not known whether DARPA will maintain this status for the project.

NASA's spaceflight program may be centered around the Crew Exploration Vehicle, while DARPA will promote the X-37 as part of the independent space policy which the Department of Defense has pursued since the Challenger disaster.

This vehicle has the potential to become United States' first operational military spaceplane, after the cancellation of Dyna-Soar in 1963. It is expected to operate in a velocity range of up to Mach 25.

# AN IN-DEPTH LOOK AT

# SPACE AND MISSILE SYSTEMS CENTER

## LEADING MILITARY SPACE DEVELOPMENT INTO THE 21ST CENTURY

**The Space and Missile Systems Center (SMC) is the Air Force's product center for the development and acquisition of space and missile systems. The Center was established in 1954 and has served as the leader in military space systems development since the earliest days of the space age. Today SMC leads the development, acquisition, fielding, and sustainment of the world's best military space and missile systems.**

The systems SMC develops and acquires enable Air Force Space Command (AFSPC) to deliver unparalleled capabilities to national decision makers, asymmetric operational advantages to joint warfighters, as well as economic and technological benefits for the nation. As a widely respected and trusted provider of critical military space and missile systems, SMC supports Air Force Space Command in enhancing national security and shaping how our nation fights and wins its wars.

This article describes SMC's mission, history, organization, responsibilities, management processes, and organizational culture, and illustrates how SMC develops and acquires cutting-edge military space and missile systems across a broad spectrum of mission areas, assigned programs, and areas of responsibilities. As well as how SMC plays a role as a major actor in the nation's overall space community.

The article starts by defining the core mission and vision of **SMC** and discussing the Center's evolution to its current organization. SMC's responsibilities, mission areas, functional expertise, and integrated management approach are then highlighted.

A look forward to the priorities and enduring values that will shape the future of the **Space and Missile Systems Center** and the Air Force's joint space warfighting capabilities conclude the article.

## *Mission + Vision*

The Space and Missile Systems Center is responsible for managing cutting-edge space systems across their entire life-cycle, from initial systems concepts and technology development, to systems demonstration and validation, full-scale development and fielding, and sustaining on-orbit and ground capabilities. The Center is responsible for a comprehensive set of military space

capabilities across all space mission areas, including force enhancement, space superiority, force projection, and space support. The Center develops and maintains a full range of systems and technical expertise including satellites, payloads, launch vehicles, missiles, ground control systems, user equipment, and ground sensors. These systems provide capabilities such as communications, precision navigation and timing, spacelift, space situational awareness, missile warning, missile defense, weather monitoring, satellite command and control, and land-based nuclear deterrence.

By executing these comprehensive mission and lifecycle responsibilities for space and missile systems, **SMC** provides **Air Force Space Command**, the joint warfighter, and the nation with unrivaled capabilities, twenty-four hours a day, seven days a week, three hundred and sixty-five days a year.

The Commander of SMC is also the ***Air Force Program Executive Officer for Space*** (***AFPEO-Space***) and is responsible and accountable for directing and executing assigned space development and acquisition programs, as well as developing the processes and expertise to manage these programs and the operation of the Center.

To support this role, SMC is organized into line program management organizations and functional management organizations.

The program management organizations — systems wings and groups — are charged with planning and executing major space development and acquisition programs. The systems wings and groups translate operational needs into system requirements and designs, formulate development and acquisition programs to satisfy those needs, and manage and execute programs with industry to develop, produce, field, and sustain space and missile capabilities for user communities. The functional directorates, including engineering, program management, finance, contracting, logistics, and manpower, are charged with developing and maintaining the expertise, processes, and workforce necessary to plan and execute programs today and lead SMC's acquisition enterprise into the future.

SMC employs a robust horizontal integration approach linking multiple programs, functional processes, and management activities together to deliver integrated operational systems that enable joint space warfighting capabilities. SMC is committed to delivering the space systems that AFSPC, the joint warfighter, and the nation require to maintain leadership and security in space.

SMC's mission and vision directly flow from the mission and vision of the Air Force and Air Force Space Command.

- ***The Air Force Mission is to deliver sovereign options for the defense of the United States of America and its global interests — to fly and fight in Air, Space, and Cyberspace.***

- ***The Air Force Vision is Global Vigilance, Reach, and Power.***

- *AFSPC’s Mission is to deliver space and missile capabilities to America and its warfighting commands.*
- *AFSPC’s Vision is to be America’s space leader ... delivering responsive, assured, decisive space power.*
- *SMC’s Mission is to develop, acquire, field, and sustain the world’s best space and missile systems for the joint warfighter and the nation.*
- *SMC’s Vision is to be the most recognized, effective, innovative, and respected developer of military space systems.*
- *SMC is a leader in the development and acquisition of military space and missile systems for the Air Force, the Department of Defense and the nation.*

## SMC Heritage

The Space and Missile Systems Center ("**Center**") has more than a half century of unrivaled leadership and achievements in developing and fielding military space and missile systems. Throughout its history, the Center developed a unique organizational culture, development practices, and record of performance. SMC's space development community integrates uniformed military personnel, civil service employees, the **Aerospace Corporation** (a dedicated Federally Funded Research and Development Center), and technical support contractors. This acquisition workforce is comprised of more than 4,500 people with diverse skills and depth of experience in the full range of space development, acquisition, and sustainment. This workforce brings a unique blend of skills to the multifaceted tasks associated with technically complex, high-risk, long-life, high performance space systems.

The team continually refines the ingredients and formulas for success in space systems development and acquisition. From its inception, SMC has led the way in systems engineering, concurrent development, systems program management, mission assurance, and risk management.

## Birthplace Of Military Space

The Space and Missile Systems Center traces its roots to the Western Development Division, activated by Brigadier General *Bernard Schriever* on July 1, 1954. Its original mission, the development of strategic nuclear missiles for the nation, was soon expanded to include the development, fielding, and operation of the nation's first Military satellites and launch vehicles.

From the first successful military space launches in the 1950s, rapid progress was made in maturing the technology and know-how to develop and operate reliable and effective systems across a broad array of mission areas. During this period, the ***Western Development Division*** underwent multiple reorganizations, until finally being designated in 1992 as the Space and Missile Systems Center.

## Creation Of Air Force Space Command

On September 1, 1982, **Air Force Space Command** was established to serve as the Air Force's operational command for military space systems. In the years that followed, the Command gradually assumed operational functions previously performed by SMC field units, including satellite operations, launch ranges, and satellite control networks.
SMC maintained its leadership role in the development of space and missile systems in support of the new Air Force Space Command mission but remained part of **Air Force Systems Command** and, subsequently, **Air Force Materiel Command.**

## Transformation Of Military Space

The end of the Cold War and collapse of the Soviet Union in the early 1990s changed the focus of military space capabilities from strategic to operational and tactical applications and began an unprecedented growth in demand for military space capabilities. ***Operation Desert Storm*** demonstrated the far-reaching applications and benefits of space capabilities in joint military operations. At the same time, defense budget reductions, industry consolidation, government and industry workforce reductions, and projected growth in commercial space investment led the national security space community to institute a series of acquisition reforms. Ultimately, these reforms proved to be flawed, and the community experienced a series of launch failures, serious program delays, and cost overruns in the late 1990s. All these factors led to a “perfect storm” within the space enterprise and a call to action to fix systemic problems.

## Realignment Of SMC

In the early 2000s, a number of studies examined management and organization of the defense space community and space acquisition, including the organizational alignment of the Space and Missile Systems Center.

In 2001, the Center was realigned under Air Force Space Command, thus bringing the developers and the operators of military space and missile systems together under one major command. Further, ***Program Executive Officer*** (**PEO**) authority was assigned to the Commander of SMC, consolidating most space development and acquisition responsibilities under a single “dual-hatted” Commander and PEO.

## Rebirth Of SMC

In the first decade of the new millennium, SMC has aimed to reinvigorate its workforce and its programs to recover from the flaws of the acquisition reforms in the 1990s. SMC has led the “Back to Basics” campaign — an initiative to reestablish rigor and discipline in space systems development. With an intense focus on mission assurance, the Center has rebuilt processes, improved engineering and program management rigor, redeveloped the workforce, reinvigorated partnerships with industry, and implemented engineering and business “best practices.” As part of this initiative, SMC also implemented a “block development" acquisition approach to manage complex systems development. The overall effectiveness of the "Back to Basics" strategy has been demonstrated by the unprecedented level of success in space and missile systems development, launch, and on-orbit performance.

## *Current Responsibilities*

Alignment of the Space and Missile Systems Center under Air Force Space Command gives unique responsibilities and opportunities within a single major command to organize, train, and equip space and missile systems in the Air Force from "cradle to grave." SMC's responsibilities begin by working with Headquarters Air Force Space Command and the user community to refine operational concepts and requirements; continue with systems definition and program formulation; extend through execution and fielding of systems in concert with industry partners; and ultimately include sustaining systems over their operational lives.

To support this full system lifecycle responsibility, SMC develops, manages, and maintains the needed workforce, processes, partnerships, and core competencies to define and execute programs and ensure the Center is ready and able to meet future challenges.

## *Executing Acquisition Programs*

The ***Commander of the Space and Missile Systems Center*** is also the ***Air Force Program Executive Officer for Space*** (**AFPEO-Space**) and in this role has overall responsibility, authority, and accountability for executing ***National Security Space Programs*** as directed by the ***Air Force Acquisition Executive***.

The AFPEO-Space is responsible for executing the full life cycle of activities associated with each of SMC's programs and does so through specific contracting, financial management, engineering, program management and personnel management authorities and accountabilities, as established by law, regulations, and policies and as specifically assigned and delegated through the Air Force chain of command and the Department of Defense acquisition management chain.

The first and most important step in systems definition and program formulation is to ensure warfighter requirements and operational concepts are fully understood and translated into system and technical requirements. The **SMC Development Planning** organization and **Space Development and Test Wing** develop system concepts, define and advocate system technologies, provide decision-quality analysis, and demonstrate and validate promising new systems that can meet operational requirements in a technically and programmatically effective way.

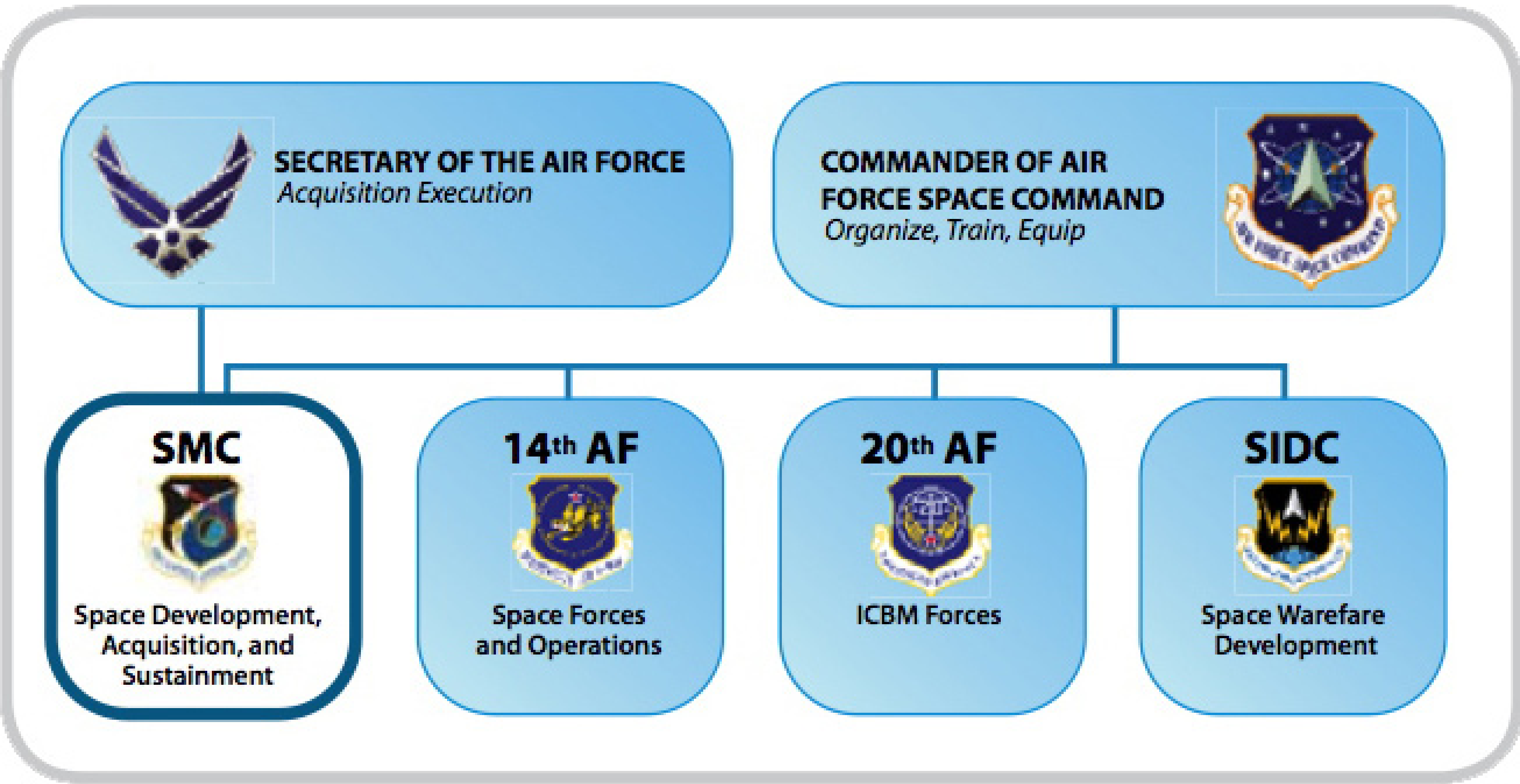
Successful developments, demonstrations, and validations are transitioned into systems wings for operational system development. Program offices are responsible for systems engineering, program management, contract management, and financial management to ensure successful delivery of required capabilities. During production, testing, and integration, multiple mission stakeholders execute rigorous mission assurance practices, including certification for space launches.

Finally, when systems are transitioned into operations, the Center, its systems wings, and its space logistics group manage sustainment for the operational life of each system.

To execute all of these activities, the **AFPEO-Space** directs and oversees the **Space and Missile Systems Center** systems wings at **Los Angeles Air Force Base**, the **Space Development and Test Wing** at **Kirtland Air Force Base**, the **526th ICBM Group** at **Hill Air Force Base**, the **Space Logistics Group** at **Peterson Air Force Base**, and the **850th Electronic Systems Group** at **Hanscom Air Force Base**.

## *Leading The Center*

The Space and Missile Systems Center is responsible for Los Angeles Air Force Base and organizes, trains, and equips the base and its workforce to ensure successful execution of the space and missile programs in the AFPEO-Space portfolio. In executing these responsibilities, the Center develops and implements critical processes, standards, and capabilities in its core competency areas of program management, systems engineering, development planning, financial management, contracting, mission assurance, and logistics.




Maintaining comprehensive and interrelated processes enables SMC to execute programs with high confidence, while supporting and leading others in the space and missile systems development community.

The Center is also responsible for recruiting, training, developing, and retaining a first-class space professional workforce dedicated to excellence in systems development and acquisition and leadership across the space community. The Center provides a wide array of education and training in technical and program management areas and aggressively develops experience and leadership through active career development for all space professionals. SMC also promotes a healthy quality of life by providing a wide variety of services for the SMC workforce, as well as the extended military, dependent, and retired community served by Los Angeles Air Force Base. Additionally, SMC and its **61st Air Base Wing** train, deploy, and support military members and families for **Air Expeditionary Force** deployments and taskings.

Finally, the Center strengthens its partnerships and relationships with key members of the broader space community. To ensure an adequate technology base for space and missile programs, SMC actively pursues comprehensive interaction with industry to develop standards, "best practices," information sharing, and "benchmarking" with individual companies.

To ensure synergy across the full spectrum of the space enterprise, SMC participates in space community forums with partners such as the **National Reconnaissance Office**, **National Aeronautics and Space Administration**, **National Oceanic and Atmospheric Administration**, **National Security Agency**, and commercial companies. To promote understanding of the military, the Air Force, and the cutting-edge work at SMC, public affairs and outreach organizations work closely with local media and community leaders. All of these activities are aimed at continuing SMC's leadership of the space and missile systems development community.

## *Mission Areas*

The **Military Satellite Communications Systems Wing** develops, fields, and sustains a full spectrum of space-based global communications capabilities to enable military operations. Communications satellites, such as ***Milstar***, ***Advanced Extremely High Frequency*** (**AEHF**), and ***Wideband Global SATCOM*** (**WGS**), ensure warfighters are always fully connected and able to receive and transmit vital information.

The ***Global Positioning Systems Wing*** is a joint service program that develops, fields, and sustains precise, effective, and reliable global positioning and timing systems and services for military, civil, and world-wide users. GPS receivers have been integrated into virtually every piece of military hardware, as well as many civilian systems.

The ***Launch and Range Systems Wing*** develops, fields, and sustains expendable launch vehicles and leads launch integration, mission assurance, launch campaigns, and range modernization at the U.S. eastern and western launch ranges.

***Evolved Expendable Launch Vehicle*** (**EELV**) boosters are the latest generation of rockets to place the nation's critical satellite systems into orbit.

The ***Military Satellite Communications Systems Wing*** develops, fields, and sustains a full spectrum of space-based global communications capabilities to enable military operations. Communications satellites, such as Milstar, Advanced Extremely High Frequency (AEHF), and Wideband Global SATCOM (WGS), ensure warfighters are always fully connected and able to receive and transmit vital information.

The ***Space Based Infrared Systems Wing*** develops, fields, and sustains space-based infrared surveillance, tracking, and targeting capabilities for the nation. Space-based global missile warning is vital to both homeland security and missile defense systems.

The ***Space Superiority Systems Wing*** develops, fields, and sustains space control capabilities to guarantee space superiority for the nation. Space control systems provide commanders and operational forces with effective space situational awareness, defense, and protection for U.S. and allied space capabilities, as well as offensive counterspace systems to gain and maintain space superiority.

The ***Space Development and Test Wing*** develops, tests, and evaluates Air Force space systems, executes advanced space development and demonstration projects, and rapidly transitions capabilities to the warfighter. Groundbreaking efforts developing operationally responsive space capabilities ensure warfighters can continue to rely on a wide range of space assets to accomplish their missions.

The ***61st Air Base Wing*** provides mission and installation support for the Space and Missile Systems Center. The Wing's administrative services, communications support, personnel support, healthcare and fitness facilities, family services, civil engineering, and security forces improve wartime readiness and ensure a healthy quality of life.

In addition to these wings are a number of direct-report groups providing additional systems and integrated mission capabilities. SMC's groups provide weather monitoring systems, satellite control and network systems, missile defense space systems, ICBM systems modernization and sustainment, and lifecycle logistics and sustainment support for a number of organizations.

## Functional Expertise

The Space and Missile Systems Center has four core competency areas and strives continuously to improve key processes in each of these areas, as well as develop and retain the necessary skills, experience, and leadership to successfully execute these processes across all programs, mission areas, and activities. SMC applies these processes and skills across the entire system development and sustainment lifecycle.

### *Program, Financial, And Acquisition Management*

SMC supports programs during each of their acquisition phases. At each program's inception, SMC solicits, evaluates, budgets for, and awards contracts which are then managed through the system's lifecycle. During the development phase, SMC establishes and manages each program's baseline, including cost, schedule, performance, and risk parameters. When ready, SMC deploys and transitions systems into operations and sustainment.

*Development Planning*

SMC defines, develops, demonstrates, validates, and evaluates system concepts and technologies to prepare them for entry into development and acquisition. SMC also develops coherent technology investment strategies and system architectures to support the Center's capability portfolio. These activities constructively influence decisions affecting future systems.

*Engineering*

SMC performs systems engineering, technical standards definition and enforcement, and risk management to ensure each system meets its mission capability requirements. The Center establishes, manages, verifies, and validates each system's engineering baseline. SMC also defines and controls each program's system and technical architecture, including establishing and controlling system configuration.

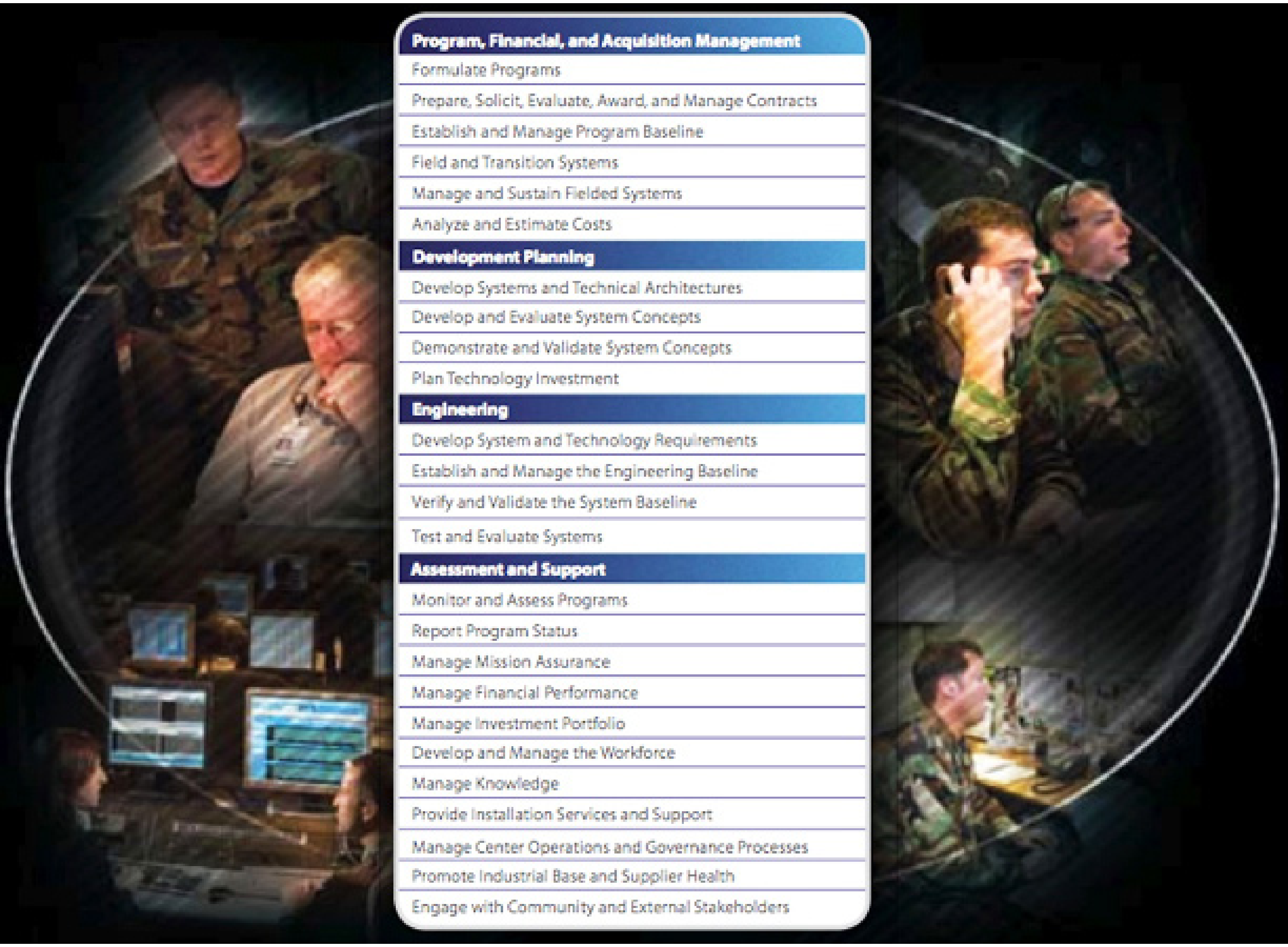
*Assessment And Support*

SMC provides integrated and independent program monitoring, assessment, and reporting to evaluate each program's progress and deliver 100 percent mission assurance. To support these and all Center activities, SMC develops its professional workforce, efficiently operates and governs its activities, effectively manages organizational knowledge, and successfully delivers community services to the total base force. SMC also develops relationships with external communities, including industrial suppliers and partners, the local community, decision-makers, media, and the public.

### *Integrated Approach*

The Space and Missile Systems Center has developed an integrated approach that promotes excellence and meets commitments to deliver effective space capabilities to joint warfighters. SMC functional directorates support systems wings by maintaining core areas of expertise and ensuring best practices are collected, disseminated, and followed. Organizations such as Program Management and Integration, Contracting, Financial Management, Manpower and Personnel, and Engineering and Architectures work to continually improve processes and performance in executing programs.

To ensure best practices are shared and consistently followed, governance forums bring together functional and system experts. Cross-center forums include the *Chief Engineer's Council*, the



*Financial Management Chiefs Council*, the *Contracting Committee*, and the *Vice Commander's Forum*.

To further integrate the SMC organization, system wings and program offices are staffed with personnel from functional directorates. These individuals are experts in fields such as program and financial execution, contract management, and systems engineering. While they use their expertise to support individual programs or wings, these individuals remain tied to their functional directorates. This ensures they bring the newest policies, developments, and process improvements from the functional directorates into program execution offices.

## Delivering On Commitments

As part of an ongoing effort to establish and grow the credibility of the Center, SMC has implemented an annual Center-wide commitments process.

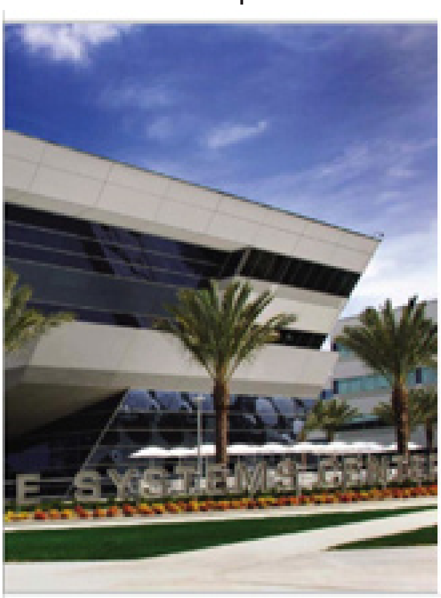
This process serves as an important and visible means for identifying and committing to what SMC and its industry partners will accomplish in the coming year. System wings commit to achieving specific major milestones for their programs, and functional organizations identify process improvements they will make. SMC actively tracks ongoing accomplishments against what was identified at the beginning of each year and regularly reports to key stakeholders how SMC is delivering on commitments.

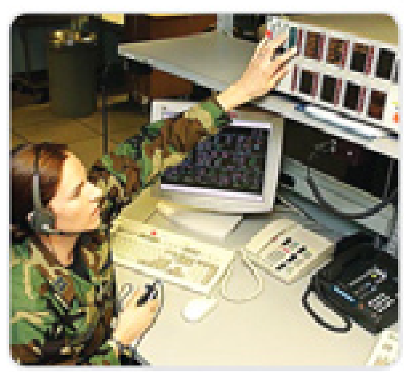
## The Way Ahead

The way ahead for the Space and Missile Systems Center includes both short-term and long-term priorities. In the next few years, SMC will field a new set of systems to provide dramatically enhanced capabilities to joint warfighters. The Center is maintaining laser focus on delivering systems such as ***Wideband Global SATCOM***, ***Global Positioning System Block IIF***, ***Advanced Extremely High Frequency*** (**AEHF**), ***Space Based Space Surveillance*** (**SBSS**), and ***Space Based Infrared System Geosynchronous Orbiting Satellite*** (**SBIRS-GEO**).

## SMC Priorities

**100 percent Mission Success.** The nation, military, and allies rely on the systems SMC develops each and every day. When SMC





launches a satellite into orbit, not only must the launch be a success, but the satellite must work continuously throughout its design life and beyond. Once in operation, systems must be responsive, reliable, and effective. A commitment to 100 percent mission success ensures warfighters are given every possible advantage on the battlefield.

**Program Success.** SMC must be a good steward of taxpayer dollars. SMC takes very seriously the responsibility invested in it by **Air Force Space Command**, the **Air Force**, and the nation. Working within annual fiscal constraints, SMC must provide warfighters with the systems they need — when they need them. SMC must deliver systems on time and on budget.

**Organizational Excellence.** SMC must be capable of meeting its responsibilities both today and tomorrow. SMC strives to be a flexible, agile organization, capable of providing innovative system solutions to whatever challenges the nation faces. SMC must be agile enough to deliver both operationally responsive space capabilities and assured strategic capabilities. SMC must spearhead new strategic approaches to meeting the requirements for surveillance, launch, communication, position, navigation, timing, and early warning.

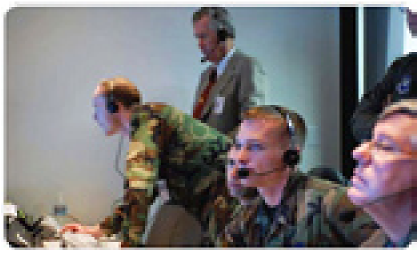
**Our People.** Space and mission support professionals, both in and out of uniform, are the critical enabler for executing SMC's missions. SMC must recruit, develop, and retain a skilled, motivated, and energized workforce. The people at the Space and Missile Systems Center are the foundation that ensures success for SMC's mission, programs, and organization.

## Core Values

The ***Air Force Core Values*** are integral to the people, the mission, and the work of SMC.

***Integrity First*** and ***Service Before Self*** set the common standard for conduct throughout the Air Force. Living up to those values means everyone goes the extra mile to ensure the highest levels of personal conduct and dedication to meeting the highest standards for mission execution. The Center and its people are committed to serving the nation and the military personnel who depend on the space capabilities SMC provides.

***Excellence in All We Do*** is critical in executing the SMC mission. SMC values and promotes excellence in all areas required to perform its mission. SMC strives to have the correct team in place to lead programs forward, valuing excellence in the Center's number one resource — our people.



## Key SMC Culture Attributes

- ***Technical Excellence – performing rigorous systems engineering, mission assurance, and risk management to ensure systems meet or exceed required performance***

- ***Critical Thinking – examining ideas at all levels and from multiple viewpoints to seek root causes, challenge assumptions, and welcome diverse reasoning in evaluating issues at hand***

- ***Teamwork and Initiative* – *valuing individual contributions, promoting interdependence and trust, and encouraging and rewarding individual and team initiative***

- ***Checks and Balances* – *empowering and integrating functional experts to provide peer review, seek consensus, and resolve differences in the mission assurance and execution process***

- ***Diversity and Respect* – *valuing the different perspectives and unique insights brought by a workforce spanning multiple career fields, generations of experience, and individual backgrounds***

- ***Accountability* – *accepting and fulfilling individual responsibility to do what is expected of each person on the team, make hard decisions, and put personal and organization reputations on the line to ensure mission and program success***

- ***Continuous Improvement* – *striving always to develop new and innovative approaches to meeting mission needs, never being satisfied with the status quo, and continuously elevating individual and team performance***

## *The Future*

Today, space is integrated and employed in virtually every aspect of military planning and operations, from peace through crisis to major theater war. Space critically enables warfare at all levels — strategic, operational, and tactical — and has become integrated into all land, sea, air, and special operations. Tomorrow will see even greater demand and dependence on space for military operations and the nation's security.

The Space and Missile Systems Center must remain a leader in providing critical space capabilities for Air Force Space Command, the Air Force, the Department of Defense, and the nation. Without question, SMC must continue to deliver and sustain dominant space and missile capabilities in what is now a contested regime. Recent events clearly demonstrate that space is no longer a sanctuary. Just as gaining air superiority is the first priority in any joint operation, gaining and maintaining space superiority must become a top priority in peace, crisis, or conflict. SMC must design future systems to be both survivable in the face of increased threats and responsive to operational needs. When delivering these future systems, SMC must never lose laser focus on its unshakable goal: 100 percent mission success.

The future will no doubt hold the opportunity to address challenges that will face the space community as a whole. The Space and Missile Systems Center must continue to provide leadership in developing and acquiring cutting-edge space capabilities. The Center has a critical future role in continuing

to help military commanders and operators understand what systems and capabilities can be developed to meet their operational needs.

SMC must continue to develop and deliver the solutions they desire, on-time and on-budget with 100 percent mission success. To do this, SMC must have continuous interaction with the supported warfighters and customers, understand the principles of war and the applications of space in joint warfighting, and develop the people and processes that are capable of delivering responsive and effective operational systems.

The nation is still at an early stage in the development and evolution of military space capabilities, doctrine, and tactics, and there is still much to learn about how best to serve and integrate with air, land, and maritime forces and operations. The men and women of SMC, in support of Air Force Space Command, will be key players in growing and evolving the role of space power in the defense, security, and well-being of the nation. The pioneers that began SMC over 50 years ago did not know where their efforts would lead, but they persevered in the face of failures and tribulations. Their efforts created the culture and systems that, today, give the nation unrivaled leadership and benefits in daily life, national security, and world affairs.

The challenge for SMC, its partners in industry, and the operational commanders and users it serves is to ensure the leadership and advantage the nation has gained in space will be sustained for decades to come.

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