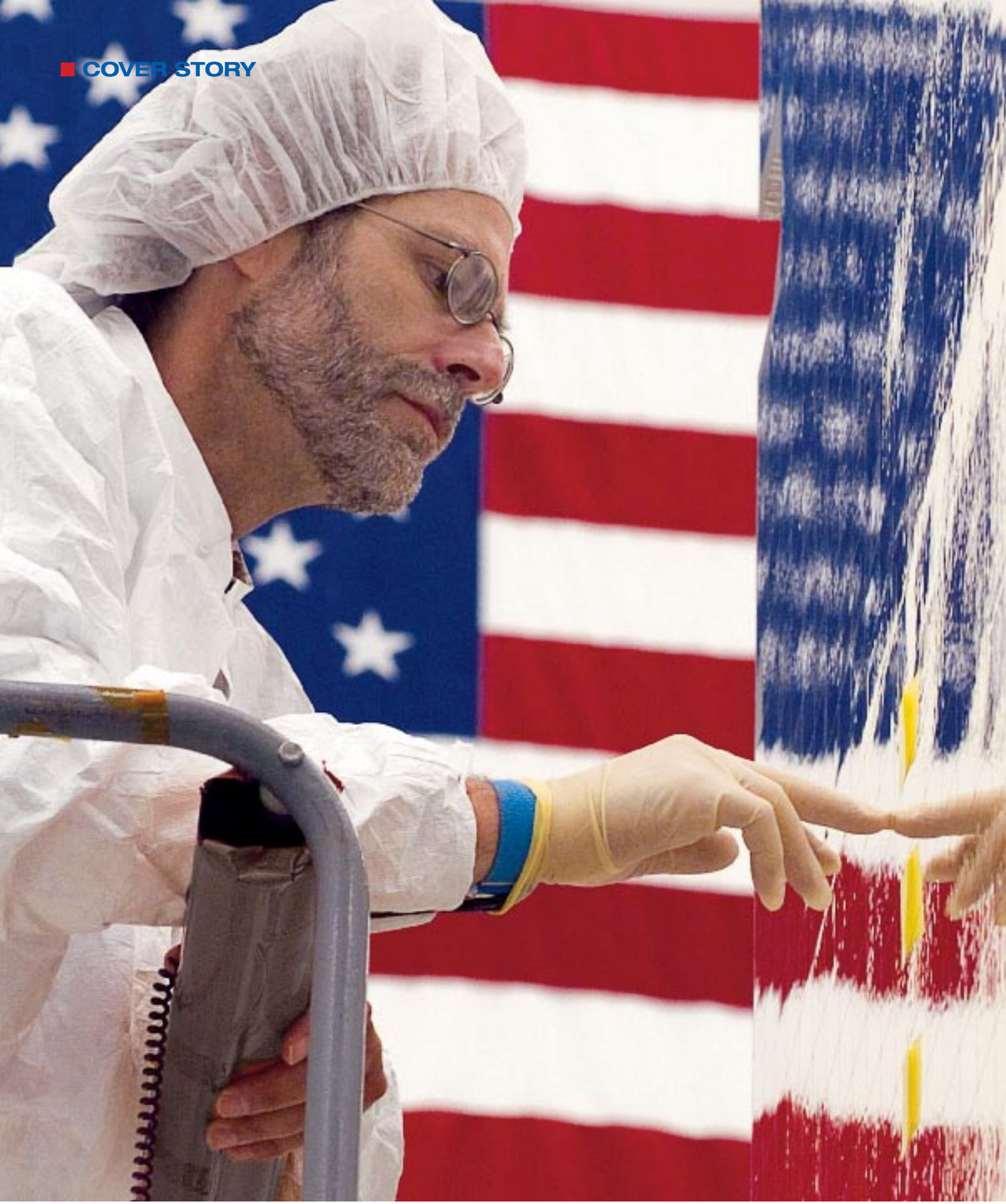


Randall Moss conducts a minute inspection of a Wideband Global SATCOM spacecraft at Boeing Space and Intelligence Systems in El Segundo, Calif.
SALLY ARISTEI PHOTO

WGS Information superiority

How a system of Boeing-built satellites will boost U.S. military communications capabilities through large data-rate information transfer

By Joel R. Nelson

Imagine this scenario: An international embassy has come under attack, and hostages have been taken. Special Operations forces are dispatched. As minutes tick away, the team requests real-time imagery and maps to find the safest and quickest route there. And it gets them, thanks to Wideband Global SATCOM (WGS), a Boeing-built transformational satellite system capable of large data-rate information transfer. Poised high above the earth, a WGS satellite provides vital communication links to the rescue team, delivering—in time—the situational awareness needed to save lives.

This resolution is close to moving from hypothetical to entirely feasible. After years of development and testing, WGS, a key element of the U.S. Department of Defense's transformational communications architecture that emphasizes networking and information superiority, is ready to fly.

WGS, which will include a minimum of five geostationary satellites, is a cornerstone of the DOD's drive to increase the reach, efficiency, and capacity of its global communications network.

In WGS, the Boeing Space and Intelligence Systems team has created a breakthrough in satellite communications (SATCOM) for the DOD and other U.S. government agencies. The system will provide the capacity needed for high-speed transfer of imagery, video and other broadband applications, such as two-way, point-to-point, multicast and broadcast communications. WGS represents a quantum leap in capacity: One WGS satellite provides the capacity of 10 satellites it will replace. For Boeing, it's a $1.6 billion program that leverages commercial, flight-proven technology and Boeing's Integrated Defense Systems best practices.

Five WGS satellites are in various stages of production at the S&IS Satellite Development Center in El Segundo, Calif. The first launch is slated for August.

NETWORK-CONNECTED

S&IS, part of IDS, has been developing the first three satellites, collectively known as WGS Block I, since 2001. Late last year, the U.S. Air Force and Boeing negotiated options for up to three Block II spacecraft; two have been ordered. Block II will be similar to Block I but features added capability to support airborne in-

telligence, surveillance and reconnaissance platforms that require additional bandwidth.

WGS will help stitch together a network that will provide vital communications connectivity to theaters of operation worldwide.

Operating in two communications bands, the system will enable networks for tactical command and control, communications, intelligence, surveillance and reconnaissance. WGS also will support the critical Global Broadcast Service, which distributes satellite imagery and video feeds from unmanned aerial vehicles and delivers news broadcasts to deployed troops. In addition, WGS will augment, and eventually replace, the Defense Satellite Communications System (DSCS) and the GBS function currently provided by Boeing-built UHF Follow-On satellites.

"We are very proud to be providing this incredibly capable and cost-effective system for warfighters," said Howard Chambers, S&IS vice president and general manager. "Boeing is pleased that the Air Force turned to us for WGS. Our commitment to them, and to the support of the United States, remains firm."

WITHIN THE NUMBERS

The numbers tell a compelling story: Each WGS satellite will provide more than 2 gigabits per second of communications capacity. By comparison, DSCS satellites provide about 200 megabits per second. That's a factor-of-10—an order-of- magnitude—improvement.

WGS will also reduce the government's reliance on costly commercial satellite communications services. The DOD currently leases about 80 percent of its SATCOM capability from commercial operators, costing more than $350 million annually. The first three WGS satellites will provide more than twice the communications capacity being procured commercially by the DOD today, at less than 20 percent the cost of leasing equivalent commercial SATCOM capabilities. And each WGS is designed to provide a minimum of 14 years of service.

Furthermore, test results indicate the first three spacecraft will provide approximately 25 percent more communications capacity as a result of better-than-expected performance by key payload units.

FLEXIBILITY COUNTS

S&IS has loaded WGS with features that will provide tremendous operational utility and flexibility for the warfighter, including capabilities not found on any other SATCOM system.

Each WGS satellite provides more than 4.8 gigahertz of usable communications bandwidth, sufficient to carry 872 standard-definition television channels or more than 800,000 telephone connections.

The satellite has 19 separate coverage areas that can be independently configured to meet operational needs and evolving mission scenarios. An onboard digital channelizer, which enables seamless communication between WGS' two communication bands, allows operators to tailor the amount of spectrum allocated for each user. That permits a highly efficient use of bandwidth.

Moreover, S&IS made the WGS payload interoperable with existing and planned ground terminal infrastructure, providing flexibility to accommodate future changes in waveform and radio technology.

WGS' utility extends to scenarios less urgent than a hostage crisis but vital to helping widely dispersed military forces operate smoothly. Every military unit needs supplies. No matter how remote forces are, they can tap WGS to place orders via laptop computers, much as shoppers do from Internet sites.

CHRONOLOGY OF KEY WGS EVENTS

2001

- Boeing is awarded a contract for initial development of WGS, then known as the Wideband Gapfiller Satellite system
- Preliminary Design Reviews are completed

2002

- U.S. Air Force authorizes production of the first two Block I satellites
- Critical Design Reviews are completed

2003

- Air Force authorizes production of the third Block I satellite
- Boeing completes spacecraft structures and begins unit integration

2004

- Boeing completes qualification on spacecraft component and subsystem, and flight software

2005

- Payload module integration testing of the first two satellites is completed
- First satellite is fully integrated, full-up system-level testing under way

2006

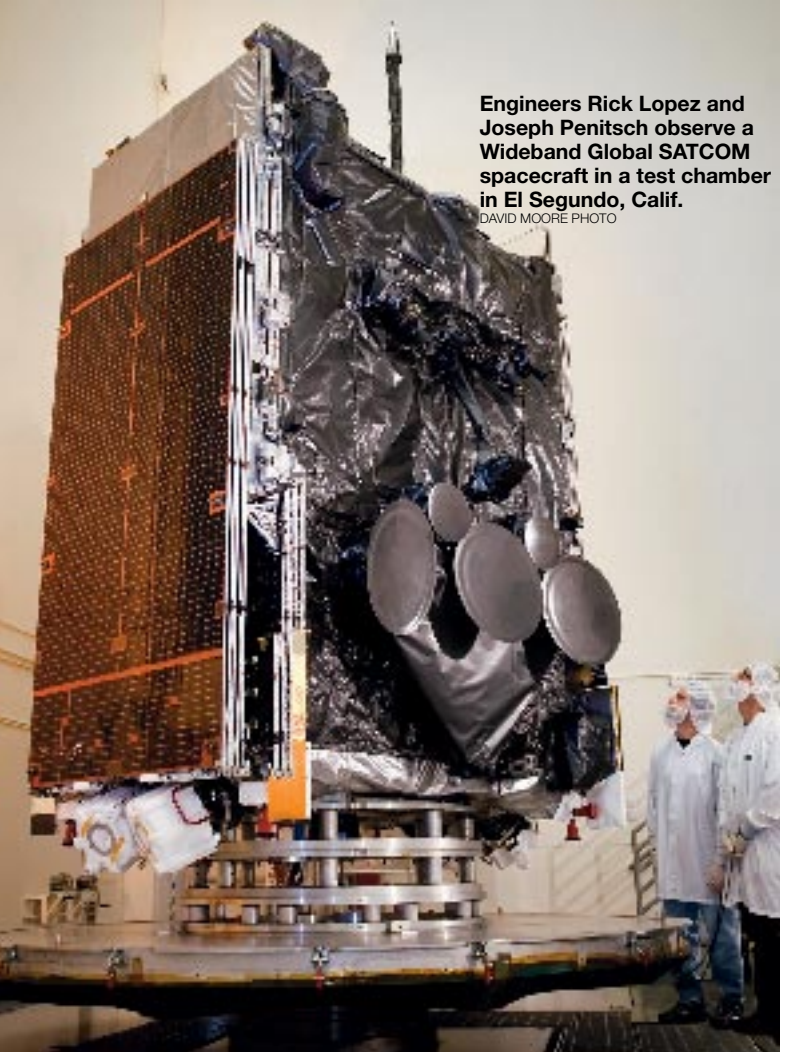
- Space-to-ground compatibility tests proving interoperability between WGS spacecraft and key ground control systems are completed
- Environmental testing is completed on the first WGS satellite
- Boeing and the Air Force sign a contract for up to three more WGS satellites
- Boeing receives authorization to build the fourth WGS satellite—the first Block II option to be exercised. Boeing also receives approval for long-lead material procurement for the fifth satellite

2007

- With WGS slated to meet the U.S. Defense Department's wideband satellite communications needs for the foreseeable future rather than act as a stopgap between heritage wideband systems and future satellite systems, the Air Force formally changes the name Wideband Gapfiller Satellite to Wideband Global SATCOM
- Boeing completes factory testing of the first WGS spacecraft in preparation for launch from Cape Canaveral, Fla. The second and third Block I satellites continue through Boeing Space and Intelligence Systems' factory in El Segundo, Calif., in anticipation of launches in 2008

BASED ON PAST SUCCESS

Because it's based on the highly successful Boeing 702 satellite product line, WGS benefits from prior commercial programs. For example, the WGS digital channelizer and phased array antenna architecture draws upon technologies used on such programs as Thuraya, which delivers mobile phone service to an area populated by more than two billion people, and Spaceway, which transmits high-definition television across North America. Some of the largest, most powerful and most complex commercial spacecraft in history bear the 702 stamp. More than 20 have been ordered, and 13 successfully launched, since its 1995 introduction.



Engineers Rick Lopez and Joseph Penitsch observe a Wideband Global SATCOM spacecraft in a test chamber in El Segundo, Calif.
DAVID MOORE PHOTO

And along with supporting WGS' high-power payload, the 702 can accommodate future payload growth to support evolving DOD communications requirements.

Getting a transformational program off the drawing board and into the factory is a major undertaking, and WGS was no exception for S&IS. Initiatives in mission assurance, Lean and supplier oversight and management over the last three years have borne fruit on both Block I and Block II.

"We have been relentless in the incorporation of Lean, and lessons learned, as we move through production," said Mark Spiwak, WGS Block I program manager. "These improvements are showing results on the second and third satellites and will also pave the way for improved performance on the Block II satellites."

For Block II, the emphasis has been on improving supplier management and oversight. "On Block I, we learned the importance of flowing adequate specifications, statements of work, and analysis requirements to our key suppliers and being actively engaged in their efforts," said John Weisinger, WGS Block II program manager. "We have leveraged best practices from Integrated Defense Systems to greatly improve the way we manage suppliers and give them better technical and programmatic oversight."

LOOKING AHEAD

Just as WGS builds upon predecessor systems, it will complement and strengthen key future programs, including the Transformational Satellite Communications System, a network-enabling military system for which S&IS is competing for a production contract (see Page 30 of the May 2007 *Boeing Frontiers*). While TSAT delivers secure, high-capacity global communications and network-centric capabilities, WGS emphasizes the quick dissemination of large amounts of data to warfighters with a growing need for bandwidth.

In the meantime, WGS is poised to take its place as the first transformational SATCOM system for the warfighter. Over the next 18 months, the first three satellites are scheduled to be launched and put into operation.

"The WGS team is very aware how WGS will help U.S. armed forces personnel around the world fight the global war on terror, and we take great pride in doing our part. We are proud of what WGS means to the end user," Spiwak said. ■

• Get to know some of the teammates on the WGS program. Pages 16-17

Reach for the sky

Here's a look at various military satellite programs.

Type	Name (first launch)	Principal characteristics and uses
Protected	MILSTAR I/II (1994/2001)	• Anti-jam capabilities provide low probability of interception and detection • Low data rates compared with later generations
	Advanced Extremely High Frequency (2008)	• Improved throughput • Improved coverage area
	Transformational Satellite Communications (2015)	• Wideband/protected communications on the move • Internet Protocol–based capabilities enabling greater capacity and point-to-point connectivity
Wideband	Defense Satellite Communications System Phase III (1982) and Ultra-High-Frequency Follow-On/Global Broadcast Service (1998)	• High data rates for tactical and enterprise users
	Wideband Global SATCOM (2007)	• Represents 10-times increase in capacity over DSCS • Enables "any-to-any" connectivity
Narrowband	Ultra-High-Frequency Follow-On (1993)	• Lightweight, mobile, communications on the move • Low data rates
	Mobile User Objective System (2010)	• Communications on the move to handheld devices

They're with the (W

Meet some of the WGS teammates

Boeing Frontiers asked teammates on the Wideband Global SATCOM program about their roles. Here are some of their responses.

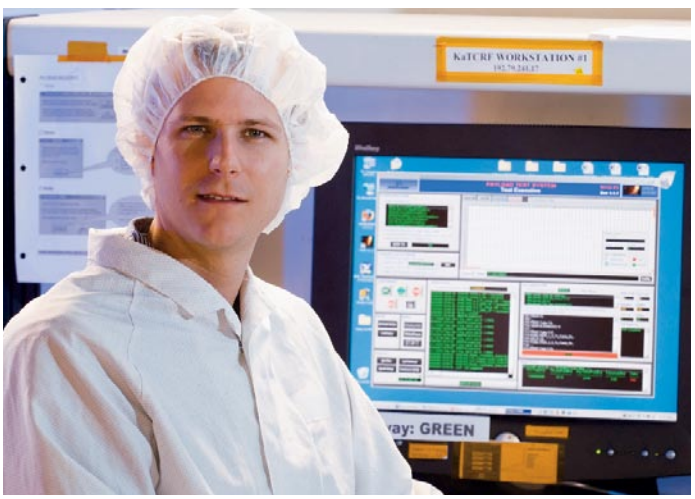
KIPP NOLDER

Years at Boeing: 6

Role on WGS: Payload system engineer. "I translate test definitions into actual tests to be run on the spacecraft, along with instructions for the test engineers. In many cases, it's my responsibility to explain the test results to the customer."

Customer reaction: "Twice I've visited Schriever Air Force Base [in Colorado] to help train people from the [U.S.] Air Force and Army in operating the WGS payload. They all told me they're really excited about getting the spacecraft."

DAVID MOORE PHOTO



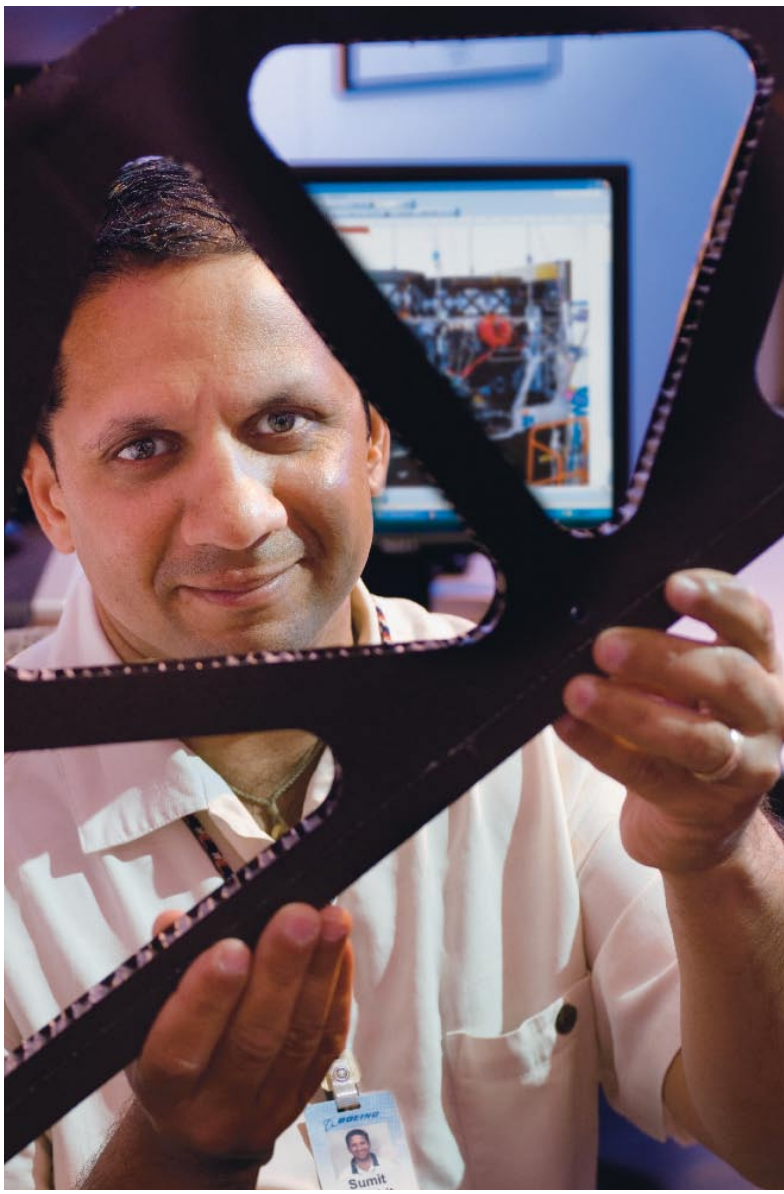
ANDY PITTMAN

Years at Boeing: 6

Role on WGS: Space segment system engineering lead for all three Block I spacecraft

WGS challenges: "Everyone has had to be extremely flexible to accommodate changing plans and requirements while maintaining quality. Also, we have to meet increased expectations of the government for a product initially developed for commercial applications."

DANA REIMER PHOTO



SUMIT PUROHIT

Years at Boeing: 6

Role on WGS: Integrated product team lead for the receive array antenna

Biggest challenge: "Getting the receive phased array antenna design effort caught up with the rest of the satellite. This involved many late nights."

What WGS means to me: "It's really satisfying to work on something that supports the military, particularly during a time of war."

DAVID MOORE PHOTO

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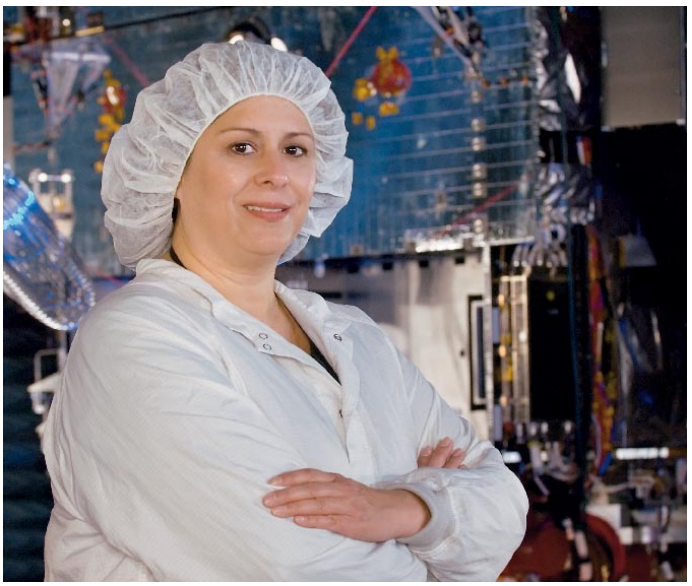


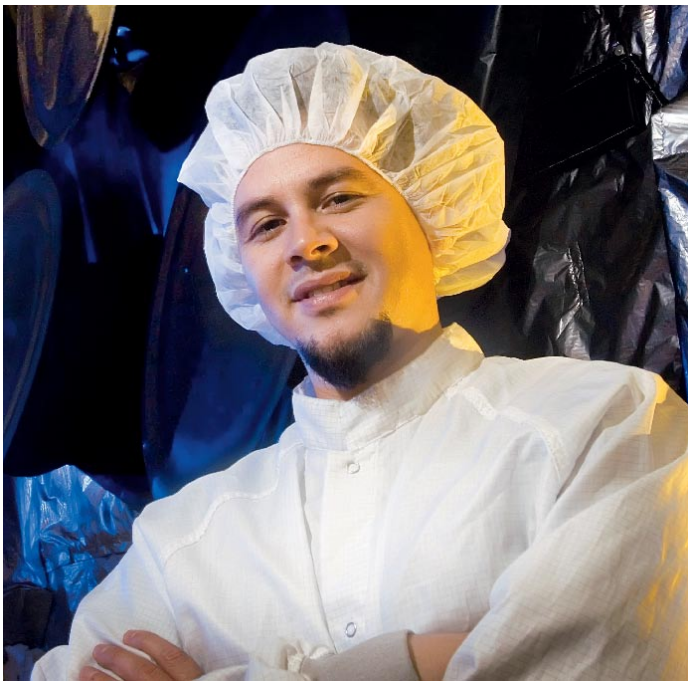
REGINA JIMINEZ

Years at Boeing: 13

Role on WGS: Spacecraft manager for the second spacecraft scheduled for launch

Most important attribute: Communication. "This is a diverse workforce, with many manufacturing disciplines. It's important to listen and understand people's issues or concerns and act promptly on resolving their issues."

DANA REIMER PHOTO



JESSE GOMEZ

Years at Boeing: 4

Role on WGS: Platform test director for the first spacecraft

What makes WGS different: "Because of WGS' enhanced capabilities, we had to develop a lot of first-of-a-kind tests that join typical 702 functions with unique WGS requirements. The complexity of the WGS spacecraft imposed many additional and unique requirements on the team."

Why WGS is important: "I have served in the military, and I have family members serving now. I feel a personal commitment to deliver a product of the highest quality that meets warfighters' needs."

DAVID MOORE PHOTO

ORLIE MENESES

Years at Boeing: 3.5

Role on WGS: Payload test engineer

WGS challenges: "Test engineers perform and troubleshoot tests 24 hours a day, seven days a week. How quickly we troubleshoot impacts the program's schedule."

Memorable moment: "One Halloween night, right before the end of a shift, the payload wasn't shutting down. After trying everything we knew, we got on the phone with our software engineer just as he was finishing trick-or-treating with his children. I didn't celebrate Halloween but felt glad that we solved a problem."

DAVID MOORE PHOTO