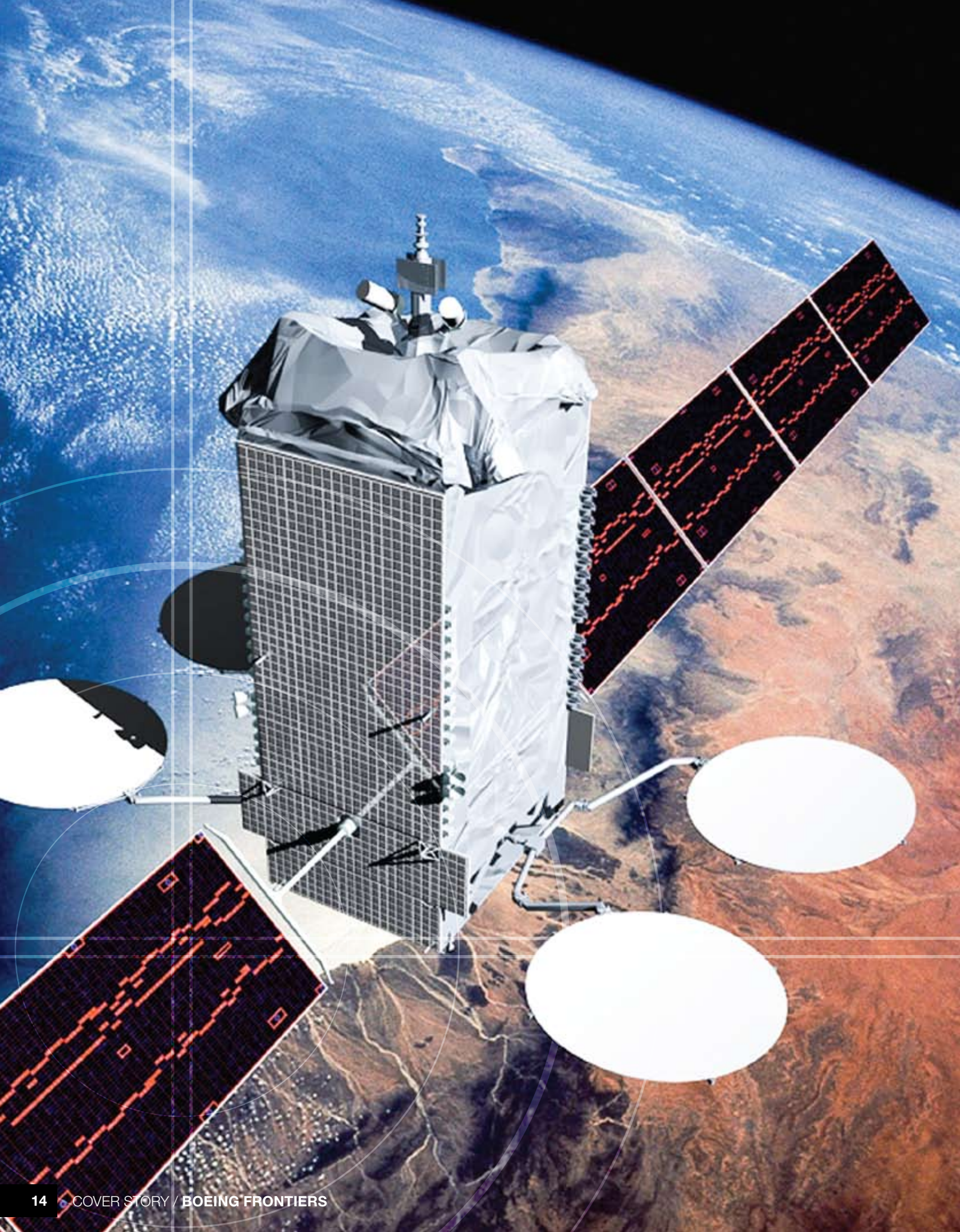

MAGIC BUS

702B aims for midsized satellite market with proven systems, adaptability

All stories by Dave Garlick

There are a few things that happen just once a decade: the U.S. census, the Great Lakes freezing over, the New York Mets going to the post-season—and Boeing Space and Intelligence Systems unveiling a new satellite model. In July, after four years of development, S&IS rolled out its 702B satellite. "I've been at Boeing for 36 years, and I've seen a new product line maybe three times," said Mike Neuman, 702B program director. In fact, the 702B debuted nearly 10 years after its older sibling, the larger, high-power 702, first launched in 1999.

Until July, S&IS' satellite strategy was to sell high-power 702s for large, complex programs such as DIRECTV, Wideband Global SATCOM (or WGS) and SkyTerra. The 702B concept grew from a satellite market study Boeing commissioned in 2004 showing a coming boom in medium-sized, medium-power satellites. Dozens of satellites built during the satellite heyday in the 1990s, many of them Boeing 601 models, were coming to the end of their useful lives and needed replacing.

Enter the Boeing 702B, designed to give satellite operators in the government and commercial worlds what they want most—choices. "We took the results of that market study and did an exhaustive study on future government requirements and used the composite of both to derive a set of requirements that drove the 702B design," said Andy Kopito, who led the 702B internal research and development design team. It may look new on the outside, but those familiar with a satellite's inner workings will recognize it as more evolution than revolution. "That's the key thing, we are not launching an entirely new bus," said Craig Cooning, S&IS vice president and general manager. "We're using flight-proven 702 technologies including flight software, avionics and the power management system."

The bus, which is the part of the satellite dedicated to navigation and propulsion, can be scaled up or down on the 702B according to what the customer needs. The satellite works in the medium-power range, 6 to 12 kilowatts—a measure of how much power the satellite can provide to its customers and their communications needs. For example, 12 kilowatts is equal to a very big light fixture holding 30 rows with 40 standard 100-watt light bulbs in each row. The biggest 702B can generate enough solar power to light all 1,200 bulbs. That's a lot of juice in a small package.

In a key sale, Intelsat and Boeing inked a deal in July for four 702Bs. "We were looking for a multi-satellite buy to introduce 702B," said Steve O'Neill, S&IS' vice president of commercial and civil programs. "Intelsat was the right customer at the right time." Intelsat Senior Vice President Ken Lee said his company based its choice on the 702's heritage. "We have done a lot of technical due diligence to make sure this spacecraft will have the highest reliability. All of the flight avionics have been flying for many years on the 702 platform."

Lee explained the 702B offers concepts and designs that match his company's changing requirements. As Intelsat diversifies its fleet, the satellite can accommodate different power needs and a wide variety of payloads. "It works out very nicely for us, and in the final analysis, we felt it is a very good value," added Lee.

S&IS is making an all-out effort to make 702B a success. "702B is our future and we have to get it right," O'Neill recently told his team.

That commitment shows up not only in the painstaking design and development of the spacecraft, Neuman said, but also in its people. S&IS staffed the program with some of its best, seasoned veterans. "Everyone on the 702B team has an average of a quarter-century of satellite experience," he said. "I really want to see Boeing become the leader in the commercial business again. This is personal for me because it is a very significant part of my life."

The first 702B is scheduled to launch in March 2012. ■

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"We are not launching an entirely new bus. We're using flight-proven 702 technologies including flight software, avionics and the power management system."

– Craig Cooning, Boeing vice president and general manager, Space and Intelligence Systems

GRAPHIC: The Boeing 702B targets the mainstream commercial satellite market with an affordable, scalable design. The propulsion tanks, for example, are available in six different sizes. JIM SANTONI/BOEING

BETTER BY DESIGN

Leveraging teamwork and technology to produce satellites faster, for less

The Boeing 702B satellite is designed to be manufactured. That sounds obvious, but you'd be surprised how many things these days aren't. As they created the 702B, Boeing engineers were thinking ahead about how to assemble and test it, and they designed features to make production faster. They were also thinking of the end-users: "We spent a lot of time talking to our government and commercial customers about their requirements and what they'd like to see in the Boeing 702B," said Andy Kopito, who led the 702B internal research and development design team. "We used that input to drive a lot of our design decisions."

This philosophy they adopted is called Design For Manufacturing And Test (DFMAT). "Planning how we are going to efficiently assemble the structure and propulsion systems and then test them was paramount in our minds because we wanted to make the 702B go through the factory faster and cheaper," said James G. Wilson III, 702B internal research and development project manager.

How did they do it? Teamwork and technology: 702B design engineers teamed with technicians, floor supervisors, production control specialists and nearly everyone else involved in building a spacecraft; engineers and technicians examined the 702B from all angles to find the quickest and most effective way to build and test it. "We let the production folks have a look at early designs," Wilson said. "We learned what things they liked and didn't like about previous designs and what, ultimately, they'd like to see for producability in our new designs."

The 702B was designed using powerful Delmia computer-aided design programs that didn't exist a decade ago when Boeing's last major satellite, the 702, first appeared. Wilson said the teams first built the spacecraft virtually, using a number of Delmia simulations. "We actually put Delmia 'virtual people' into assembly simulations and watched them work, to see if their wrists had to turn in awkward ways, for example."

The team applied the Lean and DFMAT concepts of avoiding bottlenecks in the production process wherever possible. The bottom line for any spacecraft design is fitting it into the fairing on top of the rocket. Naturally, design engineers try to compress all of the antennas and other components into small areas. But as Wilson points out, "At the end of the day, people have to go in and turn screws, so we needed to make sure we weren't doing gymnastics to try and put the parts together."

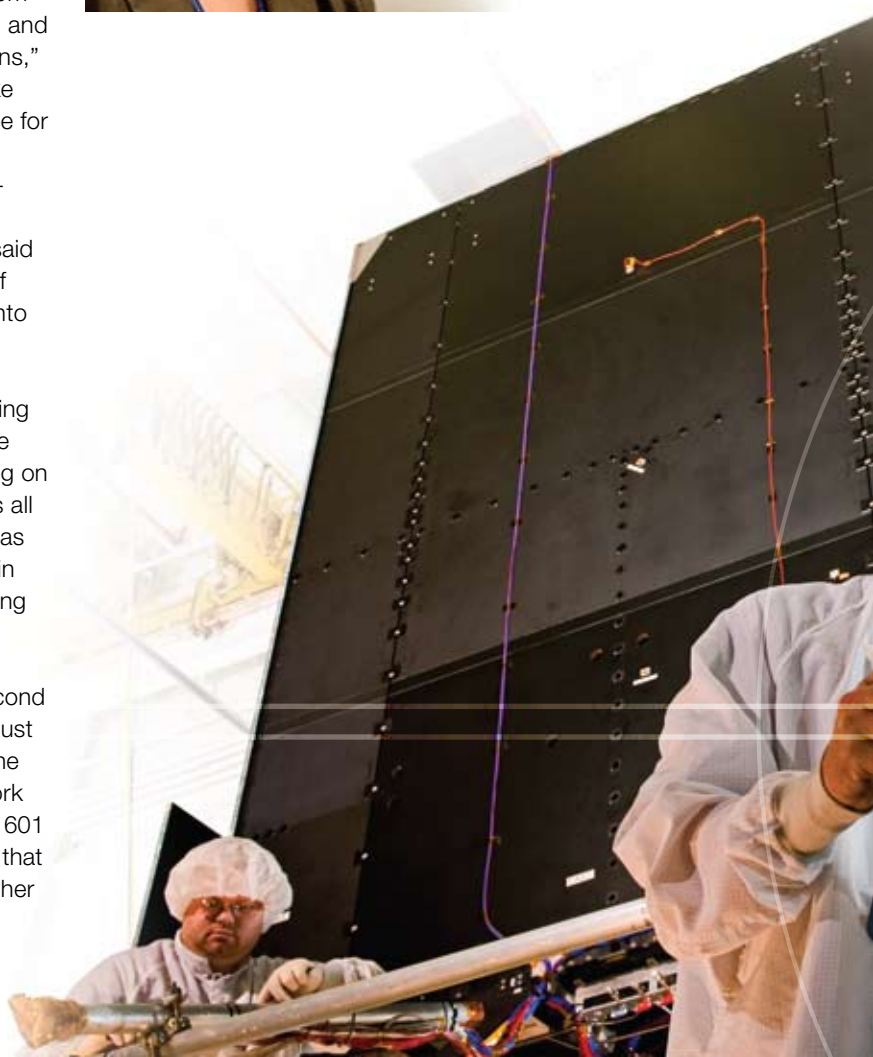
The first 702B satellite is under construction and will take about a year and a half to build and test. The goal for the second spacecraft is to complete it 20 to 40 percent quicker, taking just about a year, then to continue speeding up the process for the third and fourth satellites. Wilson said he's inspired by the work of the engineers who preceded him on the venerable Boeing 601 and 702 spacecraft. "I have a great deal of respect for those that came before me. Our advantage is, we can take it a step further with the simulations we can run today." ■

"I feel the 702B project was right in the 'wheelhouse' of my experience and capabilities, requiring me to apply nearly everything I'd learned in my career."

– Andy Mactavish, 702B chief propulsion engineer

"We built an online collaborative, communicative project management environment that reduced the amount of time and resources needed.

– Janie Warren, 702B/Intelsat project manager

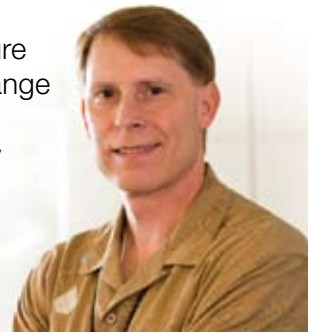


A GOOD HOST

702B can mix commercial and government payloads

"The scalable 702B architecture is designed to cover a wide range of capabilities ... If we did our job properly, this will be a very successful product line."

– Jim Smolko, 702B propulsion product team leader



"I had to make some sacrifices like working weekends and not spending as much time with my family... I wanted to see us get back to building 10–12 spacecraft a year."

– George Voulelikas, 702B system architect and chief engineer

PHOTO: (BELOW) Space simulation test senior technicians Todd Powell (background), Ken O'Connell (left) and George Brandos install and test accelerometers on the 702B to measure vibration.

ALL PHOTOS BY BOB FERGUSON/BOEING AND DANA REIMER/BOEING

The first Boeing 702B satellite to roll off the line for Intelsat will carry a Boeing-built Ultra High Frequency (UHF) hosted payload for the Australian Defence Force. A hosted payload is government-owned and -operated hardware riding on a commercial satellite. It is a way to get space-based capability launched sooner and at a lower cost than larger, more expensive government satellite programs.

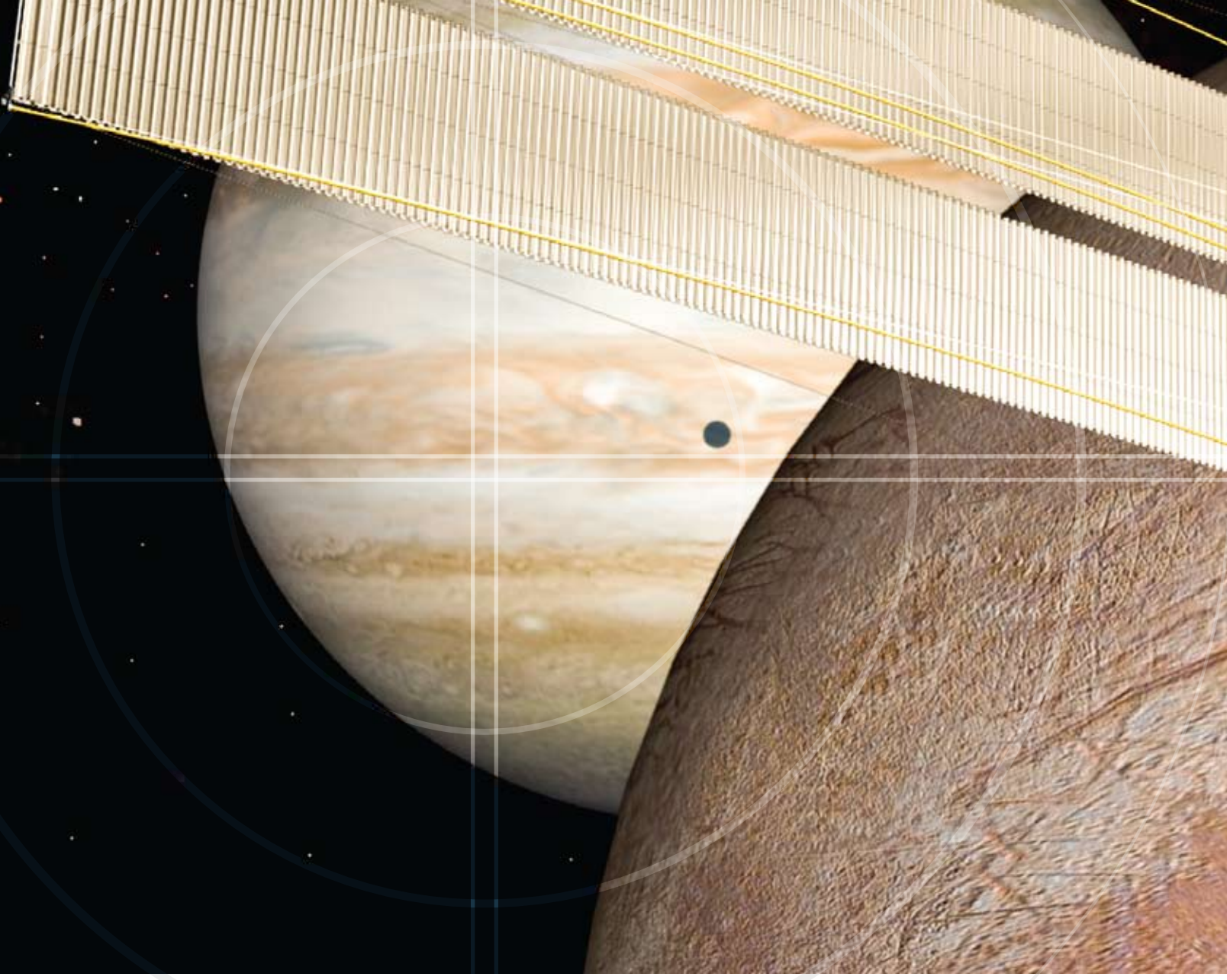
The idea isn't new; hosted payloads have long been popular in countries with limited military budgets. Both Japan and Brazil have launched hosted payloads, but the Australian deal "was visionary in terms of a commercial operator contracting with a foreign government for a U.S.-built UHF payload," said Jim Mitchell, director of commercial marketing for Boeing Space and Intelligence Systems.

Hosted payloads have not traditionally been part of the U.S. government satellite acquisition plan, which tended toward larger government-owned and -operated satellite fleets. But tighter budgets are forcing military planners to think about how to get capability in space for less. "We don't see as many new, large government programs starting up, so hosted payloads is an excellent growth area for our business," said Steve O'Neill, S&IS vice president of commercial and civil programs. O'Neill said Boeing has experience with UHF payloads dating back to 1993. That history proved to be a "strategic discriminator," an edge that helped seal the deal with Intelsat.

The arrival of the new Boeing 702B could not have been better timed. Tightening government budgets have put the spotlight on hosted payloads and 702B engineers designed accordingly, creating prime hosting real estate on top of the spacecraft. "There's an area of the spacecraft called the nadir face that is completely wide open," said Mike Neuman, 702B program director. "I think of it as a field of dreams—build it and they will come."

This Earth-facing patch is a prime location for the major types of hosted payloads; UHF communications equipment such as the Australian UHF payload; missile warning packages, which watch the Earth for the telltale heat signatures of missile launches; direct high-speed communication and data links with moving air or ground vehicles; or for space situational awareness, which is knowing where an adversary's spacecraft are at any time. "It is about flexibility," Mitchell said. "The satellite has real estate that accommodates any of the four major hosted payload classes, or if the commercial customer wants to put on extra capacity, they can do that too."

Hosted payloads also have the potential to become an important strategy to enhance space fleet survivability. Smaller payloads placed on many satellites and employed as a distributed system are less vulnerable to launch failures or foreign aggression than single, purpose-built satellites. ■



TO BOLDLY GO…

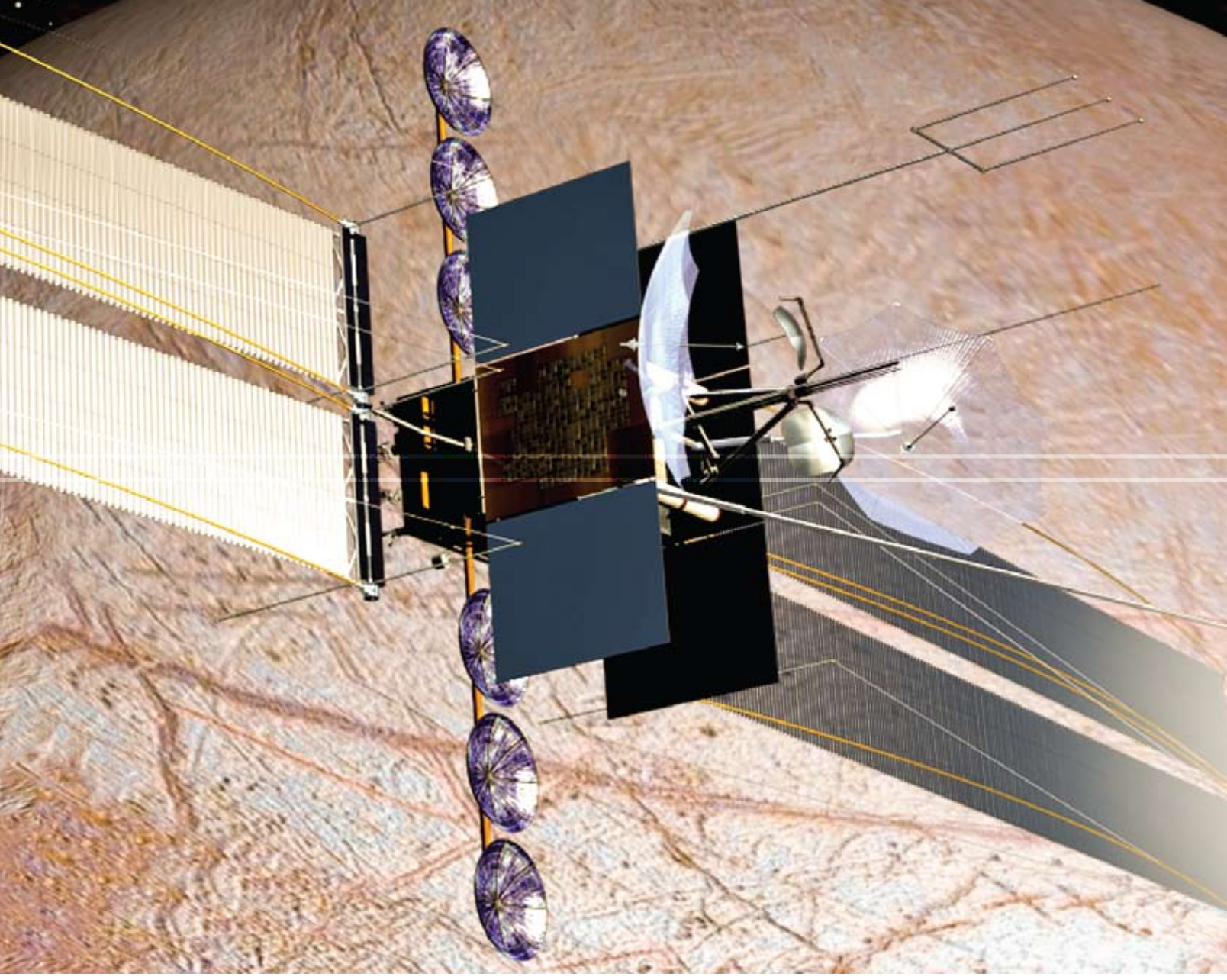
Adaptable 702B satellite has potential to conduct science, service and explore

The Boeing 702B could turn out to be one of the more multitalented spacecraft Space and Intelligence Systems has ever built. Designed as a medium-sized, medium-power geosynchronous satellite, it may one day be moonlighting as a planetary or Earth science spacecraft, if people like Mike Elsperman have their way.

As part of Boeing Phantom Works' Advanced Network and Space Systems, Elsperman is in charge of space science pursuits. He and his team think the 702B has "servicing" potential, meaning it could be used for refueling, repositioning or assembling other spacecraft on orbit. "The 702B could serve as the basic spacecraft and a derivative of Orbital Express flight software could provide autonomous guidance, navigation and flight control," Elsperman said. In 2007, Orbital Express, developed by a Boeing-led team for the Defense Advanced Research Projects Agency (DARPA), successfully performed fully autonomous servicing functions of a client spacecraft on orbit.

All that's tethering the 702B to Earth orbit now is that it hasn't launched yet. "Once it becomes flight-proven, we plan to offer it to the space science community and elsewhere," Elsperman said.

The 702B's older sibling, the more powerful 702, has no such issues. It has 16 missions under its belt and Phantom Works has been presenting it to NASA as a deep space science platform. One idea is a mission to Jupiter and its moons, using solar power. The 702 is equipped with a Xenon Ion Propulsion System, which is a low-thrust but extremely fuel-efficient engine. The more electrical



“We try to take advantage of the wide range of Boeing capabilities that can be applied to space missions.”

– Mike Elsperman, Boeing director of space science and advanced commercial space, Phantom Works

power sent to an ion engine, the greater the thrust. “The solar panels on a 702 can generate a lot of power,” Elsperman said. “Jupiter is greater than five times the distance of the Earth to the sun and currently requires nuclear power to get there, which has its own risks and challenges.”

Phantom Works’ Tom Kessler runs a program called the Fast Access Spacecraft Testbed (FAST), a DARPA program developing lightweight, compact spacecraft solar power systems. “Using FAST technology, we can fit a 30-kilowatt-power system onto the 702 or 702B, which is 50 percent more powerful and efficient than the largest solar array we have ever launched,” Kessler said.

Around November, NASA will announce its annual competition for new mission ideas for solar system exploration. It is looking for flight-proven yet affordable systems for missions to asteroids, comets and planets. Elsperman said his team still is working on the “communication satellite as space explorer” concept, but Boeing is determined to enter this competitive market. “We’re not ruling anything out as we try to take advantage of the wide range of Boeing capabilities that can be applied to space missions,” he said. “We have flight systems, mission operations expertise and an extremely talented team of people. We are pushing hard to get our foot in the door and show NASA that we can help it be successful.” ■

GRAPHIC: In this artist’s concept, Fast Access Spacecraft Testbed, or FAST, solar panels power a mission to Jupiter’s moon Europa, allowing use of fuel-efficient ion engines. JOHN RANKIN/BOEING

“The Boeing 702B gives us a visible edge, fulfilling a lot of commercial needs and military mission needs.”

– Craig Cooning, Boeing vice president and general manager, Space and Intelligence Systems

JOE ORSILLO/BOEING

ACCELERATING UNIVERSE

What the satellite business means to Boeing

In October 2000, Boeing announced it acquired Hughes Space & Communications Co. Hughes had a long history of crafting new spacecraft and communications technologies and making market breakthroughs. The deal made Boeing, which was already the largest aerospace company, the world’s largest commercial satellite provider and opened new frontiers in the satellite information and communications marketplace.

Fast forward to today. Space and Intelligence Systems is the heart of Boeing’s intelligence gathering services and government and commercial satellite programs. S&IS builds satellites and payloads for customers ranging from the U.S. Air Force to DIRECTV, NASA to SkyTerra and dozens of others. Today, well over one-third of the 279 commercial satellites in orbit were built by Boeing at its 1-million-square-foot (92,900-square-kilometer) satellite factory in El Segundo, Calif.

Recently, S&IS introduced its newest offering, the Boeing 702B, to the satellite industry with the announcement that the first four would go to Intelsat. *Boeing Frontiers* recently talked with Craig Cooning, S&IS vice president and general manager, about what the satellite business, and specifically the 702B, means to Boeing.

What impact can satellites have on Boeing’s bottom line?

S&IS is one of our pillars of customer support for the U.S. Air Force, allowing Boeing to build not only aircraft and radios but also satellites to tie them together. This gives our customers the one-stop-shopping capability they want and need.

Defense spending is decreasing. How will that affect the satellite business?

We are balancing this decline by seizing the opportunity to expand more in the commercial world. Boeing is the only satellite-maker active in both arenas. It is vitally important for us to have product offerings in both. Ten years ago, our business was predominantly commercial; today, approximately 80 percent comes from the government marketplace. Our unique ability to design satellites that serve both markets, and draw from each to the benefit of the other, is a key discriminator that helps us ensure a constant production flow in our satellite factory.

Is the Boeing 702B a brand-new satellite?

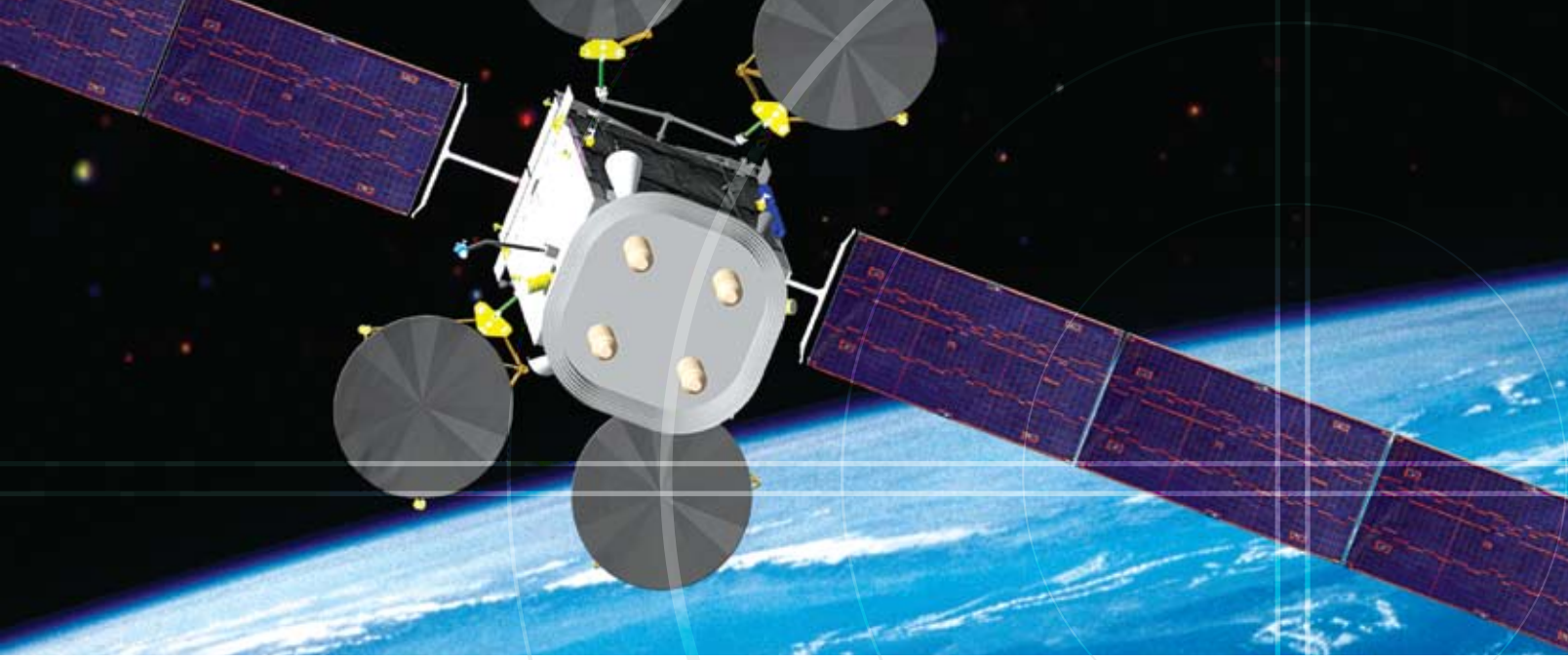
It’s an evolution of our current satellite, the 702. The Boeing 702B is designed to operate in middle-power ranges and enables us to provide satellites that meet mission requirements but don’t require the highest-power design. We’ve taken the best of the 702 and incorporated that proven technology into the 702B. It has opened doors to many opportunities in the commercial market. Our customers are very interested because 702B gives them alternatives. The satellite can accommodate different power needs and a wide variety of payloads.

Is the 702B and Intelsat contract Boeing’s re-entry into the commercial market?

I don’t believe we ever left. The significance of this contract is that it re-establishes us in the fixed satellite services and broadcast satellite services market. The Boeing 702B gives us a visible edge, fulfilling a lot of commercial needs and military mission needs. No other contractor can say that. What’s important to us is to promise what we’re going to deliver and deliver on our promises.

The first Boeing 702B has a hosted payload for the Australian Defence Forces. Do you see any U.S. interest in the concept?

The Air Force is considering expanding its military satellite assets to include hosted payloads, which means putting military equipment on commercial satellites. When you stop to consider the military’s soaring demand for communications services and the speed at which a payload can be added to a commercial satellite already under way, you can see the benefits of hosting. There’s no doubt that greater satellite capability can save lives. ■



LEAP OF CONFIDENCE

702B order continues Intelsat history of firsts

Intelsat's order for four Boeing 702B satellites makes it the first customer for the new satellite platform. Surprising? Hardly. Not when you're talking about a company that started with its first satellite, "Early Bird," or Intelsat 1, back in 1965. That satellite opened the door to commercial intercontinental voice, telegraph and television transmission via satellite and began Intelsat's 44-year relationship with Boeing.

Intelsat has been at the vanguard of the satellite communications industry ever since. Early Bird was brought back into service in 1969 to assist with the world's first global broadcast, the moon landing. Hundreds of millions of captivated viewers on six continents watched history being made, via Intelsat. In 1998, Intelsat provided the first satellite link to the Internet from Mount Everest.

Today, Intelsat owns and operates more than 50 satellites and seven teleports, connected by 28,000 miles (45,000 kilometers) of fiber, reaching 99 percent of the world's populated regions. Approximately one in every four TV channels carried over satellite goes through an Intelsat satellite, and it is the leading provider of commercial satellite services to the government sector, business, Internet and mobile network operators. Over the years, Boeing has built more than 20 satellites for Intelsat.

Intelsat did not reach its level of success by being timid. "We thought this was a win-win situation for both our companies," said Ken Lee, senior vice president of Intelsat, about the recent 702B procurement deal with Boeing. Indeed, in a landmark agreement, the first of the 702Bs will carry hosted communications equipment for the Australian Defence Force, as well as its commercial communications payload.

Lee said his company chose Boeing not only on price but also with an eye to the future. "Our intent is not just to buy spacecraft but to become partners in other ventures."

"I think the resources Boeing has put into 702B means they are doing the right thing," Lee said. "This is critical not just for our programs but for the next 10 years in the commercial arena. We did a lot of work upfront [and] we are willing to take some leaps, but at the end of the day, failure is not an option." ■

GRAPHIC: The first Boeing 702B built will be Intelsat's IS-22. It will carry Intelsat's commercial payload and a hosted Ultra High Frequency payload for the Australian military. 702B was designed specifically to carry both commercial payloads and government hosted payloads. JIM SANTONI/BOEING

"We thought this was a win-win situation for both our companies."

– Ken Lee, senior vice president of Intelsat

DAVE MOORE/BOEING

EVOLUTION OF THE BOEING 702B SATELLITE

Syncom

Launched in 1963, it was the first geosynchronous satellite. Syncom demonstrated the pioneering “spin stablized” concept, which was used by the majority of synchronous satellites until the advent of the Boeing 601 in the early 1990s.

Intelsat I ‘Early Bird’

Launched in 1965 for the newly formed International Telecommunications Satellite Organization INTELSAT, it was the first Boeing 303 model. Intelsat I inaugurated the concept of commercial intercontinental voice, telegraph and television via satellite.

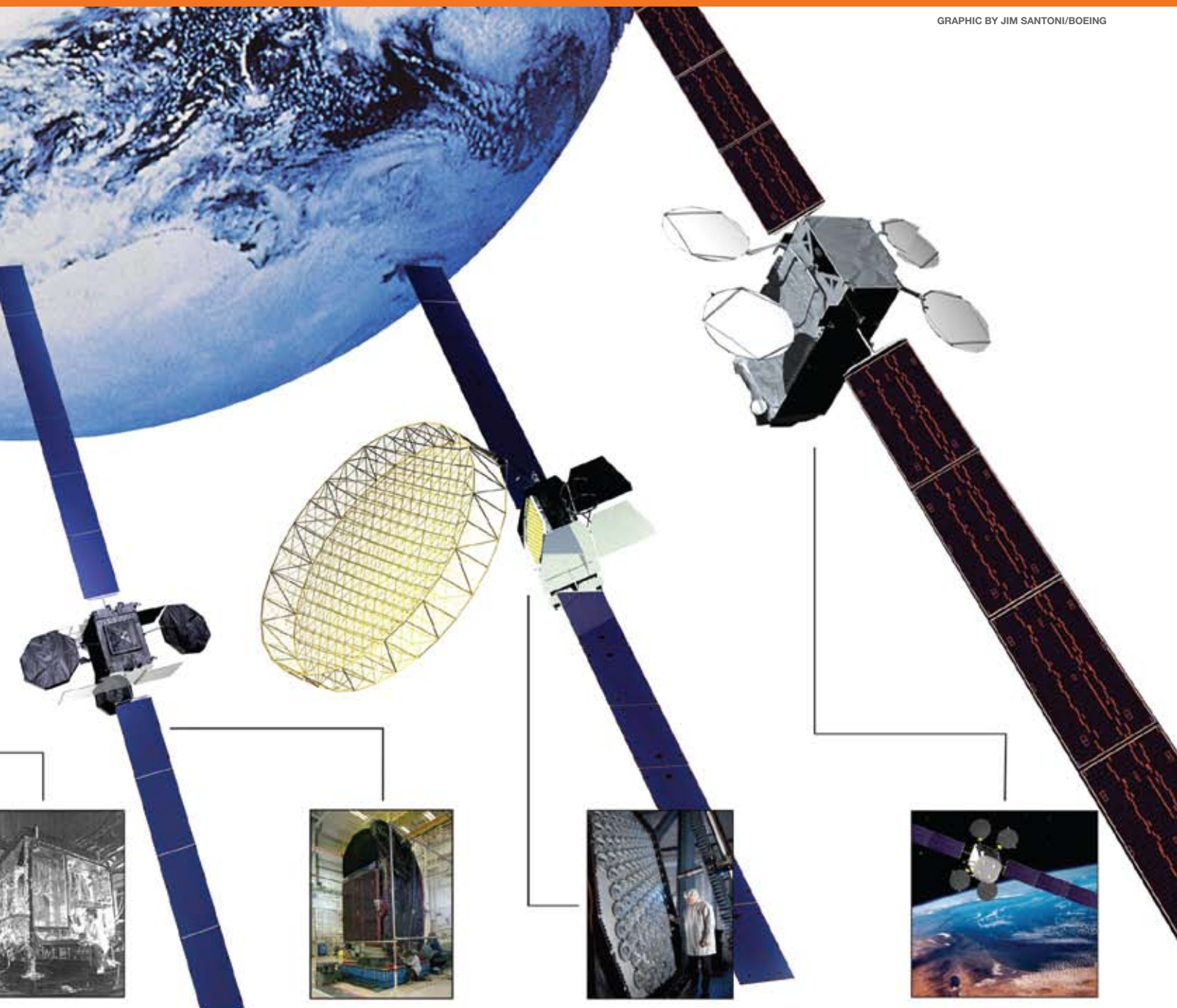
Anik A

Launched in 1972, it was the first of the new Boeing 333 spacecraft developed for the domestic use of individual nations. The large antenna produced a contoured beam, which concentrated the satellite’s signal within a nation’s borders.

SBS

Launched in 1981 for Satellite Business Systems, SBS was the first Boeing 376 series. Featuring a telescoping solar panel and folding antenna, it was compact enough to launch from the space shuttle’s cargo bay. It delivered telephone, teleconferencing, computer-to-computer and electronic mail services.

GRAPHIC BY JIM SANTONI/BOEING



Optus B

Launched in 1992 for Australia's national satellite communications company, it was the first of the new Boeing 601 body-stabilized satellites. Optus B could orient its solar wings toward the sun and generate up to three times the power of earlier satellites.

Galaxy

Launched in 1999, it was the first of the larger and more powerful 702 series and is an upgrade of the popular, proven 601. Built for PanAmSat Corp., it expanded video and telecommunications services to North America and Brazil.

Thuraya

Launched in 2000, for Thuraya Satellite Telecommunications Co. Ltd., it was the first Boeing Geomobile, or GEM, satellite. Based on the 702 model, Boeing built and delivered a complete turnkey system including three satellites, ground facilities and user handsets.

IS-22

To be launched in 2012, Boeing's 702B is the first of four spacecraft for Intelsat, the first customer. The satellite provides a flexible design to support payloads that range in power from 6 to 12 kilowatts, and can support a variety of hosted payloads.