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X-Band Advantage

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DOD LOOKS TO COMMERCIAL X-BAND SATELLITE COMMUNICATIONS TO SUPPLEMENT THE MILSATCOM FLEET.

As the U.S. defense and intelligence community have substantially increased their reliance on commercial satellite related services in recent years, the supply of commercial C- and Ku-band space segment has gone from plentiful to severely constrained. This has sparked new interest in commercial X-band and Ka-band coverage as a better approach to supplementing the MILSATCOM fleet.

"The global Ku- and C-band markets have become very expensive, and there is now substantial interference in those bands affecting our government customers. That is why CapRock started to look at X-band and Ka-band as viable options for meeting our customers' requirements," explained David Cavossa, vice president of operations at CapRock Government Solutions.

This prompted CapRock to sign a multi-year, multi-transponder agreement last December with commercial X-band provider XTAR. "That deal was the largest U.S. sale in commercial X-band,"



Notable Quote

"The truth of the matter is that you always know the right thing to do. The hard part is doing it."

~ Norman Schwarzkopf

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Cavossa explained. "In March, we announced that we had signed up customers from the intelligence community and from the Department of Defense. We've got additional customers in the pipeline who will start moving toward X-band this year or next."

The contracts referred to by Cavossa were multimillion-dollar agreements to provide more than 200 MHz of commercial X-band satellite services to two U.S. government agencies. The satellite services will utilize the XTAR-EUR and XTARLANT satellites, which are reserved exclusively for government and military applications.

The contracts represented two of the largest single awards of commercial X-band satellite services, and came just two months after CapRock's government solutions division unveiled the industry's first commercial X-band managed service offering. To support the missions of its government clients, the company has made significant investments in X-band teleport infrastructure and satellite capacity, signing a strategic agreement with XTAR that includes multiple transponders on its X-band fleet.

A number of factors have led DoD to increase its take-up of this SATCOM frequency, Cavossa said. "Until recently, X-band was considered too expensive. I've seen the price for Ku-band as high as \$8,000 per MHz, but X-band is more competitively priced. The supply rates on global Ku-band are in the high 80s or low 90s, so there is very little Ku-band available. With so many users packed into such a small amount of space, the price gets driven up and there is limited flexibility and availability."

X-band has a number of inherent advantages, noted Andrew Stanniland, business development director for Paradigm Secure Communications, which provides such services for NATO and recently began offering capability to the U.S. DoD. "X-band is very useful for a number of reasons," he said. "There are many X-band terminals out there, and once you have them you want to use them. They are also very expensive to buy compared to the nearest equivalents in the commercial world, which is an incentive for people not to switch frequencies unless they absolutely have to.

"Also, you don't have to retrain personnel because they have used the kit already. And because there are fewer X-band users around the world, even if you don't have a hardened military satellite, you get some level of protection just through the rarity of it, which is interesting to the military user," Stanniland added.

SATELLITE ALLIANCE

U.S.-based XTAR is one of two companies offering commercial FSS X-band to the U.S. government. It is owned by Loral Space and Communications and a Spanish company, HISDESAT, at a 56:44 ratio. Two satellites are in the constellation. One is owned by XTAR and the other is Spanish-owned, with XTAR owning an independent payload on it.

"As a commercial provider of X-band, we like to be thought of and to be treated like any other commercial provider, whether it is Ka, Ku, L, S or any other band," said Denis Curtin, XTAR chief operating officer. "We have coverage from Denver, east to Indonesia with dual coverage of Africa, Europe and the Middle East. We have excellent coverage of Afghanistan, Pakistan and those areas of interest today.

"We are providing services both to U.S. government departments, including DoD and other agencies, and a variety of ministries of defense and other government agencies in Europe. It shouldn't be any surprise that the majority of take-up has been within Southwest Asia and the Middle East, and we are now seeing take-up in support of endeavors within Africa," he added.

Expansion of coverage is constantly under review, which could allow XTAR users to use the service throughout the Pacific area. "Right now our inclination is to offer a hosted payload, as opposed to another owned satellite," said Bill Schmidt, the company's vice president of government services. "We think it gives us more flexibility to meet the individual needs of our customer."

All military government traffic has to have end-to-end encryption. In addressing military requirements for further protection for the service, Schmidt said, "The commercial satellite fleet may not be as robust as military communications in the sense of nuclear or EMI hardening, but the commercial operators are just as concerned about security and maintaining control of their security as is the government. XTAR has gone above and beyond, in that our control

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systems utilize the National Security Agency-approved, Caribou-level encryption scheme to ensure that those control links are more robust.”

A commercial network also provides security through diversity, Curtin explained. “It is very difficult to knock out a commercial system because there are so many. There are too many targets to take them all out. That diversity also gives you alternate resources, so if one satellite were taken, that traffic could be moved to another satellite. DoD feels this is a real advantage, and they have said that.”

Other XTAR satellite features have advanced to meet more demanding military requirements, notably use of the high power 72 MHz transponders offering double that typically found on commercial satellites, which allow the user community to transmit large amounts of data from relatively small terminals. Steerable spot beams on board also allow for even greater concentration of that power.

The U.S. Defense Information Systems Agency (DISA) and Department of State have their own Teleport site for XTAR use. XTAR is currently on the cusp of deciding on the location of two Teleport sites in Europe.

One near-term objective in the United States is inclusion in the Navy’s Commercial Broadband Satellite Program (CBSP), the replacement for the current Commercial Wideband Satellite Program (CWSP) contract. Through this, SPAWAR will procure commercial capacity and other services on an ID/IQ basis. The space segment comprises C, Ka and Ku SATCOM, but unlike CWSP, the new program will also include X-band as part of the solution.

“We view that as a very positive step and an acknowledgement that commercial X-band has a similar role to the other commercial bands in helping DoD, and in this case the Navy, meet mission requirements,” Schmidt said. “We are not submitting a response as a prime contractor, but we have provided support to all the prime teams that requested X-band. The Navy anticipates making an announcement soon.”

Looking to the future, Curtin believes government demand for an end-to-end managed service offering in which X-band will be used is growing. “We are working with a number of companies to establish that kind of service. We see it as a real value added to the user in the sense that the user can focus on their core mission and the communication provider will focus on what their mission is, and that is to provide these communications links when and where they are required.”

SKYNET CONSTELLATION

Paradigm is responsible for managing the Skynet 5 constellation, which has been used for several years by U.K. armed forces, several NATO allies and NATO itself. Earlier this year, it began supplying UHF and X-band bandwidth to DoD on a commercial basis. The six-satellite Skynet constellation (three Skynet 4 satellites and three Skynet 5 satellites) provides overlapping coverage that begins in the Midwest and extends eastward to cover Japan and most of Australia.

“We have X-band capacity for sale in all the military hotspots where people are currently deployed, and it is all NATO standard X-band,” said Stanniland. “Because of the way the U.S. and U.K. MILSATCOM systems have evolved, the U.S. doesn’t have anything quite like Skynet 5. U.S.-protected services are supported at EHF, and the workhorse for communications is the Wideband Global SATCOM (WGS) program.

“Skynet 5 is halfway between the two,” Stanniland continued. “It provides protected, survivable X-band for both protected communications and for high bandwidth communications. Although this has arisen because the U.K. doesn’t have access to its own EHF capacity, this means that the Skynet 5 X-band effectively sits within a very attractive ‘capability niche’ for the U.S. military user.

“Each of our 15 transponders (per satellite) is connected to a 160W amplifier,” he continued. “Since we deliberately built Skynet 5 with narrower bandwidth transponders than commercial satellites—20 MHz to 40 MHz—our power can be concentrated into a single transponder, which is ideal for users with small ground terminals.”

Stanniland explained other beneficial features of Skynet. "Operational flexibility is the most important attribute you can give to the military communicator, and this is most easily seen on a geographical basis. We can shape and steer all the uplink spot beams on each Skynet 5 satellite. We can use the same beam to generate up to seven hot spots within a single spot beam. That allows us to shape beams around a country or region. We can even shape the beam to the same size and shape as the coast of Africa.

"We can put a hot spot over Iraq and a hot spot over Afghanistan in the same beam but include no intervening countries," he continued. "Because of the way we designed Skynet 5 for the military operational requirement, we can switch the same channel to a different shape that does include intervening countries in a matter of minutes if it is preprogrammed ahead of time."

Skynet 5's X-band bandwidth is already being supplied through DISA via the DISN Satellite Transmission Services-Global (DSTS-G) program, under a multi-year contract that will run at least until 2011. (See *MIT, June 2009, page 9.*)

To meet U.S. demand, Paradigm has signed basic ordering arrangements, rather than partnering or distribution agreements, with a number of suppliers to the three DSTS-G primes.

"This means that when they need something quickly, they can fill out an order form without having to also spend the time needed to negotiate terms," Stanniland said. "That change has happened this year. Now they can go out and buy X-band from us, which they couldn't before. Today we roughly provide 150 MHz to the U.S. under DSTS-G, through agreements with Intelsat General and DRS Technologies, with options for more."

In addition to X-band, Paradigm has also supplied UHF from Skynet 5 to the U.S. Navy since the start of the year, also through IntelSat General.

GROUND SUPPORT

Using the available X-band bandwidth is dependent upon having terminals on the ground. L-3's Microwave Group (L-3 MG) and L-3 Communications Systems West (L-3 CSW) have been supplying the DoD terminals to support this frequency on an ongoing basis, and in most cases offering multi-band solutions.

"Focusing on the ground tactical SATCOM market, we have a number of products," explained Mark Rayner, vice president of business development for L-3 MG.

These include 0.45-meter and 0.5-m aperture communications on-the-move (COTM) antenna and terminal solutions, with L-3 Datron's FSS-4180LP and FSS-4180LC, and L-3 Linkabit's TRM-1000 terminal. In addition, there are the 3.9-m tactical SATCOM systems called Lightweight Medium Aperture Antenna (LMAA)—OE-593F.

The latter are generally used as hubs, deployed quickly to theater to provide backbone communications and operate in C, X, Ku and Ka. Apertures as small as 2.4 m can also be used in this role, and the Air Force has acquired such terminals in quad band under the Ground Multiband Terminal (GMT)-AN/TSC-179 program.

"These systems are all transit-case-based systems, unlike what you typically see with a HMMWV shelter-mounted 1.6-m or 2.4-m terminal, like the 'pop up' configuration for the quad band Phoenix terminals supplied by L-3 CSW and provided to the Army," Rayner said.

By opting for a transit case over trailer-based solutions, significant weight and volume savings are possible for shipping, Rayner noted. "We provide a system that is less than half the weight of the trailer-mounted 4.9-m Lightweight High Gain X-band Antenna, which is being used by the Army."

Opting for new or additional frequencies makes things more complex for terminal designers, Rayner said. "With Ku band, the highest frequency is 15 GHz. With Ka band, the highest frequency is 30 GHz, so Ka's beamwidth is half that of Ku. The result is that terminal designers face difficult design challenges to ensure antenna stiffness to reject wind distortion."

In contrast, on the X-band side, which is about half the frequency of Ku band, wind isn't as much of a problem. Instead, the frequency presents RF interference issues related to Passive Inter Modulation (PIM) performance, which impact the design of the reflectors and the feeder/RF electronics.

Quad band provides considerable flexibility, but not all users need all four bands nor want to pay the inevitable premium. To meet user requirements for a modular system that allows users to increase or reduce the number of bands covered, L-3 GCS recently introduced the Hawkeye III, a modular design to handle C, X, Ku and Ka independently or in combination.

"We have kept the same positioner and base structure, but offer different reflectors and amplifier sizes for different power outputs," Rayner said. "Someone could buy an X-band terminal right out of the chute but may not want Ka band. They could potentially buy the C-band and two years down the road, buy the extra pieces that would allow them to do X-band. It's a modular product line."

WIDEBAND GLOBAL

Despite the growing interest, commercial X-band is still more a support to the bulk of military X-band communications. That is the responsibility of the Air Force WGS program, which provides both X-band and Ka-band communications support to DoD.

The WGS constellation is designed to be backward compatible with existing X-band terminals that operate with the predecessor Defense Satellite Communications System (DSCS). Each of the new satellites has more than four times the X-band bandwidth as a DSCS III (1715 vs. 405 MHz) and also takes advantage of spatial frequency reuse to utilize the increased bandwidth. WGS X-band communications are provided primarily by transmit-and-receive phased arrays, with each array forming eight independent shapeable and steerable beams to enable high gain coverage.

The WGS program, for which Boeing is the prime contractor, is currently made up of two blocks of satellites. Block I consists of three satellites, including WGS-1, which was launched in 2007 and is currently supporting DoD communications in Pacific AOR. WGS-2 was launched in April 2009, completing in-orbit testing to verify functionality in June. It was turned over soon after to the government, which has begun testing to characterize payload from an operational perspective.

WGS-2 is planned to be moved over the Indian Ocean, where it will support communications for both Operation Enduring Freedom in Afghanistan and Operation Iraqi Freedom in Iraq. WGS-3 is in final preparations for launch, which is currently scheduled for September.

Block II WGS consists of a further three satellites. WGS-4 is in the integration and testing process, WGS-5 is beginning the integration of the payload portion of the satellite; and WGS-6 is building and delivering electronic units that go into the satellite.

There are some significant technical differences between the two blocks, such as Block II's use of two "bypass" channels at Ka-band, which are capable of supporting the higher data rate needs of airborne ISR platforms such as Global Hawk and Predator. DoD and the Air Force are currently considering extending the WGS program beyond the current six satellites. *

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