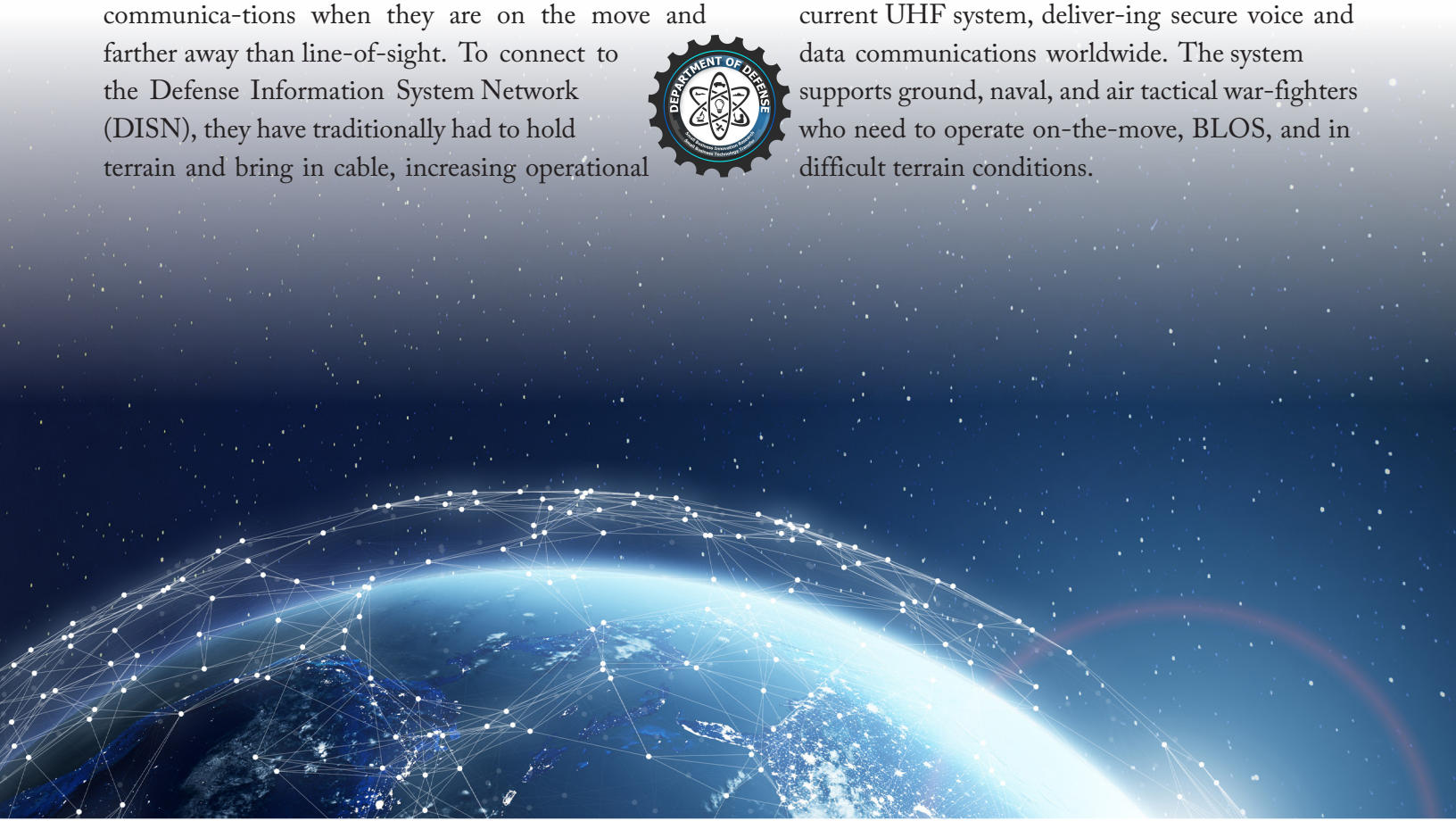
SKY'S THE LIMIT

SBIR-supported radio tech creates a new approach to satellite communications

Military satellites can be used for any number of essential purposes, from tracking military deployments and providing pictures of enemy capabilities, to the global positioning system (GPS) that directs troop movements and aids missile and drone guidance. But there is another type of military satellite that is equally important—the communications satellite (SATCOM). SATCOMs allow the military to maintain consistent communications in all environments and sit-uations, relaying intelligence and surveillance informa-tion so commanders can understand situations and act decisively. They provide beyond-line of-sight (BLOS) connectivity for mobile forces, transmitting real-time battlefield intelligence.

Warfighters often have difficulties in communica-tions when they are on the move and farther away than line-of-sight. To connect to the Defense Information System Network (DISN), they have traditionally had to hold terrain and bring in cable, increasing operational exposure. Legacy Ultra High Frequency (UHF) sat-ellites are slow, require a lot of power, have limited bandwidth, and are limited to line-of-sight. The current UHF satellites are also working past their designed life expectancy.

The next generation satellite communications system from the Department of Defense (DoD), with help from the DoD's Small Business Innovation Research (SBIR) program, will revolutionize DoD's SATCOM use. It's called the Mobile User Objective System (MUOS), and it adapts the architecture of a 3G cellular phone net-work and combines it with geosynchronous satellites (which effectively take the place of cell towers). The new MUOS system is designed to provide more than ten times the capacity of the current UHF system, deliver-ing secure voice and data communications worldwide. The system supports ground, naval, and air tactical war-fighters who need to operate on-the-move, BLOS, and in difficult terrain conditions.



When the DoD issued its initial SBIR solicitation, it was for a MUOS data link on a small satellite. Among other requirements, the radio needed to be software-defined, meaning that its operations could be remotely altered through software. (Unlike your cellphone, you can't easily trade in a radio on a satellite when technology changes.) Given the costs of wiring the radio to a satellite and putting it into space, the radio needed the ability to be updated remotely. The radio had to be light enough to launch into orbit, yet powerful enough to send and receive signals to the MUOS geosynchronous satellite constellation. Finally, the radio had to be smart, so it could detect and coordinate messages between users, and to be able to use a variety of specialized antenna systems.

Vulcan Wireless, a small company based in Carlsbad, California, was awarded the SBIR contract to make the radio the DoD needed. Building the radio, however, presented Vulcan with a number of challenges.

Commercial cell towers for terrestrial communications have a range of about five miles. The radio Vulcan was tasked with creating had to have a range of 23,000 miles to reach satellites in geostationary orbit. Vulcan put the radio software on a miniature processor and added filters and amplifiers to ensure the signal would also be resilient against jamming and interference. A signal travelling 23,000 miles can degrade along the way, so Vulcan also developed ways to make sure the signal would still be coherent when it reached its destination.

Some of this ground had already been covered, albeit in a different context. The Air Force has been using software-defined radios for a long time. A fighter pilot might need as many as 16 different radios, but only have physical room for eight, so radios with the ability to have multiple personalities were created. The radio the DoD asked Vulcan to create needed similar capabilities, but for an even greater number of radio personalities. The radio Vulcan created can be as many different types as needed. Today the radio can use the MUOS waveform, and tomorrow it can accommodate technologies that are not yet developed.

The MUOS satellites are geosynchronous, so they always stay above the same spot on Earth. If two users of the system who are on opposite sides of the globe need to communicate, they can send a message from the ground to the nearest satellite, then back to a ground station, back to the next nearest satellite, and so on until the message arrives. But it's expensive to get information from a satellite to the ground, and may be subject to additional atmospheric interference with each succeeding pass. A better method is to send the message up to the satellite, then to the next satellite, and so on, then ultimately down to the ground. The radio built by Vulcan Wireless determines which satellites to talk to in order to get the message down to the ground most efficiently.

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As a small business owner, the CEO of Vulcan Wireless, Kevin Lynaugh, encourages other small businesses to look for SBIR/STTR opportunities. "The SBIR program is an excellent way to support our men and women in the armed forces with innovative solutions that are not addressed by the commercial markets. There are so many opportunities available for the entrepreneur who wants to use their talents to solve these problems while building a company. The SBIR program has really been a challenging and rewarding program for us, and we are thankful that it is there. We went from our very first SBIR Phase 1 to providing communication solutions for a Lunar lander. We have truly taken our technology from the drawing board to the heavens above."

Modernization Priorities: Fully Networked Command, Control, and Communications (FNC3); 5G
SBIR Contract: FA9453-06-C-0062 • **Agency**: Air Force • **Topic**: AF05-034 Reconfigurable Electronics for Responsive Space Systems
SBIR Contract: FA9453-10-C-0193 • **Agency**: Air Force • **Topic**: AF093-070 Miniaturized Satellite Development for Responsive Space Missions
SBIR Contract: N66001-12-C-5210 • **Agency**: Navy • **Topic**: AF05-034 Reconfigurable Electronics for Responsive Space Systems
National Defense Strategy Pillar: Force Readiness and Lethality