

The Blackjack constellation program gains speed, raising the bar for space domain awareness ● ●

DARPA's LEO network continues its proliferation of satellites intended for its Blackjack constellation project for demonstration in 2021-22, establishing a dedicated network for government and military connectivity including the Pit Boss autonomous mission management system. The first two payloads are planned for rideshare in the summer of 2021, which will continue on to 2024, and likely beyond.

Laurence Russell, Assistant Editor, Global Military Communications

In 2018, the Defence Advanced Research Projects Agency (DARPA) awarded a series of multi-million-dollar contracts to various private groups to research the networking of satellite buses through LEO platforms. DARPA's intention with the investments was to make use of emergent LEO technology through the leveraging of private-sector manufacturers, benefiting from LEO's unique form factor and the speed of commercial pipelines.

The US Department of Defence (DoD) was eager to replace the old National Security Space (NSS) satellite infrastructure in GEO without spending the billions it would take to build for, and position at such a distance. By making use of a low-latency, orbital network mesh, facilitated by commercial off the shelf (CotS) components positioned in LEO, the DoD hoped to see a reliable defence communications hub for ISR data.

While initial talks on proliferated satellites and LEO networks at the Pentagon had procurement officers scratching their heads as to how such an ambitious project would be affordable, even

for the US military, the lowering cost of small satellites, which can now sit at around US\$15-20 million, besides the rideshare opportunities at LEO distances, made the project increasingly realistic.

Blue Canyon Technologies, recently acquired by Raytheon, was granted a US\$14.1 million contract in June of 2020 to develop a microsatellite bus. Later that December they validated their X-SAT Saturn-class bus design, the largest microsatellite bus they've ever developed, in December 2020 in support of Blackjack.

Daniel O'Dell, Program Manager, spoke to the speed of the timeline to the CDR: "This is truly a go-fast program. Blue Canyon works very fast, [the company is] building a commodity bus line, which is what DARPA is looking for. It's because of DARPA's willingness to work with us and let us produce our best effort in the time that we can truly go at breakneck speed." Blue Canyon are just one of many companies sitting on expensive contacts of various sizes to accommodate the Blackjack project.

Blackjack constellation

The Blackjack constellation should be available for demonstration by 2022, eliminating the need to individually replace and maintain singular satellite platforms, which represent significant targets to hypothetical threats. These satellites are intended to offer on-orbit processing, diverting the computing responsibility to the space domain, where physical tampering becomes near impossible. The use of LEO space allows for those advantages to leverage high throughput and low latency connections. While this of course covers a smaller area than GEO platforms, the use of a widely distributed, linked constellation mitigates the weakness.

"You need more satellites in LEO for regional or global

coverage,” explained Paul ‘Rusty’ Thomas, DARPA Blackjack Programme Manager. “But the same rocket can put two to three times as much mass into LEO as it can into GEO, and the LEO satellites are 10 to 25 times lower in mass. The lower unit size and mass also enable faster design and deployment cycles because the design/build complexity of a 200kg LEO satellite is so much lower.”

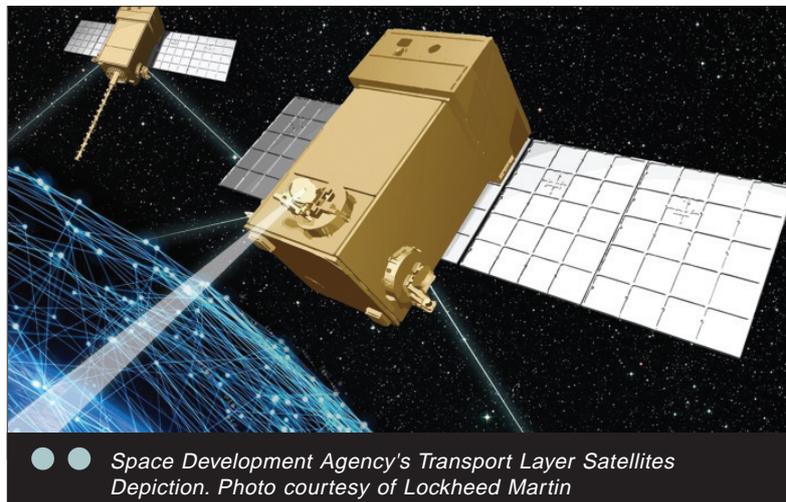
Blackjack was in part influenced by the raucous success of commercial LEO constellations and other NewSpace era breakthroughs. “Blackjack was founded on the concept of leveraging the commercial communications mega-constellations’ global datalink and the capability of their commoditised production line buses to produce a satellite a day,” Thomas explains. “Mega-constellations are in the early phases of showing these lower cost, and individual satellites can add up to highly capable global broadband networks.”

The Blackjack timeline shows its first demonstration with Mandrake 1, a cubesat fitted with supercomputer-level processing power. Mandrake 2 involves a pair of small satellites which will interface with one another via optical laser links in orbit, demonstrating the basis for an optical mesh network in LEO space. An ancillary project concerning risk reduction involves the Wildcard payload, a software-defined experiment linking LEO to tactical radio aiming to hybridise ground data delivery.

Unfortunately, on 4 January, Mandrake 1 and 2 were damaged at SpaceX’s launch processing facility at Cape Canaveral. According to an industry source, damage was caused when the payload separation system was accidentally released while they were being stacked. SpaceX has thus declined offers to comment on the incident. Derek Tournear, Director of the Space Development Agency (SDA) did take the time to clarify “the good news is, while [the Mandrake satellites] were damaged in payload processing, we will be able to repair them, and we will be able to launch them on Transporter-2.” Transporter-2 is expected to launch in June.

Orbital infrastructure

After aspects of Blackjack’s orbital infrastructure are addressed - projected for late 2021 and 2022 - the Pit Boss autonomous mission management system, supremely relegated to Raytheon, will take sharper priority. Pit Boss is designed to facilitate the collection, processing, and dissemination of critical information to tactical users across a satellite constellation. Raytheon Space Systems Director Mike Rokaw explains that: “Rather than



● ● Space Development Agency’s Transport Layer Satellites Depiction. Photo courtesy of Lockheed Martin

sending data down to a ground station for processing, which takes time we don’t have, Pit Boss will send data from space straight to the right operator at the right time.” This process will also be partly autonomous while using advanced encryption techniques.

Whilst clear plans aren’t in place, Raytheon insists the system is intended to be upscaled with artificial intelligence and machine learning (AI/ML) innovations. Rokaw adds: “Self-knowing satellites are the next step in autonomous space-based mission planning. This isn’t limited to missile warning and defence. Future constellation management systems will migrate to this type of methodology.” In space, maintenance and human input are a lot more complicated, and so the capacity to automate responses and processes is more important than in any other domain.

By 2024, DARPA and the SDA would like to see an additional 150 satellites launched for Blackjack, cementing it as the new standard for orbital ISR networking, and cornering the frontier of missile detection and tracking, though they’ll also be capable of watching the ground. SDA calls this expansion the Tranche 1 satellites, part of its seven-layer National Defence Space Architecture. These satellites will be capable of hypersonic glide vehicle (HGV) other advanced missile detection.

As cutting-edge missile proliferation continues among the global powers, suitably advanced detection will naturally be required to keep the world safe from the hypothetical threat.

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Brian Dolby
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