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Air Force works to refine IP routers for satellites

- By David Perera
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Military satellites using on-board IP routers to direct data traffic remain largely a dream even as the technology to send routers into space is more advanced than ever before.

The military originally had intended to launch its first nonexperimental router into space this year via the Transformational Communications Satellite (TSAT) program, but after years of accumulated delays, the future of that troubled project is uncertain.

Yet the basic technological modifications necessary for a terrestrial router to operate in space are minimal, said Creigh Gordon, a senior components group engineer within the space electronics branch of the Air Force Research Laboratory's space vehicles directorate.

"Obviously [the router] is not going to be conduction cooled by airflow running over it," he said. But beyond ensuring the router radiates its heat into space, "there's not a whole lot to it besides that," he added.

Using IP communication with an orbiting router would free up considerable amounts of bandwidth because today's satellite network architecture is a closed-circuit design – much like the copper-wire telephone network, said retired Army Lt. Gen. Steve Boutelle, a former Army chief information officer and now a vice president of Cisco System's global government solutions group. When signal information is digitized into packets, satellites with on-board routers can decouple the uplink and downlink frequencies, allowing dynamic spectrum allocation. Bandwidth consumption also is more efficient, Boutelle said.

Cisco is participating in a Strategic Command-sponsored Joint Capability Technology Demonstrations to launch a router into space by later this summer. The demonstration, dubbed Internet Routing In Space, will occupy a geostationary orbit that encompasses signal coverage of Africa and Central America, Boutelle said. IRIS will possess Ku- and C-band transponders with its signals receivable by the Army's Joint Network Node and the Marine Corps' Support Wide Area Network. (Army brass now officially calls the JNN Increment One of the Warfighter Information Network-Tactical program.) Most of the router components will be commercial-off-the-shelf, Boutelle added.

If the basics of sending routers into space are relatively straightforward, space can still

pose some unique challenges. Unlike a terrestrial router, there's no easy way to poke around inside the circuitry after it is in orbit. Should military planners want to replace the on-board modem, they would have to either have a Buck Rogers-like capability to capture satellites or the more realistic approach of using a Field Programmable Gate Array, a semiconductor that can be modified with software even after its deployment.

IRIS will indeed rely on FPGAs. But the state-of-the-art FPGAs generally require a triple-redundant design, Gordon said. That's because FPGAs that can be reprogrammed multiple times are subject to disruption by cosmic rays that pierce even the most effective of radiation shielding, Gordon said. (Cisco refused to specify the level of FPGA redundancy in IRIS, other than to acknowledge that it is sending up more than one such semiconductor.)

Triple redundancy ensures the router functions even during a cosmic ray event, but ideally FPGAs would not be subject at all to disruption. Designing such a chip is the goal of a four-year AFRL project now about two-and-a-half years complete.

"We end up making a more complicated FPGA at the transistor level, but at least you know that you have to only use of these FPGAs instead of three," said Ken Hunt, components group leader in the space electronics branch of the AFRL space vehicle directorate.

Hunt said AFRL anticipates producing engineering samples of a cosmic-ray proof FPGA by the end of this year.

Meanwhile, retired Col. Gary Payton, deputy under secretary of the Air Force for space programs, said Jan. 16 that the service will issue in April a final request for proposals for a restructured TSAT with an anticipated launch date in 2019.