Embedding data center compute capability at the tactical edge with open systems architectures

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At a high level, the vast majority of contemporary compute processing hardware may be divided into two domains: powerful data center processors and smaller, embedded devices. Embedded devices have the support of their data center big brothers via a network connection, giving them to access big data applications.

This approach works for many applications, but not all. Remotely accessed military tactical clouds require data center-like capabilities without data center support. This is achieved by embedding data center processors into military platforms using open system architectures (OSAs) and is ushering in next-generation military mission capabilities.

Contemporary OpenVPX (ANSI/VITA 65-2017) packaging, design and fabrication capabilities enable Intel scalable Xeon server-class devices from the same processor families that power the largest commercial clouds to be embedded into military applications. Miniaturization, protective packaging, efficient cooling, unrestricted I/O, and embedded system-wide security enable high-performance processing to be performed on military platforms remote from data centers. These enabling technologies include:

Miniaturization – To reduce a 19-inch rack server footprint to a small, defense-grade OpenVPX module requires a volume reduction of more than 90 percent, which can be achieved through miniaturization. This includes shrinking the vast amount of memory servers require into a smaller area. System memory is stacked as monolithic, multi-level entities that reduce the amount of circuit board real estate required by nearly 80 percent without degrading performance or reliability.

Rugged packaging – Scalable Xeon devices are intended for benign data center environments. Their thousands of I/O connections are made via land grid arrays (LGAs) that handle planar inequalities well. LGAs are cost-effective for data centers but unusable in defense applications due to shock and vibration (LGAs are not "hardwired"). Proven fabrication processes solder Xeon processors to their respective substrate/PCB for robust hardwired connections. This fabrication process uses military-grade tin/lead (SnPb) solder to mitigate gold embrittlement and reduce tin whiskers, both of which are found in commercial solders.

Cooling – Effective and efficient conduction (VITA 48.2), air (VITA 48.1, 48.5 & 48.7), liquid (VITA 48.4) and hybrid cooling technology are available for open system embedded processing. This cooling technology enables densely packaged Xeon processors to operate reliably at full throttle for unrestricted, sustained, deterministic processing. OpenVPX cooling technology removes heat to lower each device's temperature by several degrees to increase mean time between failures (MTBFs) and enables thermally dense devices, including Xeon processors to be deployed in small packages.

Unrestricted switch fabrics – As switch fabrics get faster and faster, modular open system compute architectures are facing bandwidth limits within their interconnects and backplanes. New OpenVPX transmission line fabrication technologies, guided by VITA 68.2, can enable full, unrestricted fabric performance (currently 40Gb/s) across the processing subsystems and temperature ranges. This technology is scalable, with a roadmap to 100Gb/s fabrics across OpenVPX systems.

Security – For foreign military sales (FMS) and deployment, military compute systems require the ability to counter nation-state reverse engineering through systems security engineering (SSE). This SSE should be built-in to enable turnkey or personalized security solutions to be quickly configured and evolve over time, building in future proofing.