

NEXT-GENERATION UAVS REQUIRE HIGH-PERFORMANCE END-TO-END CONNECTIVITY

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As the sophistication and capabilities of UAVs continue to evolve, engineers need to pay greater attention to end-to-end connectivity to avoid performance bottlenecks. Many UAVs are long-endurance platforms capable of sustained flight measured in days, loitering to perform surveillance and strike missions. In their surveillance role, UAVs may carry multiple cameras and sensors to deal with a variety of frequencies, from visible light to infrared and thermal. In addition to the spectral challenges, an important issue is creating cameras that overcome low resolution and narrow fields of view.

The ARGUS imaging system, for example, can spot a six-inch object within a ten-square-mile radius from 20,000 feet in the air. The ARGUS system uses 368 cameras and can capture, process, and download one million terabytes a day. Combining images from multiple cameras and other signal processing needs require fast embedded computers and sophisticated software. Because of the enormous amount of data generated by the sensors, an additional system challenge is separating the wheat from the chaff via onboard processing so that only critical data is transmitted to satellites or ground stations. Even if the ARGUS system can process one millions terabytes a day, the larger ISR infrastructure can't handle such loads, even with hefty data compression.

More Bandwidth

All of this means more bandwidth, not only inside the box but in box-to-box interconnections. One goal in system design is to create a transparent infrastructure giving integrators the ability to achieve a location-independent architecture. Location independence allows subsystems to be placed at optimal locations throughout the UAV.

Open architectures remain an important factor given their advantages of easier reconfiguration, ability to be upgraded, and the larger base of suppliers. Similarly, both in the overall network and in local data busses, industry-standard high-speed protocols, such as Ethernet, FireWire, or Fibre Channel, provide transparent physical layers for data transport.

VPX is the prevalent standard for embedded high-performance computing with a data rate that can exceed 6.25 Gb/s. The VPX ecosystem is rich, evolving to provide designers with an array of choices for single-ended and differential signals, mezzanine, power, optical, and RF connectivity. As VPX has evolved, new standards have been created to meet the widest range of interconnection needs. Figure 1 summarizes the main interconnections now available for VPX systems from TE Connectivity (TE) and shows a notional configuration of signal, RF, and optical possibilities on a single card edge.

Standard	Description	Connector
VITA 46	Base VPX Standard	MULTIGIG RT 2 Connectors
VITA 61	Mezzanine (XMC 2.0)	Mezalok Connectors
VITA 62	Power	MULTIBEAM XLE Connectors
VITA 66	Optical (MT, ARINC 801, Expanded Beam)	Multi-position Backplane Optical Modules
VITA 67	RF (SMPM)	Multi-position Backplane RF Modules

Figure 1. The VPX system has evolved in a rich and varied ecosystem (Source: TE Connectivity)

VPX connectors are robust and well suited to UAV applications, with the ecosystem continuing to evolve. As an example, the recently released MULTIGIG RT 2-R (VITA 46-compatible) connector from TE exceeds the original VPX environment of VITA 47, meeting the far more rigorous environmental requirements of the VITA 72 Study Group. With designer expectations for mechanical ruggedness largely met, system architects are now focusing more than ever on signal integrity. As mainstream protocols continue to move to higher data rates, VPX equipment is being characterized in parallel, paving the way for even greater functionality.

Even with the success of VPX as the most capable modern open architecture, some designers need to operate outside of standards due to a variety of packaging or application needs. Designers who want to move beyond the standards have a variety of capable interconnect solutions available to them. For example, TE's Fortis Zd connector supports 12 Gb/s data rates, features a form factor offering higher contact density in a smaller package, and provides extremely robust mechanical performance.

Input/Output and SWaP

To avoid performance bottlenecks, I/O connections need to keep pace with processors so that data is moved around quickly and efficiently. What's more, the number of interconnections is also increasing. Designers today have more choice in small circular connectors (Figure 2) that combine space and weight savings with the high-speed performance needed to meet growing data processing needs.



Figure 2. Small circular connectors support the high speeds needed for end-to-end connectivity (Source: TE Connectivity)

As I/O speeds increase, issues of signal integrity and power budgeting create new challenges. Simply put, high-speed signals are harder to manage than low-speed signals. The higher the interconnection speed, the more difficult it is to manage return loss, insertion loss, crosstalk, and similar factors that can degrade signals. While an ideal cabling system would have no intermediate connections between boxes, the real-world need for production breaks and modularity necessitates connectors in the path.

A poorly designed connector will appear as a significant impedance discontinuity. The impact of the discontinuity is frequency dependent—return loss and crosstalk increase with frequency—meaning that high-speed I/O connectors must be more carefully designed. Attenuation in the cable and insertion loss in the connector are also frequency dependent, making power budgets more challenging at high speeds.

Size, weight, and power (SWaP) issues remain tantamount to providing persistent surveillance, a better fuel-to-weight ratio, and the potential for smaller UAVs. While smaller, lighter connectors help meet SWaP goals, miniaturization can't be accomplished at the expense of signal integrity or robust ruggedness. Nanominiature and microminiature connectors already exist, but were not designed for high-speed signals.

To address this gap in fast copper connectivity, TE has recently introduced three families of CeeLok products capable of 10 Gb/s performance, each of which offers specific advantages to designers in performance and size.

CeeLok FAS-X connectors use an innovative method to maintain shield continuity through the connector. As a result, the connectors can be concatenated multiple times without degrading performance. The connector is somewhat larger than the other two discussed here, but has the highest signal integrity, while still offering field reparability. The connectors support a single 10G Ethernet channels in a size 11 shell or four channels in a size 25 shell.

CeeLok FAS-T connectors are smaller—an eight-position connector in a size 8 shell. The connector's T-shaped contact pattern provides noise cancellation and decoupling to minimize crosstalk and increase signal integrity. The backshell is integrated into the plug body to help provide low profile, low cost, low weight strain relief and EMI protection. The connector is field terminable and repairable.

CeeLok FAS-T Nano connectors use the same T-shaped contact pattern in a nanominiature size—plugs are only 0.3 inch in diameter, with a choice of push-on or threaded coupling. Unlike the larger CeeLok FAS-T connectors, the nano version is factory wired rather than field terminable. The connectors are based on the well-established NANONICS nanominiature connectors, but with an insert designed for high speeds.

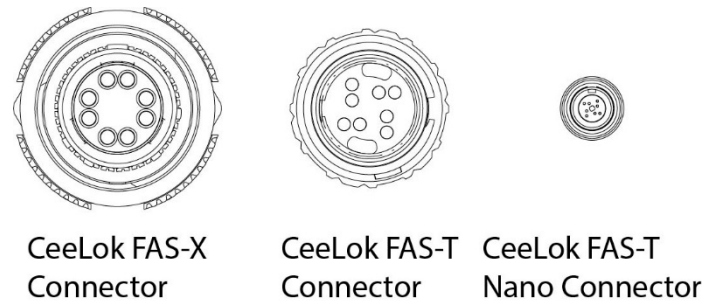


Figure 3. The 10-Gb/s CeeLok connector families give designers more choices in meeting SWaP goals (Source: TE Connectivity)

Even as high data rate copper-based connectivity is evolving, fiber-optic transmission is finding increased use. Creating location-independent architectures means different subsystems must not be constrained by cabling distances. Optical fibers have three primary advantages:

- 1. Long transmission distances.** Multimode fiber can carry today's data rates in UAVs without breaking out into a sweat. With single-mode fibers, bandwidth is virtually unlimited with respect to the distances encountered in a UAV. Bandwidth disappears as an interconnection issue.
- 2. Noise Immunity.** Optical fibers do not create EMI; nor are they susceptible to EMI. Issues like shielding, which are critical to maintaining signal integrity in copper interconnects, are eliminated.
- 3. Small Size and Light Weight.** Fiber-optic cables are smaller and lighter than copper cables, making significant contributions to the minimization of SWaP.

Fiber optics has also made strides in easier use, ruggedness, and choice. The VITA 66 standard, for example, offers a choice of ceramic ferrules for the highest level of optical performance, noncontacting expanded beam termini for increased ruggedness, and MT ferrules for high fiber counts. The same options are available for a variety of military-style circular and rectangular connectors.

Evolving into the Future

More sophisticated sensors, ever faster and more capable silicon, more sophisticated computer architectures and software—one clear future for UAV system is more bandwidth. Network backbones are already migrating from 1 Gb/s Ethernet to 10 Gb/s, with 40 and 100 Gb/s waiting in the wings. Streamlining designs with a goal of a common hardware set is also gaining ground. For example, designing interconnect to be compatible with a range of physical layer impedances, such as Fibre Channel, IEEE 1394, eSATA, and so forth, can not only simplify system design but can also reduce the number and types of cables and connectors that must be stocked. It will enhance the idea of modularity and easy plug-and-play connectivity.

While designers, in the end, will look for standardized high-performance systems and components, they still have choices when it comes to performance-based alternatives. Today's performance-based system may well become tomorrow's new standard.

Author's Bio



Gregory Powers serves as Market Development Manager for the Electronic Systems and Space segments within the Global Aerospace, Defense & Marine business unit of TE Connectivity. He received a BSME from Syracuse University, has completed numerous graduate-level studies, and holds two patents relative to optical datacom devices. Connect with Greg Powers at www.DesignSmarterFaster.com.

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