SPECIAL FEATURE

Boards and Rugged Boxes in UAV Payloads

Pre-Tested Box Solutions Accelerate UAV Payload Designs

Validated small form factor box-level systems are emerging as as high value design tools. For complex, space-constrained applications like UAV payloads these systems accelerate the path toward proof-of-concept.

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Literally hundreds of high performance computing systems may be fitted onto a single military aircraft or vehicle, defining a significant OEM opportunity even in the face of defense cutbacks. In particular, demand continues in UAVs for increased sensor capabilities combined with the ability to change or update sensor arrays based on specific mission profiles—further fueling the value of modular plug-and-play payloads that maximize combat capability, flexibility and efficiency. This puts the focus on the 'integrated system' including the network and payload along with processing, exploitation, and dissemination (PED), rather than the specific airframe itself.

Gone are the days where defense programs allow OEMs extended time and budget to design and develop individual or customized UAV applications. Application readiness is the new norm, coupled with high expectations for integrating advanced technologies that "just work".

High performance surveillance and situational awareness applications like full-motion video (FMV) are confirmed as one of the most urgent requests from the field. Small UAS are proving highly effective in delivering unmanned mission sets beyond the capabilities of MQ-1/9 and RQ-4—giving commanders and individual service members enhanced information so critically needed for today's complex operations.

Figure 1
COBALT is a highly scalable embedded computer system, sealed and validated IP67, available with a wide selection of processor, storage, power and interface options.

The demands from the front line are changing quickly, creating a growing need for validated small form factor box-level systems that can step in as high value design tools. These systems are the enabling rugged building block solutions that accelerate Proof-of-Concept (PoC) and development via a trusted COTS platform. In addition, new pre-tested systems based on Computer-on-Modules (COMs) now couple mezzanine modules with the carrier board to provide a modular approach that further streamlines development by allowing use and reuse of low power, reliable UAV designs. Packaged in highly ruggedized enclosures, these small form factor systems add significant value when partnered with processor upgradability.

Figure 2
The AiRES is an IP67 sealed switch family in a small form factor, low power design that offers 16x GbE ports with direct locking connectors. It's specifically designed and tested to operate reliably in the toughest extreme environmental conditions found in military UAV payloads.

Building Blocks and Mezzanines

Pre-validated COMs-based systems provide the small and rugged building blocks ideally suited to UAV design. Weighing less than a few pounds, they deliver efficient thermal management employing flexible and well-known COMs for the processing power at the heart of the platform. The system also includes a rugged carrier board, power module, and appropriate I/O connectors housed in a fully-enclosed, fanless system. Integrating mezzanine options with these systems allows developers to create new systems without significant modification to an original base design. Developers reduce resources and development timelines, capitalizing on the system's basic design as a foundation to build a specific system profile for their designated application.

A design methodology that leverages COM Express Type 6 pin-outs within the primary system reallocates legacy PCI pins for digital display interfaces and additional PCI Express lanes, enabling a path to future design options. Unused PCI Express lanes are then routed to serial-based mezzanine card slots such as mPCIe (mini PCIe) and XMC. The resulting expansion options support a performance jump in contrast to devices relying on earlier pin-out options.

The off-the-shelf, standards-based mPCIe mezzanine card illustrates the concept. Using an mPCIe card, designers can access specialized I/O such as video encoding, ARINC 429 or MIL-STD-1553 as well as more common wireless specifications like Wi-Fi, GSM or LTE. Embedding this type of functionality in the mezzanine card – rather than the custom-designed carrier board – assures a longer, more flexible product lifecycle.

Swapping out modules to access processor advancements allows system performance to evolve as needed. The latest Intel Atom E3800 processor on a Compact COMe provides high performance capability in a low Thermal Design Power (TDP) from 5W (single core) to 10W (quad core). The TDP is in contrast to a Core i7 COMe that can range from 20W to 45W.

Because it is standards based, there are common I/O signals from the Atom and Core i7 COMe modules that can be leveraged on a base platform such as USB 2.0, 3.0, GbE, SATA and video out. This allows for scaling the system as needed for lower or higher processing power performance, without the need to give up key I/O connectivity. This gives OEMs the ability to reuse proven designs in smaller systems, easily extending functionality while avoiding additional customization costs and development resources. Developers avoid design requalification, while the system's baseboard stack provides all required interconnects for the COM Express board and XMC and mPCIe interfaces.

Profiles Facilitate Integration

Design and development of UAV payload systems can be simplified further by working with a series of standard profiles available in pre-tested COMs-based systems, illustrated by those offered with Kontron's COBALT (Computer Brick ALTernative), a next generation high-performance embedded computer (Figure 1). A good way for developers to determine which standard profile offers an ideal base design is to first look at how to balance latencies and other requirements for overall signal processing speed. For example, low latency requirements may indicate a profile intended for dedicated video or data acquisition.

These systems are built to handle specific tasks through special algorithms, in contrast to a server profile which is simply designed for more generic processing performance. Server profiles may offer high performance data collection and storage, but overall performance is dependent on the limitations of their connected devices. In this scenario, transmitting analog data from a camera to an onboard network may require greater compression time in a situation where milliseconds matter.

As a result, developers will have to carefully consider design choices such as dedicated hardware solutions or network-based systems. By connecting several pre-validated systems based on different profiles—for example a situational awareness profile and a server profile—, developers can quickly address a larger set of performance requirements. With the addition of an XMC signaling card, the same systems can also be configured to act as sensors, ultimately networking the system back to the server profile. It is also essential that system engineers determine in advance the ideal base configuration for their specific application. There are trade-offs in using a carrier board rather than a backplane in pre-validated systems based on COMs, resulting in a limited number of mezzanine expansion slots.

Storage and Connectivity Options

Basic performance configurations include increased storage capabilities with either fixed or removable solid state drives, wireless connectivity options such as Wi-Fi, WiMAX or a 3G/4G modem, or additional network port connections via an L2/L3 GbE switch. For instance, opting for a pre-validated system that offers a storage-focused profile enables access to a variety of storage types and capacities. Systems can be more

Figure 3
Air Force UAV resources have shifted to focus on MQ-9 Reaper UAV procurement support based on its 600 percent higher payload capability compared to theMQ-1.

easily reconfigured and remain adaptable to military program requirements. This may provide an ideal base design for systems that require storage devices to be removed frequently in the field, or for secure systems that require removal of the device itself rather than transmitting network data.

A situational awareness profile may be an ideal base configuration for systems that require video capture, compression, storage and analytics. Systems based on COM Express already have an advantage in these applications, as the standard incorporates long-life video support natively within the chipset. If additional video cards are required by the application, they can be added via an XMC module—further assuring that video processing does not borrow performance from system CPUs. By adding a video encoder profile for video capture and suppression, this configuration quickly becomes a dedicated video or data acquisition system optimized for mission critical data gathering.

When required to connect and manage multiple systems and IP based devices, a fully managed L2/L3 Ethernet Switch like the Kontron AiRES product is a compact, low power solution highly suited to UAV payloads (Figure 2). Adding this hardware device creates a reliable switch-stacked profile, connecting sensors and devices such as IP cameras to a central server solution, and enabling developers to add applications on top of network server capabilities. This type of profile may provide an ideal foundation for high-speed signaling, image detection or sensor arrays such as biometric, thermal, motion or radar are found onboard vehicles or helicopters.

Simplifying Payload Development

Air Force UAV resources have shifted to focus on MQ-9 procurement support based on its 600 percent higher payload capability compared to theMQ-1 (Figure 3). The MQ-9's anticipated effectiveness gets a huge boost when combined with versatile and powerful Wide Area Airborne Surveillance (WAAS) sensors. With more reliance on theMQ-9 Reaper, Combat Air Patrols (CAPs) are expected to increase in effectiveness by more than 1,200 percent initially, and are calculated to provide an eventual 6,000 percent improvement over the MQ-1 Predator.

In these, as well as smaller airframes such as Wasp III, RQ-11 Raven and Scan Eagle, developers must respond to continually increasing demand for functionality and performance – even as airframe space becomes smaller, and tightly constrained with no option to expand system footprint. COMs-based small form factor platforms are answering the need as modular, flexible systems that focus on integrated features, advanced functionality and payload processing rather than the airframe itself.

The availability of established performance profiles keep OEM resources in check, offering a starting point for high performance designs and a fast path to PoC and prototype development. Traditional backplane-based systems are often too large to be competitive in some unmanned environments; a smaller overall footprint can be achieved with a module-approach that also provides a design path for inevitable upgrades in payload computing. Tested, pre-integrated and application ready, COMs-based systems deliver the performance demanded by UAV designs today and remain flexible enough to improve future payload performance when enhancements are eventually called for in the same physical space.

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