EXCLUSIVE: PACKAGING CONSIDERATIONS FOR SMALL FORM FACTOR BOARDS PG. 14

PC/104 and small form factors

THE JOURNAL of MODULAR EMBEDDED DESIGN

@sff_mag

SUMMER 2014
VOLUME 18 NUMBER 2

WWW.SMALLFORMFACTORS.COM

SBCs: PC/104 USE IN UNMANNED AIRCRAFT

PG. 10

» PROCESSOR ARCHITECTURES

WHERE ART THOU, POWERPC?

PG. 18

PC/104 and small form factors — OpenSystems media

PC/104 and Small Form Factors Editorial/Production Staff

John McHale, Editorial Director
jmchale@opensystemsmedia.com

Lisa Daigle, Assistant Managing Editor
ldaigle@opensystemsmedia.com

Brandon Lewis, Assistant Managing Editor
blewis@opensystemsmedia.com

Steph Sweet, Creative Director
ssweet@opensystemsmedia.com

Sales Group

Tom Varcie
Senior Account Manager
tvarcie@opensystemsmedia.com

Rebecca Barker
Strategic Account Manager
rbarker@opensystemsmedia.com

Eric Henry, Strategic Account Manager
ehenry@opensystemsmedia.com

Ann Jesse, Strategic Account Manager
ajesse@opensystemsmedia.com

Susan MacLeod, Strategic Account Manager
smacleod@opensystemsmedia.com

Kathleen Wackowski, Strategic Account Manager
kwackowski@opensystemsmedia.com

Christine Long
Vice President
clong@opensystemsmedia.com

Asia-Pacific Sales
Elvi Lee
Account Manager
elvi@aceforum.com.tw

Regional Sales Managers
Barbara Quinlan, Southwest
bquinlan@opensystemsmedia.com

Denis Seger, Southern California
dseger@opensystemsmedia.com

Sydele Starr, Northern California
sstarr@opensystemsmedia.com

EMEA Sales
Gerry Rhoades-Brown
gerry.rhoadesbrown@husonmedia.com

Reprints and PDFs

republish@opensystemsmedia.com

OpenSystems Media Editorial/Production Staff

Embedded Computing Design | Military Embedded Systems | DSP-FPGA.com | Industrial Embedded Systems | PC/104 and small form factors | PICMG Systems & Technology | VITA Technologies

John McHale
Editorial Director
Military Embedded Systems
PICMG Systems & Technology
jmchale@opensystemsmedia.com

Jerry Gipper
Editorial Director
VITA Technologies
jgipper@opensystemsmedia.com

Curt Schwaderer
Editorial Director
Embedded Computing Design
cschwaderer@opensystemsmedia.com

Joe Pavlat
Editorial Director
PICMG Systems & Technology
jpavlat@opensystemsmedia.com

Brandon Lewis
Assistant Managing Editor
Embedded Computing Design
PICMG Systems & Technology
Industrial Embedded Systems
blewis@opensystemsmedia.com

Lisa Daigle, Assistant Managing Editor
Military Embedded Systems
ldaigle@opensystemsmedia.com

Amanda Harvey, Assistant Editor
VITA Technologies
Military Embedded Systems
aharvey@opensystemsmedia.com

Monique DeVoe, Managing Editor
Embedded Computing Design
DSP-FPGA.com
mdevoe@opensystemsmedia.com

Sally Cole, Senior Editor
Military Embedded Systems
scole@opensystemsmedia.com

Konrad Witte
Senior Web Developer

Steph Sweet, Creative Director

David Diomede, Creative Services Director

Joann Toth, Senior Designer

Jake Rojas, Graphic Designer

Corporate

Patrick Hopper, Publisher
phopper@opensystemsmedia.com

Karen Layman, Business Manager

30233 Jefferson
St. Clair Shores, MI 48082
Tel: 586-415-6500

www.opensystemsmedia.com

Rosemary Kristoff, President
rkristoff@opensystemsmedia.com

Wayne Kristoff, CTO

Emily Verhoeks, Financial Assistant

16626 E. Avenue of the Fountains, Ste. 201
Fountain Hills, AZ 85268
Tel: 480-967-5581

Subscriptions

www.opensystemsmedia.com/subscriptions

Tel: 586-415-6500
subscriptions@opensystemsmedia.com

small MATTERS

By John McHale, Editorial Contributor

Military UAS market ideal for PC/104 & SFF designs

Unmanned Aircraft Systems (UASs) are typically smaller than manned aircraft, and as a result often have stricter Size, Weight, and Power (SWaP) requirements in their avionics, sensor payloads, and other systems. The lower SWaP requirements – combined with a push toward open architectures and commonality resulting from cuts in Department of Defense (DoD) funding – make the military UAS market a perfect fit for PC/104 and other Small Form Factor (SFF) suppliers.

"PC/104 technology is used across unmanned aircraft platforms including command and control, ground stations, and payloads," says Stephen St. Amant, Director of Marketing at RTD Embedded Technologies, Inc. (State College, Pa.) "RTD has been serving the unmanned systems market for many years and we see PC/104 use only growing in this sector. It is a perfect match of technology to an application because it sits in that spot between [Commercial-Off-the-Shelf] COTS and custom.

PC/104 and SFF products are used in a variety of UAS applications, says G.T. Hilliard, Applications Engineer at WinSystems (Arlington, Texas). Some integrators use the technology for computing-intensive applications such as video processing, while other lower-end applications take advantage of the low power of Atom processors on SFF designs, he adds.

"While it's available off-the-shelf, PC/104 is also flexible and scalable due to its stackable and modular nature, giving UAV integrators multiple configuration options depending on their requirements," St. Amant says. "PC/104's SWaP advantages also make the technology attractive for military SWaP-constrained UAS platforms."

A DoD report, titled "Unmanned Systems Integrated Roadmap" – which adds a C to SWaP, not for cost but for cooling – states that the DoD wants to "reduce the size, weight, and power consumption of military platforms, as does the consumer electronics business, because large SWaP-C impedes mobility and raises maneuvering costs." According to the report, "miniaturization generally enables smaller systems and, when combined with more persistence, often minimizes investment," weight, and power consumption. The report, a 25-year roadmap for unmanned systems, can be read at http://www.defense.gov/pubs/DOD-USRM-2013.pdf.

The report also foresees the trend toward modularity in payload designs continuing thanks to open standards, because modularity "allows plug-and-play capabilities in joint and combined architectures," making upgrades easier.

Recent budget cuts have forced a drive toward commonality across DoD platforms; this roadmap confirms that trend, calling for more use of "open standards and interface definitions" to mitigate interoperability challenges with "unmanned systems communication infrastructures." The report says enforcement of open standards and "government-owned data rights will promote the leveraging of common components and facilitate reuse among heterogeneous unmanned system platforms."

In other words, suppliers that produce COTS hardware and software are well-positioned to weather the current economic challenges in the military market, and even thrive in the long run, as embedded signal processing and open architecture-based computing solutions will likely dominate unmanned system Intelligence, Surveillance, and Reconnaissance (ISR) payload development.

While the current military unmanned systems market is a bit flat and should remain so for the near future from a platform level, the DoD will still be spending money to sustain and upgrade these current platforms and their sensor payloads, which means more opportunities for PC/104, SFF, and other COTS suppliers.

"We can have platforms for 10 to 15 years and upgrade the sensors, communications, and weapons systems to meet the standoff detection and ISR requirements and then focus on meantime between replacement for system elements such as communications, EO/IR, and others," said Ron Stearns, Research Director at G2 Solutions (Kirkland, Wash.), in the fall issue of Military Embedded Systems. "It is a flat market and if flat is the new up, then there is sustainability from a DoD perspective. If you bend metal and make airplanes, it is going to be a tough road; but if you make command-and-control technology, flight controls, communication technology, and sensors, and the business model continues to open up, it could be a time of opportunity for you. The need for ISR is not going away. Even as CENTCOM winds down, ISR missions will be needed in AFRICOM and USPACOM after that."

While military programs, and DoD ones especially, dominate unmanned system use and development today, that will probably not be the case 25 years from now. Commercial applications, as well as civilian and consumer use of unmanned technology, will eventually surpass that of the military. The roadmap authors say that commercial use of unmanned systems will be good news for U.S. taxpayers because increased commercial use of unmanned system technology could "reduce the price point of these systems for the military." All of this is good news for PC/104 and SFF suppliers.

www.smallformfactors.com
www.pc104online.com

PC/104 and small form factors

THE JOURNAL of MODULAR EMBEDDED DESIGN

Volume 18 • Number 2

ON THE COVER:
A U.S. Air Force MQ-1 Predator Unmanned Aerial Vehicle (UAV) assigned to the California Air National Guard's 163rd Reconnaissance Wing undergoes a post-flight inspection at the Southern California Logistics Airport in Victorville, Calif. U.S. Air Force photo by Tech. Sgt. Effrain Lopez.

Features

Columns

Web Resources

Subscribe to the magazine or E-letter
http://opensystemsmedia.com/subscriptions
Live industry news • Submit new products
http://submit.opensystemsmedia.com

White papers:
Read: http://whitepapers.opensystemsmedia.com
Submit: http://submit.opensystemsmedia.com

Advertiser Index

Published by: OpenSystems media

ISSN: Print 1096-9764, ISSN Online 1550-0373

LinkedIn: PC/104 and Small Form Factors
www.linkedin.com/groups?gid=1854269

@sff_mag

AMD

What you don't see
IS AS IMPRESSIVE AS
WHAT YOU DO

Technology with a human touch.

We are more than just the chips that power embedded devices. AMD Embedded Solutions are virtually everywhere, underlying a landscape of technology that enables users to interact with the world in revolutionary ways, empowering embedded designers to bring the next generation of amazing user experiences to reality. What you know is only the beginning.

Learn more at www.amd.com/embedded

AMD EMBEDDED SOLUTIONS

Inspiring Embedded Innovation.

By Alexander Lochinger, SFF-SIG President

Transition boards bring COMs to save I/O stacks

Embedded board stacks are celebrating two decades of use in a variety of applications. Typically, there is a single host CPU card at the top, bottom, or even the center of the stack, driving the expansion buses upward and/or downward. Previously, that host CPU had to follow the same form factor standard as the I/O cards. But with Computer-On-Module (COM) products taking the Small Form Factor (SFF) market by storm, it was just a matter of time before COM CPUs for custom systems penetrated stackable systems as well. In this first of two columns on transition boards, the focus is on how to extend the life of legacy stacks.

In the late 1980s, the ISA bus appeared in a horizontal stacking format. Originally just for CGA graphics expansion – but in a more compact and rugged format than desktop CGA cards – the stacking bus gained traction for other types of I/O and became the PC/104 bus standard five years later. The 8-bit and 16-bit real-world I/O cards found homes in applications including real-time motor control, data acquisition, medical devices, and transportation. Two decades later, these I/O cards are still in production, even as generations of CPUs have come and gone.

Well over a dozen manufacturers used to build SFF CPUs for these stacks. These days, however, the overall market for stackables has narrowed a bit, and tighter budgets for military, Unmanned Aerial Vehicle (UAV), and transportation applications is threatening to turn stackable CPU vendors into endangered species.

An unlikely lifeline

In spite of the best efforts of standards trade groups to promote stackable architectures, the very members of these groups began to move their higher volume stackable customers over to a new architecture – namely, COM. The benefits and ROI of this move were clear: Invest in a custom carrier board up front, and shrink the system size while saving build costs for years to come. When inevitable processor End-Of-Life (EOL) issues arise, simply unplug the CPU module and replace it with the latest one. Because COM processor modules have a much broader market appeal, they reached critical mass for low-cost Asian manufacturing quickly, and the cost savings have been staggering.

One by one, CPU and I/O stacks in medical and other applications were lured into COM architectures such as the ETX form factor with custom-designed carrier boards. The total available market for stackables stopped growing for years until stackable CPU manufacturers finally realized that COMs were a direct threat. Finally, it was the stackable I/O vendors who answered the "S.O.S." – that is, "Save Our Stacks" – with an unlikely lifeline: embracing COMs with transition boards. One of the first such transition boards is shown in Figure 1.

The ETX-NANO-104 from ACCES I/O looks like a tiny embedded motherboard with VGA, RS-232/422/485, USB, audio, PS/2 mouse and keyboard, and Ethernet ports. It features ISA and PCI bus expansion upward from the top surface, as shown. Noticeably absent is a large processor chip on the top. That's because it isn't on the top, and isn't on the bottom either. On the bottom surface (not shown) is a connector array for a pluggable CPU that gets cooled by a flat heat spreader plate. The processor, chipset, LAN controller, RAM, and power supplies for the core voltages reside on the COM, which uses the high-volume, low-cost ETX form factor. Many legacy-friendly ETX modules are still in

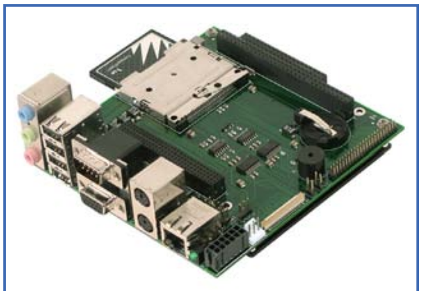


Figure 1 | ACCES I/O's ETX-NANO-104 transition board brings COMs to I/O stacks.

the market, with single- and dual-core Gigahertz x86 processors to provide a wide range of performance, price, and power-consumption solutions.

Quite a diverse set of applications can be covered with this approach. The transition board, often called a baseboard or carrier board, also provides PC-style connectors for the I/O that comes off the ETX module, which can simplify system cabling substantially. The ETX expansion buses pass through to the upward stacking bus interface. System OEMs can now use an off-the-shelf transition board to extend the life of their legacy I/O stacks and legacy software while tapping into the wide offering of ETX CPUs. The amount of engineering effort to move these stacks to new bus technology is sizable, and fortunately there is a viable alternative to expensive new stackable CPUs in the form of a transition board.

Next quarter, we examine how I/O vendors are turning the tables on full-custom designs, thereby breathing new life into mezzanine and stackable I/O architectures.

Small Form Factor
Special Interest Group
408-480-7900
info@sff-sig.org

By Dr. Paul Haris, PC/104 Consortium Chairman and President

Unmanned vehicles and the PC/104 architecture

Unmanned vehicles, throughout their long history, have typically been focused around the military and national security industries. The initial use of these vehicles was simple: To remove humans from high-risk situations and go to places where humans could not. In the beginning, unmanned vehicle technology was large, heavy, and not very powerful. However, miniaturization and technological advancements in processor power versus power consumption – as well as advancements in surveillance, communications, robotics, and software – mean that unmanned vehicles became and continue to be the go-to solution for a wide variety of military and nonmilitary operations.

> "Subsystems often need to be able to survive in the harshest of conditions. We can expect these systems to change rapidly as requirements are refined, technology advances, and lessons are learned."

The tipping point for widespread use of unmanned vehicles came during the 1991 Gulf War. Since then we have seen an explosion in investment in research and development, not only in the aerial arena but also for land and sea vehicles. Today we see unmanned fixed- and rotor-wing aircraft, boats, submersibles, spacecraft, vehicles, and throwable robots, with sizes ranging from hand-launched to very large. Current applications include combat, surveillance, research, search and rescue, sports, law enforcement, geophysical surveys, disaster relief, and remote sensing. Additionally, as

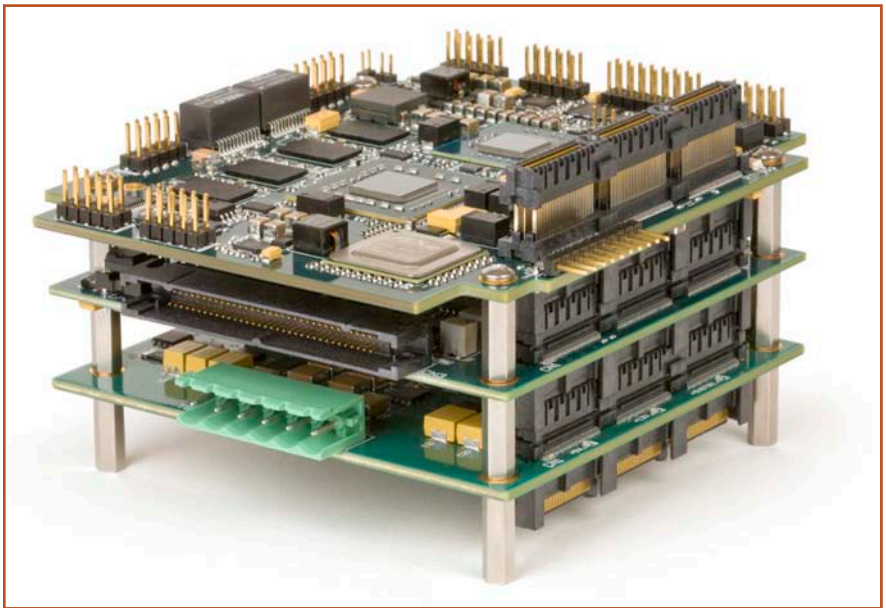


Figure 1 | As requirements change and power consumption requirements decrease, the PC/104 stack inside the unmanned vehicle can be readily updated.

more emphasis is placed on the use of unmanned vehicles among civilian populations, we can only expect the unmanned-vehicle industry to expand.

UAVs can have numerous subsystems, depending on the application, but central to any of them are guidance and control, communications, power, sensory input, and data-gathering equipment, most often video surveillance. Other subsystems can also include such aspects as robotics if physical tasks need to be performed. Subsystems often need to be able to survive in the harshest of conditions. We can expect these systems to change rapidly as requirements are refined, technology advances, and lessons are learned.

So where does the PC/104 architecture fit into this picture? The short answer: everywhere. What benefits does it provide over other architectures and how is it being used today and into the future? Clearly this is a very large topic, but let me touch on a few aspects.

I have often written about the inherent ruggedness of the PC/104 architecture. In my last article, I talked about how the PC/104 architecture not only carries its own unique stackable features allowing for compact sizes, off-the-shelf and custom configurations, maintainability, and simple upgradability, but it also overlaps with some of the strength of the mezzanine COM and card-cage architectures. This setup provides a truly versatile system-based design, which reduces time-to-market and total lifetime program costs.

These benefits mean that we find the PC/104 architecture being used in many unmanned vehicle applications today and being designed into many future systems. Since the architecture is based on an ecosystem principle of interoperable peripheral modules, OEMs have many off-the-shelf products in the areas of processors, DSP, FPGA, analog and digital I/O, RF communications, serial communication links, Ethernet, switches, routers, motion controllers, video and video capture, GPS, motion sensors, standard/isolated/MIL-SPEC power supplies, battery packs, and storage – just to name a few. In addition, numerous application-specific cards have been created to meet whatever requirement is needed. As these requirements change, as new functionality is needed, and as processing power needs increase while power-consumption requirements decrease, the PC/104 stack inside the unmanned vehicle can be easily updated with readily available products.

For more information visit the PC/104 Consortium website at www.pc104.org.

PC/104 and UASs: The beauty of the system

By Mike Southworth

The RQ-5B Hunter Unmanned Aircraft System (UAS) used by the U.S. Army integrates a DuraCOR PC/104-based mission computer as a payload interface for onboard electronics and sensors. Photo courtesy of Curtiss-Wright.

Good things really do come in small packages: It's as though small, lightweight PC/104-based subsystems and Unmanned Aircraft Systems (UASs) for defense and aerospace applications were made for each other.

PC/104-based systems are handling processing and networking duties on many Unmanned Aircraft Systems (UASs) flying missions around the globe today: Several examples include serving as mission computers on the MQ-5B Hunter and acting as mobile network router systems on the Predator. In fact, you can find PC/104 technology flying today supporting the U.S. Navy, Air Force, Army, and Coast Guard aboard unmanned surface vehicles, unmanned helicopters, and unmanned fixed-wing aircraft.

> "One of the growing trends the industry is seeing with UAS-deployed PC/104 systems is the growth of LRU functionality consolidation, as system integrators are looking to put more functionality than ever before into the same physical envelope."

One of the beauties of the PC/104 architecture is that when these cards are packaged within a rugged chassis, the system designer can access all the benefits of this well-established, widely used standard without actually having to deal directly with the modules themselves. When deployed in enclosures with standard interfaces, the user experiences a highly reliable, easily inserted or removed, compact, and cost-effective "black box" solution. What's in the box matters only in that the solution delivers optimal performance in harsh environments with the most compact footprint.

PC/104-based boxes hit all the key sweet spots for UAS system integrators looking to add highly rugged and Size, Weight, and Power (SWaP)-optimized mission computers and networking nodes to their platforms (Figure 1).

When it comes to open-standard, broadly supported system architectures, PC/104 delivers all the high-demand requirements in a cost-effective small package that loads the benefits of proven COTS technology into an easily integrated Line-Replaceable Unit (LRU). That's not to say that PC/104 is the answer for every situation, however. If the application requires flight- or safety-certified system hardware, or the function needs intensive levels of processing horsepower that requires multiple bigger and hotter processors, the integrator may instead want to consider a high-performance bus/backplane approach. In such cases, a Line-Replaceable Module (LRM) such as VPX may be a better option. A good rule of thumb is if the required module dissipates more than 100 W, PC/104 is not likely the best solution. Moreover, while it's possible to pursue rigid design assurance certifications such as DO-254 or DO-178 with PC/104-based solutions, the associated cost and the need for detailed artifacts for each of the system's components tend to argue for a custom solution rather than a COTS PC/104 design. However, PC/104 is hard to beat for the numerous types of mission computers and network switch applications that UASs require for onboard systems management and data communications.

Stability and flexibility

In recent years, as UASs have proliferated, it was only natural that PC/104 would find a place on these highly SWaP-constrained platforms. Starting with the module itself, the PC/104 story is one of stability and flexibility. The PC/104 form factor, regardless of which variant one considers – the newest-generation card types that feature PCI Express or the legacy cards built around the PCI/ISA bus – provides a consistent form factor, measuring roughly 3.6" x 3.8", that delivers an ideal small building block for systems design that has remained stable since it was first introduced in the early 1980s. Since then, PC/104 has been embraced as the go-to small-form-factor choice for building lightweight, low-power processing systems. Today there are more than 100 suppliers of PC/104 cards, providing system designers with countless options for mixing and matching Single Board Computer (SBC) and I/O module types. This well-established market ecosystem ensures longevity of support while keeping costs competitive.

Figure 1 | Rugged PC/104-based computer subsystems routinely serve as mission processors for Size, Weight, and Power (SWaP)-constrained airborne, land, and maritime platforms.

Because of the large number of suppliers, system integrators can mix and match modules, virtually as easily as one would with Lego blocks, enabling users to configure the particular I/O their application requires without the higher cost of a backplane or the larger chassis required by 3U or 6U backplane-based designs.

Rugged without compromise

Another important feature of PC/104 cards is how rugged they are. In fact, because the modules have a very small surface area and their main connectors provide a very reliable connector from board-to-board, PC/104 offers a system building block that is inherently rugged for vibration and shock (Figure 2). Standard procedure at Curtiss-Wright for Parvus PC/104 solutions is to perform defense and environmental tests, including MIL-STD-810 and 461 EMI; newer systems are tested through DO-160 for environmental and EMI for commercial aerospace applications.

Figure 2 | Rugged PC/104-based computer subsystems routinely serve as mission processors for Size, Weight, and Power (SWaP)-constrained airborne, land, and maritime platforms.

Processing on UASs

PC/104-based subsystems are frequently used today as mission computers on UASs, providing general-purpose PC functionality with a processor and traditional peripheral I/O devices, such as Ethernet, serial, analog, digital, and audio/video. Because each UAS platform will require specific communications interfaces depending on the types of payload they carry, the mission computers are modified to support the specific devices onboard the aircraft or vehicle, such as the 1553 bus; ARINC 429 databus; or synchronous, asynchronous, or digital I/O needed for the particular radios or avionics that the processor will communicate with.

These mission computers – typically located in front of the UAS's network router and switches – gather information from the platform's sensors and then share the data through the switches and routers.

Networking on UASs

Because UASs are essentially sensor platforms, PC/104 hardware is frequently used for adding Ethernet connectivity between the sensors and other computing devices onboard a UAS. This enables information gathered by the sensors or processed by the mission computers to be shared locally on a LAN. When a PC/104 Layer 3 router device is used, it enables an interlink to be established between the devices on the UAS and other platforms in the air, or to remote stations on the ground or at sea. For example, a UAS might have a tactical radio or satcom connection to the router, which then can relay data off the platform to provide situational awareness to the warfighter. In this fashion, every UAS or platform can become a node in the network, providing information that enables mission commanders and mission planners to make informed decisions on the battlefield.

PC/104 in the air: The MQ-5B Hunter

A good example of how PC/104 systems are deployed on UASs today is provided by the Hunter from Northrop Grumman. The MQ-5B Hunter UAS is currently being used by the U.S. Army to conduct battlefield surveillance using its multi-mission optronic payload. The UAS flies over the battlefield gathering reconnaissance, surveillance, target-acquisition, and battle-damage information in real time. It then relays the information via video link to commanders and soldiers on the ground.

The mission computer on the Hunter is a Curtiss-Wright Parvus DuraCOR 810 subsystem. The system integrates a low-power 1.4 GHz Intel CPU, together with a MIL-STD-704/1275 power supply in a rugged aluminum chassis that uses MIL-DTL-38999 connectors. Up to six spare PC/104-*Plus* slots are available for mission-specific I/O functionality. Weighing only 7.8 lb. (3.5 kg), this compact system measures only 10.60" (269.24 mm) x 5.30" (134.62 mm) x 5.30" (134.62 mm), including its connectors.

Going forward

One of the growing trends the industry is seeing with UAS-deployed PC/104 systems is the growth of LRU functionality consolidation, as system integrators are looking to put more functionality than ever before into the same physical envelope. As semiconductor devices continue to reach higher levels of integration, it becomes increasingly viable to combine a number of separate functions that would have formerly required their own dedicated chassis into a single box.

With the mission profile of UASs continuing to evolve, PC/104 hardware – by its very nature small, lightweight, and low power – will continue to be a good host, providing a cost-effective, stable, and flexible means of deploying ever-greater amounts of processing and connectivity to support and protect warfighters. **SFF**

Mike Southworth *is Product Marketing Manager for Curtiss-Wright Defense Solutions.*

Curtiss-Wright Defense Solutions
msouthworth@curtisswright.com
www.parvus.com

Packaging considerations for Small Form Factor boards

By Vlad Konopelko

Electronic equipment requires effective packaging solutions to prevent critical electronic components from overheating and to ensure consistent performance in demanding industrial environments. Therefore, design engineers must consider many diverse factors when choosing a packaging solution.

A changing industry

As the electronics industry increasingly focuses on flexibility, performance expectations, and design considerations, we are seeing several market trends:

Miniaturization

Virtually every industry, not least of all electronics, is seeing components getting smaller. To use a healthcare example, a patient may have had to go to a specific room for a procedure. Now, however, with the shrinking of machinery and components, a mobile or handheld device may be used in the patient's own room, thereby providing a more efficient outcome.

In the electronics industry, many manufacturers are transitioning from larger 19-inch systems to Small Form Factor (SFF), single-board computing. This shift requires a flexible packaging solution that can accommodate SFF printed electronics, including Single Board Computers (SBCs), Computers-On-Module (COMs), nanoETXexpress, Mini-ITX, and Nano-ITX.

Lifecycle reduction

Suppliers are introducing innovative electronic solutions with advanced capabilities at a rapid pace. As lifecycles for electronics continue to shrink, engineers must design efficiently to maximize the return on total-cost-of-design and cost-of-ownership investments. For instance, only a few years ago, an electronic communications system would be deployed in the field for an average of five or more years before it was replaced with an upgraded model. Now, however, with increasing technological advancements, an updated (next-generation) solution with the latest and greatest technology and features is typically released each year, dramatically shortening the lifecycle of a product. Thus, in this case, there are two options: Either deploy "future-proof" systems that may be updated as technology and application trends change, or replace with entirely new equipment.

Lifecycle reduction also forces the customer to consider the Total Cost of Ownership (TCO) of a product, which includes the initial cost to deploy, maintenance during the operational lifespan, and how long the solution will last. A key component to ensuring a cost-effective, future-proof, electronic solution includes the enclosure. For example, consider two enclosures that are priced competitively: Enclosure A is initially a low-cost solution but requires a complex and lengthy assembly time and significant investments in engineering and modification costs throughout the lifecycle. Enclosure B is offered at a slightly higher initial cost, but is based on a configurable platform that may be modified or reconfigured in accordance with changing requirements during the lifecycle at a minimal cost, and is assembled in two quick steps to help reduce assembly time and costs. Even if Enclosure B has a higher initial cost, the design engineer and assembly team save significantly in product lifecycle and labor costs, which may ultimately result in a better ROI.

Price
Industrial OEMs are seeking ways to accomplish greater productivity by minimizing the quantity or excess of resources. By employing a cost-effective solution that offers multiple functionalities, such as electromagnetic shielding, thermal management, interconnectivity, and the like, design engineers can save significantly because they don't have to purchase multiple pieces of equipment or components.

Next generation
The electronics industry is also moving toward a trend of not having to worry about the details of the mechanics of a solution; it should work well and accommodate diverse application requirements. Design engineers expect manufacturers to stay on top of trends and technology, and to continually incorporate these advancements in their products. Additionally, OEMs expect a product to fit their application needs. While a product may have similar features and functionality year over year, it should also have some differentiation and flexibility to fit a user's exact need.

Industry expectations
When selecting an enclosure or case for sensitive electronic components, the following factors should be considered:

Assembly
Easy and fast assembly and disassembly of an enclosure or case is important, as it directly impacts productivity. If an enclosure takes a significant amount of time to put together, this can result in a halt in operations, which in turn affects a company's bottom line (Figure 1).

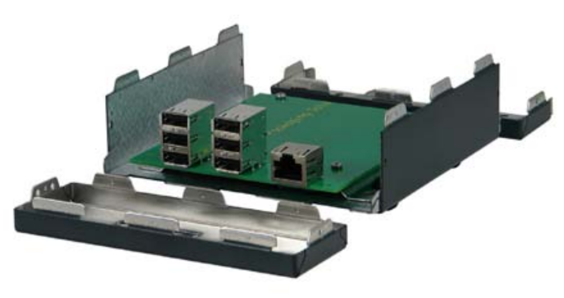


Figure 1 | Easy and fast assembly and disassembly of an enclosure or case is important, as it directly impacts productivity.

Access
The enclosure or case should also provide quick access to the Printed Circuit Board (PCB), allowing for fast equipment service and maintenance, upgrades, solution of technical issues, and/or component replacement. Easy and quick access to the PCB is also critical to the product's lifecycle. For example, in medical applications, equipment may need to be tested for proper calibration and performance. If the enclosure or case does not provide immediate access, this will slow testing procedures and may result in a delay of operations.

EMC shielding
With today's equipment running at higher frequency and generating increased power, the need to shield components from Electromagnetic Interference (EMI) is critical. Design engineers need components that do not interfere with other electronics, in addition to ensuring that the enclosure itself does not radiate interference.

To address these needs, enclosures with built-in Electromagnetic Compatibility (EMC) shielding save time and ensure continuous operation. While gasket solutions can also be used, these require additional assembly, separate ordering, and the risk of lost or misplaced components, as gaskets are very small. Employing an enclosure with built-in EMC shielding offers more convenience and minimizes the purchasing decision (Figure 2).

Figure 2 | Enclosures with built-in EMC shielding save time and ensure continuous operation.

Cooling accessories
Enclosures with multiple equipment components residing inside will naturally generate increased heat, which means that effective cooling solutions must be implemented. Tests should be performed to identify the EMC shielding and cooling capabilities required for optimal performance.

The location of the heat source and the size of the enclosure greatly affects the EMC shielding and cooling requirements. For example, if an enclosure measures 1U high and 19 inches wide and is populated with equipment, it may be able to achieve as much as 26 Cubic Feet per Minute (CFM) with a standard fan bank running on high in a push-cooling configuration. Cooling requirements vary significantly from application to application, making it important to test separately for each one.

Figure 3 | Custom accessories can include sizing, solid or perforated side panels, PCB mounting, ventilation, or mounting feet.

Optimized accessories
In addition to testing for EMC shielding and cooling capabilities, design engineers should consider enclosure accessories to help reduce integration time. These accessories may include:

- Board fixing, such as a mounting plate, flexible rail system, studs, self-adhesive support pads
- Mounting feet, including plastic feet, feet with tip-up function, and stacking feet
- Snap-on fan fixings or fan mounts for heat dissipation
- Enclosure mounting
- Digital assets, such as test reports, STEP 3D files, and user manuals

Customization
Depending on the application, enclosure or case customization may be required to either accommodate a corporate identity or fit a specific application need. For example, instead of having perforations on the side, top-to-bottom cooling may be better suited for a particular project. Custom accessories can include sizing, solid or perforated side panels, PCB mounting, ventilation, and mounting feet (Figure 3).

Applying the technology
Flexible packaging for electronic modems
While flexible enclosure solutions can be applied in virtually any industry, manufacturers of sensitive electronics especially appreciate flexibility. For example, critical electronics – such as two-way satellite time and frequency transfer modems – need an enclosure solution to effectively protect and cool the components to ensure continuous operation. However, the electronic components may differ in size and shape, requiring a flexible protection solution.

To satisfy this challenge, the manufacturer can employ a flexible enclosure with varying standard sizes that can be modified to specific application requirements. To provide the necessary cooling capabilities, the enclosure should also offer built-in EMC protection, eliminating the risk of interference without added effort or cost.

Customized packaging for audio/video cases
Audio/video cases require extensive customization due to the high quantity

> "While flexible enclosure solutions can be applied in virtually any industry, manufacturers of sensitive electronics especially appreciate flexibility. For example, critical electronics – such as two-way satellite time and frequency transfer modems – need an enclosure solution to effectively protect and cool the components to ensure continuous operation … To provide the necessary cooling capabilities, the enclosure should also offer built-in EMC protection, eliminating the risk of interference without added effort or cost."

of cutouts and flexible design. For instance, when considering a specific case, the case may require multiple customization options, including:

- **Design:** The front of the case has a large cutout for a specific plug-in module, which will be covered by an additional panel screwed onto the case.
- **Height:** Since the case will be mounted on gliding channels, the height of the case must be adjusted to accommodate the additional size.
- **Cutouts:** The back panel will be used for cutouts and printing, which the taps will interfere with. Instead of a standard four-part version, a three-part version will be used where the back panel is slightly redesigned. The taps will be screwed on the top of the case in place of the back panel, ensuring the flexibility of the removable back panel and a stable and fixed front panel.
- **Perforation:** The side of the case has a special perforation for the cooling fan.
- **Studs:** To accommodate cost-effective, large production runs, the inside of the case will house various studs.

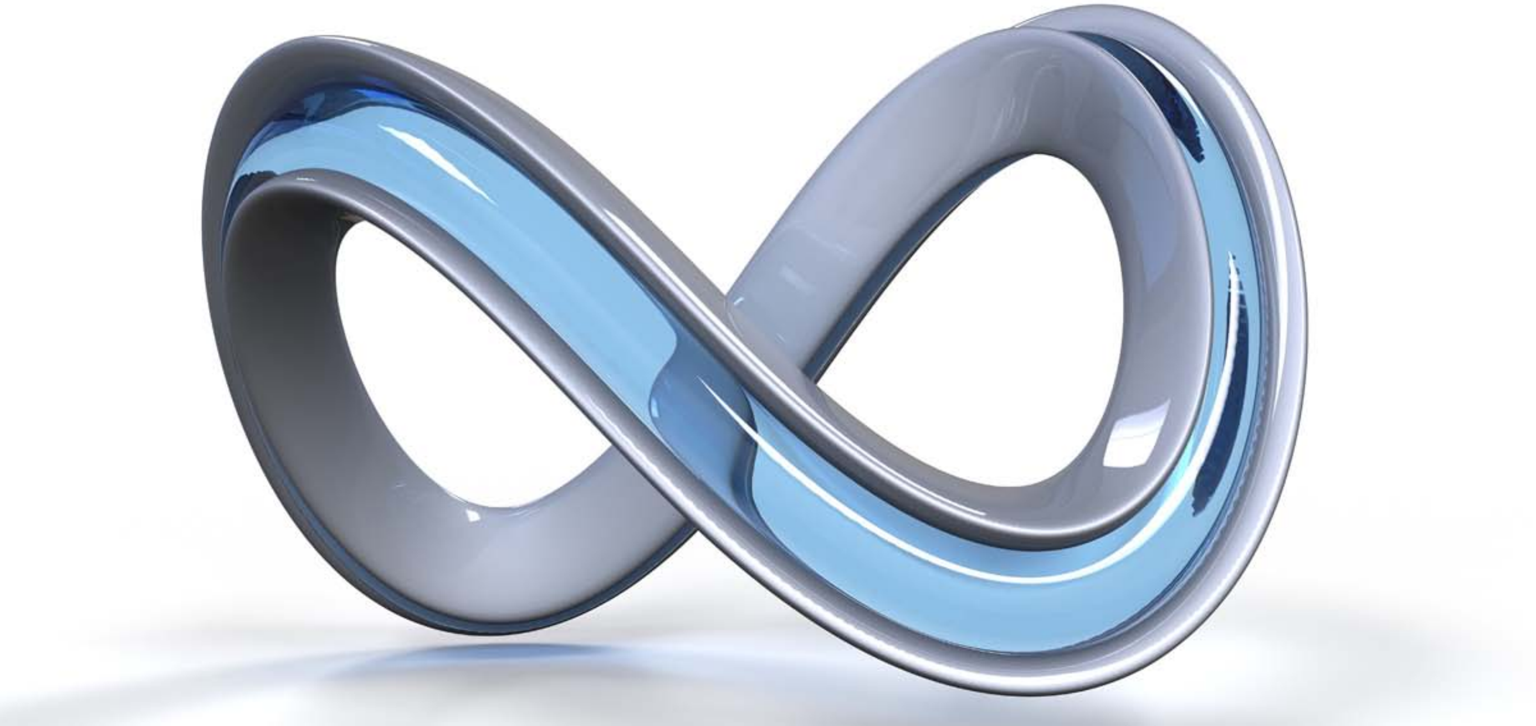
As described, this type of enclosure is significantly different from a standard case, providing a completely modular platform solution.

Conclusion

With industry trends constantly changing, it is critical that enclosures accommodate market expectations and diverse application requirements. By employing an enclosure with versatile sizing and accessories and increased modification options, design engineers can effectively protect their critical electronics with a highly versatile enclosure solution. **SFF**

Vlad Konopelko is a Product Marketing Manager for Pentair Electronic Packaging – Schroff.

Pentair Electronic Packaging
Schroff
info@pentair-ep.com



Where art thou, PowerPC?

By Brandon Lewis, Assistant Managing Editor

Once championed by Apple desktops, consumer gaming consoles, network servers, and aerospace and defense applications alike, the Power Architecture – while still strong in niche applications like Unmanned Aircraft Systems (UASs) – is not the dominant force it once was. Now, low-power requirements are forcing embedded computing engineers to turn toward ARM-based Systems-on-Chip (SoCs) with integrated FPGAs for compute-intensive applications, and x86-based CPUs for general-purpose housekeeping.

When the Apple Computer, IBM, Motorola (AIM) alliance formed in the early 1990s, it appeared that the Power Architecture had emerged as a formidable RISC architecture that made a case in nearly every walk of computing. However, after being used in Apple's Macintosh desktop offerings for more than a decade, popular gaming consoles such as the Xbox 360, and enterprise-class servers and mainframes, the Power Architecture suddenly fell out of favor. But why?

There are many possible explanations (and much speculation) as to why Apple dropped PowerPC and gaming platforms decided to part ways with Cell processors, but continual performance advances from Intel and others certainly didn't help. And, although a number of vendors were producing compatible PowerPC processors, no one ever took the lead on the "next big splash" and the Power Architecture eventually fell behind, says Flemming Christensen, CEO at Sundance Multiprocessor Technology, Ltd. in Buckinghamshire, UK (www.sundance.com).

"I honestly believe that the PowerPC has seen its best days and it will go the same ways as MIPS and the rest of the RISC architectures," Christensen argues. "The PowerPC itself is a better processor, it's a better architecture, it performs faster than an Intel processor, and it's got all sorts of good things behind it, which you could see in the fact that Apple picked it as a successor when they used the [Motorola] 68040," says Christensen. "But Intel just has this magic wand that they keep making things go faster and faster and faster. That's why Apple eventually gave up on PowerPC, and then the game consoles gave up on PowerPC, as did typical embedded. What's happening in the aerospace environment is that PowerPC has more or less lost out as well, and people are using things like LEON – an open type of CPU, although still RISC architecture.

"When Apple gave up [on PowerPC] that was a massive, massive blow," he

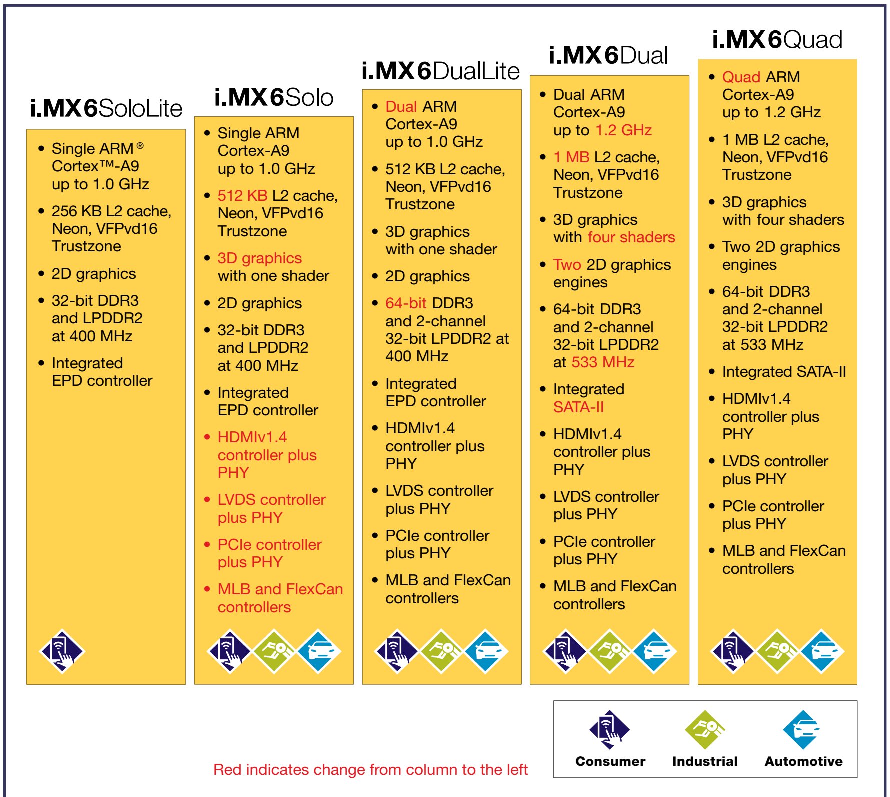


Figure 1 | The Freescale i.MX 6 series processors are available in compatible SoloLite, Solo, DualLite, Dual, and Quad variants based on the ARM Cortex-A9 core, well-suited for Small Form Factor (SFF) board development.

continues. "They didn't lose a massive customer in terms of volume, but they lost their most prestigious one. There was a good reason for Apple to use a PowerPC because it was the best and [Apple] had been known for always doing the best – then they gave up on it. And eventually the games console people gave up on the Cell processors, and so they lost their volume and the prestigious customer, which left them with possibly putting them on the servers, but everybody wants to do a server chip."

Where Power fell short, and the ARM alternative

Despite the marketing ramifications of losing a customer like Apple, the Power Architecture also faced competition from computing advances such as multiprocessing and integrated graphics, Christensen says. Today developers are turning to ARM-based Systems-on-Chip (SoCs) for the programming and control functionality the Power Architecture afforded when integrating FPGAs onto Small Form Factor (SFF) boards, he adds.

"There were some problems with getting some graphics into [PowerPC] as well, so obviously with Intel integrating the graphics processing it took a little while before the PowerPC could do that," Christensen says. "The other thing that happened is that PowerPC was not very good at multiprocessing, so the four-core processors – from Freescale effectively, because IBM doesn't produce any commercial chips anymore – didn't really work as well as an Intel processor, and Freescale jumped into the ARM race and added a single-, dual-, and quad-core ARM-based processor, which I think is so much better-suited for SFFs because it's lower power and it's used by millions and millions of people (Figure 1).

"We used PowerPC mainly with FPGAs because they were so damn conveniently built into the FPGA fabric," he explains. "We had them as part of an FPGA, which really makes sense because you can program the FPGA from within or from a processor, and then Xilinx gave up on it as well: actually at Xilinx they had a 4- and an 8-core PowerPC on their Virtex roadmap, but they never made them and only made the dual-core PowerPC.

"We will be using the Zynq at some point because it's a nice thing to have a processor core inside an FPGA because you can get it going," Christensen continues (Figure 2). "The ARM inside Altera and Xilinx is meant to program, and then you have some fabric as well. That's how I looked at it when we came out with our PowerPC-based FPGA boards – you can actually use the PowerPC as your processor board and your fabric for your high-performance stuff and all of your interfaces and not have to have an Intel processor. That hasn't happened. Everyone ended up using an Intel processor as the CPU and the FPGA as an FPGA, and forgetting the PowerPC because there wasn't really a benefit at the time. And with the PowerPC tools from Xilinx you have to use Wind River Systems initially, and it costs you about $20,000 to buy the PowerPC compilers and yet you can get them for only $99 for Intel processors."

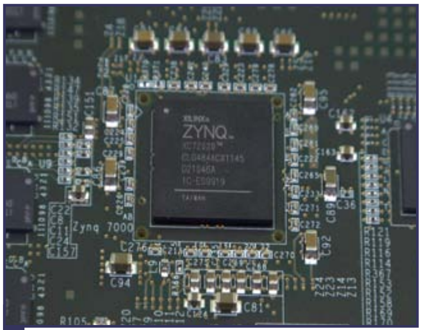


Figure 2 | The Xilinx Zynq-7000 All Programmable Systems-on-Chip (SoCs) combine the software flexibility of a dual ARM Cortex-A9 MPCore with the hardware programmability of Xilinx 7 series FPGAs.

Evolving ARM I/O opens doors into PC/104

While ARM-based SoCs have traditionally lacked the I/O necessary to power x86-centric SFF boards, evolutions in the processor architecture have mirrored Intel interfaces to be able to support newer SFF variants such as PCIe/104 and PCI/104-Express. Christensen says he hopes this will enable highly integrated, controllable Digital Signal Processing (DSP) boards that catch on better than similar efforts using PowerPC.

"Longer term, our PC/104 platform will be using ARM and fabric, and it will hopefully do what we failed to do with the PowerPC three or four years ago when we introduced those: have a single board that will have a processor, which in this case was a dual-core PowerPC and will be a dual ARM Cortex-A9 core that will do all the low-level housekeeping stuff and have a big piece of fabric that will do all the various high-level DSP. With the Xilinx Zynq and the Altera Cyclones, you can save power by not running the fabric as fast and the processor is in charge. It's a highly integrated solution.

"Now ARM processors are actually becoming more like Intel processors, Christensen says. "So on an ARM integrated processor now you've got USB; you've got SATA; all these interfaces that were normally found on an Intel processor, you've got them as default now whereas five years ago you didn't have those things. So all the ARM processors now are like SoCs. Freescale has come out with these i.MX 6 CPUs, which are lovely because they've got five variations of the same footprint-compatible device with either one core, two cores, or four cores. All the peripherals are the same as you'll find on an Intel Atom or Core i7, and hence they all fit nicely onto PC/104. You don't need the legacy PC/104 bus anymore with the old ISA and PC/104 buses that are very, very centric around Intel processors, and the PCIe/104 and PCI/104-Express can be plugged into anything."

> "… on an ARM integrated processor now you've got USB; you've got SATA; all these interfaces that were normally found on an Intel processor, you've got them as default now whereas five years ago you didn't have those things."

Niche applications remain open for RISC

Though the Power Architecture may no longer be poised for widespread use in many upcoming embedded deployments, RISC architectures are still desirable in a number of niche applications that require more control over low-level instruction sets, says Christensen. For sensitive applications such as Unmanned Aircraft Systems (UASs), these and other types of compute elements are critical to balancing performance and power limitations (Sidebar "Heterogeneous architectures for UAS applications").

"We're doing a European research project called EMC2, which is a massive multichannel, multicore consortium," Christensen says (www.emc2-project.eu). "One of the chaps we were doing low-level processing work with said 'I don't want an ARM, I don't want an Intel processor, I want something that I can go change instruction sets of.' I asked him why that is, and he said, 'I need to optimize something, and the only way I can optimize it is by actually optimizing the instruction set of the processors, and you can't do that with Intel and you can't do that with an ARM either.'

"There will be peripheral processors – LEON, OpenRISC, and a few similar processors – that are open core but can go onto an FPGA fabric," Christensen continues. "So they are looking at putting loads of effectively specialized small processors on a board because it suits them and they can run at whatever speed they want to, which you can't do with an ARM. So, when you buy your ARM, you buy an ARM. That's it. You are forced to choose compatibility. Same with Intel." **SFF**

POWER CONSTRAINTS SUGGEST HETEROGENEOUS ARCHITECTURES FOR UAS APPLICATIONS

One constant struggle in resource-constrained embedded platforms such as Unmanned Aircraft Systems (UASs) is balancing performance needs with power limitations. Particularly for smaller UAS classes that perform Intelligence, Surveillance, and Reconnaissance (ISR) missions, the power drain of high-performance FPGA processing can cause serious reductions in flight duration, says Flemming Christensen, CEO at Sundance Multiprocessor Technology, Ltd. in Buckinghamshire, UK (www.sundance.com).

"As in the past, FPGA processing takes too much power," Christensen explains. "You lose so much flight time because you have to spend so much energy on the FPGAs. What you have to do is come up with possible heterogeneous architectures where you have a way to control what is required. So when it's just flying and doing nothing, everything else needs to be shut down somehow. That almost requires a custom chip."

Figure 1 | Team AREND is using the Hyperion 2.1 as a baseline development model for an Unmanned Aircraft System (UAS) that will be used to combat African poachers. This system will require a heterogeneous processing platform to maximize performance and power usage.

Citing the need for a scalable, low-cost processing solution, Christensen points to the Aircraft for Rhino and Environmental Defense (AREND) project, an environmental conservation team interested in using UASs to protect African wildlife (www.facebook.com/teamAREND). For platforms such as the Hyperion 2.1 shown in Figure 1, a heterogeneous architecture capable of cycling on and off would be a key enabler of mission success.

"If we could just make ASICs a bit cheaper, that would be fantastic," Christensen says. "When you've got these FPGAs flying around, no matter what they do they take 20 W, and it's a lot. So if you could have a heterogeneous platform where you could say, 'okay, I'm now in flight mode, I'm doing nothing, I'm going to coordinate XYZ, then wake up again,' then you will have some power savings. It's not for Sundance to get involved in designing chips, but that's effectively what should be done with chip designs that are suitable for UASs."

Rugged Atom-based embedded computers

Engineers at WinSystems have designed a new product line – the SBC35-CC405 series – of multicore Intel Atom E3800-based embedded computers that will operate from -40 ºC to +85 ºC in a 3.5-inch SBC format COM Express carrier. The processor is integrated via a Type 6 COM Express module that supports a quad-core, dual-core, or single-core processor and includes as much as 8 GB of DDR3L SDRAM. The Intel Atom E3800 family's enhancements include computational performance improvement, greater energy efficiency, better power management, enhanced virtualization, and improved security – all while maintaining a low Thermal Design Power (TDP) range of 5-10 W. The Intel Generation 7-based graphics engine supports up to two simultaneously active displays with interfaces available for analog VGA, DisplayPort 1.1, and LVDS connections.

The embedded PC series has onboard Gigabit Ethernet, USB, serial ports, and additional I/O expansion through MiniPCIe and IO60 connectors. Its rugged platform base, which protects the PCB assembly, is enabled by a low-profile thermal solution. For networking and communications, the SBC35-CC405 has two Intel I210 Gigabit Ethernet controllers with IEEE 1588 time stamping and 10/100/1000 Mb/s multi-speed operation. The SBC35-CC405 operates over an input power range from 10-50 V DC. Enclosures, power supplies, and configuration services are also available. WinSystems provides drivers for Linux and Windows 7/8 as well as pre-configured embedded operating systems.

WinSystems, Inc. | www.winsystems.com | smallformfactors.opensystemsmedia.com/p9917320

Small form factor computer for extreme environments

The NanoPAK small form factor computer, produced by Themis Computer, leverages the Intel Core i7 processor and is targeted for rugged commercial and military field applications. It integrates an Intel 3rd generation Core i7 (Ivy Bridge) processor with flash storage in a small, light footprint for more efficient size, weight, power, and cooling. Military applications for these devices include real-time control, data recording, small storage and communications systems, and mobile robotics in various unmanned vehicles, ground vehicles, man-wearable, shipboard, and other extreme environment platforms.

The NanoPAK computer has a hardened-aluminum air-cooled chassis for surviving harsh environmental conditions. All standard PC interfaces are available for the device; additional interfaces include discretes. All of its I/O and power come through the 100-pin Micro D-Sub connector on the front of the module and two USB 3.0 connectors on the rear of the module. The .77-Kg Themis device has Linux or Microsoft Windows Local or Network PXE boot, as much as 8 GB system memory, and an air-cooled ambient temperature of -40 ºC to +71 ºC. Its mechanical dimensions are (W x H x D): 133 mm x 93 mm x 37 mm (which includes fan assembly). It also meets MIL-STD-810G.

Themis Computer | www.themis.com | smallformfactors.opensystemsmedia.com/p9917308

Enhanced processor architecture enables better real-time responsiveness and power efficiency

The Expanded i.MX 6 architecture from Freescale Semiconductor leverages ARM Cortex-A9 and Cortex-M4 technology to enable systems designers to run user interfaces without sacrificing real-time responsiveness or power efficiency. It is targeted at the consumer, industrial, and automotive infotainment markets. The i.MX 6 series applications processor is a heterogeneous applications processor design that provides additional low-power modes to reduce standby power consumption, enable smaller form factor design, and execute fast, real-time responsiveness to system inputs.

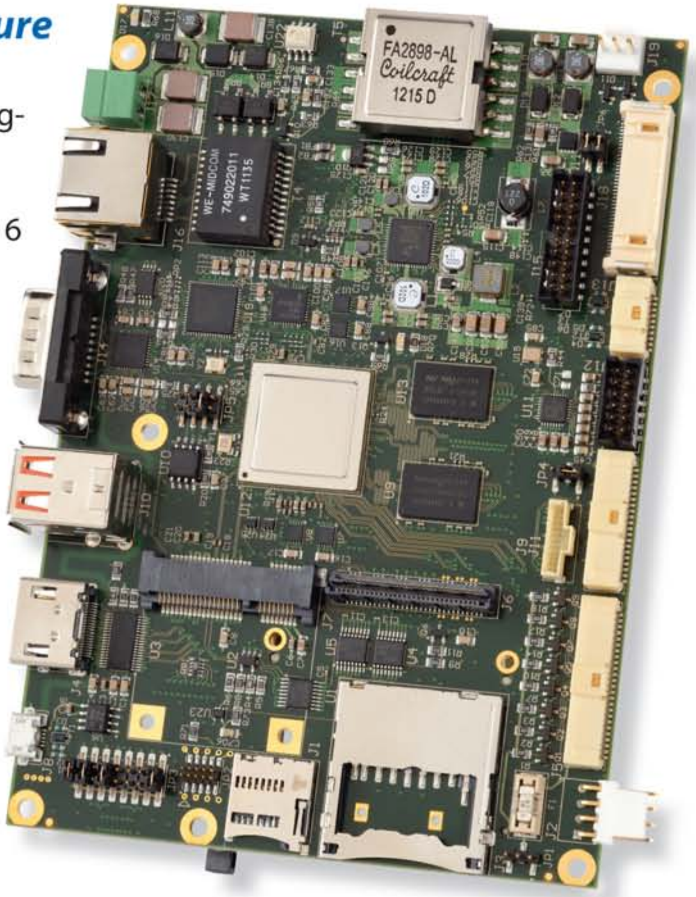
The i.MX 6Quad family has a quad-core platform running as fast as 1.2 GHz with 1 MB of L2 cache and 64-bit DDR3 or 2-ch., 32-bit LPDDR2 support. Additional features include: dual-port gigabit Ethernet audio video bridging; a 2D and 3D Graphics Processing Unit (GPU) for enhanced HMI development; and flexible boot options. The family of processors also use Freescale PF100 power-management units and can handle an industrial temperature range of -40 ºC to +105 ºC. The security aspect supports cryptographic cipher engines, High Assurance Boot, tamper detection, and random number generator. Software support includes Android and Linux for the Cortex-A9 processor, the MQX OS for the Cortex-M4 processor, and the ARM community of support.

Freescale Semiconductor, Inc. | www.freescale.com | smallformfactors.opensystemsmedia.com/p9917319

Industrial ARM® Single Board Computers

High-Performance Graphics with Industrial I/O and Expansion

-40° to +85°C Operating Temperature



Designed for demanding applications and long-term availability, WinSystems' SBC35-C398 single board computers feature Freescale i.MX 6 industrial application processors with options for expansion and customization.

Features

- ARM Cortex™-A9 Processors; Quad, Dual, or Single Core
- Multiple Graphics Interfaces
- Wide Range DC or PoE Power Input
- Gigabit Ethernet with IEEE-1588™
- USB 2.0 Ports and USB On-The-Go
- Dual FlexCAN Ports
- Multiple Storage Options
- Mini-PCIe and IO60 Expansion
- Linux and Android™ Supported

Call 817-274-7553

Ask about our product evaluation program.

Learn more at
www.WinSystems.com/ARMP

WinSystems®
An Employee-Owned Company

715 Stadium Drive • Arlington, Texas 76011
Phone 817-274-7553 • FAX 817-548-1358
E-mail info@winsystems.com

Extended Temperature
Linux
ARM CONNECTED
freescale Enabled

Scan this tag to read more about our ARM SBCs.