SOLUTIONS BRIEF

Lightning: mission ready systems delivering on the promise of COTS

abaco SYSTEMS

Lightning: mission ready systems delivering on the promise of COTS

Introduction

The term "commercial off-the-shelf" (aka "COTS") is widely known and largely well understood. An example is what you get when you run down to Best Buy or press that 'one-click' order on Amazon. A product that is complete, suits your needs and is delivered right away. Instant gratification without the risk; you get what you ordered, without delay and for a known price.

This was the great hope for COTS for the military - and nowhere is this desire felt more than in the acquisition of computers. At Abaco, we'd already been in business many years when, in 1994, then Defense Secretary William Perry challenged the US military to use COTS products and practices to realize just these benefits. We, and others, have worked hard to step up to that challenge. But: while many benefits of COTS have been realized, the military is still not getting what it wants.

Indeed, COTS in the military world has grown to mean something rather different to what was first envisioned. The reality is that COTS has become defined as "anything that shortens the time from 'want' to 'have'". That path has indeed shortened, but most often it is still measured in months, and even years - when it would ideally be weeks.

Why is this so? There are several reasons:

1. Military requirements are often much stricter than commercial standards and dictate rigorous testing and verification to ensure hardware is up to the task. This can make many commercial equipment solutions unacceptable.

2. DoD procurement policy follows strict regulation and eliminates many commercial businesses.

3. Integration of new technology on existing platforms requires special designs, often requiring unique interfaces to legacy equipment.

4. Size, weight and power (SWaP) considerations often limit the adoption of additional hardware, limiting the fit of existing commercial hardware designs.

Lightning: mission ready systems delivering on the promise of COTS

18,000+
armored vehicles

300+
ships

6,000+
jets

3,000+
other assorted aircraft

1000+
Intelligence assets

Paradox

Therein lies a paradox. Commercial embedded computing development is heavily market-driven to be rugged, light, and consume less power. Product geometries get smaller, easing shock and vibration design. They consume lower power, raising battery life and also easing thermal design. And they become increasingly powerful, rising to ever-greater computational demands.

Thus, in theory, the job of designing COTS hardware for military applications should be (and in technical respects is) getting easier. So why does it still take so long? We'll examine this below.

First, however, there is a fifth compelling reason why the adoption of true COTS is problematic in the military space. This is somewhat more complex.

The US military is vast; ~18,000 armored vehicles, ~300 ships, 6,000 jets, 3,000 other assorted aircraft, thousands of radar, air defense, communications and Intelligence assets, satellites, rockets, missiles and countless logistics and support equipment. The maintenance of such an enormous collection of assets requires rigorous attention to cost and leads to standardization (enabling economies of scale in purchase and logistics).

So: Imagine that technology is available that will improve performance, eliminate obsolete- or hard to source parts, or provide new capability. That's very desirable. However: the fact is that the cost of refitting standard gear to use that technology is enormous, the change-over burdensome and lengthy – very often, in our cost-constrained environment, unaffordable. And by the time it can be adopted, it is often obsolete.

Compelling reason

There is a compelling reason for change in military equipment; the need to counter adversaries that have adopted new technologies. Nearly all our adversaries have far fewer assets to change (and have far fewer strict procurement and testing standards). Accordingly, these adversaries can quickly embrace and deploy new technologies, leaving our military at a disadvantage. This is the tyranny of sheer numbers and it is the enemy of agility, modernization and military capability.

This conundrum - of the need for change and the inability to change - is not easily resolved.

In addressing point one above, the DoD is taking major steps. As a way of saving money, adopting commercial practice and establishing a path for technology insertion, the US DoD has adopted open standards. OpenVPX is one example of this; industry groups come together and set a commercial standard for supply of computing hardware for rugged applications. Today, OpenVPX is widely used in military computing applications and Abaco is a major supplier of these.

Wealth of capability

Another good example is adoption of open software standards to tap into the wealth of development and capability in the commercial sector. In 2009, the then acting DoD Chief Information Officer David Wennergren wrote: "To effectively achieve its missions, the Department of Defense must develop and update its software-based capabilities faster than ever, to anticipate new threats and respond to continuously changing requirements. The use of open source software can provide advantages in this regard."

Regarding point two, the DoD this year is opening new avenues for procurement. Ross Guckert, Deputy Program Executive Office, US Army Combat Support and Combat Service Support recently said that the US Army must improve efficiencies, mitigate obsolescence and enhance capabilities. To do this, the Army must accept more risk; accept commercial equipment that is "good enough", and embrace non-traditional vendors working in advanced capability areas. Clearly, the need for speed and capability is reaching parity with the traditional avoidance of risk.

So far, so good - but what of points three and four outlined earlier? Open standards and the adoption of "good enough" still do not address the need to integrate easily with legacy systems (many with proprietary interfaces and data structures) nor do they directly address the need for low SWaP. These are hard-core technical issues and they require technical solutions at an affordable price.

Lightning: mission ready systems delivering on the promise of COTS

A daunting problem

Addressing the need to quickly and affordably introduce new technologies into existing platform architectures is a daunting problem; computers are used in every system on every platform in the DoD inventory – from mission computing, vehicle management, video processing, electronic warfare, communications, command and control, weapons targeting, navigation and others. In many cases, just as in computers in commercial use, the hardware doing the computing is the same (a collection of I/O, FPGA, memory, CPU and GPU elements) across these applications - yet the way they are used, their software and their interfaces vary greatly.

Therein lies the heart of a different paradigm; a move away from a bespoke design for a specific application and toward core designs with many uses. Clearly this is not a new paradigm at all; as far back as the 1980s, this has been the commercial computing design philosophy.

This is what the DoD seeks, and this is what Abaco is producing in a program we call "***Lightning***".

Key elements

Starting with this basic idea of one core design/many uses, Abaco began the *Lightning* program by breaking down computing systems into key elements: data ingest, front-end computing, real-time computing, output and graphics computing and so on. Each of these elements connects to the other quite readily, with established, standard interfaces and data fabrics - and so can be used in various combinations to suit the end application.

They also comply with open source software and, as such, readily host existing applications. This may sound like no great innovation, but in itself it does not address the one critical problem; the embedded computer 'end point' must communicate with other systems that are a hodge-podge of differing interfaces: serial, CANbus, MILCAN, USB, Ethernet (in many variations), CameraLink, HD-SDI, VGA, HDMI, RS-170, SATA, ARINC429, MIL-STD-1553, GPIO, ADC/DAC and others.

390k+

I/O combinations

This is the very reason why, traditionally, embedded computer systems are designed as bespoke to the application; with custom arrangements of computing elements, custom backplanes, connectors and so on and, once assembled, are qualification-tested according to a specific plan. This is, of course, a serial process requiring a great deal of time and expense. If some of this could be achieved ahead of time, the process would be shorter and far less expensive.

What we do

1. Design and build computing elements - FPGA, CPU, GPU and so on - modules that can all connect via standard data fabrics and have 'stations' for I/O adaptor modules.

2. Design and build I/O modules for the most common interfaces that fit these I/O stations.

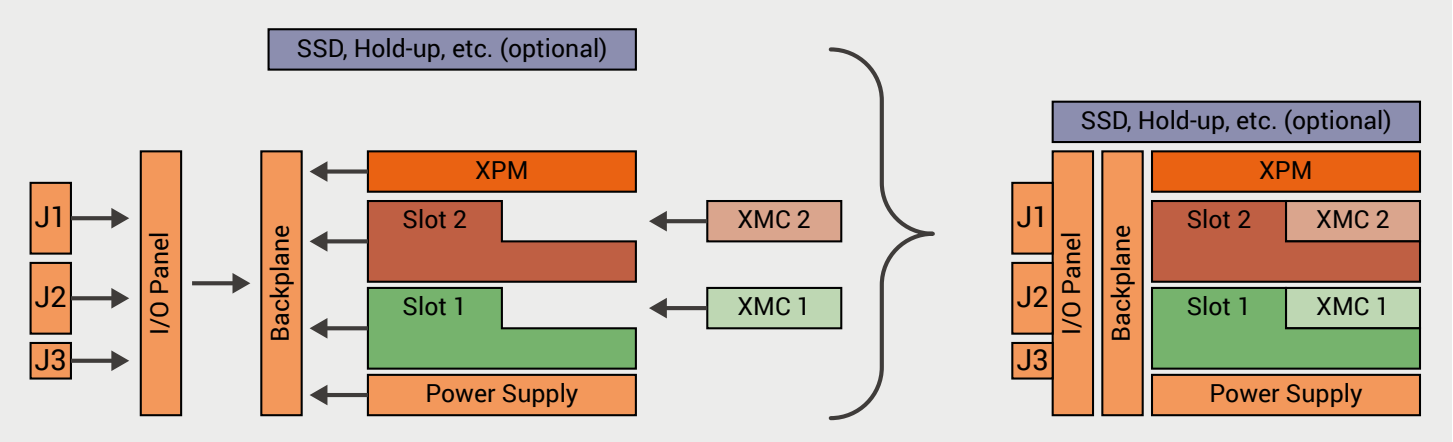
3. Design and build enclosures with two or more element "slots" and suitable power supplies for the most common packages (air-cooled, baseplate cooled, with and without removable hard drives, etc.).

4. Utilize all open standard software and interfaces.

5. Pre-qualify all elements, modules and packages to the most common environmental specifications.

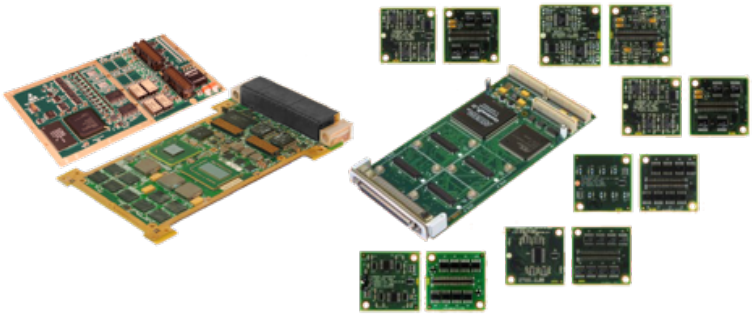
With these pre-designed, pre-qualified parts, a myriad of system configurations can be assembled into systems quickly, with high confidence that they will perform in situ. Utilizing new design and production tools aids the assembly of the various elements needed for requirements, further speeding the process.

Lightning: mission ready systems delivering on the promise of COTS



Slots can be occupied by FPGA, CPU or GPU processor elements. XMC stations (aka mezzanine slots) can provide interfaces for anything from discretes to Ethernet. The XPM board has I/O capabilities (Ethernet, serial) but also is a carrier for Micro Mezzanine System (MMS) and Electro-Conversion Module (ECM) 'tiles' that provide additional I/O support. Key to this approach is the absolute granularity of the MMS architecture, enabling incredibly precise customization of the I/O.

Below are examples of a CPU with XMC site and an XMC card as well as an example MMS module that could be carried on an XPM board expansion site.



Sustainable design

Far beyond the obvious benefits of building bespoke systems from standard building blocks is the notion of evolution, upgrade and obsolescence management.

Lightning is, at its heart, a sustainable design. In the past, the LRUs (Line Replaceable Units) needed for platform operation that became obsolete permitted only three options

1) continue purchasing the item at increased expense as obsolete parts are sourced from 'gray-market' suppliers

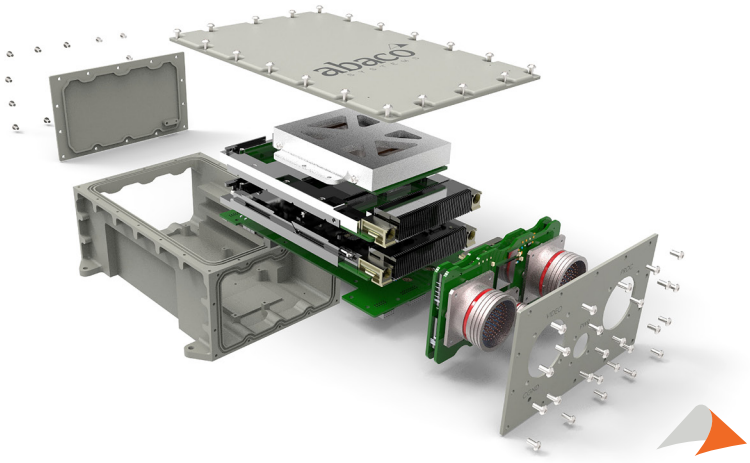
2) fund form/fit/function replacements, or

3) redesign the entire system that utilizes the obsolete part.

None of these options is sustainable. Eventually, the 'gray market' dries up, and one of the other options must be undertaken and the obsolete hardware disposed of – disposing any intrinsic value in the equipment - committing it to the scrap heap and suffering the expense in time, money and risk of a whole new design.

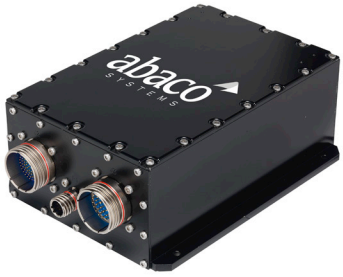
The *Lightning* alternative is sustainable because, if an internal part becomes obsolete, that part can be replaced easily. Modules, tiles and boards are refreshed with new technology automatically and are backwards compatible. Moreover, because these elements are interchangeable, new platform and system interfaces can be catered for and performance improvements can be made without discarding those parts and interfaces still viable (and valuable) to the platform.

Following is an illustration of a typical assembly:



Lightning: mission ready systems delivering on the promise of COTS

Enclosures are also pre-built and qualified and allow rapid assembly of standardized backplane and connector arrangements.



Qualification takes the form of testing for temperature, temperature shock, altitude, humidity, shock/vibration, EMI, sand/dust, salt spray, water ingress and flammability to standards such as MIL-STD-810G method 514.7, 516.6, DO-160G Sections 4-21, 25 and MIL-STD-561G.

Shortening lead times

The goal of the *Lightning* platform and process is to bring typical lead-times for what are, in effect, custom systems, down from the months that are typical today to a matter of weeks. Delivering product from requirement to fulfillment in weeks versus months requires extensive streamlining and automation.

At Abaco, we use the latest design methodologies to incorporate standard modules in use across military applications together with new modules that lend themselves to rapid evolution and interchangeability as requirements change. New configuration and middleware tools that speed the "what-works-with-what" process are in development to facilitate the customer process. Costing and schedule information (optional services such as additional testing or modifications) are produced quickly and with high accuracy.

Assembly is simplified using standard parts and facilitated by standard tools, techniques and fixtures. Finally, confidence and FAT (factor acceptance test) testing are conducted using standard facilities, fixtures and procedures providing the potential for order fulfillment in weeks.

At the **heart** of MMS technology is the EMC FPGA-based carrier card.

FOUR
1 Gigabit Ethernet ports
(optionally 10 Gigabit)

TWO
USB 2.0 ports
(optionally USB 3.0)

FOUR
configurable RS232/422/485 ports

FOUR
ECM tiles
(25 are currently available)

Lightning: mission ready systems delivering on the promise of COTS

Conclusion

The promise of COTS espoused by Secretary Perry over 20 years ago is becoming a reality at Abaco Systems. The *Lightning* platform is a revolutionary response to a problem that has thus far proven to be intractable by our industry: how to substantially reduce the lead times for custom systems, giving them an availability that is much closer to 'off-the-shelf'.

Mission ready systems based on the *Lightning* architecture are modular, scalable and simply and cost-effectively upgradable. They leverage Abaco's unique MMS technology to make configuring an application's precise I/O requirement simple, straightforward – and highly cost-effective. They feature the latest processor technologies, and are made possible by state of the art manufacturing techniques and design and test processes.

Abaco's *Lightning* architecture is truly responding to the needs of our military customer for better, faster, less expensive, more capable and more sustainable embedded computing – and to benefit from those advantages far more quickly than has historically been possible.

Americas: 866-OK-ABACO or +1-866-652-2226 Asia & Oceania: +81-3-5544-3973
Europe, Africa, & Middle East: +44 (0) 1327-359444
Locate an Abaco Systems Sales Representative visit: abaco.com/products/sales
abaco.com | @AbacoSys