TECHNOLOGY WHITEPAPER

7 Simple Steps to Upgrading Your VME Single Board Computer

CURTISS-WRIGHT

DEFENSE SOLUTIONS

Read About

- Determining the right feature set for your VME SBC upgrade
- Backwards compatibility for backplane pinouts
- Modernizing security capabilities in VME systems

Introduction

Almost every VME system will require an upgrade at some point in time, whether it's a tech refresh to incorporate the latest processing technology and improve performance, a modernization process to meet changing security requirements, or inevitable diminishing manufacturing sources (DMS) management.

This guide is designed to help system integrators map out the full scope of the upgrade process to ensure all important considerations are identified in the planning stage, as well as provide a framework for selecting a new VME single board computer (SBC) that meets key program criteria – including budgetary and backward compatibility requirements.

The full scope of your VME SBC upgrade includes requirements for performance, power consumption, processor capability, I/O and security (among others).

Step 1: Determining the Right Feature Set

It's most effective to define all or most of the required features for your new VME SBC at the very start of your upgrade program. While this advice may seem obvious, it's easy to become too narrowly focused on your top requirements and potentially overlook certain aspects that will influence other decisions. Before evaluating any new technology, consider the following questions that will help ensure you define your requirements from all angles:

+ How much processing performance is required?
+ What are the SBC power supply requirements?
+ Are there any SBC power dissipation constraints?
+ How much memory is required, and what type?
+ How many serial ports, and what type(s)?
+ How many DIO ports, and what type(s)?
+ How many DiffIO ports, and what type(s)?
+ Are there any graphics/display interfaces needed, and what type?
+ What other interfaces are required (ex: USB, SATA, etc.)?
+ Are there any security features and capabilities required?

If the purpose of your upgrade is to replace an SBC that has become obsolete or includes end-of-life components, a contemporary SBC that matches the processing performance, power consumption, and I/O interfaces of your current solution may satisfy your requirements. On the other hand, if your goal is to increase performance or support new functionality, these enhancements may impact the rest of your SBC's features and specifications (such as power consumption). Documenting these program requirements and system constraints at the beginning of the upgrade process creates a comprehensive set of criteria to measure potential solutions against in order to find the right fit and avoid getting tunnel vision.

Step 2: Understanding Backplane Pinout Compatibility

Your product selection will be heavily influenced by whether or not you intend to alter your system backplane to accommodate a new VME board's potentially different pinout. Replacing or modifying your backplane can be a costly and time-consuming endeavor, but, depending on the full scope of your upgrade, it may be the logical choice. For instance, if your modern VME SBC replacement delivers more functionality than the board it's replacing, you could consider consolidating the number of cards in your system, such as graphics or storage modules. Doing so would allow you to maintain the same level of functionality and free up a slot, but may require changes to your backplane.

This option makes most sense in systems where reducing size, weight, and power (SWaP) is a top concern, or in those where it would be beneficial to add a new card in the now unoccupied slot. For programs with time to market pressure or budgets that can't accommodate the cost of redeveloping the backplane, however, this path is not ideal.

If your goal is to upgrade your VME SBC with minimal or no changes to the remainder of your system, choosing a new VME board with a compatible backplane pinout is optimal. While you will still have to integrate your new SBC with other existing cards and requalify the system, the board's backplane compatibility and fit within your overall power envelope will greatly reduce the costs and risks of your upgrade compared to re-spinning the backplane, which will in turn accelerate your time to market. As well, choosing an SBC that is compatible with your existing backplane simplifies your upgrade by allowing you to modify deployed systems without significant effort or having to recall platforms.

Step 3: Selecting a Processor

Single-core processors, once the dominant architecture, have become increasingly rare as today's processing technology has moved toward multi-core system on chip (SOC) designs. Newer multi-core processors vary from low-power and lower performance dual-core devices, such as the NXP® Power Architecture® P2020, to powerful multi-core devices, such as the NXP dual-threaded quad-core T2080 or the Intel® 8th generation Xeon® processor (formerly known as "Coffee Lake").

As stated in Step 1, one of the first requirements to consider is processing capability. If your legacy product's processing output is sufficient, it may be possible to choose a modern SBC with a processor that offers a low number of processing cores to satisfy the application's requirements. Alternatively, a new SBC with a higher core count can be configured so that some cores are disabled, which would match your existing performance levels while reducing power consumption.

If, however, more processing power is needed, you'll have to balance your performance requirements with your system's power constraints. Fortunately, next-generation processors are typically capable of providing higher performance while consuming less power. For example, a single core on the NXP T2080 running at 1.8 GHz provides 2.2 times the processing performance of the 1.2 GHz NXP MPC7447A/7448 processor with similar power consumption. Similarly, operating one core (dual-thread) on the Intel 8th generation Xeon processor running at 2.7 GHz can provide six times the processing power of Intel's Core 2 Duo processor, again at similar power consumption levels.

That said, it's still important to fully understand the power consumption implications of your new solution. Even if your new VME SBC is supplied the same amount of power as its predecessor, the card could draw more or less of this power from specific power supply rails, creating an issue with the existing power supply. And, of course, if your new VME SBC does consume more power than the card it's replacing, there will be an impact on the chassis's thermal performance and existing power supply.

When a significantly greater amount of processing performance is required, upgrading with a multi-core processor-based VME module is the preferred solution. Even if your original application is single-threaded, today's multi-core processors are capable of running single-threaded applications much faster. Multi-core processors can also be leveraged to consolidate multiple single-threaded cards, and can even be configured to run different applications independently on each core, if required.

Step 4: Defining Security Requirements

Cyber threats are rapidly and continuously evolving. Fortunately, modern processors offer increasing levels of protection against malicious interference through a variety of Trusted Computing capabilities.

First, a hardware-based secure Root of Trust is the foundation for many of the security capabilities on modern embedded computing systems. The Root of Trust is a unique, robust and system-specific mechanism that cannot be compromised, providing a level of trust that is guaranteed to be genuine. The system is assured to boot in an authentic and secure way, and provides a security foundation upon which a secure computing platform can be built. Because each subsequent level of security relies on the one previous to it, every level of security in the chain effectively relies on the Root of Trust.

One of these next layers of security is a secure boot process, which prevents unauthorized applications from loading during the start-up process and extracting sensitive information or modifying security and other device configurations.

While these security features provide a solid foundation for Trusted Computing, these protections must be properly enabled and configured. If done incorrectly or ineffectively, a compromised chain of trust can put people, equipment, and missions at risk. It's imperative to understand whether your hardware vendor has put the time, effort and expertise into implementing a robust Root of Trust and boot security capabilities as part of a layered Trusted Computing strategy.

Step 5: Picking an Operating System

At this stage of the upgrade process, you'll need to determine if your legacy operating system (OS) is sufficient or must be replaced. Even if you're happy with your current OS, moving to next-generation hardware often means your exact OS version may not be supported on the new processor. For example, when the latest Linux® kernel is coded to support newer processors, this support is typically not ported back to previous versions of the kernel. Even if your new hardware supports a legacy version of your chosen OS, it's generally recommended to upgrade to the newest release possible to take advantage of the latest fixes, features, security patches, and board support packages (BSPs).

Compilers and middleware must also be taken into consideration, as older compilers may have problems working with newer generations of devices and drivers. Moving to the newest versions will often resolve legacy issues, but comes with the expense of additional porting and validation.

Should you decide to evaluate moving to a new OS, you can either begin by finding a VME SBC that meets the requirements laid out in Step 1 and choose from the OSs for which it offers support, or select a new OS and work with a trusted vendor to choose a hardware solution that meets your needs.

Step 6: Considering Mezzanine Support

In VME systems, the most common system expansion approach is through the PCI bus-based PMC mezzanine module, which was the only open standard option available years ago when many of these systems were first designed. The next generation XMC mezzanine standard (VITA 42) modernized the approach with significant enhancements, such as support for much faster PCI Express® (PCIe®) and higher speed differential I/O interfaces.

Although XMC mezzanines have become increasingly popular in contemporary VME system designs, many older PMCs remain in use and can be expected to stay in service for many years to come. If your current VME SBC supports a PMC, your selected upgrade VME module should support both PMC and XMC cards.

Because today's new microprocessors only support PCIe interfaces (and not PMC mezzanines' native PCI interface), your VME SBC replacement must perform a conversion from PCI-to-PCIe with a bridge device in order to support a PMC mezzanine. Unfortunately, PCI-to-PCIe bridging can sometimes detrimentally affect performance, a factor that must be considered during the upgrade process.

It's important to note that, while your new SBC may support a PMC, you'll also need to determine whether the appropriate drivers are available for your PMC to run the OS you've selected. If not, you may need to upgrade your PMC in order to support your preferred OS or write a driver for the OS version you intend to use. In this case, unless you have unique requirements that can only be fulfilled by your PMC, you may want to evaluate upgrading to a contemporary XMC mezzanine during your SBC upgrade.

Your mezzanine I/O is also a consideration. PMC modules use connector Pn4 for I/O signals, whereas many XMC mezzanines use Pn6 for I/O signals. As VME systems cannot support the high-speed signaling speeds of Pn6, all mezzanines – including XMC – should maintain I/O on the Pn4 connector.

Step 7: Evaluating the Options and Selecting Your Best Fit

Updating a legacy system to incorporate modern technology and features can be a daunting task, especially when working within the confines of an existing structure. While outlining your requirements provides a solid foundation for selecting the solutions that will replace your older technology, the vendors you evaluate should have the experience and expertise to add even further value by understanding your specific needs, proactively identifying any roadblocks you may face in your upgrade, and providing guidance throughout the pre- and post-purchase stages.

Boosting Performance without Adding SWaP-C

As previously mentioned, newer VME SBCs are often capable of delivering higher performance processing while consuming less power. Not only that, modern VME SBCs, such as Curtiss-Wright's VME-196, are designed to enable the reuse of application software. These factors – in addition to the backward pinout capability discussed in the next section – can reduce the budget impact of your VME upgrade, making boards like the VME-196 ideal for SWaP-C consolidation.

Customizable Backplane Pinout Compatibility

Whether you opt to replace your backplane or choose a solution that matches your existing VME pinout, Curtiss-Wright can support your system modernization.

Curtiss-Wright maintains as much backwards backplane pinout compatibility as possible between generations of its VME modules in order to reduce the cost and complexity of your upgrade. As well, the feature sets are often nearly identical, with the exception of older standards that have become less commonly used between generations, such as SCSI.

If a specific backplane pinout requirement needs to be met, Curtiss-Wright can modify one of our current-generation VME boards to meet the backplane requirements of your previous generation card. Curtiss-Wright can even match the features and pinouts of other vendors' VME modules, giving you the flexibility to choose the best solution for your needs without feeling tied to your legacy board's vendor.

If you're replacing your backplane, or in instances where your chassis, power supply, and/or backplane may be affected by your desired VME card upgrade, Curtiss-Wright can help assess your requirements and bring you toward a full system solution.

TABLE 1: Curtiss-Wright VME SBCs and Pin-Compatible Upgrades

PROCESSOR TYPE	LEGACY VME MODULE	PINOUT COMPATIBILITY	UPGRADE OPTION
NXP Power Architecture	VME-178 VME-179 VME-181	~90% match	VME-186 VME-194/B VME-196
	VME-182 VME-183 VME-184	~100% match	VME-186 VME-194/B VME-196
Intel	VME-1901 VME-1905 VME-1908, VME-1908B	~100% match	VME-1909 VME-1910

Table 1: Curtiss-Wright VME SBCs and pin-compatible upgrades

Flexible Processor, Memory and I/O Options

Curtiss-Wright offers a broad selection of contemporary VME processing modules to meet various performance, power, memory and I/O specifications.

Figure 1: Examples of air-cooled (VME-1909) and conduction-cooled (VME-186) modules

<table>
<tr><th colspan="2">TABLE 2:</th><th colspan="5">Latest Curtiss-Wright VME SBCs</th></tr>
<tr><th>PRODUCT NAME</th><th>PROCESSOR</th><th>MEMORY & STORAGE</th><th>MEZZANINE</th><th>SUPPORTED I/O</th><th># OF CPUs</th><th># OF CORES/ THREADS PER CPU</th></tr>
<tr><td>VME-196</td><td>NXP Power Architecture QorIQ® T2080</td><td>16 GB</td><td>XMC, PMC</td><td rowspan="3">Gigabit Ethernet
EIA-422/485
EIA-232
MIL-STD-1553
SATA, USB, DIO</td><td>1</td><td>4/8</td></tr>
<tr><td>VME-194B</td><td>NXP Power Architecture QorIQ P2020</td><td>2, 4 or 8 GB</td><td>XMC, PMC</td><td>1</td><td>1/2</td></tr>
<tr><td>VME-186</td><td>NXP Power Architecture P4080</td><td>512 MB, 1 GB or 2 GB</td><td>XMC, PMC</td><td>1</td><td>8</td></tr>
<tr><td>VME-1910</td><td>Intel 8th Gen Xeon</td><td>8 or 32 GB DRAM

Up to 256 GB SSD</td><td>XMC, PMC</td><td rowspan="2">Gigabit Ethernet
EIA-422
EIA-232
SATA, USB, DIO
DVI-D
VGA (RGBHV)
Analog Audio</td><td>1</td><td>6/12</td></tr>
<tr><td>VME-1909</td><td>Intel 5th Gen Core i7</td><td>8, 16 or 32 GB

Up to 128 GB SSD</td><td>XMC, PMC</td><td>1</td><td>4/8</td></tr>
</table>

Table 2: Latest Curtiss-Wright VME SBCs

Protection against Modern Security Threats

Curtiss-Wright's contemporary SBCs offer Trusted Computing features to modernize and protect older VME systems from the latest security threats.

For example, Curtiss-Wright's Intel 8th generation Xeon processor-based VME-1910 has been designed to support a powerful and flexible set of hardware and software capabilities that protect critical resources from unauthorized access or modification. The VME-1910 includes a TPM 2.0 hardware security device that can be used to generate, store, and recall security keys, and can be used to create a secure computing environment, ensuring only trusted and signed BIOS and software can execute on the board. The VME-1910 fully supports Intel Boot Guard to provide a trusted and measured boot process, as well as UEFI Secure Boot to validate the OS boot loader, and extends trust security into the operating system (read more about Intel security features).

Curtiss-Wright's Power Architecture-based VME SBCs provide a similar set of Trusted Computing capabilities to protect operation from the moment a system powers on. The NXP Power Architecture T2080-based VME-196, for example, supports NXP Trust Architecture and Secure Boot to ensure safe, reliable and trusted operation (read more about NXP Trust Architecture).

Best-of-Breed Software Support

OS support for Curtiss-Wright VME SBCs, provided either directly from Curtiss-Wright or from our software partners, includes today's leading names:

+ Concurrent Real-Time RedHawk™ Linux
+ Green Hills Software INTEGRITY®
+ Linux (Red Hat RHEL or CentOS, Fedora, NXP, etc.)
+ Lynx Software Technologies® LynxOS®
+ Microsoft® Windows® (Intel)
+ Wind River® VxWorks®

While often APIs must change as modern SBC functionality evolves, Curtiss-Wright strives to keep APIs as consistent as possible between generations.

When it comes to software support, older single- or dual-processor VME modules ran in an Asymmetric Multi-Processing (AMP) mode, which allowed for a multi-core design featuring multiple CPUs with different architecture types and OSs, and facilitated communication between them. Conversely, newer, more powerful processors are available only with support for Symmetric Multi-Processing (SMP), which requires a homogeneous multi-core design (i.e., all CPUs must have the same architecture). However, certain newer Curtiss-Wright VME SBCs, such as the SVME-194B, can run with an AMP BSP if required.

It's also possible with today's multi-core processors to run with a hypervisor, enabling multiple independent operating systems and applications to run on a single processor and VME module. Alternatively, many OSs support the concept of core affinity, where an application only ever runs on a single core, allowing applications in AMP mode to be ported with less effort.

PMC/XMC Mezzanine Expansion Support

The majority of Curtiss-Wright VME SBCs provide Pn4 I/O for backward compatibility to support both PMC and XMC cards. For instance, both the VME-1910 and VME-196 include dual PMC/XMC mezzanine sites. Featuring the latest rugged Intel and Power Architecture processors (respectively), these boards deliver next-generation performance enhancements while preserving clients' investments in PMC expansion modules, or supporting a wide variety of high-performance contemporary XMC mezzanine cards, including FPGA, GPGPU and storage modules.

Longevity Support and Investment Protection

Obsolescence is an inevitable part of the technology lifecycle but, when it occurs earlier than expected, its impact can be significantly greater than planned for. Such was the case with the IDT TSI148 (also known as TEMPE) interface chip, which was unexpectedly discontinued in 2014 and forced many VME systems users, both in the commercial and aerospace and defense sectors, to consider costly redesigns to move to a new form factor once their systems required a technology refresh. With no compatible alternative providing the same feature set of the TEMPE PCI-to-VME interface chip, Curtiss-Wright began future-proofing its VME products by developing an FPGA interface chip it dubbed "Helix". While providing full VME interface functionality, Helix's FPGA design makes it obsolescence resistant to protect the viability of VME systems for years to come.

As well, Curtiss-Wright offers comprehensive Total LifeCycle Management (TLCM) services to proactively mitigate DMS challenges during the active stage of your program and provide extended longevity support for long-term builds and repairs.

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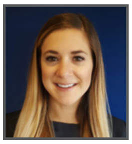

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To ensure component obsolescence issues don't impact your VME solution's ability to meet your program needs, TLCM gives you configuration control with the ability to approve or reject engineering change proposals. TLCM customers receive last time buy priority, with early alert notifications providing an advance opportunity to secure and protect components in the event of a lifetime buy decision.

Curtiss-Wright even provides onsite storage for customer-owned inventory, alleviating the burden of maintaining, storing and managing your purchased components.

With real-time DMS reporting and 24/7 access to key lifecycle information through the industry-leading TLCM web portal, Curtiss-Wright offers unprecedented support and visibility throughout the duration of your program.

Need support for your VME SBC upgrade? Contact your Curtiss-Wright representative today.

Learn More

White Papers

- The Many Faces of Trusted Computing
- Getting Secure, Intel-Based Solutions to Market Faster - Why the Hardware Vendor's Boot Security Implementation Is So Important
- Embedded High Assurance Computing Using NXP Trust Architecture

Videos

- Helix FPGA VME Interface video

Products

- 6U Intel Single Board Computers
- 6U Power Architecture Single Board Computers
- Total LifeCycle Management brochure