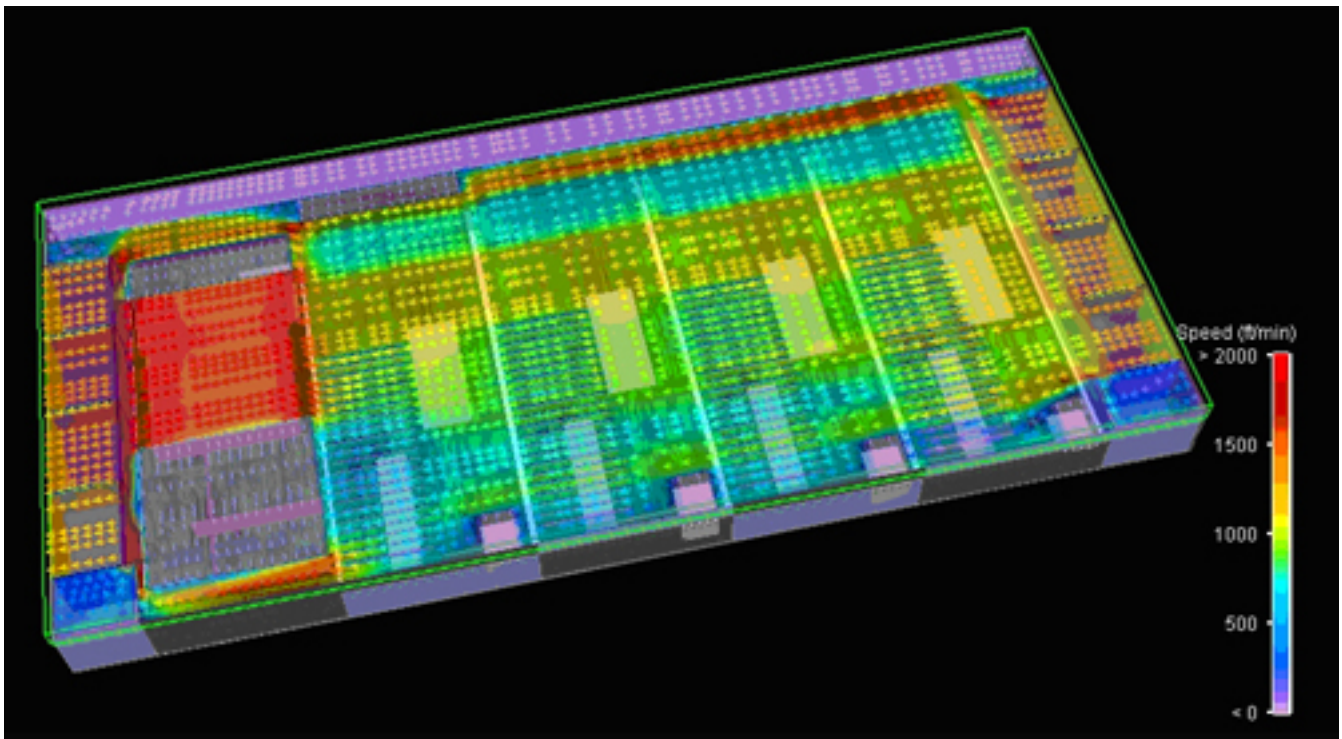
Compact Packaging – Squeezing Every Inch Out of Embedded System Platforms

Justin Moll, Manager of Marketing, Elma Americas, Elma Electronic Inc.

Design applications are getting increasingly dense for embedded system platforms. You name the application, and in most cases, space it at a premium. Packaging the boards, power supplies, fans, drives and other components into these smaller spaces can be challenging. Plus, cooling the densely packed systems is a key concern. We'll illustrate these trends using newer architectures MicroTCA and VPX, which each tell a story from a different point-of-view.

MicroTCA is a good example of the trend in industrial and consumer computing systems to offer more performance in less space and at a lower cost. The architecture is gaining popularity in Communications-based systems. However, to enable competitiveness in enterprise and industrial applications, designers are finding new ways to balance space, performance, and costs. VPX on the other hand is more geared toward Mil/Aero and Scientific/Research applications, where costs are not as much an issue as is mission-critical performance. Many Mil/Aero applications also have demands of high performance in smaller and smaller spaces. This can be witnessed by the needs of processor intensive systems such as UAVs, FLIR systems, LIDAR/RADAR systems, etc.

MicroTCA Enabler
MicroTCA uses AdvancedMCs (which have been around for several years) providing approximately 5,000 MB/sec slot-to-slot performance. The modules can be as small as approximately 75mm H, 14 mm W, by 180mm D. The MicroTCA community is trending towards systems that will be competitive in markets that demand lower costs. The architecture is competitively priced for many access edge and core applications, but not always the case for enterprise and industry embedded systems.



Thermal simulation helps optimize cooling performance of this 1U MicroTCA chassis. The colors show airflow speed. The red area is the faster air speed to cool the hot-running power module.

To achieve the lower cost goals, there are two main directions for the architecture. These “MicroTCA Enablers” if you will, involve going slim or simplifying features. Going slim involves designing the chassis in a horizontal-mount versus a vertical-mount configuration and maximizing performance density. Most MicroTCA chassis started in a vertical-mount orientation, and a 5U height was a common size. This allowed 14 slots – often 1 MicroTCA Carrier Hub (MCH), 1 Power Module (PM), and 12 AMCs (single module/full size). However, a horizontal chassis can hold 6 AMCs (going to a single module/mid size), along with 1 MCH, 1 PM, and 1 J-TAG Switch Module – all in a 1U height! With specially designed compact cooling modules, adequate thermal management can be confirmed through simulation and testing, even in a side-to-side airflow configuration. (See Diagram 1 for example of thermal simulation for a 1U MicroTCA chassis).

The other direction for MicroTCA is to simplify the features away from the needs or higher-end telecom to simpler solutions. For example, some MicroTCA systems have full redundancy, individually managed Field Replaceable Units (FRUs) such as power modules and fans, and complex routing. Instead the backplane can have simpler direct links for PCIe, SATA/SAS, as well as putting the IPMI intelligence on the backplane. This can be performed by putting the IPMI voltage and control intelligence onto an active backplane. This reduces the costs of having intelligence on each individual FRU (Field Replaceable Unit) such as Cooling Units and Power Modules. As low-cost MCHs (MicroTCA Carrier Hubs) with simplified switching are introduced to the market, the overall system costs can be further reduced. The lower-cost approach is helping MicroTCA be more amenable to a wider range of applications. Requiring less slots and FRUs also allows the packaging size to be

more condensed.

VPX

VPX (VITA 46/48 specifications) is a powerful new architecture with approximately 5,000 MB slot to slot performance. With a compact size and tremendous performance potential, it is an ideal fit for dense and rugged applications.

Whether using 3U or 6U high cards, cooling VPX enclosures can be a challenge. Typical wattage/slot today is 100-120W, with higher amounts expected in the future. Therefore, enclosures need to cool these chassis in creative ways, especially in densely packaged designs. With applications such as UAVs, forced-air cooling may not be an option. VITA 48 will provide a pathway to liquid cooling through the individual modules. A cost-effective solution in the meantime is to have the liquid go through the chassis sidewalls. This can provide up to 150W/slot of cooling, without the tricky issues with the liquid having to go through each card.

A modular design for these architectures helps make customization more cost-effective, time saving, and easy. It also helps minimize the rack space used by utilizing every inch. An experienced design engineer can arrange the power supplies, fans, I/O cabling, filters, shock isolators, etc, in a wide range of configurations with a modular design. This can be achieved using any of several modular enclosure types depending on the application, these include:

• Portable -- with carrying handles, often scratch-resistant, not too large
• 19” Rackmount or desktop – hinges for rackmount, optional feet for desktop
• EMC Shielded – gaskets added or stamped into metal, covers may have edges folded over the sides for extra sealing
• Severe environment -- various types for environmental protection, shock & vibration, etc.
• Economic -- often stamped sheet metal, lower cost, less complex
• Aesthetic – often have attractive bezels, powder coated or painted, smooth/round edges, double walled, etc.

A wealth of possibilities: each design brings its own set of challenges to balance density/space limitations, cooling, EMC, ruggedization, I/O, reliability/uptime, etc.

(See Figure 2 showing a wide range of enclosure types) Whether VPX or MicroTCA are used or another standard or custom architecture, system platforms for the embedded market will continue to see new challenges. Creative approaches and modular designs will help squeeze every bit of space and maximize performance density.

Justin Moll
Manager of Marketing, Elma Americas
Elma Electronic Inc.
510-656-3400
www.elma.com [1]
justinm@elma.com [2]

Justin Moll has over 13 years of high-tech marketing and sales experience and has been with Elma Electronic since 2000. As the Manager of Marketing, Elma Americas, he has led the company's charge in several next-generation backplane and chassis technologies. Justin is active in VITA and PICMG and has been a guest speaker at several industry events. He also is a co-founder of PKG magazine, an RTC group publication; and has served as the VP of Marketing for the StarFabric Trade Association. Justin received his Bachelor of Science degree in Business Administration from the University of California, Riverside.

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