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COM Express Gains on PC/104 in Military

Overview

As the military transitions to network-centric warfare, there's a greater need for systems that incorporate more powerful technologies to support high bandwidth communications, advanced data processing and improved quality graphics. These requirements are especially challenging for space-constrained designs, such as battlefield equipment and unmanned vehicles, and this white paper discusses tradeoffs between PC/104 and COM Express when faced with these challenges.

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Executive Summary

As the military transitions to network-centric warfare, there's a greater need for systems that incorporate more powerful technologies to support high bandwidth communications, advanced data processing and improved quality graphics. The latest military networks look like telecom networks, where very intelligent, field-based endpoints, such as unmanned robots and navigation systems, share real-time information with ground stations and command centers. This evolution is especially challenging for designers of small form factor systems who face stringent space and power constraints.

The need to increase performance on a number of fronts—compute, I/O and graphics—is making it harder for system designers to satisfy these requirements with PC/104-based boards. For example, the PC/104-Express standard, developed to support PCI Express® for high speed I/O, uses an additional connector that takes up valuable board space and employs a complicated stack-up. Consequently, less board real-estate is available to deploy the latest processors and digital signal processors (DSPs) required for higher performance applications.

Offering similar small form factor benefits, COM Express, a computer-on-module (COM) standard, overcomes these limitations by offering greater board space efficiency and more I/O flexibility than PC/104. This white paper discusses some of the tradeoffs between PC/104 and COM Express for space-constrained designs, such as battlefield equipment, unmanned vehicles and other mobile military assets.

Small Form Factor, Big Challenges

Supporting an agile military, equipment manufacturers keep packing more computing power into mobile systems used in fighter jets, big trucks, bomb deactivating robots, and command, control and communications (C3) intelligence systems, just to name a few. Small form factor doesn't imply low performance, but actually the opposite, as the latest processors, I/O connectivity and graphics technologies must be squeezed into extremely small devices.

How are mobile systems evolving? Powerful multi-core CPUs are processing high bandwidth radar streams; high-speed PCI Express links are transmitting high definition video images; and state-of-the-art graphics are displaying detailed in-vehicle maps across VGA, LVDS and other video interfaces. Today, the main choices for standards-based, commercial, off-the-shelf (COTS) solutions are PC/104-Express and COM Express, as illustrated in Figure 1.

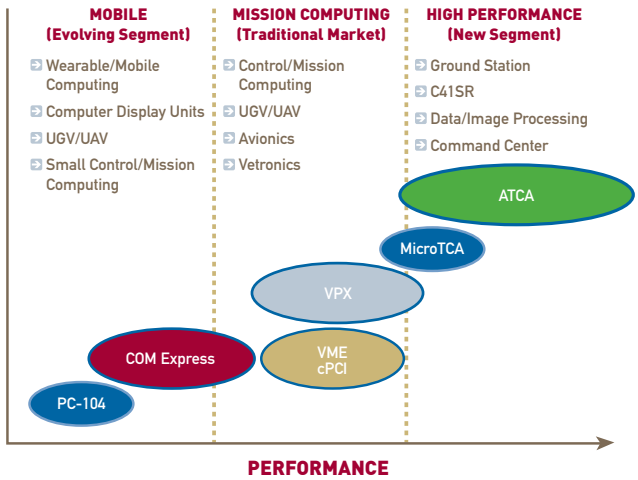


Figure 1. *Mil-Aero Market Segments Served By COTS Suppliers*

New Technology, Lower Cost

The PC/104 Consortium[1] was established in February 1992 by twelve companies with a common vision of adapting desktop computer technology for embedded applications. Soon thereafter, a specification emerged offering the power and flexibility of an IBM compatible personal computer in a size ideally suited for small, but rugged equipment. The PC/104 specification has adopted new technologies over the years, including the ISA bus in 1997, the PCI bus in 2003 and the PCI Express bus in 2008.

PC/104-based products have been instrumental in driving greater acceptance of COTS solutions in military applications, because their modularity provides a dramatic savings in R&D cost and time while reducing risk for equipment manufacturers and customers. However, the cost benefits of PC/104 products are starting to erode as the stackable architecture and the associated connectors add cost and reduce board real-estate efficiency. In addition, many PC/104 connectors are double-sided for stacking purposes, making them more costly than single-sided connectors used by COM Express. Double-sided connectors are twice as expensive, in terms of board space, as single-sided connectors that can have components placed on the opposite side.

Whereas PC/104 is a multi-stack architecture, COM Express has just two layers comprising a computer module and a carrier board that can be customized according to specific application requirements. The carrier board can incorporate all the custom I/O of a PC/104 stack, thereby reducing cost and allowing manufacturers to keep proprietary I/O in-house. System designers have more flexibility because the carrier board size isn't fixed, therefore it can be enlarged to support the latest computing technologies, as needed. Furthermore, COM Express offers the same standards-based COTS advantages as PC/104, in addition to other benefits listed in Table 1, highlighted in a VDC Research survey.

Reasons for Using or Selecting Computer-on-Module (COM) for Target Application	Rank
Industry standard product class	1
Backwards compatibility with a legacy product	2
Modularity of boards	2
Reliability of boards	2
Size of boards	2

Table 1. *Data From Respondents Indicating COM Express Use (Source: VDC Research, Merchant Computer Boards for Real-time and Embedded Applications, October 2008, p. 304)*

Comparing PC/104-Express and COM Express

The open-standard specifications for PC/104-Express and COM Express define many design requirements, such as board sizes, connector signal assignments and stacking. The board sizes are illustrated in Figure 2, showing one option for PC/104-Express and three options for COM Express, including a new 95 x 95mm compact version defined in COM.0 R2.0, which is expected to achieve approval in 2010.

As mentioned previously, one of the major differences between the PC/104 specification and COM Express is the choice and use of the connector. Processor performance and features have increased dramatically in the last several years. The addition of integrated graphics/video, PCI Express and other high performance interfaces requires a connector with higher bandwidth and more pins in a smaller space than was used for PC/104.

The connectors on COM Express were selected for several reasons:

- *Size*—The connector is a small surface mount technology (SMT) connector utilizing a minimal amount of board real estate.
- *Pin Count*—The connector supports the required number of I/O and future expansion.
- *Signal Integrity*—The connector delivers the level of signal integrity needed for high performance I/O such as PCI Express, Video, LVDS and Gigabit LAN.

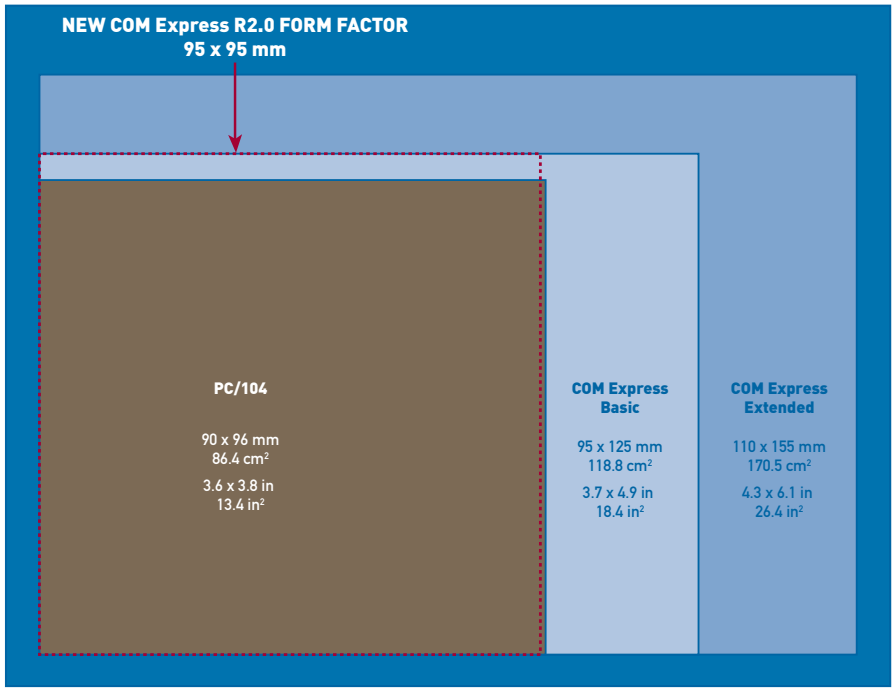


Figure 2. *Board Size Comparison*

Table 2 shows the comparison of the I/O capabilities of COM Express and PC/104 connectors.

As shown in Table 2, PC/104 supports PCI Express, but it does so by adding another connector to an already real estate challenged board. In order to add features, such as video, LAN or SATA, additional connectors must be added to the base PC/104 board, and the signals are not available to other boards in the stack. COM Express, on the other hand, brings all of the signals down to the carrier card where connectors can be added as required by the system application. For example, the carrier card can be used to interface with military standard connectors as required on most military applications.

As military applications grow in complexity, COM Express is well-equipped to handle more demanding computing, I/O bandwidth and graphics requirements. On the other hand, increasing the capability of a PC/104-Express solution often means adding more stacked boards and connectors and possibly ending up with a rather cumbersome system, as shown in Figure 3. Because COM Express uses just two boards,

PC/104-Express™ Connectors	COM Express Connector
4 x1 PCI Express links 1 x16 PCI Express link	6 x1 PCI Express links 1 x16 PCI Express link (or SDVO, dedicated I²C)
PCI Bus 32bit 33/66MHz	Same
Not available	PATA ATA100 (1 Port only)
SMBus	Same
Not available	I2C Bus
Not available	AC'97 / HDA
Not available	LPC Bus
2 x USB 2.0	8 x USB 2.0
Not available	SATA 150-300
Not available	LAN Port 10/100 or Gigabit
Not available	Digital Display Interfaces
Not available	VGA (dedicated DDC)
Not available	LVDS (A&B, dedicated I²C)
Not available	GPI[0:3] GPO[0:3]
Not available	Speaker out

Table 2. *Board Connector Comparison*

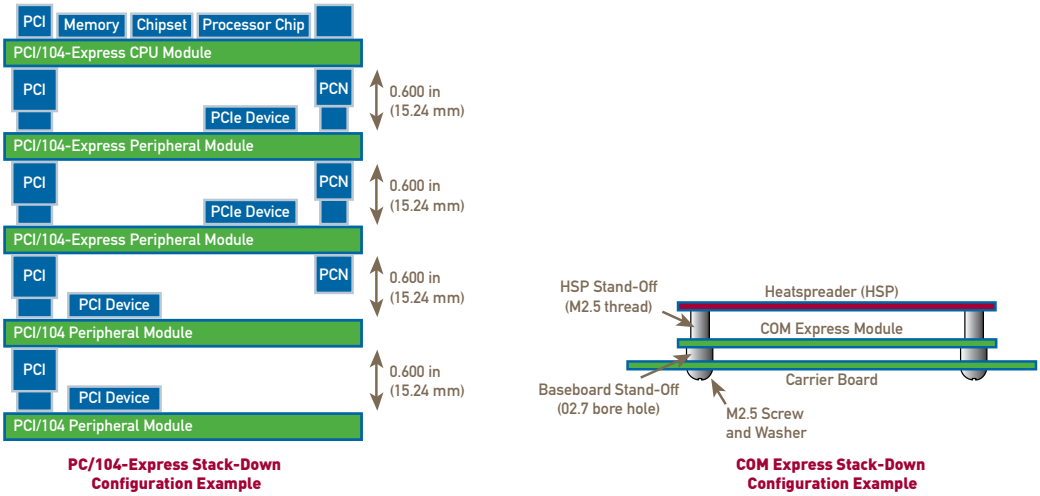


Figure 3. *Stack-up Configurations*

it provides benefits over PC/104 with respect to system cost, cooling, height, parts management and signal integrity, as described in Table 3.

Processors Integrate Graphics

Integrated graphics engines, embedded into Intel® Core™ i7 and Intel® Core™ i5 processors, provide enhanced graphics capabilities and performance while reducing overall platform power requirements and footprint. Compared to the integrated graphics in the Intel® GM45 Express chipset, the Intel® processor-based graphics engines perform 1.8 times and 2.6 times better for two 3DMark tests, as shown in Figure 4. In addition, these dual-core processors can process up to four software threads simultaneously with the integration of Intel® Hyper-Threading Technology, which boosts the performance for parallel, multi-threaded applications.

In order to utilize this graphics performance, most military systems require multiple displays and input devices. By having all of the video signals on the COM Express connectors, the carrier card can provide the different video and input interfaces required by the system. On a PC/104 board, all of the connectors would have to be on the base board, which would further reduce the usable board space.

Design Consideration	COM Express Benefits compared to PC/104-Express
System cost	Greater board efficiency reduces cost
High performance CPUs/ Heat dissipation	More board area to place components Easier to implement heat spreader, heat sink
Vertical height	Shorter and predictable height
I/O	Greater flexibility with carrier board More PCI Express and USB ports
Parts management	Fewer boards to manage
Board space constraints	Unconstrained carrier board (except for total form factor)
Signal Integrity	Better since signals pass through no more than one connector
Connector constraints	Easier to accommodate tall connectors and connector placement

Table 3. *Benefits of COM Express over PC/104-Express*

Radisys COM Express Solutions

Radisys® Procelerant™ COM Express product family consists of more than a dozen extended and industrial temperature range modules, some of which are listed in Table 4. Leveraging this portfolio, military equipment manufacturers can meet their harsh environmental requirements while shortening their time to market and reducing development costs.

By removing the processor, chipset and memory from the rest of the design, manufacturers are free to focus engineering resources on developing differentiating features, avoiding the design churn that comes with implementing new processor generations and increasingly complex design rules. Radisys also provides a wide range of COM Express custom services that further accelerate customer time to market by supplying carrier concept definition and design, carrier schematic reviews, BIOS customization and thermal design.

Meeting the Needs of the Advanced Military

The technical specifications for military systems continue to escalate, driving the requirement for higher performance processors and DSPs, lower support costs, and faster I/O and graphics. As systems become more network-centric, it's an ideal time for PC/104 developers to take a close look at COM Express, offering newer technology at a lower cost.

COM Express was defined with the transition to PCI Express and higher bandwidth I/O requirements in mind, whereas the PC/104-Express adopted a new, rather cumbersome, stackable connector. Instead of meeting emerging requirements with a large stack of PC/104 boards, system developers can deploy a flexible two board solution based on COM Express.

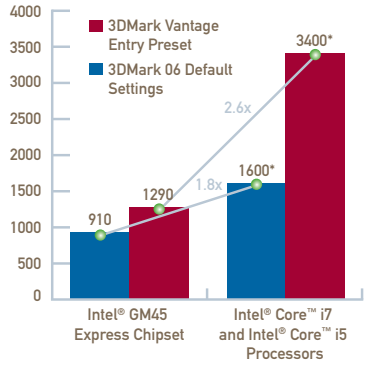


Figure 4. *Comparison of Graphics Performance: Chipset and Processor*

Features	Sample of Radisys COM Express Modules			
Product	Procelerant CEGM57XT	Procelerant CEGSXT	Procelerant CEZ5XL	Procelerant CEZ5XT
Size	95 x 125mm	95 x 125mm	95 x 125mm	85 x 70mm
Processor	Intel® Core™ i5 and i7 processors	Intel® Core™2 Duo processor	Intel® ATOM® Z530 processor	Intel® ATOM® Z530 and Z510 processors
Max Memory	8 GB	8 GB	2 GB	2 GB
Operating Temperature	-25 to +70˚C	-25 to +70˚C	-40 to +85˚C	-25 to +70˚C
PCI Express	6 PCIe x1 + 1 PCIe x8 + build–option for 1 PCIe x16	5 PCIe x1	5 PCIe x1 + 1 full-bandwidth PCIe x1	2 PCIe x1

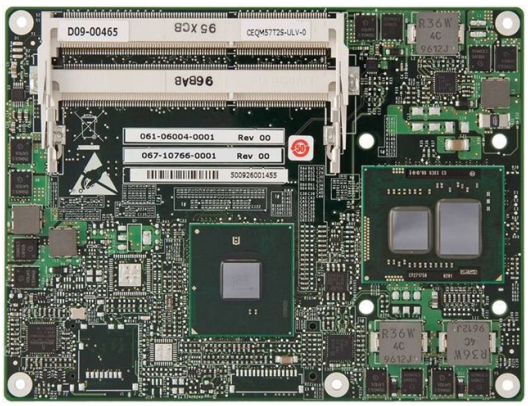
Table 4. *Sample of Radisys COM Express Modules*

Radisys Procelerant COM Express products are a fit for demanding military applications, and can help equipment manufacturers reduce development costs and shorten their time to market.

For more information please visit http://www.Radisys.com/Products/COM-Express/COM-Express-Modules.html

Keeping Ahead of the Technology Curve

The Procelerant CEQM57XT combines the next generation Intel® Core™ i5 and i7 processors with a -25˚C to 70˚C temperature range and extended vibration specification to provide breakthrough processing performance on a basic size COM Express module for harsh environments. The compact 95 x 125mm module is ideal for compute intensive military–aerospace applications that require high levels of computing, I/O, storage and graphics capabilities. Radisys delivers the CEQM57XT module in a Type 2 and Type 3 pin-out, enabling customers to easily upgrade from their previous generation module while boosting features and performance with up to 8GB memory, SSDDR3 options, additional PCI Express lanes, and improved storage, graphics and audio.



Procelerant CEQM57XT COM Express Module

References

[1] http://www.pc104.org/history.php/104+history

About the Author

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Lorraine has primary responsibility for the COM Express product line at Radisys. With over 10 year's of experience in product management and business development roles, Lorraine has an in-depth knowledge of how new processor technologies along with smaller footprints have opened up a multitude of design options for military equipment manufacturers. Lorraine received her BS in Electronics Engineering Technology from the DeVry Institute of Technology.

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