COM Express: The next generation Computer-On-Module standard

By Bob Pebly

In this article Bob outlines Computer-On-Module (COM) advantages and discusses the ripple effect movements from legacy and parallel bus interfaces to high-speed differential serial interconnects have had on standard form factors.

Introduction

The concept of a Computer-On-Module, or COM, is not new within the embedded computer industry. Various COM solutions and implementations have been around for years, but none ever took hold as a dominant or de facto standard within the embedded computer industry. Conceptually, the function and benefits of a COM are straightforward. Modularize the processor, Northbridge, Southbridge, memory, and Flash of a typical PC in a compact, highly integrated fashion and you have a COM. The key advantage of the COM in a typical embedded design is that the most rapidly changing part of the design, the portion riding along on Moore's law, is modularized and decoupled from the rest of the system design. By segmenting the processor complex onto a COM module, embedded designers can focus on the key features and devices within their systems and design an embedded COM carrier board free from the rigors of keeping pace with the continuous board turns of the commercial PC industry.

Taking advantage of a fragmented embedded market and technological disruptions within the PC industry, the PICMG COM Express specification defines a standard COM form factor that brings modularity and standardization to unite embedded COM designs in the future.

Mezzanines and COMs: Today and tomorrow

The embedded market is extremely fragmented. No universally accepted standards for COMs, mezzanines, or small form factors exist, as multiple standards serve specific market subsegments. There are literally dozens of small form factor COM and mezzanine module implementations. Despite this fragmentation, VDC projects a compound annual growth rate of 54 percent for the COM market through 2006.

One of the first questions faced by any new standards effort is why not reuse or adapt an existing standard? Several mezzanine and module standards (such as PMC, AdvancedMC, XMC, and PC/104) have all been suggested as potential form factors for a COM standard. However, on closer examination, each falls short of the requirements for a next generation COM standard. The PCI Mezzanine Card, or PMC, is probably the most successful and only embedded small form factor that has achieved broad adoption across multiple market segments, applications, and host form factors. However, the primary shortcoming of PMC for next generation COM requirements is insufficient pins to support the breadth of I/O demanded by COM applications and the inability of its connectors to support newer high-speed differential serial interconnect technologies such as PCI Express, eXtended Mezzanine Card (XMC), the natural evolution of PMC, addresses the connector signaling issues of PMC; however, it still falls short on I/O pin count for the COM market.

Another mezzanine standard emerging from the telecommunications market is the Advanced Mezzanine Card, or AdvancedMC, which is primarily targeted for use in AdvancedTCA systems. Much like XMC, the AdvancedMC design utilizes a lower pin count connector geared towards fabric only implementations. Another key design point of AdvancedMC, hot swappability, is simply not a requirement for the majority of embedded COM applications and does not warrant the additional cost or complexity. Older standards such as PC/104 do not support next generation signaling technology and also rely on the stacking of multiple modules to achieve I/O density.

Several de facto standards and proprietary implementations such as ETX, Plug-N-Run, and ESB were also suggested, but each had its own shortcomings in meeting the requirements for a next generation COM standard. A new solution was required to address the COM market moving forward.

Standardization opportunities via technology disruptions

The PC industry is currently in its second major bus transition. Unlike the past transition from ISA to PCI, however, there is also a broader technology disruption afoot transitioning from legacy and parallel bus interfaces to high-speed differential serial interconnects. Examples include the migration from PCI to PCI Express, ATA to Serial ATA, and SCSI to Serial Attached SCSI. Additionally, legacy free designs are becoming a reality with the I/O interfaces of the typical SuperIO migrating to USB. These transitions have a ripple effect over standard form factors across the industry, including both common commercial and embedded form factors.

This multifaceted technology disruption presented the opportunity to standardize an otherwise fragmented COM market. In late 2003, RadiSys, along with Intel, Kontron, and PFU Systems formed a working group to define a next generation standard for COM modules. Recognizing the need to avoid yet another fragment in an already fragmented market, the working group formalized itself within the PCI Industrial Computer Manufacturers Group (PICMG) in the spring of 2004. Over 40 companies responded to the call for participation and the resulting PICMG subcommittee is now well underway to publish the COM Express specification by year-end 2004.

What is COM Express?

The COM Express specification defines the mechanical, electrical, and thermal requirements for a highly integrated COM mezzanine. The standard specifies a rich set of high-speed serial and I/O interfaces while preserving key current interface technologies to ensure a smooth migration path.

COM Express features[1]
The COM Express specification defines two module sizes. The basic module is 95 mm x 125 mm, while the pin compatible extended module size is 110 mm x 160 mm. The extended module size is intended to support both larger processors and denser memory solutions over the smaller basic module size. In addition, the modules support:

- Internal and external graphics
- Multiple display devices
- Audio
- Networking
- Storage
- Various I/O and expansion interfaces

Primary power for the module is 12 VDC, with the module responsible for converting down to the core voltages necessary to support circuitry on the module. All interfaces between the module and carrier are via a 440-pin connector; the COM Express module specification defines no cables or external connectors. Figure 1 illustrates the basic features of a typical COM Express Module.

The interfaces defined by the COM Express specification between the module and carrier are summarized as follows:

- Display
  - Two serial DVO channels capable of supporting various display types including DVI, LVDS, and TV out devices
  - Analog VGA
  - LVDS flat panel
  - TV out
- Audio
  - AC '97 digital interface
  - Speaker out
- Storage interfaces
  - Four Serial ATA ports
  - Parallel ATA port supporting two IDE devices
- Networking
  - Gigabit Ethernet
- Expansion
  - x16 PCI Express interface, which enables high end external graphics devices
  - Up to six x1 PCI Express interfaces
  - Sideband support for up to two Express Card interfaces
  - PCI Revision 2.3 32-bit interface
  - Up to 8 USB 2.0 ports
  - Low Pin Count (LPC) bus
- Miscellaneous
  - 12 V primary payload power
  - 5 V standby power
  - GPIO
  - SM bus
  - I2C

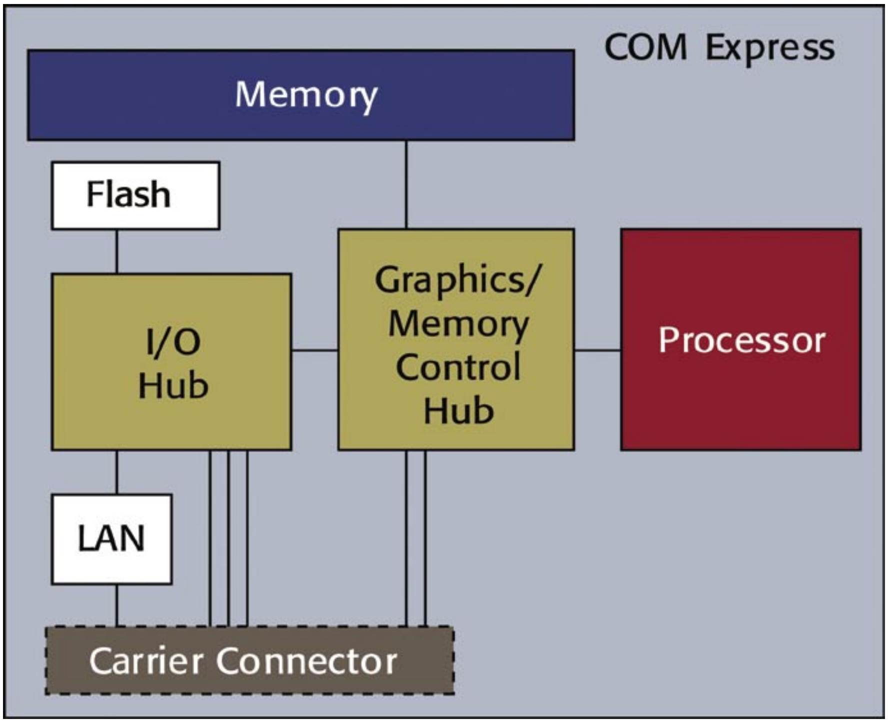

Figure 1

Note that the COM Express interfaces are legacy free and do not directly provide any PS2, floppy, COM, or LPT interfaces. The inclusion of a LPC interface does allow system designs that require these interfaces to include them via a SuperIO on the COM Express carrier board.

Benefits to the customer

Aside from the usual benefits of standardization and modularity, the COM architecture and methodology also enables a much broader level of reuse and reduced development expense, further accentuating the typical time-to-market and time-to-revenue advantages. A few of the target markets for COM Express include medical, test and measurement, gaming and entertainment, industrial automation, and Point of Sale, among others. Large OEMs in many of these segments typically have a broad portfolio of products with a variety of computing demands from low end to highly compute-intensive applications, simple text displays through 3D graphics and limited, dedicated I/O functionality through highly configurable and extensible systems. Form factors range from battery powered, portable devices through bench top, rack mounted, and self-standing equipment. With the multiplatform architecture COM Express, huge gains can be made through the reuse and interchangeability of modules and carriers and through common software libraries, operating system support packages, and application middleware. The decoupling of the processor complex from the rest of the system also allows a much later binding point for selection of the proper sized computing subsystem to address various price points, models, and product configurations. Standardization and broad industry participation enables continued innovation and cost reduction through competition and allows OEMs to keep pace with technology.

Specification status and schedule

As of Fall 2004, the COM Express specification was in active development and review within the PICMG subcommittee. Full member review within PICMG is expected in the late 2004 timeframe with specification adoption likely in the fourth quarter of 2004 or first quarter of 2005 timeframe. COM Express compliant products are expected to quickly follow in the first half of 2005.

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[1] As with any specification in development, exact specifications and features are subject to change during the development process.