*An **ACCES I/O Products** Whitepaper*

ETX Driving Embedded I/O

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One of the fastest-growing concepts in the embedded world is the "computer-on-module" or COM. The COM approach takes the traditional concept of a computer motherboard with plug-in I/O modules and turns it around so that the motherboard, now called a baseboard, contains all the I/O and the CPU with its core support chips and memory plug in as a module. The result of this reversal is an approach that blends the advantages of custom design with those of standard products. Products based on the COM approach maintain long-term viability while retaining access to the latest in computer technology.

One of the principal COM implementations available in the market is the Embedded Technology eXtended (ETX) specification, first developed by Kontron in early 2000. The ETX specification defines a module that is approximately 100-mm square **(see Figure 1)** and contains the core of a personal computer (PC), including CPU, chipset, memory, and core I/O capability. The core I/O includes Ethernet, graphics, USB, keyboard, mouse, and serial interfaces along with a PCI/ISA bus for connection to additional peripherals. Four surface-mount connectors route the module's I/O to the baseboard, which can be designed to meet an application's specific needs.

The original ETX specification was quickly adopted in the embedded industry and is now monitored by the ETX Industrial Group (ETXIG), which is dedicated to keeping the specification in line with advancing technology and market needs. The organization's goal is to keep ETX viable by incorporating new capabilities while maintaining compatibility with existing system baseboards. For example, ETXIG adopted Rev 3.0 of the specification in early 2006, adding a Serial ATA option to the module's design without altering connector pinouts.

What the COM approach, typified by ETX, brings to system design is a combination of customization and upgradeability for embedded applications. Embedded systems typically need long application lifetimes and have

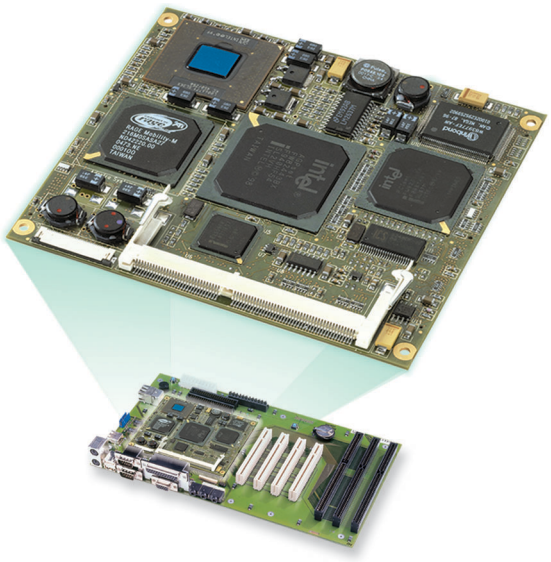

Figure 1 – The ETX Specification defines a computer-on-module with standardized I/O and pinouts that, when combined with application-specific baseboards, creates a readily upgradeable design.

White Paper

relatively stable I/O requirements. What changes for them is the scope of the application software and the CPU performance required. With ETX, developers can create baseboards that handle the stable aspects of the application yet can accept a wide range of processor modules from a number of vendors. The developer can focus on the application rather than the base computer.

ETX ADVANTAGES

There are many advantages to the ETX approach. Developers have as much control as they need over the size and shape of the baseboard, the I/O capabilities to be included, and the number and type of connectors to be used, while having a range of CPU types and performance levels available. This results in a highly individualized design at much lower cost and less development time than a full custom approach.

The ETX approach also encourages design reuse, with its attendant cost and time efficiencies. Product families with differing features and performance levels can stem from a single baseboard that uses differing CPU options. ETX even allows a product's viable installed lifetime to be extended because it assures the availability of an upgrade path for increasing CPU performance by means of a simple module exchange.

These advantages make ETX appealing for many markets. Some of the first users were gaming systems, point-of-sale kiosks, and medical instruments, all of which benefit greatly from ETX's advantages. Medical systems, for example, require expensive and time-consuming regulatory approval of new designs. By working with an already-approved baseboard design, developers can create new systems with higher performance while cutting in half the effort needed to gain regulatory approval.

More recent markets that are benefiting from the ETX approach include mobile systems and security, both requiring continual performance upgrading, which is easily handled with CPU module exchanges. Another new market for ETX is military systems. Module vendors have begun creating ruggedized CPU modules, allowing development of systems that satisfy the military's need for extremely long field life out of commercial off-the-shelf (COTS) embedded products. Basing a design on a ruggedized ETX module ensures that these systems will have compatible replacement modules available regardless of an individual CPU's rapid obsolescence.

BASEBOARDS GO COTS

In addition to gaining new markets, ETX has been gaining new design options. The original approach called for the baseboard to be a custom design while the CPU module was COTS. Either the system developer handled the baseboard design or contracted the CPU module vendor to do the work. Later, engineering design houses began to offer ETX baseboard design services to system developers.

As ETX grew in popularity, however, standard COTS baseboards began to appear. These typically were created as low-volume substitutes for other form factors, such as ATC, CompactPCI, and PXI or as part of development kits.

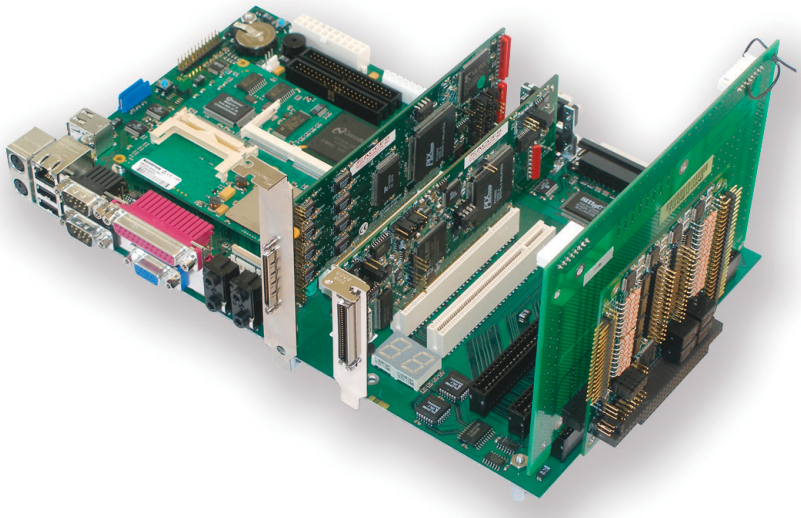

Figure 2 – Developers can quickly create a semi-custom embedded design by using an ACCES I/O development baseboard and plugging in the ETX CPU module and I/O functions they require, then have ACCES I/O create the final baseboard from that configuration.

Because the ETX boards were easier to develop than these other form factors, they were often made available as part of the CPU and chipset's initial release.

Since they represented an additional reduction in development time and cost, these standard COTS baseboards held strong appeal for many customers. Their need for custom I/O capability, however, prevented them from adopting these COTS boards in significant numbers. Yet, the desire for additional cost reductions remained, prompting ACCES I/O to develop its unique Semi-Custom baseboard concept.

ACCES I/O's Semi-Custom approach allows developers to speed the development of their baseboards by accessing a large library of analog, digital, and serial I/O functions from an exclusive I/O manufacturer. During development, customers can pick and choose the I/O their baseboard requires and integrate it with their custom logic to quickly arrive at a finished design. Since the library functions are already proven, the resulting baseboard requires much less debug and test effort than a full custom design. The library functions come with full software support, so the software design, debug, and test efforts are reduced as well.

Implementing a design using the Semi-Custom approach is a simple, three-step process. First, developers define all the I/O their baseboard and application will require. Next, they obtain an ACCES I/O development baseboard and select ACCES I/O modules that correspond to their requirements **(see Figure 2)**. This combination serves as the hardware and software development platform during the early design stages. Once the hardware design stabilizes, ACCES I/O can develop a prototype baseboard with all of the I/O choices integrated while the developer continues application software development on the evaluation hardware. Developers can then verify their software and applications against the prototype, typically with first-pass success, before ordering productions units.

The result of following this approach is a considerable reduction in development time. Experience has shown that creating a baseboard from scratch can take as long as 24 weeks. By using library I/O functions and software, design times are typically cut in half, allowing market entry of the final product as much as three months earlier. The approach also reduces production costs. Since the final baseboard design utilizes the same components as ACCES I/O's COTS modules, the customer gains the benefits of ACCES I/O's greater buying power, superior delivery, and reduced inventory costs. Thus, both the time and cost thresholds for creating an embedded solution are reduced.

THE ETX-NANO-104

One example of this Semi-Custom approach is ACCES I/O's ETX-NANO-104 baseboard **(see Figure 3)**, which targets industrial applications. This unique offering merges three computer standards: ETX, PC/104, and NANO. NANO is the ultra-small motherboard (120x120 mm) developed by VIA Technologies to showcase its chipset technology. The larger Intel and AMD CPU chipsets are difficult to fit into such a small outline. NANO is currently the smallest standard square motherboard size available that offers standard motherboard connectors.

The ETX-NANO-104 baseboard achieves its near NANO size (120 X 125mm) by sandwiching two boards togeth-

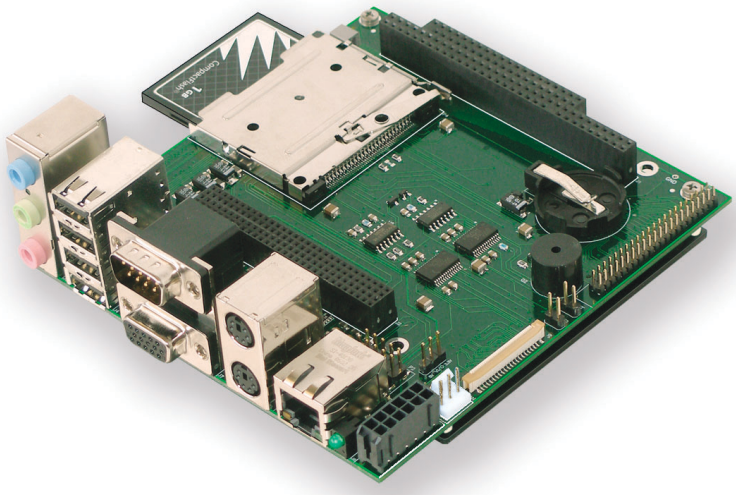

Figure 3 –The ETX-NANO-104 CPU module from ACCES I/O combines ETX and PC/104 I/O capability with the functionality and form factor equivalent to the ultra-small NANO motherboard.

er to create greater electronics density. The CPU section incorporates a fanless CPU(fan header available on-board for extra cooling) with an aluminum heat spreader and is positioned facing downward. Since the ETX connectors are on the underside of the ETX-NANO-104 baseboard, the CPU can dissipate heat underneath the baseboard to the chassis below. The baseboard's other connectivity includes four USB 2.0 ports; VGA, PS/2, mouse and keyboard ports; 10/100 Ethernet, flat panel, IDE, compact flash, AC97 audio, and two RS-232 serial ports with one also configurable for RS-422/485.

Since the baseboard provides full PC/104 Plus I/O expansion, designers have access to a giant base of manufacturers that provide I/O and peripheral cards for the popular bus. PC/104 allows designers to assemble a system by plugging together small, rugged, stackable modules. Connectors carry the bus through each module to the next, providing mechanical stability to the stack. The ETX standard supports both the ISA and the PCI bus. This allows the baseboard's PC/104 interface to handle both PCI and ISA at the same time, increasing the range of designer options available.

The result is a cost effective design with fast time to market no matter what the production quantity of the final product. Large quantity OEMs can use the wide range of COTS PC/104 and ETX products for simple and easy prototyping and evaluation purposes then use ACCES I/O's Semi-Custom baseboard program to quickly and easily manufacture their high-volume systems. Embedded developers designing systems requiring smaller quantities gain the benefit of easily choosing and upgrading their system CPU and the high availability of COTS PC/104 modules. In both cases, time to market is dramatically reduced and future upgrades are as easy as choosing a new ETX CPU and/or PC/104 module.

FUTURE DIRECTIONS

Semi-Custom baseboards such as the ETX-NANO-104 provide developers with an incredible range of design possibilities, but they are not the end of the story. The advent of the PICMG-supported PCI Express bus to replace PCI in high-performance designs will have its effect on ETX. PCI Express is likely to dominate future embedded PC designs because of its smaller connectors, higher performance, greater fan-out, and ability to support the latest chipsets.

The ETX community has addressed PCI Express in two different ways. One is the XTX specification, which supports the traditional PCI bus used by PCI/104 but replaces ISA with PCI Express. Intended as an upgrade solution for ETX, XTX uses the same connectors and form-factor as ETX. Unfortunately, to gain the benefits of PCI Express, users need to redesign their baseboards. Further, ETX baseboards can be damaged by the insertion of an XTX module, making XTX a potential hazard for existing installations. As a result, XTX is likely to be only an interim upgrade solution.

The second approach to handling PCI Express is ETX Express, also called COM Express, which has the support of PICMG as well as the larger ETX companies. ETX Express is a new type of module that drops ISA support and legacy motherboard I/O in order to support PCI Express while offering new I/O such as Gigabit LAN. It does not use the legacy ETX connectors, however, so there is no possibility for inadvertent damage to an existing ETX system. New system designs needing the higher speed of PCI Express will likely adopt this approach.

For systems that do require legacy I/O support but also need newer mass storage peripherals, the ETX 3.0 version is another option. It is pin-compatible with older ETX versions but includes the Serial ATA interface on small additional connectors. This creates a true upgrade for ETX baseboards and is suitable for supporting PC/104 as on the ETX-NANO-104.

All these variations as well as the many possibilities inherent in ETX are part of the reason that the computer-on-module approach is one of the fastest growing single-board computer solutions in the embedded world. The approach allows developers to access the latest computers while maintaining long-term viability for their designs. It is able to implement one of the smallest and most powerful motherboards available—the ETX-NANO-104—while offering COTS I/O expansion for fast development time and lower costs. Add to this the advantages of semi-custom design and its software support, and it is clear that ETX will be driving embedded I/O for years to come.