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Standard COM Carrier Boards Offer Benefits Over Traditional SBCs

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Embedded systems designers are under pressure to reduce the cost and size of electronics while improving time-to-market and overall system reliability. Today, many systems use off-the-shelf x86 single board computers (SBCs) with I/O modules stacked above or below to implement the special-purpose I/O that makes the hardware fit the application requirements. Designers understand the benefits of using a proven off-the-shelf processor board while focusing their design efforts on the application-specific and frequently custom I/O that makes their application different from others.

Traditional SBC-based systems were built using EBX or EPIC form factor SBCs or PC/104 CPUs. These boards provide expansion buses (PCI and ISA) to enable the inclusion of off-the-shelf I/O expansion modules from a broad ecosystem of PC/104 I/O modules that has grown over time to hundreds of modules from dozens of suppliers to meet diverse system level requirements (see Figure 1).

FIGURE 1: Older designs consisted of cumbersome stacks of CPU and I/O cards.

Yet standard SBC-based systems with large I/O requirements have a number of significant drawbacks that have vexed embedded designers, including:

- Relatively large sizes due to the number of add-on I/O boards
- Packaging difficulties resulting from the somewhat odd format of a stack of boards with I/O connectors on all sides
- The cabling nightmare driven by the need for transition cables between the SBC and I/O modules' pin headers to appropriate connectors on the enclosure bulkhead
- The incredible assembly and maintenance difficulties associated with a tightly integrated stack of boards
- Increase purchasing efforts and planning complexity resulting from dealing with a large number of suppliers
- Increased system cost due to the presence of expensive interconnects between boards

In response to these drawbacks of SBC and PC/104-based system architectures, the embedded board industry introduced Computer-On-Module (COM) products which shrank the CPU to a minimum footprint and brought all I/O through a small set of standardized connectors to application-specific COM carrier boards (also known as baseboards). The form factor of each baseboard may be customized to meet the needs of the application enclosure, frequently eliminating all transition cables. Application specific I/O functionality can be implemented on the baseboard, eliminating multi-board stacks and enabling the I/O to meet the exact needs of the application.

COMs Tradeoffs

The attractiveness of a COM-based solution is demonstrated by the fact that COM CPUs far outsell (in unit volume) all standard small form factor SBCs (including PC/104 CPUs) combined. However, COM products bring two significant new requirements to the embedded designer:

- The design of a custom I/O baseboard for the application
- The requirement to attain expertise in the needed I/O circuitry

Until now, these requirements have limited COM solutions to high-volume applications for OEMs with board design expertise or the willingness to pay high-NRE board development fees to third parties. Frequently, time to market is extended while the custom board is designed and put into production and all the technical hurdles are overcome. OEMs who lack the confidence or skill to design their own baseboard or the NRE budget to pay others to implement a custom baseboard, as well as most small and medium volume OEMs who simply cannot tolerate the development cost either way, have elected to stay with an SBC or PC/104-based solution due the lack of suitable alternatives.

Now, for the first time, a middle ground has been created in the form of off-the-shelf I/O-rich COM carrier boards in standard SBC form factors, giving designers the best of the SBC and COM worlds without the budget and schedule risk associated with a full custom baseboard solution. Even better, these off-the-shelf baseboards can be customized if needed to particular application requirements (form factor, connectorization, specific I/O functionality) for far less cost and with much less risk than starting a custom I/O baseboard from scratch.

Best of Both Worlds

This new design paradigm enables traditional users of stackable single board computers (SBCs) to gain many of the benefits of a COM-based solution without having to deal with most of the drawbacks. It consists of an off-the-shelf application-oriented I/O-intensive computer-on-module carrier board mated with an industry-standard off-the-shelf COM CPU. Using this approach, a two board “sandwich” (COM CPU plus carrier) provides a complete application solution that may have previously required three, four, five or more stackable I/O modules in addition to a CPU card.

By using off-the-shelf industry standard COM modules as the CPU, each of these new carrier boards can support a wide performance range of solutions – effectively an instant product line. The new approach offers significant advantages over traditional stacked solutions in addition to greatly reducing overall system size. The approach enables a more reliable, easier to assemble solution with reduced and simplified cabling. In addition, widely popular COM CPUs are frequently much less costly than an equivalent CPU on a larger single board computer form factor.

An example of the new direction is Diamond Systems' Neptune SBC, implementing a rugged, extended temperature, I/O-rich high-integration ETX baseboard (see Figure 2). The Neptune baseboard integrates the capabilities of five traditional PC/104 I/O modules into a single EPIC-sized board. Unlike ATX-style reference design carrier boards offered by COM suppliers, Neptune is a standard product intended for production deployment. However, as OEM production volumes grow, or if a different set of I/O is required, the Neptune baseboard can be modified as needed.

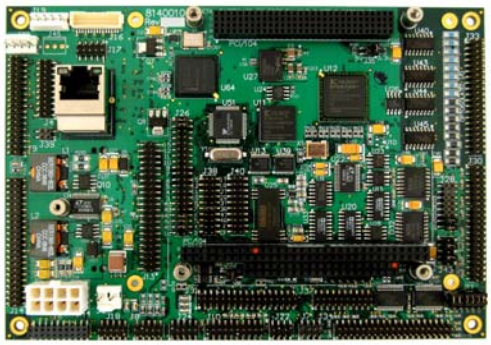

FIGURE 2. Neptune I/O-rich baseboard replaces the stack of cards in Figure 1.

By using the industry standard ETX interface, Neptune offers a wide performance range of available ETX CPU modules. The ETX CPU plugs into the bottom of the baseboard, which allows the implementation of an efficient thermal solution by conducting the heat from the processor and chipset directly to the bottom surface of the enclosure.

With an ETX module attached, Neptune includes extensive set of standard PC I/O such as four USB 2.0 ports, Serial ATA (S-ATA) and EIDE hard drive interfaces including CompactFlash™ socket and IDE Flashdisk interface, 10/100 and Gigabit Ethernet controllers, six RS-232 serial ports (four with RS-422/485 capability), AC'97 audio, and legacy keyboard and mouse interfaces. While providing all this I/O, Neptune includes a PC/104-*Plus* expansion (PCI and ISA buses) interface to accommodate still more I/O if needed.

This extensive collection of I/O features is organized conveniently as a row of pin headers along the front edge of the board. To eliminate transition cables altogether, an optional Panel I/O Board plugs directly into the front edge pin header row.

Unlike other off-the-shelf carrier boards, Neptune offers advanced, comprehensive, integrated data acquisition capability, with 32 single-ended (16 differential) analog inputs with 16-bit autocalibration A/D, 250KHz sample rate and 1024 sample buffer, four analog outputs with 12-bit D/A and 100KHz waveform output capability, 24 programmable digital I/O lines, 8 optically isolated digital inputs, 8 optically isolated digital outputs, and two counter/timers. The analog I/O circuitry supports interrupt A/D transfers and uses an enhanced FIFO with programmable threshold for maximum flexibility and data reliability.

Unlike the typical ATX-style carrier boards that are large and require multiple input voltages, Neptune has a true embedded carrier board that requires only a single input voltage. A wide input voltage range of 5-28V DC is supported on the board, without requiring an external power supply, making it ideal for

many industrial and vehicular applications. Neptune packs all of the I/O and power circuitry into a tiny 4.5 x 6.5" (115mm x 165mm) board, in compliance with the EPIC 2.0 specification.

Availability & Customization

Neptune is a family of single board computers, supporting different ETX CPU options installed on the bottom side, initially Neptune-LX with an AMD LX800 processor and Neptune-PM with a 1.4GHz Pentium M 738 CPU (see Figure 3). OEMs selecting a Neptune solution gain the benefit of COM CPU without the need to deal with the potential customization issues involved in the inclusion of other ETX CPU choices.

FIGURE 3. Neptune single board computer with an ETX CPU installed.

For OEMs for whom the Neptune baseboard does not provide the specific I/O functionality required or who require a different form factor and/or connector implementation, Diamond Systems has announced their ETX-Based Application-Specific Program to customize the Neptune baseboard to a specific set of requirements. Due to the proven functional blocks of the Neptune design and components selected for long-term availability, customization of a COM baseboard is much less costly and time consuming with much lower risk than starting a new baseboard design from scratch. Figure 4 represents how custom I/O blocks are attached to buses from the ETX module.

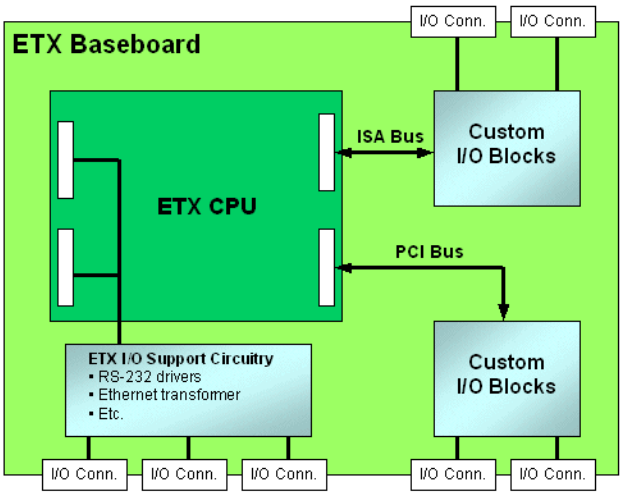

FIGURE 4. I/O blocks attached to the ETX buses lead to custom computing solutions.

Over the next several years, Diamond Systems will bring additional, application-specific ETX baseboards to market that will serve both as off-the-shelf solutions and as the starting point for a quick and easy customization to meet additional specific application needs. The goal is to deliver faster time to market with more efficient solutions, lower risk, and lower cost.

Summary of Benefits Using the COM Baseboard Concept

Many more embedded system manufacturers of all sizes can now move to the latest Computer-On-Module technologies and architectures without incurring the schedule, risk, and cost of custom baseboard development. The numerous benefits of this standard COM baseboard approach include:

- Reduced cost of goods
- Greater reliability due to a smaller number of boards and less cables
- Smaller footprint
- More efficient thermal solutions
- CPU lifecycle management / improved protection from obsolescence
- Simple technology insertions / upgrades
- Reduced purchasing and supply chain activities
- Reduced assembly and maintenance costs
- Shorter time to market
- Scalable performance without redesign