Open Standard Computer On Module Choices in 2015 Optimize Intelligent Systems & the Internet of Things

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TECHNOLOGY IN SYSTEMS

COM Modules—Sorting Out the Variety

COMs continue their evolution, enabling a wider-than-ever range of small form factor performance options. For intelligent applications like connected healthcare and the Internet of Things, developers need to understand advantages and best fit in order to make ideal COM-based design choices.

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Small form factor designs are found just about everywhere on the planet, playing an essential role in the intelligent systems that form the Internet of Things (IoT). Connecting people, equipment and services – and solving business challenges through the power of real-time data – these compact, sophisticated devices are enabling such things as healthcare anywhere, factory floor automation, sophisticated digital signage and safer, smarter transportation. Developers are fostering these advancements by delivering low power and high performance in a very small footprint, but they also face a challenge in keeping up with the fast and ongoing evolution of small form factor platforms.

In a design universe where options include proven SBCs and stackable solutions like PC/104, perhaps no other small form factor arena has seen a pace of evolution as significant as Computer-on-Modules (COMs). Over the last 15 years, COMs have matured from a single-standard solution to a diverse slate of high performance platforms optimized for connected embedded applications. New standards have steadily improved and expanded design considerations based on price, performance and I/O. Current open standard COMs include COM Express 2.0, Qseven and SMARC – many supported by a global ecosystem of providers, and each with a best fit and purpose as a design platform for connected embedded systems.

Defining a COM

The COM platform consists of a CPU module with standard computing core functions, mounted on a carrier board with customer-specific functions and sizing for the end-use application. Think of the carrier board as a custom I/O card. Application customization has an enduring lifecycle by virtue of this two-board practice. Because the module can be switched out for higher performance without affecting the customization, the COM platform is highly scalable and upgradable for long-life industrial deployments. Switching to the most current processor advancements in reduced power consump¬tion and higher performance is a simple matter of swapping out the COM (Figure 1).

Figure 1
The concept of the COM approach is to have the CPU and memory on one board that can be easily switched out and to have the more application-specific I/O circuitry on a carrier card.

With unlimited time, resources and budget, many designers would prefer to develop their own custom computer board with exact performance requirements. However, the challenge comes to light when resources are not unlimited, and product development must prioritize time-to-market as a competitive advantage. COMs provide an alternative to chip down designs, and allow developers to create their own custom carrier board as part of the platform solution. Instead of worrying about ultrafine pin grids and highly EMC-sensitive high-speed differential signals, OEMs can concentrate on their core competencies in application know-how and manufacturing, while purchasing the latest application-ready processor technology to complete their design.

With engineering resources focused on system functions, designers benefit with reduced development costs and faster time-to-market. The ability to scale performance can enable broad product families, as well as fast reaction to market trends in performance requirements. Long-term designs are protected with easy technology upgrades, including future-proofing that is further secured with a well-established global ecosystem for COMs technology.

Understanding the Evolution

ETX is the grandfather of current COMs technology; ETX modules are about the size of a postcard at 3.7" x 4.5" (95mm x 114mm) and incorporate four high-density, low profile connectors on the underside of the module. As the first formal COMs standard – introduced in 1999 and established by the year 2000 – ETX COMs have a solid global installed base primarily in industrial automation, followed closely by medical, transportation and gaming. The platform's maximum Thermal Design Power (TDP) of 40 watts suits these applications, along with legacy-friendly support for both the ISA and PCI buses.

ETX, however, is not considered an active platform for new development. Today there are no CPU platforms with native ISA support available. The ISA bus needs to be generated by a PCI-to-ISA bridge. The bridge adds latency to the ISA bus and limits some ISA functionalities, but this is suitable for most legacy applications. In recent years, CPUs have also stopped supporting the PCI bus. Thus, ETX COMs utilizing the latest CPUs have to use two bridges in a row to generate the ISA bus signals. The PCI Express to PCI bridge followed by the PCI to ISA bridge adds

significant cost and only provides a limited set of ISA functionality with a high level of added latency. Therefore, EXT modules are used primarily in legacy projects requiring ISA communications, providing an option to the PC/104 boards that also enable the decades-old ISA bus.

COM Express Gains Real Ground

By 2003, silicon evolution brought the PCI Express (PCIe) bus into the mix. ISA was slow by comparison, and modules needed to support both PCI and PCIe. COM Express was the winning scenario, ratified by the PCI Industrial Computer Manufacturers Group (PICMG) in 2005. Legacy-free COM Express is extremely scalable, accepting x86 processors from single-core, low power Intel Atom up to the high performance, quad core Intel Core i7. Using the same application-specific carrier board, developers can extend the life of systems by upgrading modules for better performance, create a next generation product using a more advanced processor, or take a market lead by introducing an entire product family at once. For instance, a large, stationary medical imaging device could use the same customization as a cart-based version of the same application; using even smaller COM Express COMs, the same design could be implemented as a handheld portable device. It's this flexible range of performance that has given COM Express a significant market advantage – the standard has broad recognition worldwide, with rich ecosys¬tem and vendor support.

Two sizes were initially defined by the specification – basic at 3.7" x 4.9" (95mm x 125mm) and extended at 4.3" x 6.1" (110mm x 155mm), as well as several 'types' which each represent different pin-out configurations using the standard's two 220-pin connectors. In 2010, COM Express 2.0 made some overall improvements to the earlier specification, such as adding PCI Express Gen2 and Gen3 signaling for all PCIe lanes, adding optional support for SDIO using existing GPIO signals, support for HD audio, and reducing maximum TDP for Types 2-5 to 137 watts and to 68 watts for Type 1. Other significant improvements include the removal of TV out and PS/2 key/mouse and the addition of SPI, I2C multi master support and USB client feature.

COM Express 2.0 also formally adopted the compact size of 3.7" x 3.7" (95mm x 95mm), reflecting the ongoing evolution toward integrated chipsets and smaller system-on-chip (SoC) designs. Two new connector pin definitions, Type 6 and Type 10, were also introduced to allow for technology upgrades. Type 6 builds upon the highly successful Type 2, maintaining the same basic or compact footprint while upgrading functionality for three digital display interfaces, 6 PCI Express lanes, two serial ports, fan control, lid switch, TPM physical presence signal and enabling USB 3.0 in four of eight available USB ports. PCI and IDE signals have been traded for a complete PEG port implementation which is no longer multiplexed with the digital video signals.

The Type 10 is also gaining popularity, building on Type 1 to use just one of the standard's 220-pin connectors to optimize module display interfaces for future designs. Type 10 also added two optional 2-wire serial ports and reduced storage and I/O bandwidths down to two SATA interfaces and four PCIe links. These features are highlighted in the 2.1 revision of the COM Express specification from May 2012 with the small size definition COM Express Mini, about the size of a credit card at 2" × 3.3" (55mm × 84mm). It is designed specifically for the extremely compact, low power applications common to gateway IoT deployments (Figure 2).

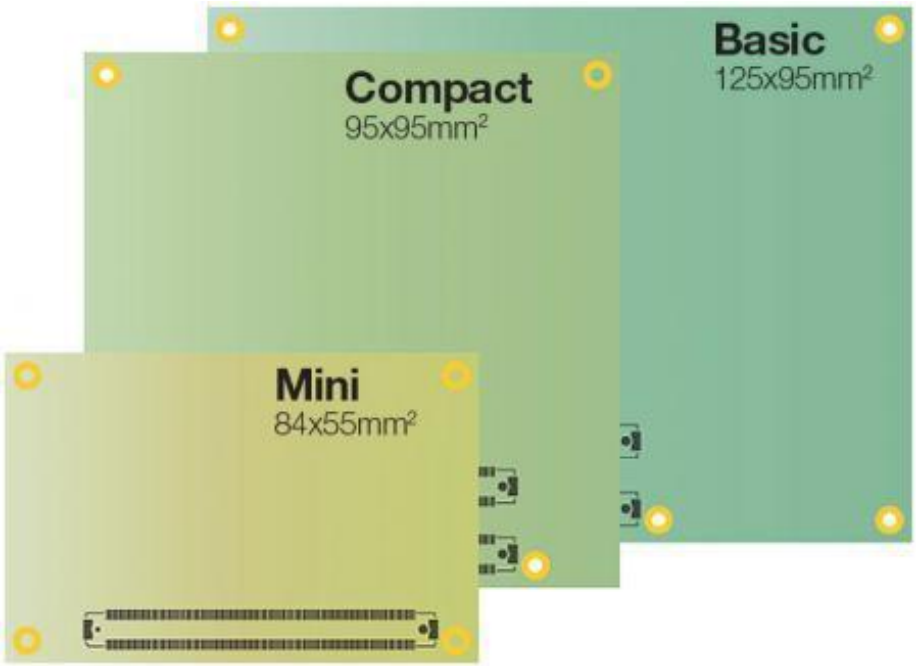

Figure 2
Three major form factors of the COM express standard.

Because of this, Type 10 Mini can be considered the most versatile COM Express module and can handle a very broad spectrum of portable and fixed applications with a minimal number of carrier board designs. The Mini form factor is tied to the type 1 and type 10 pinouts and features a wide range DC input from 4.75 up to 20 V DC. The 2.1 revision also included the signals for two USB 3.0 ports for Type 10 and added CAN bus and an alternative eDP pinout for the LVDS signals for type 6 and type 10.

Where Does XTX Fit?

Most COM Express size variants incorporate two high speed connectors on the underside of the module, rather than the four defined in ETX. The buses and signals are quite different too. As such, the two standards are not mechanically or electrically compatible, and moving from ETX to COM Express is a costly proposition in terms of design resources and redevelopment of carrier boards. Some designs may warrant the expense in order to gain access to the other features that represent significant improvements over ETX , while others can readily move to the compatible XTX standard for a simple performance increase.

The XTX standard was introduced by congatec, Ampro and Advantech, about the same time that PICMG ratified the initial COM Express standard in 2005. Instead of costly migration to COM Express for faster bus communications, XTX would allow developers to access PCIe and SATA support within the existing +5V power and electromechanical footprint. XTX is the same size as ETX and offers four connectors, but provides native SATA support directly off the top of the module and replaces the ISA bus with four PCIe lanes on one of the four carrier board connectors. This enabled new high speed interfaces, based on a performance boost up to 2Gbit/s per lane, while preserving investments in carrier designs. The idea was that any customer who had previously used ETX modules could do a very simple modification to their carrier board and use XTX, or no modification at all if the carrier board didn't use ISA in the first place and PCIe isn't actually needed. This would avoid the major carrier board modifications necessary to adopt COM Express.

Major manufacturers still support XTX. The standard provides a highly relevant, affordable upgrade option to the broad install base of ETX-based systems. When ISA bus is no longer required, XTX provided a gateway to dual core performance without costly redesigns.

Enter Qseven for Low Power Design with Both x86 and ARM

Low-end mobile solutions needed yet another variation of the COMs platform, particularly as industrial systems continue to adapt their graphical user interfaces (GUIs) to mirror the specifications of consumer smartphones and tablets. Enter Qseven, introduced as an open standard to meet the trend toward increasingly compact and power-efficient devices with high performance multimedia features. Qseven steps into this landscape to enable developers to work with low power ARM and x86 processors as never before for small, low power, mobile applications. It provides developers with a modern, legacy-free option along with a new connector concept and low profile fanless cooling specifically designed for compact and ultra-compact devices.

Specified by congatec, MSC and Seco in 2008, Qseven was ratified by the Standardization Group Embedded Technologies) (SGET) in 2012. By using a cost-effective and high speed 230-pin MXM2 card edge connector instead of board-to-board connectors, Qseven simultaneously reduces design costs and achieves a lower overall height that allows for slim designs. Qseven modules (Figure 3) are available in two footprints, including a standard size at just 2.76” x 2.76” (70mm x 70mm) and a half size at 1.57” x 2.76” (40mm x 70mm).

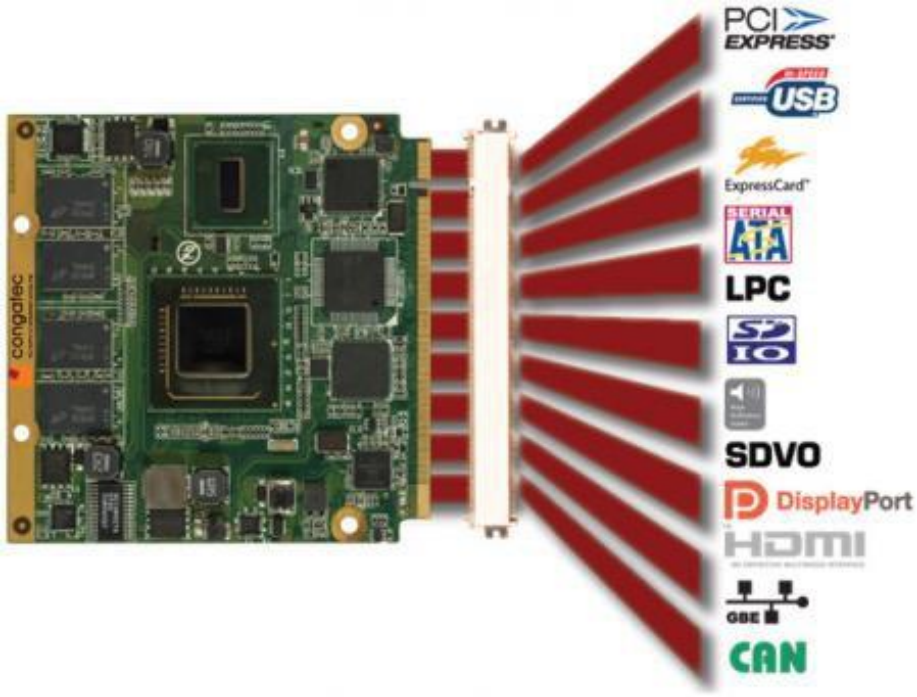

Figure 3
The Qseven concept aims specifically at mobile and low-power applications with an edge connector that carries a strong selection of modern interface standards.

Legacy-free Qseven offers a modern set of interfaces, including up to four lanes of PCI Express 2.0, SATA and USB 3.0, and also supports Gigabit Ethernet, SDIO, two LVDS ports, and digital interfaces like SVDO shared with HDMI and DisplayPort. Because Qseven supports 2x24 Bit LVDS, it can control higher-resolution displays than COM Express Mini, which supports only 1x24 Bit LVDS. Revision 2.0 of the Qseven specification also extends the use of ARM processors in order to achieve even lower power dissipation.

TDP is capped at just twelve watts and its speci¬fied 5V power enables easy battery operation, for example a mobile device that can run efficiently on two lithium cells. The standard includes a thermal cooling interface, as well as onboard RAM and Flash for rugged applications. Qseven’s features are optimized for mobile or ultra-mobile applications – for example any kind of application that requires battery or Power over Ethernet (PoE) capability and can benefit from unique features like a common em¬bedded application programming inter¬face (EAPI) for industrial applications. EAPI is a free available specification from PICMG which also supports COM Express, XTX

and others. It adds a watchdog timer, I²C Bus, display brightness control, BIOS storage area and reading of system temperatures.

Despite competition from increasingly smaller COM Express form factors, Qseven has firmly established itself in the x86 world. Today, there are more than 20 manufacturers who design and sell Qseven modules in over 100 different models.

Welcome SMARC

Like Qseven COMs, SMARC modules can be fitted with either x86 or ARM processors. Ratified by SGET in 2011, SMARC is also intended for the development of compact, low power systems and has only subtle differences to the Qseven standard. SMARC uses a 314-pin MXM3 connector and is available in a full size of 3.15" x 3.23" (80mm x 82mm) and a short size of 1.97" x 3.23" (50mm x 82mm). SMARC supports the same class of processors as Qseven and COMe Type 10 Mini, with similar power consumption characteristics.

Mobile devices or IoT gateways are suitable applications for Qseven or SMARC. The two platforms are similar in performance and size, so the design choice comes down to investigating the supply base for each type of module. SGET notes just 16 modules on its SMARC product listing, in contrast to more than 70 Qseven modules.

Making Strategic Design Choices

Legacy updates, as opposed to ground-up new designs, drive very different decisions in choosing a COM platform. If your task is to extend the life of an ETX-based system with the least expenditure on new research and development, then the ETX and XTX platforms are for you. Entirely new platforms, or designs that need to make the platform switch now in order to add longevity issues later or meet specific performance requirements, are ripe for the other options on the landscape.

COM Express provides an opportunity for the most scalable system design. Developers can develop an entire product family around a single carrier board – a low end microwave, a high end commercial microwave, and then the monster microwave that cooks for an entire platoon at once. For ultra-low power applications – small, low cost and highly portable – Qseven and COM Express mini provide excellent platform options. In contrast to comparable ARM-based systems, they offer full x86 code compatibility coupled with minimum power consumption. This means existing x86 applications can continue to be used in smaller and smaller devices without any need for porting to a new platform. Qseven and COM Express mini modules also support the Intel Atom E3800 processor family (codenamed Bay Trail-I), providing the appropriate embedded hardware that keeps IoT applications both smart and safe. Both modules integrate the validated combination of hardware with software from McAfee and Wind River, known as the "Intel Gateway Solution for IoT," enabling a stable and secure platform for all IoT and cloud-based applications.

Small form factor intelligent systems are making a real difference in life and business, with IoT applications fueling advances in medical, industrial, transportation, entertainment and much more. IoT forecasts are impressive, with the number of IoT appliances predicted to explode to around 26 billion worldwide by 2020, and developers need to know their way around the numerous COMs platform options. Understanding the advantages and overall value proposition of each platform is essential to compete, fueling a leadership position in today's connected, embedded markets.

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