WHITE PAPER

Computer-on-Module Technology Offers Substantial Benefits for Embedded Systems

COMs Ease Concerns Related to Compatibility, Long-Life, Security, and More

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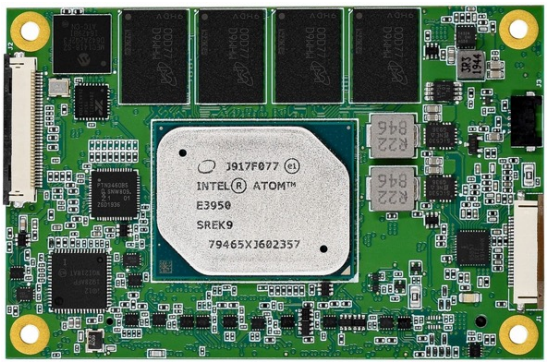
WINSYSTEMS, INC.

SCOPE

This white paper explains the difference between Computer-on-Modules (COMs) and single board computers (SBCs), and highlights several key advantages that COMs technology can convey to embedded computing systems. These advantages range from processor flexibility, to reduced development costs, increased cybersecurity, upgradability, and extended product life cycles.

OVERVIEW

A Computer on Module (COM), sometimes referred to as a System on Module or SOM, is a single physical module that typically comprises the ICs necessary to handle most computing functions. That could include a microprocessor, memory (RAM, ROM, and flash), a power management unit (PMU), I/O controllers, and various communications radios, such as Ethernet, WiFi, Bluetooth, and even 5G.



The COM solution, like the WINSYSTEMS COMeT10-3900 industrial COM Express Type 10 Mini module shown here, offers a host of advantages over more traditional board-level options.

COMS OFFER EXPANDED FLEXIBILITY

COMs are essentially embedded computers built on a single circuit board. What differentiates the COM from a conventional single-board computer (SBC) is that it lacks the standard connectors needed to directly connect external I/O devices. Hence, the module would be mounted onto a carrier card or baseboard that breaks the system and I/O buses out to allow for connection to standard peripherals. That carrier card can also break out to custom I/O if needed for a particular application.

COM technology has been around in various forms for decades and consists of a mezzanine approach with CPU, memory, and basic I/O interfaces on a module that mounts to a single carrier board or a stack of boards to complete the I/O and system requirements. The approach allows the most complicated part of the design to be separated from the unique I/O requirements of different carrier board solutions. PC/104 is often considered one of the original COM module approaches. Not only does PC/104 provide an ecosystem of CPU and I/O vendors, but many OEMs also used the standardized bus and mounting to design unique carrier cards using off-the-shelf CPU modules available from multiple vendors.

COM standards should not be confused with the recently released Modular Open Systems Approach (MOSA) standards, developed mostly for defense-related applications. Technically, MOSA is not a certified standard, but rather a design strategy that prioritizes the use of open standards-based technology. The MOSA “directive” has accelerated the adoption of a host of open standards, such as The Open Group Sensor Open Systems

Architecture (SOSA) and the U.S. Army CCDC C5ISR Center's C5ISR/EW Modular Open Suite of Standards (CMOSS), that have been adopted by all three military branches. With all that said, COMs are now starting to appear in both MOSA and SOSA applications, as they fit the bill of "tried and true."

ENSURING LONG LIFE, UPGRADABILITY

Having the carrier card also allows for a simple upgrade path. For example, when a new processor becomes available and is designed into a new COM. Then you simply plug that COM onto the existing carrier board. If designed properly, the software should operate transparently as well. Obviously, at some point you may want to upgrade the carrier board, but it should last for at least two or three generations of CPU.

The COMs approach allows for prototypes to be developed and tested with far less expense than designing and manufacturing complete CPU-based SBCs.

The alternative to using a COM would be to deploy a full-blown motherboard or do a custom design. This approach may not be the right choice because a COTS motherboard may contain lots of functionality that is not needed for your application, adding to your cost. A custom design could be a good option if the required volumes are high. The up-front design and development cost would be significantly higher, but with volumes in the hundreds of thousands, you could recoup that cost.

The baseboards (or carrier boards) into which the COMs plug into, can be customized around the CPU to suit the specific application, including performance requirements, graphics capability, I/O drivers, and dedicated digital signal processing.

Most industrial applications require high volume quantities that can run into many thousands, which is the sweet spot for COMs. You're getting just the functionality you need at a cost that makes sense.

DESIGNER CHALLENGES/OBSTACLES

Some of the challenges a system designer typically faces include:

- Compressed development cycles
- A need to design and enable increasingly sophisticated, interconnected applications
- Extending the life cycles of existing designs to delay system obsolescence
- Reducing the risks and costs associated with new product development
- Ensuring that embedded computing systems are secure and supply chains remain reliable

Meeting these challenges requires highly reliable embedded computing solutions that incorporate extensive functionality yet can be modified to fit any application or be easily upgraded. These capabilities and others have been the driving factors in the explosive growth worldwide of COM solutions.

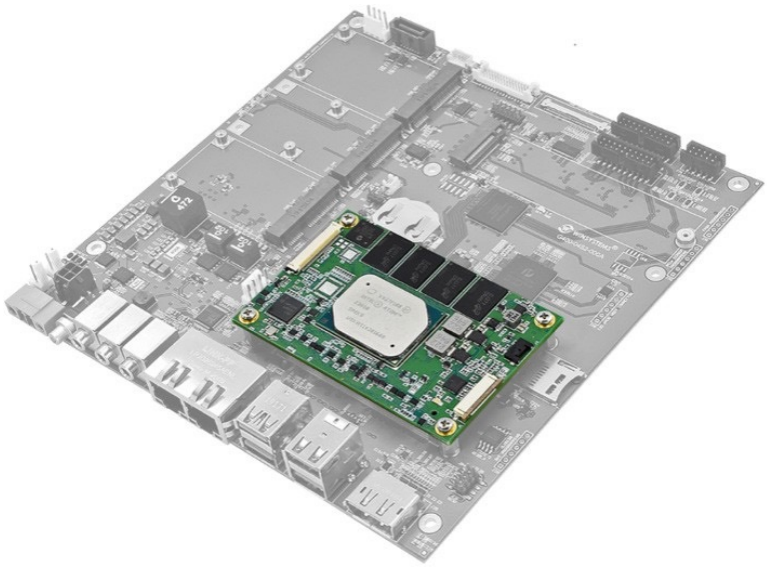
CHOICES ABOUND, INCLUDING SECURITY

The popularity that we've witnessed for COMs growth adds another benefit for system designers—lots of choices. Whereas initially, the choices in terms of CPUs and peripherals on the COMs were limited, that's far from true today. In fact, the options that are now available span the gamut from low-cost and limited functionality, all the way up to full-featured high-performance modules capable of handling the latest Edge-based AI applications. CPU options are wide as well, including those based on Arm, X86 (from Intel and AMD), and NVIDIA. Options include most communications interfaces, lots of I/O, including multiple video streams, and various analog and digital I/O. And of course, the latest in security is included, both in

hardware and software.

The security component is not something that can be taken lightly. Cybersecurity breaches are occurring on a regular basis, both malicious and unintentional. Either way, having your data exposed can leave your IT and OT systems vulnerable to attack. The Cybersecurity Improvement Act, passed in 2020, clearly defines the minimum security requirements for protecting IoT devices.

This is an area where COMs offer an advantage. The modules can be designed with the requisite security features, then once they are plugged in, those security features remain intact, regardless of the carrier board it gets plugged into. For example, the WINSYSTEMS COMeT10-3900 industrial COM integrates on-board discrete TPM 2.0 hardware security. This security element, developed by the Trusted Computing Group, defines a hardware root of trust which operates in conjunction with software to provide protected functions that can't be tampered with. It also includes shielded locations where sensitive data can reside when it is being operated on, as well as protected objects that hold data that gets encrypted when it's not in a shielded location.



Pictured here is the WINSYSTEMS' COMeT10-3900 Type 10 Mini Module mounted to the ITX-M-CC452-T10 carrier board.

Keep in mind that the COMeT10 and its TPM could upgrade previous COM+Carrier systems that were designed before the TPM requirement came about. It's a relatively easy upgrade, that occurs by replacing the previous COM with the WINSYSTEMS' COMeT10-3900 industrial COM Express Type 10 Mini Module, which would add the TPM to the system and enable it to meet the new requirements. Note that WINSYSTEMS is readying a new COM, based on the Type 6 Compact form factor. The COMeT6-1100 is designed with an Intel 11th Gen Intel Core i3/i5/i7 Processor and holds up to 32 Gbytes of LPDDR4 system memory, operating at 4266 MT/s.

TIERED PRODUCT LINES

Systems integrators like to offer tiered product lines, and that is far easier using the COMs approach. For example, they can design a system with a baseboard and COMs connector, then insert the COM that fits the customer's need. It might be an older generation X86 processor with limited memory. Or it might be the latest Core i7 CPU with the fastest memory available. From the embedded systems developer's perspective, the baseboard would be identical, and it would simply mean swapping one COM for another.

Another consideration, particularly in the current environment of chip shortages, longer lead and delivery times, and so on, is that the proven COM computing solution is a practical way to minimize single-source risks. This is because similar, although not exact, COMs are available from multiple vendors. Providing your baseboard is designed to one of the industry standards, you should be able to implement COMs from multiple manufacturers with minimal tweaking.

The application areas that have proven themselves to be appropriate for COMs is an extensive list. It would include, but not be limited to:

- Industrial automation/IIoT/Edge computing
- Machine Learning/AI
- Robotics
- Unmanned Systems/Platforms
- Medical diagnostics and equipment
- Military/COTS
- Transportation Management
- Energy Management
- Test & Measurement Equipment

Note that the continued growth of the Industrial IoT (IIoT) sector is driving more computational power to Edge computing platforms where COMs with specialized carrier boards provide the connectivity and sensor inputs.

DIFFERENT COMS CHOICES

One of the most popular and widely used versions of a computer-on-module is COM Express (COMe). COMe is often found in industrial, military-aerospace, gaming, medical/healthcare, transportation, IoT, and general embedded computing applications.

Note that COMe is generally available in four different form factors: Mini (55 by 84 mm or 2.2 by 3.3 in.), Compact (95 by 95 mm or 3.7 by 3.7 in.), Basic (95 by 125 mm or 3.7 by 4.9 in.), and Extended (110 by 155 mm or 4.3 by 6.1 in.). New versions are just becoming available thanks to the recent COM-HPC standard. In addition to COMe, other defined standards include ETX, XTX, Qseven, and Smarc. These latter standards are less widely used as they blend some of the features of the previously mentioned standards and are often used by a single vendor.

KNOW YOUR COMS VENDOR

When evaluating COM makers, there are many factors to consider. One of those is where the different departments of the manufacturer are located. For example, some claim to be “American made,” when only the design team resides in the U.S. Another may manufacture parts of the module in the U.S., but full board population happens somewhere offshore. With supply-chain issues paramount, and security and quality control a never-ending concern, having every aspect of the design and manufacture process performed in the U.S. can be a key advantage for a system supplier and its customers.

COMs could be available either with or without associated software but getting all the hardware and software from one vendor can be a big plus, both in terms of pricing and ease of integration. That software package could/should include an operating system, drivers, and security.

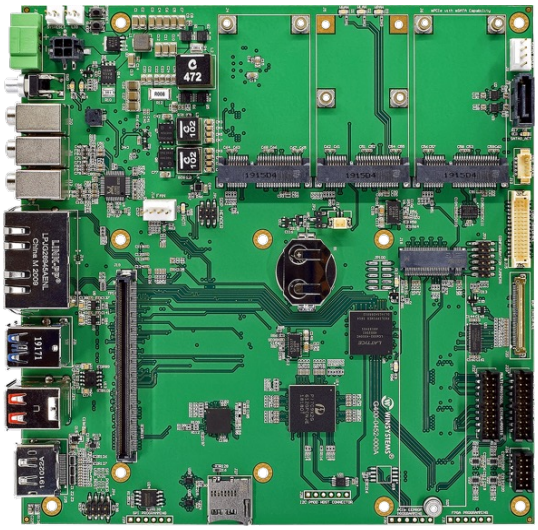
WINSYSTEMS is an example of an embedded computing vendor that operates out of the United States

exclusively, including testing. Delays are less likely to occur, as all the processes occur on the same continent, and in the case of WINSYSTEMS, all in the same time zone. And as we all know, when a delay does occur, it can snowball down the line, where the delay of a single component has been known to shut down an entire assembly line.

In addition, OEMs doing business with U.S.-based manufacturers can have confidence that their trade secrets are more likely to remain secret. This may be true for foreign suppliers, but it is harder to control. WINSYSTEMS operates out of its nearly new state-of-the-art facility in Grand Prairie, Texas, a suburb of Dallas.

Examples of COM-related products offered by WINSYSTEMS include an industrial COM Express Type 10 Mini, both the module and the carrier board, designated as the COMeT10-3900 an industrial COM Express Type 10 Mini module and the ITX-M-CC452-T10, an industrial Mini-ITX small form factor Type 10 reference carrier board.

The COMeT10-3900 industrial COM Express Type 10 Mini module is designed with an Intel Atom E3900 microprocessor and is fully compliant with PICMG standards. The small form factor module can be plugged onto a WINSYSTEMS or another PICMG-compliant carrier board that contains user-specific I/O requirements.



The ITX-M-CC452-T10 industrial Mini-ITX small form factor Type 10 carrier board adheres to the PICMG COM Express specifications. Hence, it's compatible with any other COM Express mini type 10 modules that comply with the standard.

The ITX-M-CC452-T10 is an industrial-rated mini-ITX carrier board, with open schematics and layout available as a reference and evaluation carrier board for WINSYSTEMS Type 10 COM Express modules. It can be combined with a COM module, Mini-PCIe expansion cards, display and M.2 NMVe solid-state disk. Because the carrier board adheres to the PICMG COM Express specifications providing compatibility with other COM Express Mini type 10 modules, it can be used to fully test WINSYSTEMS' COMeT10-3900 COM Express Type 10 Mini module.

In addition to these products, WINSYSTEMS is readying an industrial COM Express Type 6 Compact module and carrier board. RFQs for this new module are now being accepted, with delivery commencing in the first quarter of 2023.

For 40 years, WINSYSTEMS has been proving solutions and technical expertise to the embedded computing industry, not only for COMs and carrier boards, but for the OEM's base software needs, supporting critical infrastructure and applications. Its products offer highly reliable performance in harsh environments,

operating in the industrial temperature range (-40°C to+85°C). Extended product life cycles, up to 15 years in some cases, ensure that your product can be in operation for a long time. Both custom and standard products are available.

In addition, the combination of WINSYSTEMS' highly curated technology partner ecosystem and hardware expertise results in embedded solutions with robust cyber security. Talk to the experts at WINSYSTEMS today for your embedded computing needs.

CONCLUSION

When designing embedded systems, depending on the application specifications, it may be worth exploring COMs as an alternative to traditional SBCs, especially when security, longer product life cycles, and speed to market are of critical importance.

Consider working with a U.S.-based embedded computing technology partner, one with proven expertise in industrial embedded systems design and the manufacture of both COMs and SBCs. They can help you weigh the options and choose the optimum solution for your program.

This white paper has been made available through WINSYSTEMS, INC. and is offered as an educational resource. Please feel free to contact us if you have questions about what you have read or would like to speak with one of our application engineers.

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WINSYSTEMS, INC.
2890 112th Street, Grand Prairie, Texas 75050

www.winsystems.com

Telephone: +1 817.274.7553

Email: info@winsystems.com