Computer-on-Modules Invade HPC

Ready for Today's Demanding Embedded & IoT Projects

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The View Inside

A range of industry applications face escalating demand for high-performance embedded computing. More specifically, this growing demand is for solutions built on standard hardware form factors with low power consumption and modularity in mind. At the same time, compact and efficient computer-on-modules (COMs) have evolved to support some of the most sophisticated embedded processors to manage heavier workloads than previously possible using the form factor. This cross section of modern high-performance embedded computing requirements coupled with a maturing COMs technology and supplier landscape is fueling its expansion into a variety of relatively new product designs and applications.

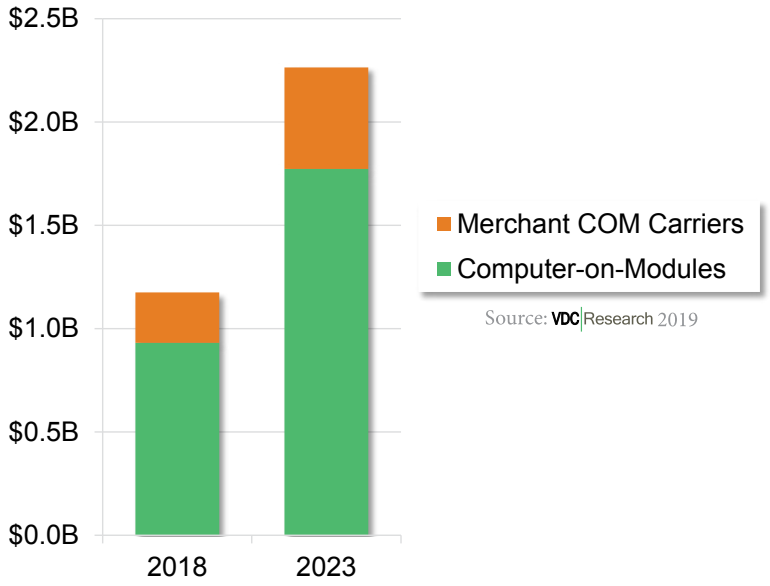
COMs Ripen for High-Performance Computing

Expanding Markets & Capabilities

The global market for embedded COMs has grown steadily since the release of the first COM Express standard in 2005. Since then, COMs have flourished in a wide variety of embedded designs and applications, particularly those requiring low-footprint optimization and hardware flexibility. The communications and network infrastructure, gaming, industrial automation, and health care industries were quick to adopt COMs to satisfy their hardware requirements years ago while others like energy/power and retail automation continue to grow. COMs and their inherently scalable hardware architecture are particularly attractive for emerging high-performance applications supporting artificial intelligence (AI) / machine learning (ML), edge computing and analytics, vision-based processing, and other high-value workloads.

Embedded COMs offer many advantages compared to other hardware solutions and paths for development. Traditional embedded processors (e.g., CPU/MPU, MCU, SoC) do not feature the same level of hardware integrations of components for power management, connectivity, clocks, and other peripherals. Other module types are, for the most part, surface-mount devices that are not readily “plug-and-play” for development. Similarly, traditional off-the-shelf mainboards or motherboards are static/fixed and cannot easily adapt with the evolution of industry applications. All the while, COMs continue to expand in performance and functionality due to the active and growing supporting ecosystem of dedicated standards organizations and leading embedded technology suppliers.

Exhibit 1: The Global Market for COMs & Carriers, Revenue Shipments (2018 & 2023)

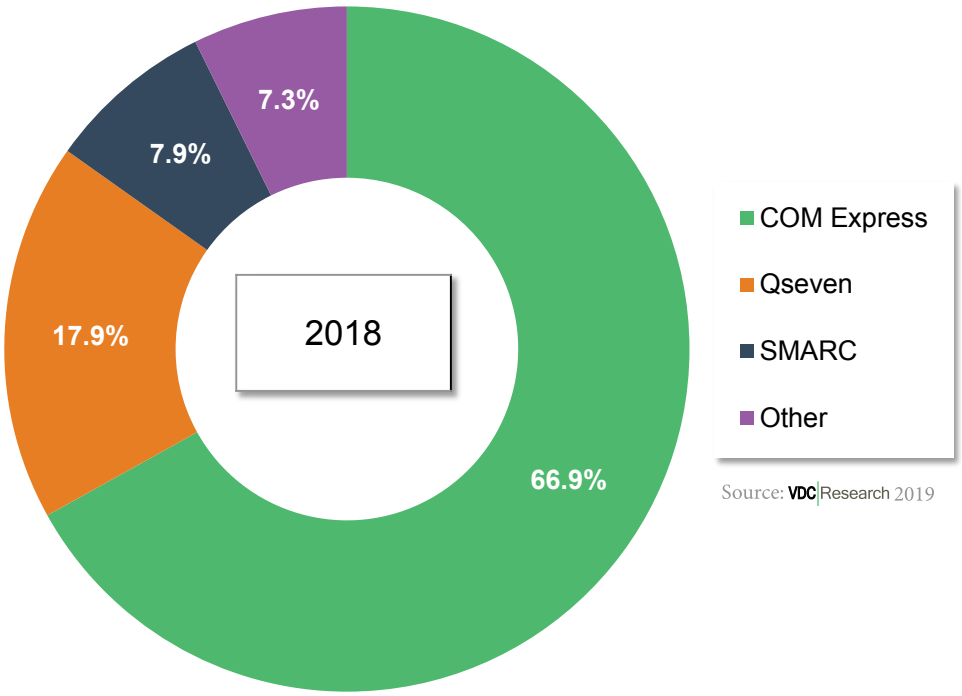


Source: *2019 Embedded Boards, Modules & Systems Market Dataset* (VDC Research)

Technology Growth Built on Strong Standards Leadership & Backers

A technical standard is only as valuable as the support it receives from users and those steering its direction. Fortunately for the COM hardware form factor, strong leadership has come from several directions including not-for-profit consortia like PCI Industrial Computer Manufacturers Group (PICMG) and the Standardization Group for Embedded Technologies (SGET) as well as from leading embedded hardware providers, including Advantech, congatec, and Kontron. Founded in 1994, PICMG is a "flat" organization with more than 140 member companies and steers the dominant COM Express standard as well as other widely used boards standards such as AdvancedMC, AdvancedTCA, CompactPCI, MicroTCA, and SHB Express. Meanwhile, SGET is at the head of the standards for Qseven and SMARC modules and focuses its efforts through formal working groups that conduct forums, technical exchanges, and collaboration. The leading providers of COMs are members of both organizations, ensuring strong support for a variety of form factors through the next several years.

Exhibit 2: Computer-on-Modules Market Segmented by COM Architecture/Form Factor (Percentage of Revenue Shipments)



Source: VDC Research 2019

The COM Express standard was designed with flexibility in mind and features three different pinout types with varying features, performance, and cost targets while maintaining common connectors, signaling, and mounting holes where appropriate. COM Express modules can be used either as a standalone single board computer or, more commonly, as a processor mezzanine that can be plugged into a carrier board consisting of application specific I/O. When used with a carrier board, OEMs and systems integrators can easily upgrade to newer chipsets with commercially available COMs. COM Express supports high-speed serial interfaces, including PCI Express Gen 3, 10GbE, USB 3.0, SATA, as well as high-resolution graphics. Alternative architectures such as Qseven and SMARC have their own unique benefits and roadmaps for design into low-power and mobile embedded designs and indifferent support for ARM and X86 architectures.

A New COM Open Specification on the Horizon

COMs are not staying in their traditional lane of low-power and small form factor computing. The standard is expanding into industrial clouds and beyond. However, the existing standards that have ferried COMs to its current stronghold applications will no longer be sufficient to cope with data growth and processing requirements. Demand is bubbling for new COM concepts for 5G, AI, autonomous vehicles, factory floor & HPC workloads including COMs with server-class (e.g., Xeon) processors for higher-end platforms enabling IIoT applications. In June 2019, the PICMG Committee addressed this need and announced the development of a new COM open specification for high-performance edge computing with support for high-speed interfaces such as PCIe Gen 4/5, 100Gb Ethernet to serve as a complement to—not replacement for—COM Express. In parallel, Kontron, the COMs market share leader, announced that its first HPC COMs are expected in early 2020.

High-Performance Embedded/IoT is a Different Animal

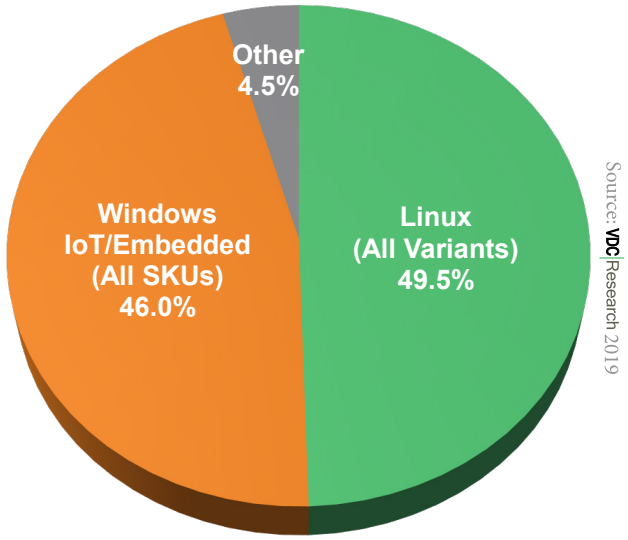
Specialized Requirements for Emerging Industry Applications

Embedded projects are generally becoming more complex across industries while adapting to trends relating to next-generation automation and connectivity. In particular, the high-performance computing domain is meeting new challenges to cost-effective embedded ruggedization, thermal and power management, and industry/safety standards compliance. Growing requirements for real-time/deterministic computing and networking will disrupt embedded development and the selection process for different stack components for new designs as well. COMs are providing a versatile hardware development platform embedding support for many of these design elements, allowing more engineering time to be dedicated to building application value and differentiation.

Hardware Value is Limited by Software

Embedded and IoT systems engineering is not the same today as it was a decade ago. Development time and costs continue to shift from mechanical and electrical design to the software, data/analytics, and cloud/IoT domains. The high-performance computing space itself demands new software tools and resources to maximize the hardware resources available. COMs are well supported by rich Linux- and Windows-based operating systems today although they are not typically bundled with hardware offerings, placing a growing premium on pre-integrations, with key OS providers such as Mentor Graphics, Microsoft, and Wind River. Additionally, security software is now a major criterion for IoT/embedded technology and COMs selection to help protect IP and systems from reverse engineering or tampering.

Exhibit 3: Computer-on-Modules Market Segmented by Embedded Operating System Use, 2018 (Percentage of Revenue Shipments)



Flexible software frameworks and plug-ins are critical to further architecture/standards expansion and hardware platform potential. Developers and engineers need to be able to interface with different hardware components ranging from power and I/O to memory and board information for long-term success. Tools for device monitoring, control, and management are also rising in value, with the IoT driving greater need for access to a variety of information as well as secure connectivity to remotely interface with custom sensors, device fleet management, and device authentication. Full integration into existing OEM software is as crucial as enabling new functions and capabilities. In addition, a wide variety of suppliers are looking to enable and facilitate IT/OT convergence from both the embedded and enterprise/IT domains, placing a premium on partnerships and strategic alliances for end-to-end development and application support.

VDC's View

Modularity is Critical for Next Generation Embedded/IoT Development

Whether for hardware or software, modularity is important to suit the dynamic development requirements, preferences, and system configurations of a broader set of embedded/IoT projects. Traditional static development frameworks and environments cannot adapt and/or scale at the speed required of emerging high-value industry applications, particularly those with heavy data workloads. Embedded engineers and developers are in need of easier development paths in the face of mounting time-to-market pressures and escalating design requirements. COMs drastically simplify embedded development for a range of customer types and a growing list of addressable applications driven by strong backers of standards bodies and hardware market leaders.

COMs Need New Support for the High-Performance Domain

As COMs grow into new, higher-end systems, the corresponding support in software tools, OS compatibility, SDKs/APIs, security, etc., escalates. In addition, expanding hardware requirements for real-time processing and low-latency networking will fuel demand for multi-OS/RTOS support, hypervisors/virtualization, and industrial I/O (e.g., TSN, fieldbus support) going forward. Fortunately, various COM players already catering to high-performance embedded market opportunities support these features and capabilities. Most market leaders for COMs have much broader portfolios of server-class embedded/IoT hardware and software as well as support for facilitating IT/OT convergence, which will grease the skids for COMs to expand into high-performance computing applications.

Flexible Hardware Architectures Feature Immense Value

OEMs, systems integrators, and other embedded hardware users are generally looking to source a higher level of off-the-shelf integrations from embedded hardware. COMs provide an easier development path for those traditionally sourcing embedded processors and other components to integrate with their in-house/custom board design. COMs enable cost-effective design flexibility and scalability to replace/upgrade semiconductors and other hardware resources used with a carrier board over time to meet dynamic workload needs. COMs are evolving with broader advances in technology for embedded processors, memory devices, and protocols to take on heavier workloads and HPC. Hardware modularity begets design flexibility and ease of development, which are critical for the growing high-performance computing space. The COMs market is riding strong tailwinds driven by a number of favorable market trends, developer preferences, and its growing supporting ecosystem to invade the high-performance embedded computing sector.

ABOUT THE AUTHORS

Dan Mandell

Dan Mandell supports a variety of syndicated market research programs and custom consulting engagements in the IoT and Embedded Technology practice. He leads VDC's annual research services for embedded processors, boards, integrated systems, IoT gateways, and other computing hardware. Dan's insights help leading technology providers align their go-to-market planning and competitive strategies with the dynamic embedded landscape and its constantly evolving buyer behaviors, technology adoption, and application requirements. His working relationship with VDC dates back to 2005 and includes time supporting Business Development as well as the AutoID practice. Dan holds a B.S. in Information Systems Management from Bridgewater State University.

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Chris Rommel is responsible for syndicated research and consulting engagements focused on development and deployment solutions for intelligent systems. He has helped a wide variety of clients respond to and capitalize on the leading trends impacting next-generation device markets, such as security, the Internet of Things, and M2M connectivity, as well as the growing need for system-level lifecycle management solutions. Chris has also led a range of proprietary consulting projects, including competitive analyses, strategic marketing initiative support, ecosystem development strategies, and vertical market opportunity assessments. Chris holds a B.A. in Business Economics and a B.A. in Public and Private Sector Organization from Brown University.

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ABOUT VDC RESEARCH

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