



White Paper
Military, Aerospace
and Government

Accelerating the Transformation

Intel's Leadership in Embedded Systems,
Communications and Networking
Maximizes Innovation and Choice
for Network-Centric Warfare

Introduction

Intel's broad range of innovative, modular and standards-based technologies enable the Department of Defense (DoD) and its vendors to apply innovations which cost-effectively implement the network-centric vision. Based on proven leadership in modular embedded systems, communications and networking architectures, Intel is uniquely qualified to help integrators deliver standards-based commercial off-the-shelf (COTS) solutions capable of accelerating the ongoing process of force transformation.

Meeting the Challenge of Transformation

The ongoing process of force transformation is guided by a vision of Network Centric Warfare (NCW). The transformation to NCW promises to deliver the power and flexibility of information-age technologies to maximize mission effectiveness. The NCW concept also involves the rapid and continuous implementation of new capabilities through spiral evolution. The objective of NCW is to provide warfighters with the *information advantage* – optimized information sharing and shared situational awareness – and a *warfighting advantage* – characterized by enhanced collaboration, self synchronization, sustainability and speed of command in the battlespace. By applying advances in information technology and development models, the Department of Defense (DoD) will enable the future force to “*See first. Understand first. Act first. And finish decisively.*”

The NCW vision imposes significant system-level requirements. Multiple complex systems must interoperate and provide backward compatibility with current force systems. The system architecture must enable technology insertions at commercial enterprise refresh rates and scale to meet the demands of constantly changing missions and force levels. Systems must be designed to meet form factor and environmental requirements.

NCW requires a system architecture that comprehends all of these requirements, and also addresses the need to meet today's aggressive cost containment targets and timelines. The concurrent challenges of sound program economics and rapid time-to-deployment has created a widespread recognition of the value of commercial off-the shelf (COTS) solutions. Intel's experience in mission-critical embedded systems, telecommunications and networking elements shows that to be maximally effective, COTS solutions must be based on common technology standards. An open, standards-based, modular platform architecture provides a COTS foundation capable of accelerating and sustaining force transformation.

Challenges

- Life-cycle management
- Performance/Watt
- Interoperable open systems
- Information assurance
- Commercial economics/COTS

Intel® Solutions

- Extended product life-cycles
 - Low-power, 64-bit multi-core architecture¹
 - Broad ecosystem of third-party vendors
 - Virtualization and trusted technologies
 - Standards-based commercial platforms
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Intel® Technology Leadership

With an annual research budget regularly in excess of \$4-5 billion, Intel's R&D programs enable continuous advances in silicon process technology, multi-core processors, energy-efficient computing platforms and robust wireless communications. While Intel is widely known for "Moore's Law" of geometrically increasing transistor integration and the co-invention of Ethernet technology, the company's current R&D priorities span a broad range of silicon (and advanced non-silicon materials), computing, communications, systems, standards, and exploratory research.

Intel's intensive R&D effort drives the non-stop advances in commercial technology and development of new generations of processors that balance improvements in power, performance, functionality and cost. Significant advances in silicon process technology enable integration of additional transistors into existing power envelopes, in accordance with Moore's Law.

Information Assurance

Intel® processors and chipsets enable the implementation of virtualization and secure boot technologies that provide the foundation for cost-effective, high-performance "Information Assurance" platforms. Trusted Platform Management (TPM) silicon and Intel® Trusted Execution Technology² provide the hardware-hardened framework that enables the underlying hardware and software to be trusted.

A third-party hypervisor software layer is used to create and manage the independent "virtual machines," each of which runs in a different security domain. As a result, instead of separate "Unclassified," "Secret," and "Top Secret" systems, each security level can be combined into a single system, with individual user access limited to authorized domains.

Intel Research on the Leading Edge

The DARPA Grand Challenge is a driving force for technology innovation, and Intel has sponsored entrants from Carnegie Mellon and Stanford Universities. In 2005, 20 of the 23 finalists, including all five finishers, utilized Intel® architecture-based platforms.

In addition to participating in the DARPA Grand Challenge, Intel plays a role in research programs at Carnegie Mellon, the University of California, and the University of Washington, and is a key member of standards bodies including the IEEE and WiMAX Forum.

Open, Interoperable Systems

Today, system architects can build Intel®-based solutions in a variety of standard form factors. This includes standards such as VME, and also Modular Communications Platforms (MCP) such as AdvancedTCA*, AdvancedMC* and MicroTCA* that are architected from the ground-up to meet the highest reliability, stability, and scalability requirements of communications devices. The MCP framework incorporates a broad range of building blocks including silicon, boards, chassis, operating systems, middleware and applications.

Intel processor-based MCP designs for computing, communications and networking platforms enable reduced program cycle time, and are designed to integrate and interoperate with other systems. Extensible MCP architecture also maximizes application life-span, enables rapid technology insertion in response to changing requirements, and accelerates the transition to converged all-IP networks.

Open, interoperable systems have multiple benefits for the DoD:

- Improved force readiness through accelerated deployment of network-centric systems
- Increased interoperability for systems in Joint, Interagency and Multinational operations
- Reduced development costs and increased commonality of design in future systems tailored to standards and best practices
- Reduced systems cost and sustainability through component re-use and commonality facilitating ease of integration, upgradeability and support
- Reduced development costs through the identification of common components required in the network-centric environment
- Improved force effectiveness through focused development on domain-specific warfighting capabilities

To help manufacturers realize the benefits of MCP framework, Intel provides modular building blocks suitable for use in current form factors including PC/104, ECX and VITA in addition to more advanced telecom industry standards from PICMG which offer enhanced bandwidth and scalability.

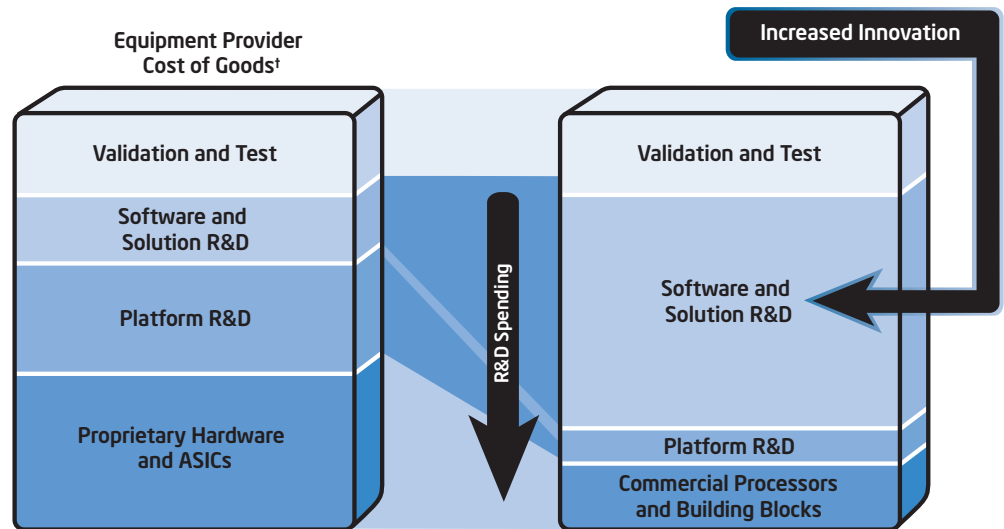
AdvancedTCA* (PICMG* 3.x) meets DoD requirements for high availability, processing power, bandwidth and simple upgradeability over extended system lifecycles which enables spiral insertion of future processors and interconnect technologies. This open, board-based, carrier-grade architecture is designed for telecom applications. AdvancedTCA enables high levels of backplane interconnect bandwidth, performance and flexibility not previously possible in standards-based products.

Advanced Mezzanine Card* (AdvancedMC*) is the mezzanine standard designed to enhance modularity and high-speed serial connectivity for AdvancedTCA and other platforms. AdvancedMC enables manufacturers to bridge between proprietary and standards-based interfaces and to implement a variety of embedded processors, digital signal processors, network processors, and other components in modular Field Replaceable Units (FRUs).

MicroTCA* is designed to deliver improvements in size, weight and power (SWAP) compared to older form factors, MicroTCA maximizes the design and implementation choices available from the industry. The MicroTCA standard includes a standard backplane with built-in redundancy using the proven technology framework of AdvancedTCA. MicroTCA accepts AdvancedMC modules and provides high levels of throughput in a compact form factor. Ruggedized implementations are under development.

Rack Mount Servers (RMS) include carrier-grade RMS (CGRMS) and IP network servers. NEBS-compliant CGRMS deliver an ideal solution for the demanding environment and limited space of rugged environments. Intel® Communications RMS are standard building blocks that enable manufacturers to create their own value-added solutions for a variety of applications.

Benefits of the Standards-based MCP Framework

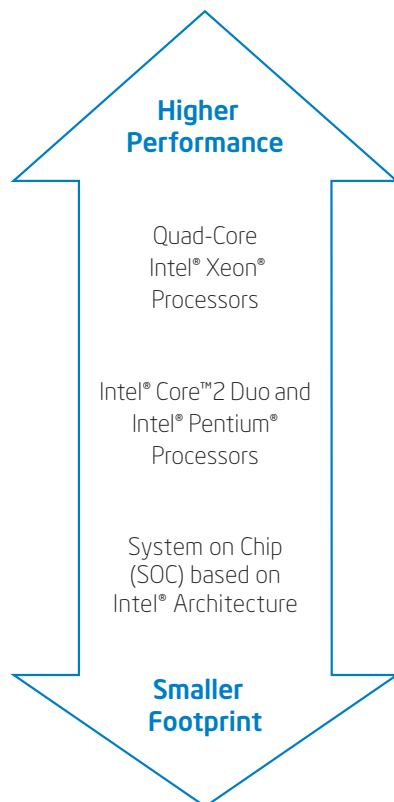


Standards help drive the shift from proprietary to high-volume COTS systems.

High-Performance Energy-Efficient Processors

Intel offers scalable, complementary embedded life-cycle building blocks for computing and communications platforms with clear upgrade paths and long-term product road maps.

- **Intel® Architecture Processors** — At the forefront of innovations including multi-core processing, 45 and 65 nanometer process technology, Intel Architecture Processors help manufacturers optimize SWAP. These characteristics make Intel architecture components well suited for a broad range of high-performance, low-power ruggedized systems, including computing and communications systems for combat vehicles. To meet the requirements of network-centric environments, Intel processors and chipsets provide high-bandwidth I/O interfaces including PCI Express* graphics, Serial ATA and Gigabit Ethernet while maintaining support for legacy I/O technologies.



- **Multi-core processing** — Intel's industry-leading process technology provides the foundation for multi-core processors, where multiple microprocessor cores are integrated onto a single chip. This technology leadership enables Intel to design innovative features, including virtualization and security, into energy-efficient silicon products. Of special importance in network-centric applications, Intel® multi-core processors include microarchitectural enhancements that accelerate processing-intensive tasks such as signal and 3D image processing.
- **Energy-efficient processing** — Intel's growing product line of multi-core processors enables a wide range of low-power, high-performance communications and embedded applications. These processors provide intelligent power management features to deliver significantly greater performance per watt. Multi-core processors with on-demand coordinated performance and enhanced power management enable significant power savings. Intel's advanced thermal management system delivers precise acoustic control for quieter, cooler and thinner system designs.
- **Software, tools and flash memory** — Another compelling advantage of Intel Architecture Processors is the proven code base and development environment, which is compatible with open-source operating systems and familiar to generations of software engineers and programmers. Intel helps you translate multi-core processing power into application performance with tools that help you create, debug and optimize your code.

Building on two decades of experience in non-volatile memory, Intel offers a product line of solid state drives based on NAND flash memory with multiple densities and industry standard Universal Serial Bus (USB) interfaces. Compared to hard disk drives (HDD) or removable USB storage devices, solid state drives deliver faster boot times, embedded code storage, rapid data access and low-power storage alternatives.

A Broad Ecosystem Maximizes Innovation and Choice

Intel continues to work with industry leaders to provide a wide array of standards-based communications building blocks from multiple sources. The Intel® Communications Alliance provides a point of entry through which manufacturers, the federal government and the DoD can connect with Intel's world-class developer community and access the depth and breadth of the offerings of member companies. Working with these vendors and their validated hardware and software solutions enables manufacturers and contractors to start their development process at a higher level of system integration.

Because they understand the value of modularity, members of the Intel Communications Alliance have the expertise to deliver high-volume embedded computing, communications and interconnect solutions. Technology decision makers benefit from innovation, best-in-class products, economies of scale and extensive R&D investments by the members of the alliance.

Teaming with the members of the alliance, Intel supports the industry standards that provide the foundation for the MCP paradigm. Intel performs this role through leadership in standards development, significant investments in R&D, and a broad array of product offerings.

Members of the ecosystem provide:

- Interoperable COTS solutions
- Standards development
- A broad array of silicon, board, chassis and software products
- Embedded computing and communications solutions

Working with these vendors and their validated hardware and software solutions enables manufacturers and contractors to start their development process at a higher level of system integration.

Conclusion

With its leadership in technology innovation and its expertise in developing building blocks, development platforms and software for embedded systems and communication networks, Intel is highly qualified to help the DoD implement the NCW vision, while maximizing innovation and choice for contractors. Intel enables embedded computing, communications and networking solutions that harness innovations in processing performance, programmability and bandwidth. By providing the building blocks for modular, standards-based COTS solutions, Intel can help the DoD meet cost and schedule requirements and mitigate program risk, while helping to accelerate the process of force transformation.

www.intel.com/go/military

¹64-bit computing on Intel architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers and applications enabled for Intel® 64 architecture. Performance will vary depending on your hardware and software configurations. Consult with your system vendor for more information.

²No computer system can provide absolute security under all conditions. Intel® Trusted Execution Technology is a security technology under development by Intel and requires for operation a computer system with Intel® Virtualization Technology, an Intel Trusted Execution Technology-enabled processor, chipset, BIOS, Authenticated Code Modules, and an Intel or other compatible measured virtual machine monitor. In addition, Intel Trusted Execution Technology requires the system to contain a TPMv1.2 as defined by the Trusted Computing Group and specific software for some uses. See <http://www.intel.com/technology/security/> for more information.

³Actual investments will vary.

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