RadiSys
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WHITEPAPER

DUAL-CORE PERFORMANCE ON COM EXPRESS

VERSION 1.0 | APRIL 2007

CONTENTS

FEATURE	DESCRIPTION	FUNCTION	BENEFIT
INTEL ADVANCED SMART CACHE	• Up to 4MB shared and multi-core optimized L2 cache • Higher L2 cache to processor core bandwidth	• Improves execution core access to data in high perf. L2 cache • Dynamically allocates cache based on core workload—entire L2 cache can be allocated to one core (dedicated L2 for each core)	• Better performance on single & multithreaded applications • Access to larger cache means faster data access & improved performance of content creation and entertainment applications
INTEL ADVANCED DIGITAL MEDIA BOOST	• Single cycle SSE/2/3 instruction execution	• Allows full 128 bit SSE/2/3 instructions to execute in a single clock cycle (vs. 2 cycles for previous generations)	• Better performance on video, gaming and multimedia applications • Higher FP, Linpak, & HPC application performance
INTEL WIDE DYNAMIC EXECUTION	• Efficient 4-wide, 14 stage pipeline	• Executes 4 instructions per clock (vs. 3 per clock for previous generations)	• Better performance on multiple application types and user environments
INTEL INTELLIGENT POWER CAPABILITY	• Powers on processor elements only when needed • More precise control of power to buses and arrays	• 65W desktop mainstream TDP • 80W svr mainstream & 40W ultra dense TDP • Enables continued low power mobile platform 35W TDP	• Can help enable quieter, more power efficient system designs • Can reduce overall power consumption & TCO
INTEL SMART MEMORY ACCESS	• Improved pre-fetchers • Out of order memory accesses	• Efficiently feeds the Intel Wide Dynamic Execution engine • Benefits for memory operations streamlines latency	• Better performance on all types of applications and user environments
INTEL VIRTUALIZATION TECHNOLOGY	Manages shared resources among multiple virtual machines on a single physical machine	• Allows multiple virtual machines to run simultaneously as independent computers	• Increased robustness, where one virual machine “lock-up” does not affect the others and can be restarted independently

The Intel Wide Dynamic execution provides efficient 4-wide, 14 staged pipeline access to the processor from memory. This enables 4 instructions per clock versus 3 per clock in previous single core processors. This pipelining keeps data flowing to the processors so the processor is not starved and waiting for data.

The Intel Intelligent Power Capability provides power to the processor element only when needed. The greatly reduces the overall power consumption of the processor and provides a more attractive thermal envelope for embedded applications that require long life and reduced noise.

Intel Smart Memory Access is an improved pre-fetcher system to address out of order memory accesses. It efficiently feeds the Intel Wide Dynamic Execution engine and helps to streamline and reduce latency. This feature results in improved performance for all applications as the pipeline to the processor is filled more efficiently.

Intel Virtualization technology enables resources to be shared among multiple processors and operate as independent computers. This feature is one of the more exciting advances that can be fully customized to an application. It can enable real time deterministic response from the processors by using two operating systems, a standard OS and a real time OS to be running individually on each core. Systems can respond more quickly to emergencies saving time and cost.

DUAL CHANNEL MEMORY— KEY TO THE PERFORMANCE LOCK

The Dual-core architectural advantages cannot stand on their own. The key to unlocking the performance potential lies in the simple requirement for ample available memory bandwidth to keep both cores from idling. A dual channel memory architecture accomplishes this. Dual channel memory capability has been a feature of performance Intel chipsets since the early 2000s, and two channels are commonly populated on standard size boards. However, in the modular form factor market, dual channel memory is very atypical—two SODIMM sockets are extremely difficult or near impossible to fit on 95 x 125mm size board. Off-chip memory access is key to the CPU performance gains and without a dual channel architecture, the true potential of dual-core performance is not fully realized for small form factor boards.

Dual channel memory architecture has the following options that increase memory access performance:

- A simultaneous read and write
- Two simultaneous reads or writes.

Simultaneous read-write and simultaneous write or read accesses reduce memory access congestion and in turn reduce idle CPU cycles. Simultaneous reads are of special importance to SIMD operations, where the same operation is performed on very large sets of operand pairs. Simultaneous read-write accesses speed up overall graphics performance by allowing faster access to CPU data by the graphics processor through the memory subsystem. Such operations are very common in digital signal processing and graphics rendering operations, which rely heavily on linear algebraic operations, such as inner products and matrix-matrix or matrix-vector multiplications.

	1x1GB DIMM	2x512MB DIMMs
Copy 32	2909MB	4000MB
Copy 64	2909MB	3764MB
Scale	2909MB	4000MB
Add	2181MB	2526MB
Triad	2461MB	2909MB

STREAMED BENCHMARK RESULTS

1x1GB DIMM	2x512MB DIMMs
2428	5113

MCS BENCHMARK RESULTS

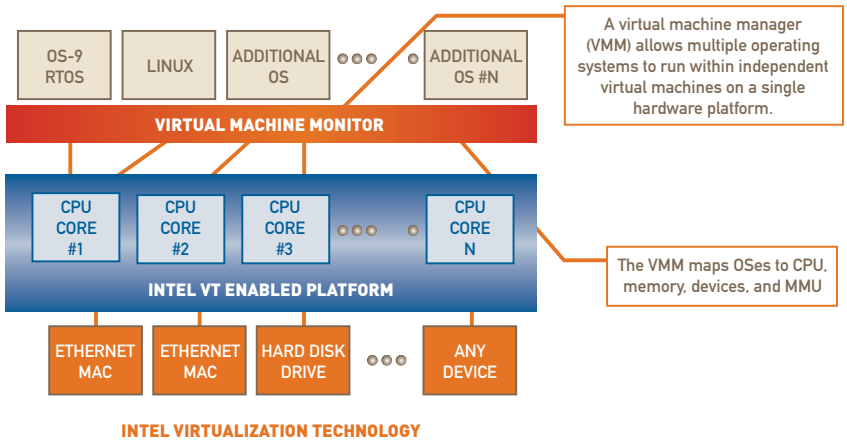
The Intel 945GM dual channel memory controller interleaves addresses between the two channels, with the switch happening after each cache line (64-byte boundary). A second read or write request queued up behind the first for an address on the opposite channel can have its data transfer completed independent of the first request. Two consecutive cache lines can be requested and retrieved simultaneously, since they are on opposite channels.

The dual channel memory architecture advantage is clearly evident from benchmark results. The Streamed benchmark is representative of the memory accesses occurring in medical and other imaging applications, while the MCS benchmark is representative of general computational tasks. Both benchmarks show vast improvement in CPU performance with a dual channel memory configuration over a single channel one, with nearly 30% improvement in case of the Streamed benchmark and over 50% in case of the MCS one.

VIRTUALIZATION

The dual-core, dual channel hardware performance gains of the RadiSys module can be multiplied by intelligent software use. Designers can now mix and match multiple operating systems on a single device with the introduction of Intel Virtualization Technology (VT) and consolidate multiple processor boards into a single Com Express solution.

For example, a typical high end medical imaging implementation often has separate processor boards, one for the high-reliability, high-performance real-time instrumentation control, and another for the less critical, general purpose computational, display and networking functions. With dual-core, these multiple boards can now be consolidated to a single Com Express solution. A high-performance real-time OS, such as RadiSys Microware OS-9, can run in one core in parallel with a general purpose OS such as Windows or Linux running on the other core. Designers cut costs, simplify design and lower power consumption.



Virtualization brings other benefits as well. A crash in one core doesn't affect the operation of the other—so system reliability improves, and if security is a concern, virtualization ensures that the software running in one core can be isolated from software running on the other core. A trusted, long life real time operating system, such as OS-9, can be used to run secure and critical applications on one core, while less critical or secure application can run on a general purpose OS, such as Linux, on the other core. Designers no longer need to retest and qualify critical applications with every frequent release of a new Linux or Windows update.

FIGURE 2. Virtualization represents a wave in the future of managing HW and SW resources more efficiently.

THE RADISYS PROCELERANT CE945GM: THE DUAL-CORE ADVANTAGE IN A MODULAR FORM FACTOR

The RadiSys Procelerant CE945GM brings together the benefits of dual-core Intel processors and dual-channel memory in a COM Express module measuring only 125mm x 95mm. It is fully compliant with the PICMG COM Express module specification and is the only such product with standard dual channel SODIMM memory support in the market. This results in an impressive memory expansion capacity at 2GB DDR2 667MHz SODIMM memory per channel, or a total of 4GB.

The Procelerant CE945GM is available with a range of processors. Modules equipped with the Intel Core 2 Duo processor L7400 deliver the performance headroom required for imaging, test and measurement, gaming and other compute intensive applications. Modules equipped with an Intel Core Duo processor T2500 at 2 GHz deliver scalable performance at low power dissipation for the most demanding imaging, graphics processing or data acquisition & analysis applications, and modules equipped with a low voltage Intel Core Duo processor L2400 at 1.66GHz enable designers to meet very tight power dissipation requirements.

The Procelerant CE945GM sports five x1 PCI Express links with total peak transfer rate of 25Gbps in full-duplex mode. Alternatively these links can also be configured as a single x1 and single x4 link. A dedicated x16 link allows a high-performance graphics subsystem to be added on the carrier board, while two SATA links provide an aggregate of 300M bytes/sec peak data transfer speeds. Dual SDVO links provide independent, dual head display capabilities via the integrated graphics processor in the Intel 945GM chipset and a 1Gb Ethernet connection provides high-speed network access. A 32-bit/33MHz PCI 2.2 bus and an ATA33 IDE interface provide legacy I/O support, including support for CompactFlash ATA-compatible memory devices.

RadiSys is a founding member for the PICMG COM Express specification and has seen customers benefit from adopting the COM Express standard for their application. These benefits include:

- Performance scalability. Modules with higher CPU, chipset and I/O performance can replace older modules without redesign of carrier board.

- Exact form-fit-function. Carrier boards are easily designed to fit a particular form factor, allowing product differentiation and better, more functional and user-friendlier designs, such as portables, handhelds, etc.
- Long product life. Plug-compatible modules replace those with end-of-life parts without the need to change carrier board, thermal, mechanical and software design.
- Lower development cost and risk. By removing the need to design high-speed CPU systems, product development risks are lowered and costs are reduced, as it is not necessary to upgrade expensive CAD tools and expand engineering staffs.
- Focus on core competency. Since the host processor subsystem is generic, there is not much competitive advantage gained by allocating expensive resources for its design. Instead, these resources can now be focused on subsystems, which are non-generic and add true market differentiation and customer value.
- Faster time-to-market and time-to-revenue. The reduced design cost and development risk results in faster time-to-market and consequently, faster time-to-revenue.
- Innovation and service. Access to an open industry standard spurs innovation in the supplier base and secures greater levels of customer service.

CONCLUSIONS

The Procelerant CE945GM COM Express modules unlock the true potential of the Intel dual-core processors with Intel 945GM chipset through full support of dual channel memory. These modules are the only COM Express Basic form factor modules available today that pack so much performance in such a tiny package. Through the combination of dual-core and dual channel memory technology, the Procelerant CE945GM modules provide designers of high performance medical imaging, industrial imaging, gaming and test & measurement equipment with unparalleled performance in the smallest available package.

Intel Core Duo processors bring unprecedented performance gains to modular embedded systems through dual processor cores paired with large, independent, dynamically sizable L2 caches, support for SSE2 and 3 instructions, execution of up to four operations per instruction, out of order memory access and support for virtual machines. Dual channel memory is responsible for maximization of these performance gains through doubling of memory bandwidth, with two reads, two writes or a pair of read and write operations performed independently of each other. Intel Core 2 Duo processor performance gains of more than 50% can be achieved for general purpose computing tasks, while nearly 30% gains can be achieved for imaging, graphics processing and data acquisition applications.

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