

Intel® 925X/915 Express Chipsets: A Giant Step in PC Architecture Evolution

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Intel® 925X/915 Express Chipsets: A Giant Step in PC Architecture Evolution

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Overview: Revolutionary PCI Express* Architecture

Intel is introducing a new family of advanced chipsets that drive the most profound changes in PC platform architecture in more than 10 years. Capabilities for high-definition video, multistreaming audio, and wire-speed Gigabit Ethernet are all arriving on the PC, coupled with dramatic improvements in storage performance and reliability, wireless networking, and ease of use that will empower new home and business usage models.

The new Intel® 925X/915 Express Chipsets provide the bandwidth and headroom of PCI Express* architecture to further unleash the performance of Intel® Pentium® 4 processors with Hyper-Threading Technology (HT Technology)¹.

Extreme Enhancements

These chipsets provide PC users with extreme PC performance. The revolutionary PCI Express architecture enables these chipsets to feed multiple threads to the processor, while providing the bandwidth to support emerging PC usage models and the enhanced storage performance and data protection of RAID (redundant array of independent disks) technology.

The *Intel® 925X Express Chipset* complements the Intel® Pentium® 4 processor Extreme Edition at 3.4GHz with Hyper-Threading Technology. The Intel 925X Express Chipset is also the first Intel chipset to deliver the dramatically improved bandwidth of PCI Express* x16 graphics to meet the demands of applications requiring high-definition video. PCI Express graphics delivers up to 4 gigabits per second (Gbps) per direction, or more than three-and-a-half times the bandwidth of previous AGP 8X-based graphics solutions. This processor and chipset combination is designed to provide the increased performance demanded by PC enthusiasts, high-end gamers and other power users. It advances the ultimate PC experience even further with a range of integrated capabilities including Intel® High Definition Audio and dual-channel DDR2 (double data rate) memory at 533 MHz.

The *Intel® 915 Express Chipset family*, including the Intel 915G and 915P Express Chipsets, provides high-bandwidth interfaces and flexible graphics options that complement Intel Pentium 4 processors with Hyper-Threading Technology. The Intel 915G Express Chipset is the heart of Intel's next corporate stable platform, and includes Intel's latest graphics technology to deliver incredible PC-based digital entertainment experiences in mainstream PCs within the home. The Intel 915P Express Chipset delivers PCI Express x16 graphics, and is designed to enable flexible PC configurations.

Intel's new chipsets enable a broad spectrum of new platform capabilities:

- The Intel® Graphics Media Accelerator 900, integrated in the Intel 915G Express Chipset, is optimized for Microsoft* DirectX* 9 and provides dual independent display capability with support for the latest 16:9 ratio monitors, in addition to conventional 4:3 displays.
- Intel® High Definition Audio enables multistreaming, 7.1 surround sound and dynamic jack retasking in a groundbreaking PC audio solution that provides performance comparable to high-end consumer electronics (CE) equipment.
- Intel® Matrix Storage Technology provides the performance benefits of RAID 0 for media-intensive applications and the added protection of RAID 1 for critical digital media files and data on just two drives.

- The I/O Controller Hub 6 (ICH6R version) supports four 1.5 Gbps Serial ATA* (SATA) ports with Advanced Host Controller Interface (AHCI) capability, enabling Native Command Queuing for enhanced storage performance.
- Four PCI Express x1 high-speed expansion ports are ready for Gigabit Ethernet and future applications, including multiple TV tuners implemented in a single card.
- Intel® Wireless Connect Technology enables users to create or expand a wireless network without external access point hardware. Intel Wireless Connect Technology requires a specific Intel 9XX Express Chipset and a separate Intel wireless LAN solution to operate. Availability is limited.
- Dual-channel DDR2 memory provides additional memory bandwidth to feed higher performance processors and Intel's new GMA 900 graphics engine.

The Intel 925X/915 Express Chipsets advance the PC architecture along three primary vectors:

- Increased platform bandwidth and system-level performance enabled by PCI Express architecture, DDR2, RAID 0/1 drive technology and Intel's Direct Media Interface.
- Revolutionary new features such as Intel High Definition Audio and High Definition TV support that have been designed from the ground up to take advantage of this bandwidth and enable new digital home and digital office usage models.
- Enhanced ease of use, including the Intel® Application Accelerator migration tool for implementing RAID array capability, Intel® flexible memory technology that enables a spectrum of DDR2 or DDR implementations in a single PC, and the enhanced Plug and Play capability enabled by High Definition Audio jack retasking.

This article provides a high-level overview of these new platform capabilities. For more details, see the links provided under More Info at the end of the article. For additional information on Intel High Definition Audio, see the article *Intel® HD Audio* in this issue of Technology@Intel Magazine.

Improved Performance and Bandwidth

By leading the transition to 90nm technology, Intel has set the stage for ongoing processor performance improvements based on larger L2 caches, new processor instructions, and higher clock frequencies. By providing a direct electrical connection between the chip module substrate and the motherboard, the new Intel LGA775 (Land Grid Array) package (below) provides the robust power and signal delivery needed for future performance headroom.



Intel 925X/915 Express Chipsets deliver accelerated system-level performance and responsiveness when combined with Intel Pentium 4 processors with Hyper-Threading Technology. By integrating PCI Express architecture, these chipsets are designed to take advantage of a point-to-point dedicated serial architecture with concurrent read/write capability that enables the chipset to more efficiently feed multiple threads to the processor. Other integrated features, including Dual Independent Display and High Definition Audio multistreaming, enable users to directly experience the power of Hyper-Threading Technology.

The Intel 925X Express Chipset delivers optimized system-level performance through enhanced memory pipelining that enables a higher utilization of each memory channel, improving data access. The result is a performance-oriented platform optimizing data transfers between the processor and system memory for platforms configured with 800-MHz system buses and DDR2 memory.

As shown in **Figure 1**, the Intel 925X Express Chipset is designed to improve performance in several ways:

- Reducing overhead associated with memory maintenance by interleaving data and maintenance commands.
- Rearranging data stored in memory to optimize access time by taking advantage of all ranks and channels.
- Using today's advanced DDR2/533-MHz memory technology.

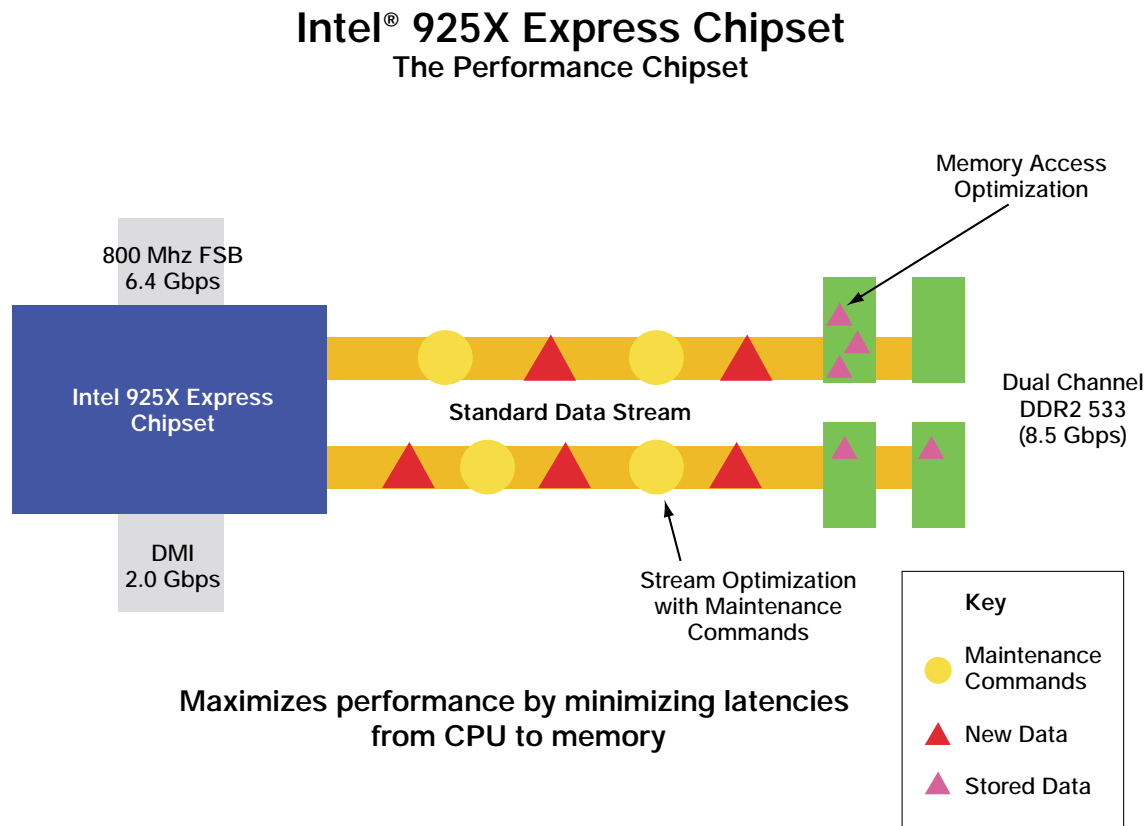


Figure 1. The Intel 925X Express Chipset is designed to complement the performance of Intel Pentium 4 processors with Hyper-Threading Technology. The chipset maximizes performance by reducing latencies from the processor to memory, by optimizing the efficiency of data stored in memory, and by taking advantage of the performance of DDR2/533 MHz memory. Future versions of the chipset will support ECC memory.

Intel 925X/915 Express Chipsets include a new Graphics Memory Controller Hub (GMCH) interface with wider internal data buses that support dual-channel DDR2 memory technology at 533 MHz, for up to 8.53 Gbps of peak memory bandwidth. The new GMCH design supports both asynchronous and true isochronous data traffic with dedicated internal pipelines and specialized arbitration.

The chipset also implements the Intel Direct Media Interface, the new high-speed point-to-point bus architecture replacement for Intel® Hub Architecture that links the GMCH to the ICH6, delivering up to 2 Gbps of concurrent bandwidth.

The increased performance of the Intel 925X Express Chipset is illustrated in **Figure 2**.

Platform Performance Advancement Big Boost in 1 year

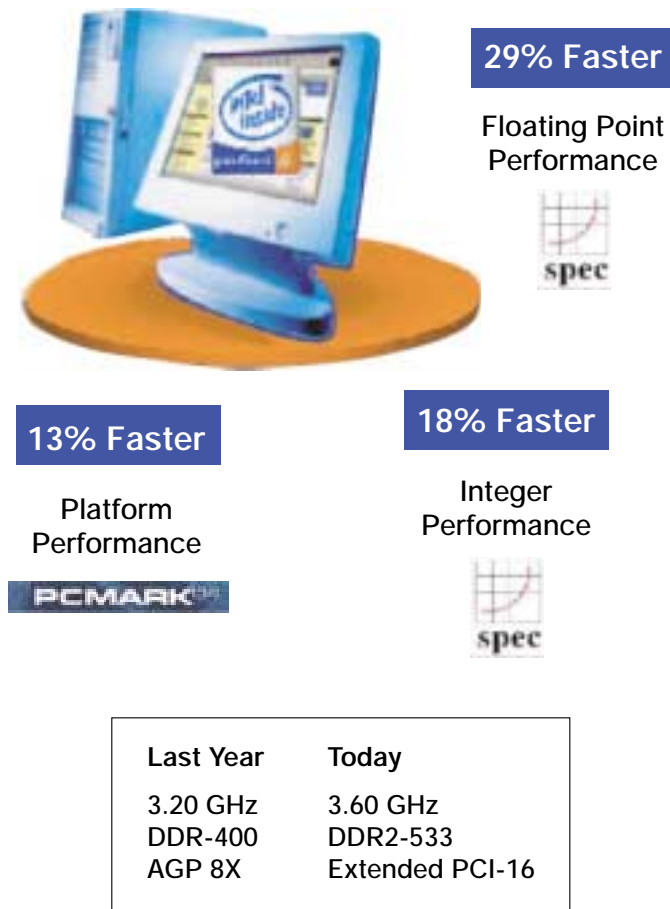


Figure 2. The Intel 925X Express Chipset, combined with the Intel Pentium 4 processor 3.60 GHz with HT Technology, delivers enhanced system-level performance.

Source: Intel. Baseline Configuration: Intel® Pentium® 4 Processor with HT Technology 3.20 GHz - Intel® D875PBZ Desktop Board (AA-204), 1GB DDR400 CL3-3-3, ATI Radeon 9800 Pro AGP graphics, ATI CATALYST 3.5 Driver Suite: display driver 6.14.10.6360, Intel® Application Accelerator RAID Edition 3.5 with RAID ready, Intel® Chipset Software Installation Utility 5.01.1015; Performance Configuration (system compared against Baseline Configuration): Intel® Pentium® 4 Processor 560 with HT Technology - Intel® 925XCV (AA400) chipset-based Motherboard, 1GB DDR2 533 CL4-4-4, Pre-production eVGA GeForce 6800 PCI Express, Pre-production nVidia driver 6.14.00.6160, Intel® Application Accelerator RAID Edition 4.0.0.6211 with RAID ready, Intel® Chipset Software Installation Utility 6.10.1014; All Platforms - Seagate® Barracuda® 7200 Serial ATA 160GB Hard Drive - ST3160023AS, DirectX® 9.0b, Windows® XP Build 2600 SP1, Intel® PRO/1000 MT Desktop Adapter. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Intel Processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

PCI Express Graphics

The growing consumer adoption of High Definition TV (HDTV) and HD video, in addition to the latest generations of advanced PC games, puts tremendous emphasis on video and 3D graphics performance. The platform must be able to handle extremely fast transfers of textures, physics, and geometry data between memory and the processor to the graphics subsystem.

Next-generation games will stress bandwidth requirements even more by implementing photorealistic textures, coupled with lifelike physics and geometry. Massive multiuser (MMU) games will require support for persistent effects that enable characters to interact with changes in the gaming environment, such as battle damage, smoke, or weather effects. All of these applications can stress the present AGP bus to its limits.

The Intel 925X Express Chipset with PCI Express graphics is designed to enable tomorrow's digital home usage models, including ultrarealistic 3D games and real-time editing and sharing of High Definition (HD) video streams. As shown in **Figure 3**, PCI Express provides up to 8 Gbps of dedicated bidirectional bandwidth, enough to move HD video streams between the system memory and the hard drive out to the graphics card and back to the memory/hard drive. PCI Express X16 graphics supports the rendering of multiple HD (720p) video streams at up to twice the frame-rate of AGP 8X.

PCI Express* X16 Next-Generation Discrete Graphics

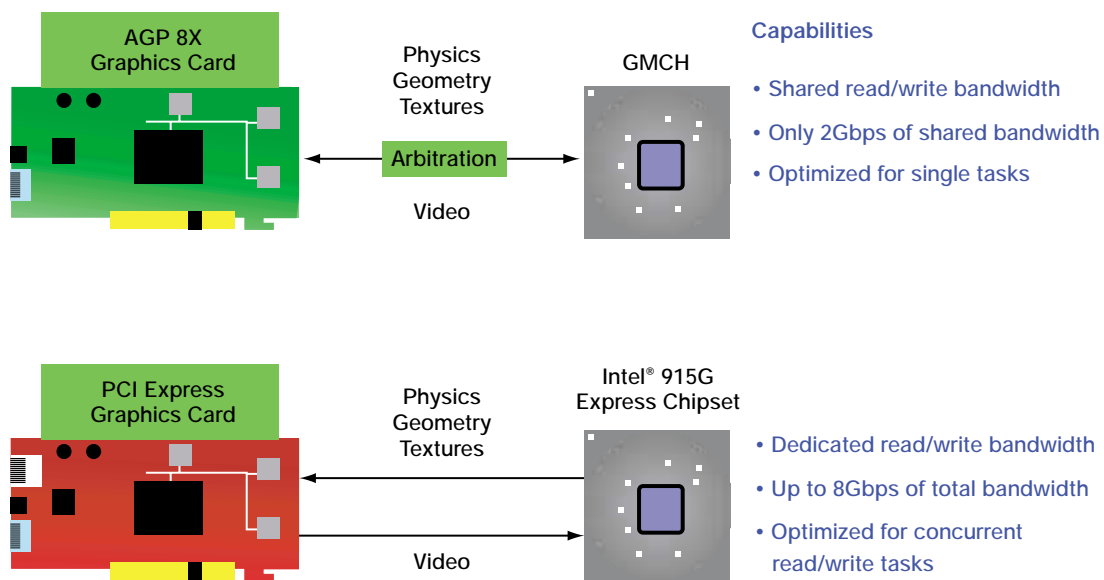


Figure 3. PCI Express X16 graphics provides the massive dedicated bi directional bandwidth required to move and edit HD video.

Intel® GMA 900

Integrated into the 915G Express Chipset, the Intel® Graphics Media Accelerator 900 (Intel GMA 900) provides 2D, 3D, and video acceleration, with the GMCH providing interfaces to the Intel microprocessor and the I/O subsystem.

The 3D graphics pipeline is broken up into four major stages, including geometry processing, setup (vertex processing), texture application and rasterization. The Intel GMA 900 is optimized to use the Intel Pentium 4 processor for software-based geometry processing (such as transform and lighting) defined by Microsoft DirectX 9.

The Intel GMA 900 handles the remaining three stages, including converting vertices to pixels, applying textures to pixels, and rasterization – the application of lighting and other effects to produce the final pixel value. From the rasterization stage the Intel GMA 900 writes the final pixel value to the frame buffer for display. Intel GMA 900 includes two independent display pipelines that enable operation of dual displays.

Intel GMA 900 utilizes a shared memory architecture. Since memory is shared by both graphics and other system applications, memory bandwidth is critically important for quality and performance. The 915G Express Chipset meets this requirement by supporting dual-channel DDR2/533-MHz memory. See **Figure 4**.

Next-Generation Intel Graphics on Intel® 915G Express Chipset

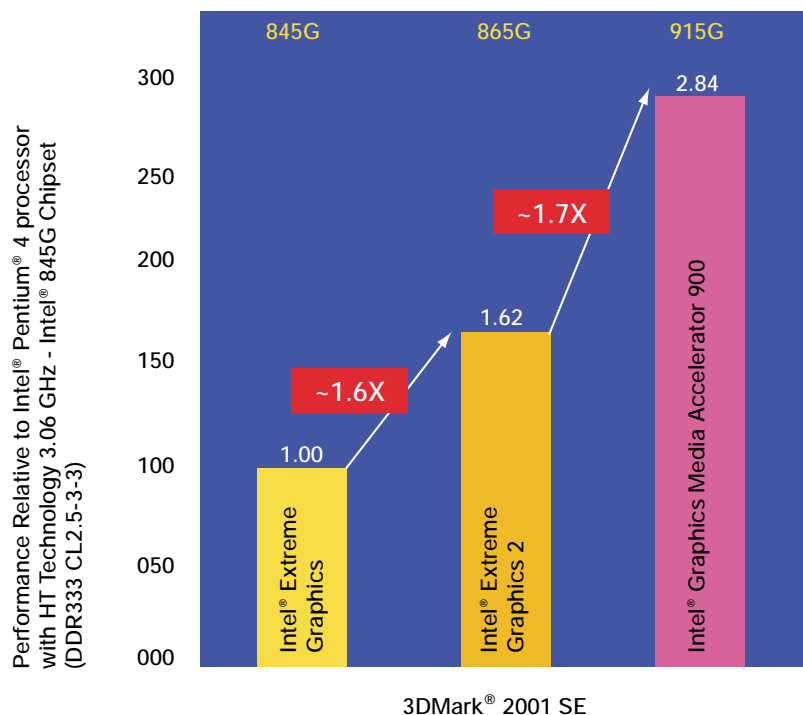


Figure 4. The Intel GMA 900 enables the Intel 915G Express Chipset to deliver enhanced visual quality compared to earlier Intel chipsets.

Configurations and Disclaimers

Source: Intel. Configuration: Intel® 845G Chipset Platform – Intel® D845GEBV2 Desktop Board, 1GB DDR400 at DDR333 CL2.5-3-3, Integrated graphics with Intel® Extreme Graphics, Graphics Driver v6.14.10. 3756, IBM® 80GB 120GXP IC35L080AVVA07-0 ATA-100 Hard Drive, Intel® Chipset Software Installation Utility 5.01.1015, Intel® Pentium® 4 processor with HT Technology 3.06 GHz; Intel® 865G Chipset Platform – Intel® D865GLC Desktop Board, 1GB DDR400 CL3-3-3, Integrated graphics with Intel® Extreme Graphics 2, Graphics Driver v6.14.10. 3756, Intel® Chipset Software Installation Utility 5.01.1015; Intel® 915G Express Chipset Platform – Intel® 915G Express Chipset Preproduction Board, 1GB DDR2 533 CL4-4-4, Integrated Graphics with Intel® Graphics Media Accelerator 900, Intel® 915G Express Integrated Graphics driver 6.14.10. 3756, Intel® Chipset Software Installation Utility 6.10.1002; Intel 865G Chipset and Intel 915G Express Chipset Platforms – Intel® Pentium® 4 Processor with HT Technology 3E GHz, Seagate® Barracuda® 7200 Serial ATA 160GB Hard Drive – ST3160023AS; All Platforms – DirectX® 9.0b, Windows® XP Build 2600 SP1, Intel® PRO/1000 MT Desktop Adapter. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

Intel Dynamic Video Memory Technology allocates additional memory for graphics processing based on application demand. When the application is closed, the memory is released to the system. Dynamically allocating memory for graphics use ensures the optimum balance between system and graphics performance.

The Intel 915G GMCH also provides a variety of display interfaces. Intel GMA 900 includes an integrated digital-to-analog (DAC) converter, two Intel® Serial Digital Video Out (SDVO) ports that can interface to digital video interface (DVI), and low-voltage differential signaling (LVDS) transmitters, SD/HDTV-out encoders, and additional DACs.

Intel® High Definition Audio

Intel High Definition Audio (Intel® HD Audio) enables multiple independent streaming of audio for an exciting variety of emerging usage models. Multistreaming capabilities will make it possible to use two or more different audio streams, such as game sounds and voice chat, or to send audio streams to different destination devices simultaneously from the same PC.

High Definition Audio can support up to eight channels at 192kHz/32-bit quality, compared to six 96kHz/20-bit channels enabled by AC'97. Intel HD Audio also provides dynamic bandwidth assignment that provides dedicated system bandwidth for critical audio functions to help optimize audio quality. Intel HD Audio supports array microphones with up to 16 elements.

Dolby Laboratories has selected Intel HD Audio to enable Dolby's quality surround sound technologies on the PC, as part of its PC Logo Program*, and Intel HD Audio is supported by Microsoft's Unified Audio Architecture* (UAA), which will provide one driver to support all Intel HD Audio-compliant controllers and codecs.

For additional information on Intel High Definition Audio, see the article *Intel® HD Audio* in this issue of Technology@Intel Magazine.

Intel® Matrix Storage Technology

More and more, consumers use their PCs to store precious family memories, including digital video and photos, valuable music libraries, realistic 3D-gaming environments and even recorded TV programs. For businesses of all sizes, the value of the data stored on PCs far exceeds the value of the systems themselves. Yet very few PC users routinely back up their files, and disk drives do fail. In these environments, protecting against a catastrophic hard disk drive failure is more important than ever before.

Intel 925X/915 Express Chipsets include Intel® Matrix Storage Technology, which enables PCs with two hard disk drives to implement two kinds of RAID technology:

- RAID 1 uses mirroring to protect against a hard disk failure by creating a redundant copy of stored data.
- RAID 0 enables higher storage performance by striping data across disks — allowing simultaneous access to both disks at higher media transfer rates.

These features are enabled by Intel Matrix Storage Technology on systems based on the ICH6R I/O Controller Hub. In addition to providing four 1.5-Gbps Serial ATA ports, the ICH6R also features Advanced Host Controller Interface (AHCI), which enables Native Command Queuing.

As shown in **Figure 5**, when paired with capable hard disk drives, Native Command Queuing dramatically enhances storage performance with random workload operations by enabling drives to reorder commands based on their location on the disk. In addition to Native Command Queuing, AHCI also enables each drive to act as a master, and supports hot-plug and advanced power management. With Intel Matrix Storage Technology's capability, manufacturers and users can implement both RAID 1 and RAID 0 simultaneously on platforms with two hard disk drives, a feature found today only on high-end RAID cards supporting multiple volumes per array.

Intel® Matrix Storage Technology Exceptional Storage Performance with Native Command Queuing and RAID 0

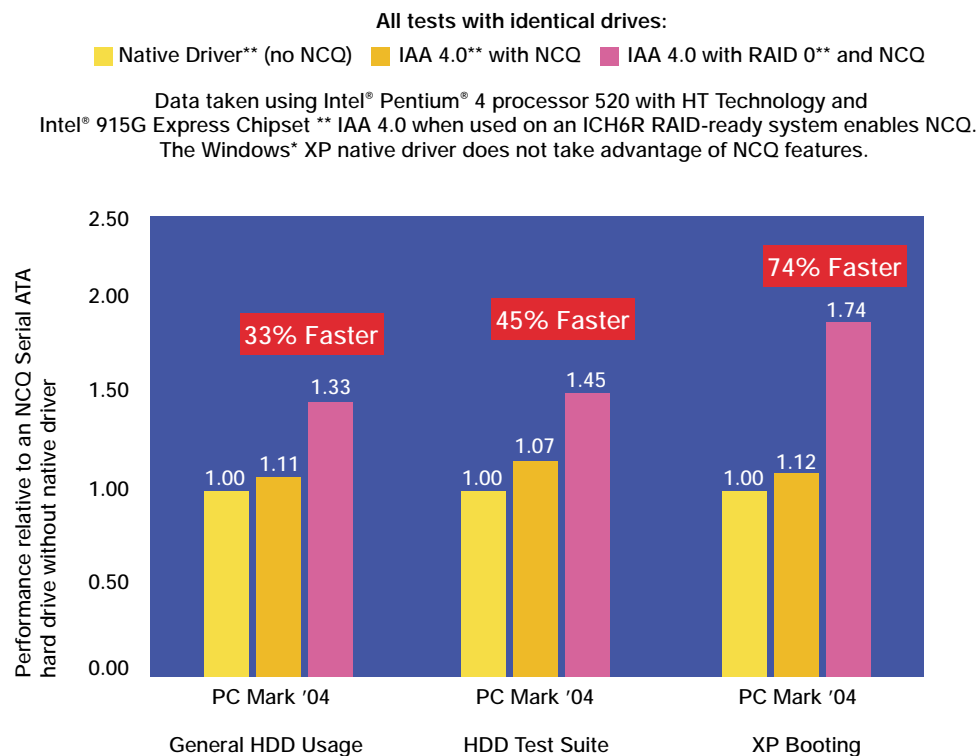


Figure 5. Intel Matrix Storage Technology improves performance in RAID 0 with Native Command Queuing (NCQ), as shown in this comparison of two-drive RAID 0 with NCQ using IAA 4.0 to a single drive using the Windows* XP native driver.

Configurations and Disclaimers

1 When comparing two-drive RAID 0 with NCQ using IAA 4.0 to a single drive using the Windows* XP native driver Source: Intel. Configuration: All Platforms – Intel® Pentium® 4 Processor 520 with HT Technology and Intel® 915G Express Chipset –Intel® 915G Express Chipset Preproduction Board, 512 MB DDRII 533 CL4-4-4; preproduction Maxtor DiamondMax* 10, 200 GB, 8 MB cache buffer 7200rpm SATA hard disk drive; Intel® Graphics Media Accelerator 900, Intel® 915G Express Integrated Graphics driver v14.3.0.3774, Intel® Chipset Software Installation Utility 6.0.0.1008, Windows* XP Build 2600 SP1, HD Audio driver 5.10.00.5007. Native Driver – Windows XP SP1 storage driver. NCQ Serial ATA Drive & NCQ Serial ATA Drive with RAID 0 – Intel® Application Accelerator 4.0.0.6180 Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

Ease-of-Use Breakthroughs

In addition to their enhanced bandwidth and robust integrated feature sets, specific versions of Intel 925X/915 Express Chipsets are also designed to make PCs easier to use, from setting up a wireless home network to adding RAID to an existing system.

Intel Wireless Connect Technology For the average consumer, setting up a home network can be a complex, time-consuming, and intimidating task. Intel Wireless Connect Technology provides simplified connectivity options for users who have an existing wireless network, and also provides a wireless access point (AP) option for users who are creating their first network. Users who already have a wireless AP can configure their PC as a client and connect it to the existing network. Users who do not have a wireless network can create a new network by configuring the PC as the main wireless hub.

To aid this process for nontechnical users, Intel Wireless Connect Technology includes a simplified setup wizard that makes creating a wireless home network an “out-of-the-box,” four-step process. The wizard automatically configures Internet Connection Sharing (ICS) with a firewall, Network Address Translation (NAT), and Dynamic Host Configuration Protocol (DHCP) server.

Intel Wireless Connect Technology is AP Wi-Fi* certified for 802.11* b/g, and features WEP and WPA-PSK wireless security. Intel Wireless Connect Technology requires a specific Intel 9XX Express Chipset and a separate Intel wireless LAN solution to operate. Availability may be limited; it is expected that this technology will initially ramp slowly while Intel and system providers assess the usage models and implementation options. Intel expects this technology to become more broadly available in the first half of 2005.

Intel HD Audio Plug and Play To achieve audio Plug and Play capability, Intel HD Audio supports improved jack retasking. The PC can sense when a device is plugged into an audio jack, determine the device type, and retask the port function if necessary to accommodate the device. With this capability, the user decides if his/her audio jacks are all output jacks or input jacks, and/or a combination of the types to enable audio streaming or capture, as desired, to or from multiple sources or devices.

Intel® Matrix Storage Technology featuring the Intel® Application Accelerator Upgrading a PC with a single Serial ATA hard drive to accept a RAID array typically requires the reinstallation of the operating system (OS) and applications. In a suitable system with an Intel 925X/915 Express Chipset with Intel Matrix Storage Technology, upgrading to RAID capability when adding a second Serial ATA hard drive does not require reinstalling the OS.

The Intel® Application Accelerator utility, included in platforms that support Intel Matrix Storage Technology, handles the configuration and migration in the background, while allowing users to surf the Web or read e-mail while the RAID installation is in progress. This capability enables PC and motherboard original equipment manufacturers (OEMs) to market reduced cost “RAID-ready” configurations.

Intel® Flex Memory Technology This technology provides a simplified upgrade path to dual-channel memory performance. The GMCH is Intel’s first dual-channel DDR/DDR2 Memory Controller Hub with Intel® Flex Memory Technology. This memory architecture provides the optimum combination of memory configuration flexibility and performance when used with an Intel Pentium 4 processor with an 800-MHz front-side bus and DDR2/533-MHz memory.

The MCH interface supports dual-channel, symmetric memory configurations for increased performance, as well as single-channel and dual-channel asymmetric mode. The performance benefits of dual-channel memory can now be achieved with different memory densities, different numbers of dual-inline memory modules (DIMMs), or different memory speeds, so long as the same amount of memory is used for each channel.

System expansion Intel 925X/915 Express Chipsets support up to eight High-Speed USB* 2.0 ports and four PCI Express x1 ports for easy peripheral expansion.

Summary

The Intel 925X/915 Express Chipsets enable PC users to truly experience the performance of Intel Pentium 4 processors with Hyper-Threading Technology. The revolutionary PCI Express architecture enables these chipsets to feed multiple threads to the processor while providing the bandwidth to support emerging PC usage models, including HDTV and HD video, multistreaming Intel High Definition Audio, and the enhanced storage performance and data protection of RAID technology.

Intel’s new chipsets represent the most compelling platform advance since the implementation of the PCI bus more than 10 years ago. Never before has a new platform architecture provided the opportunity for so many revolutionary changes.

More Info

Read the press release about these new chipsets, or check out the fact-loaded virtual press kit at the Intel Press Room.

Learn more about Intel® Express Chipsets at the Intel Web site.

Compare Intel® Desktop Boards featuring the new chipsets at the Intel Web site.

Author Bio

In his 10-year Intel career, Steve R. Peterson has managed the marketing, introduction and high-volume ramp activities for numerous Intel chipsets going back to the Intel 440LX/440BX AGPsets. Prior to these products, he worked as a product marketing engineer on the Intel 430VX/HX and 430TX PCIsets. He holds a B.S. in MIS from San Jose State University.

¹Hyper-Threading (HT) Technology requires a computer system with an Intel® Pentium® 4 processor supporting HT Technology and a HT Technology enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. See www.intel.com/info/hyperthreading for more information, including details on which processors support HT Technology.

—End of Technology@Intel Magazine Article—