Intel Processor Reference Guide
Presented by CDW•G

Choosing the right computer processor for your needs
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(But do they understand you?)

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About Intel

CDWG.com/intelguide

Introduction

Intel microprocessors are one of the most ubiquitous technology products on the planet. They power more than 90 percent of the personal computers on the market and have been the mainstay of personal computer architecture since the original 4004 microprocessor was used in the first IBM PC. Today, Intel microprocessors continue to evolve to meet ever-changing market conditions.

History

Intel was founded in 1968 to build semiconductor memory products. In 1971, the company introduced the world’s first “computer on a chip,” or microprocessor. This 4004 processor contained 2,300 transistors and could process about 60,000 operations in one second. Shortly afterward, Intel released the 8008 processor, which had roughly double the performance of the 4004. This performance increase followed an observation made in 1965 by Intel engineer Gordon Moore—an observation that is now popularly known as Moore’s Law. Moore observed that processors seemed to approximately double the number of transistors every couple of years and predicted that the trend would continue. Moore’s Law has proven itself in history, as Intel processors evolved from 2,300 transistors in 1971 to more than 40 million today.

Intel In Depth

Today, Intel employs approximately 78,000 people in more than 48 nations worldwide. In 2003 the company had net revenues of $30.1 billion with a net income of $5.6 billion. Intel invested $4.4 billion into research and development, one of the company’s largest areas of expenditure in 2003. Research and development not only focuses on new processor products but also on overcoming technical hurdles—such as the processor manufacturing process—which can limit the products Intel can produce. Intel Labs, which handles the company’s research and development, employs more than 6,000 researchers and scientists in laboratories across the globe.

Today, Intel supplies the computing and communications industries with chips, boards, systems and software building blocks that are the “ingredients” of computers, servers, networking and communications products. These products are used by industry members to create advanced computing and communications systems.

Principal Products and Services

Intel offers a complete line of microprocessors, also called central processing units (CPUs). Frequently described as the “brain” of a computer, they control the central processing of data in personal computers (PCs), servers, workstations and other devices.

In This Chapter:

• Intel in depth
• Processors defined
• Intel introduces processor numbers
PCs and Enterprise Systems:
- Microchips used in high-performance and high-value desktop and mobile PCs, Tablet PCs and entry-level to high-end servers and workstations
- Chipsets, which perform the essential logic functions surrounding the CPU, for computers, servers and workstations
- Motherboards, which combine Intel microprocessors and chipsets to form the key subsystem of a PC or server

Intel’s future will be one of continued advancement. The company will continue to leverage and develop its Hyper-Threading (HT) Technology, an innovation that has considerably improved processor performance. Originally introduced in the Intel® Xeon™ Processor family for servers, Hyper-Threading Technology is now available in the desktop-oriented Intel® Pentium® 4 Processor family.

Intel believes in using what it sells. The company has based its entire worldwide operation around its products and technologies, and is a pioneer in e-business, today processing about 85 percent of its customer orders and 60 percent of its materials transactions electronically.

Although Intel is perhaps still best-known for its line of microprocessors, particularly the Intel® Pentium® Processor family, the company actually offers a much broader range of building blocks for the modern computing industry.

Networking and Communications:
- Microchips used in the systems that transmit and direct traffic across the Internet and private networks
- Networking devices and equipment that provide access to the Internet, local area networks (LANs) and personal networks
- Hardware and software for integrated voice and data networks
- Hardware components for high-speed, high-capacity optical networks
- Embedded control microchips designed to perform specific functions in devices such as laser printers, automation instruments, cellular phone base stations and network communications hubs, routers and switches

Wireless Communications and Computing:
- Applications processors, which process data functions such as calendar and e-mail programs for wireless handheld devices and cellular phones
- Baseband chipsets, which enable voice communication functions for wireless handheld devices and cellular phones
- Wireless networking products for personal and organizational use
- Flash memory, which retains data when a device’s power is turned off

Processors Defined
A microprocessor, or simply processor, acts as the central brain for a modern computer. Physically, an almost unbelievably small sliver of silicon, the processor consists of literally millions of switches and electronic pathways that work together to form the core logic of the computer. Complex modern operating systems (OSs) such as Windows and Linux “speak” the processor’s native language, or instruction set, asking the processor
to perform complex mathematical and logical operations, which, in turn, make the OS itself operate. Today's Intel processors combine more than 40 million transistors and perform hundreds of millions of calculations each second.

Processors do not operate independently; they rely on a host of peripheral devices to provide data storage, user interaction and other important functions. Typically, processors are paired with chipsets, which act as the processor's interface to much of the other hardware in a computer. Chipsets typically provide functions that range from interfacing with the computer's onboard dynamic memory to implementing connectivity with Universal Serial Bus (USB), serial ports, parallel ports and more.

More complex chipsets may also include integrated graphics processors for creating a visual display or audio circuitry for sound production. These chips, the processor and many other core functions are combined on a motherboard, a single, multi-layered collection of electrical paths and electronic components that form the basis for a computer.

Processors for Specific Computing Environments

Intel's original 4004 processor—and indeed, many of its successors all the way through to the popular Intel386™ Processor family—was a single, general-purpose processor intended for use in all kinds of computers. Today, Intel recognizes that specific computing environments—such as servers and notebook computers—demand specific support from both the processor and its supporting chipset. Today's Intel processors each focus on a specific area of computing:

- **For notebook and mobile computers**—Intel® Centrino™ Mobile Technology is Intel's first integrated computing technology designed from the ground up for wireless notebook PCs. One component of Intel® Centrino™ Mobile Technology is the Intel® Pentium® M Processor. Additional processors used in notebook and mobile computing platforms are the Mobile Intel® Pentium® 4 and the Intel® Celeron® M Processor families.

- **For desktop and workstation computers**—the Intel® Pentium® 4 Processor (including models with Hyper-Threading Technology), Intel® Celeron® Processor and Intel® Xeon™ Processor families

- **For server and blade computers**—the Intel® Itanium® 2 and Intel® Xeon™ Processor families

These processors all share similar capabilities and characteristics, but each is optimized for a particular computing environment, providing a balance of raw computing power, multimedia capabilities, memory and peripheral support, power management, multiprocessing capabilities and more.

Preventing a Meltdown

One challenge of processor performance is thermal management. No electronic system is perfect; the inherent electrical inefficiencies of any electronic or electrical device produce heat. With processors running in excess of 3GHz, Intel faces considerable challenges in creating processors that do not produce excess heat.

Although large servers and even workstations have room to accommodate bulky heat sinks and cooling fans, smaller form-factor computers, such as notebooks, require processors that simply generate less heat—ideally without compromising performance. Intel continues to deliver processors that meet this demand by developing new manufacturing processes and processor design techniques that help reduce electrical inefficiencies and thermal production. This development exemplifies the continuous evolution of Intel processor technology that carries on today.

Intel Introduces Processor Numbers

Just as there may be additional capabilities in the platform beyond the processor, there are additional features within the processor beyond clock speed. In order to better convey the overall feature set of Intel processors and help IT customers make more informed decisions about their PC purchase, Intel has introduced “processor numbers” for its desktop and notebook products.

Intel's use of processor numbers is meant to allow differentiation among comparable processors and to analyze or take into account more than one processor feature during the selection process.

All processor families have their own unique value proposition and correspond to differing usage models. Once IT managers determine how the PCs will be used, they can select a processor family that corresponds to the desired computing experience. In that context, processor
numbers can be used as a guide in determining what combination of features is most preferable.

**Processor Number Guidelines**

Processor numbers should be used to differentiate between the relative overall features within a certain processor family (e.g. within the Intel® Pentium® 4 Processor family) and within a numbering sequence (e.g. 550 vs. 540). However, the digits themselves have no inherent meaning, particularly when looking across families. For example, 710 is not “better” than 510 simply because it is greater from a numerical perspective. The numbers are aligned with different processor families and thus represent different value propositions.

Processor numbers are also not a measurement of performance. A higher number does not necessarily mean higher performance for any given usage model or any given system configuration. Tools are available to IT purchasers wishing to evaluate processors from solely a performance-based perspective. In these cases, the IT buyer may refer to industry-standard benchmarks, which measure PC performance while running specific applications. Processor numbers do not represent specific system configurations, but rather a set of available processor features, and therefore cannot be used as a proxy for system-level benchmarks.

Intel's processor number nomenclature took effect with mobile processors in May 2004 and with desktop processors in June 2004. Continue to check the Intel Web site (intel.com) for more details on processor numbers as they develop.

**Processor Numbering Nomenclature System**

Going forward, Intel processors will be named using a combination of the processor brand (the “processor family”) and a specific three-digit number (the “processor number”).

Processor numbers will be categorized in three-digit numerical sequences such as 7xx, 5xx or 3xx. This number plus the processor family comprise the overall “processor name.” The processor number should

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**Intel Processor Timeline**

- **1970**
  - 1972: 8008 Processor (Mark 8 Computer)
  - 1974: 8080 Processor (First personal computer)
  - 1979: 8088 Processor

- **1980**
  - 1978: 8086 Processor (IBM Personal Computer)
  - 1979: 8088 Processor
  - 1982: 80186 Processor (IBM “AT” Computer)

- **1985**
  - 1985: Intel386™ DX Processor (Full multitasking)

- **1989**
  - 1989: Intel486™ DX Processor (Integrated math coprocessor)
be used to quickly differentiate the relative features within a processor family (e.g. Intel® Pentium® 4 540 vs. 555). Processor numbers are not an effective method to compare processors from different families. Intel’s processor numbering system will represent multiple aspects of a computer; this includes system architecture, cache, clock speed, front side bus (FSB) and other Intel technologies as they evolve over time.

### Examples of specific Intel processor families include:

#### Desktop Processor Family

<table>
<thead>
<tr>
<th>Processor Family</th>
<th>Number Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® Pentium® 4 Processor (including the Intel® Pentium® 4 Processor supporting Hyper-Threading (HT) Technology and Intel® Pentium® 4 Processor with HT Technology)</td>
<td>5xx</td>
</tr>
<tr>
<td>Intel® Celeron® D Processor</td>
<td>3xx</td>
</tr>
</tbody>
</table>

#### Mobile Processor Family

<table>
<thead>
<tr>
<th>Processor Family</th>
<th>Number Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® Pentium® M Processor* (including the Intel® Pentium® M Processor Low Voltage (LV) and the Intel® Pentium® M Processor Ultra Low Voltage (ULV)</td>
<td>7xx</td>
</tr>
<tr>
<td>Mobile Intel® Pentium® 4 Processor (including the Mobile Intel® Pentium® 4 Processor supporting HT Technology and Mobile Intel® Pentium® 4 Processor with HT Technology)</td>
<td>5xx</td>
</tr>
<tr>
<td>Intel® Celeron® M Processor</td>
<td>3xx</td>
</tr>
<tr>
<td>Intel® Celeron® M Processor (ULV)</td>
<td>3xx</td>
</tr>
</tbody>
</table>

*The Intel® Pentium® M Processor is the processor component of the Intel® Centrino™ brand, which also encompasses a mobile chipset and integrated wireless LAN capability.

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CDW®G is ready to answer all your questions about Intel processors and more. Contact your CDW®G account manager today.

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1993 Intel® Pentium® Processor
- Multimedia support

1997 Intel® Pentium® II Processor
- 7.5 million transistors and MMX technology

1998 Intel® Celeron® Processor
- Entry-level, value-priced

1999 Intel® Pentium® III Processor
- Internet streaming extensions, 9.5 million transistors

2000 Intel® Pentium® IV Processor
- 42 million transistors and 1.5GHz performance

2001 Intel® Itanium® Processor
- 64-bit, EPIC architecture

2003 Intel® Pentium® M Processor
- Intel® Centrino™ mobile technology

1995 Intel® Pentium® Pro Processor
- Integrated cache memory and 5.5 million transistors

1998 Intel® Pentium® II Xeon™ Processor
- Midrange servers, 4- and 8-way multiprocessing

1999 Intel® Pentium® III Xeon™ Processor
- Internet streaming extensions, 9.5 million transistors

2001 Intel® Xeon™ Processor
- High-end, multiprocessor applications

2002 Intel® Itanium® 2 Processor
- 64-bit, enterprise-class performance
Our technology specialists won’t solve all of your problems.

(Just the most difficult ones.)

At CDW•G, we have several teams of technology specialists and engineers on staff, each trained by manufacturers in one area of expertise. There’s no better resource on storage, networking, security, voice and data, volume software licensing and mobile-wireless. Count on CDW•G to have the technology products you need. And the technology advice as well.

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Notebooks and Tablet PCs

The notebook market has exploded in recent years, with new technologies—particularly Wi-Fi wireless networking—making notebooks more flexible and more powerful. New processors and power-management technologies have made notebooks smaller, lighter and able to run longer on a single battery charge. The introduction of Microsoft’s Tablet PC, and its accompanying Windows XP Tablet PC Edition OS, have added a new twist to the notebook computer world. Tablet PCs come in a variety of sizes, fulfilling many of the functions of a full notebook computer (and, in some cases, a full desktop computer), while providing handheld-like functions, such as electronic ink and handwriting recognition.

Intel offers processors that power a full range of mobile PC form factors. The Intel mobile processor family includes the Intel® Pentium® M Processor—one of the three components which make up Intel® Centrino™ Mobile Technology—Mobile Intel® Pentium® 4 Processor, Mobile Intel® Pentium® 4 Processor supporting Hyper-Threading (HT) Technology and Intel® Celeron® M Processors. These processors are far more than just specially branded versions of Intel’s familiar Pentium and Celeron families; they offer extended battery life and additional special features targeted specifically at the mobile computing market.

Intel® Centrino™ Mobile Technology

The new Intel® Centrino™ Mobile Technology is designed specifically for mobile PCs. It’s not a processor per se; rather, Intel® Centrino™ Mobile Technology is a mobile platform consisting of three technologies—the Intel® Pentium® M Processor, the Intel® 855 Chipset Family and the Intel® PRO/Wireless Network Connection—which are tested and tuned to maximize interoperability and compatibility. These components enable outstanding mobile performance, extended battery life and integrated wireless LAN capability in thinner and lighter notebooks. Intel® Centrino™ Mobile Technology enables a variety of mobile form factors including full size, thin and light, ultra portable and Tablet PCs.

In This Chapter:

- Intel® Centrino™ Mobile Technology
- Intel® Pentium® M and Mobile Intel® Pentium® 4 Processors
- Intel® Celeron® M Processor
- Intel® Centrino™-powered Tablet PCs drive learning at Full Sail

Intel® Pentium® M Processor Overview

Intel® Pentium® M Processors feature a new microarchitecture, which includes a power-optimized 400MHz processor system bus. This bus provides fast performance while helping to minimize demands on the battery, thereby improving battery life. Intel® Pentium® M
Processors also feature Micro-Ops Fusion and Dedicated Stack Manager, which allow the processor to execute instructions more quickly, while helping to minimize demands on the battery. Intel® Pentium® M Processors also include advanced processor instruction prediction, which helps the processor avoid running instructions multiple times during program execution. Every instruction handled by the processor requires power, so reducing repeated instructions helps to lower battery consumption.

Intel® Centrino™ Mobile Technology supports Enhanced Intel® SpeedStep® Technology. This technology allows the system processor to run at multiple voltage levels and varying frequencies. Lower processor frequencies reduce performance, but can help conserve a considerable amount of power. When a task doesn’t require maximum performance—playing solitaire in an airport, for example—the processor’s frequency can be scaled back. Scaling back allows the processor to continue providing an acceptable level of performance while increasing the lifetime of the system battery.

One problem with traditional high-speed processors has been their higher heat production. Heat requires the use of fans—sometimes multiple fans—and fans consume power. Heat also places size limitations on the notebook, as smaller notebooks offer less room for fans and heat sinks. Intel addresses this problem with Intel® Centrino™ Mobile Technology through Intel® Mobile Voltage Positioning. Based on processor activity, the system can automatically lower the voltage delivered to the Intel® Pentium® M Processor. Less voltage means less heat, which means fewer fans and smaller heat sinks. Thus, Intel® Mobile Voltage Positioning helps conserve power and makes it possible to create smaller form-factor devices, such as the newest generation of subnotebooks and smaller Tablet PCs.

Past attempts at creating highly efficient mobile processors have often meant tradeoffs. For example, many older notebook computers can support only 256MB of memory, which definitely limits what you can do with today’s powerful software applications and OSs. Intel® Centrino™ Mobile Technology supports as much as 2GB of installed memory when combined with the Intel® 855PM Chipset.

Technical Specifications

The Intel® Pentium® M Processor, Intel® 855 Chipset family and Intel® PRO/Wireless Network Connection are all key components of the Intel® Centrino™ Mobile Technology. The Intel® Pentium® M Processor is available at a variety of speeds:

- 2GHz, 1.80GHz, 1.70GHz, 1.60GHz, 1.50GHz and 1.40GHz regular voltage versions
- 1.30GHz, 1.20GHz and 1.10GHz low-voltage versions
- 1.10GHz, 1GHz and 900MHz ultra low-voltage versions

These processors are supported by the Intel® 855 Chipset family, featuring a power-optimized 400MHz processor system bus, Dedicated Stack Manager, Micro-Ops Fusion, Enhanced Intel® SpeedStep® Technology and support for Intel® Mobile Voltage Positioning. Intel® Pentium® M Processors at 755, 745 and 735 all feature a 2MB power optimized Level-2 cache and 90-nanometer process technology. The processors' Micro FCPGA (Flip-Chip Pin Grid Array) and FCBGA (Flip-Chip Ball Grid Array) packaging technologies are optimized for thinner, lighter notebook and Tablet PC designs, including form factors less than 1-inch thick.

Additional processor features include:

- Support for as much as 2GB of DDR RAM (Double Data Rate Random Access Memory)
- 32KB Level-1 instruction and data caches
- Advanced branch prediction and data prefetching
- Streaming SIMD (Single Instruction Multiple Data) Extensions 2 support
- Intel® MMX™ media enhancement technology support
- Advanced thermal monitoring capabilities
Unlike the two fixed frequencies of earlier generation processors, the Intel® Pentium® M’s SpeedStep® Technology features multiple operating frequencies. Processor frequencies and voltages can be shifted in real time, allowing the processor to dynamically respond to changing performance demands and power conditions. This dynamic shifting capability is provided by means of switching the system bus ratios, core operating voltage and core processor speeds, all without resetting the system.

The Intel® 855 Chipset family includes three options for use with Intel® Centrino® Mobile Technology:

• Intel® 855GM Chipset—This highly integrated mobile Chipset solution supports the Intel® Pentium® M Processor and high-speed DDR memory. It also provides integrated graphics capabilities: the Intel® Extreme Graphics 2 technology provides realistic 3-D graphics while enabling balanced memory usage between graphics and system use. The 855GM Chipset also supports USB 2.0, integrated low-voltage differential signal interface (enabling smaller notebook designs) and dual independent display capabilities. One key feature of the 855GM Chipset is the ability to rotate the display, a requirement of hybrid-style Tablet PC designs that can operate in a traditional “portrait” mode as well as the Tablet PC landscape, or slate mode.

• The Intel® 855PM Chipset—This highly integrated mobile chipset solution also supports the Intel® Pentium® M Processor and high-speed DDR memory. It includes an integrated Advanced Graphics Port (AGP) 4X interface and provides flexible support for high-performance, discrete graphics solutions. Like the 855GM, the 855PM supports USB 2.0.

• The Intel® 855GME Chipset—This mobile chipset supports the Intel® Pentium® M Processor and high-speed DDR memory and offers integrated graphics capabilities and power-saving features. The integrated graphics utilizes Intel® Extreme Graphics 2 Technology. Like other chipsets in the 855 family, the 855GME supports USB 2.0, and like the 855GM, the 855GME supports dual independent displays and display image rotation. The 855GME also includes Intel® Display Power Saving Technology (Intel® DPST), which can reduce power-hungry backlight requirements by as much as 25 percent with minimal visual impact. The Intel® Dual-Frequency Graphics Technology (Intel® DFGT) allows the integrated graphics controller to reduce its power consumption based on end-user configurations.

Chipsets play an important role in computers. As the figure on page 12 illustrates, chipsets provide most of a processor’s connectivity to external devices, such as USB interfaces, displays, power management, memory and so forth.

**Wi-Fi CERTIFIED Wireless LAN Support**

Intel® Centrino™ Mobile Technology provides Wi-Fi CERTIFIED wireless LAN support and the ability to connect to 802.11a-, b- and g-based infrastructures. It includes a fully integrated, single-band 802.11b, dual-band 802.11a/b or dual-mode 802.11b/g Wi-Fi CERTIFIED wireless LAN capability. (Note, low-band capabilities are not supported in all countries.) Included with this wireless LAN capability is 802.1X port-level security support, Wired Equivalent Privacy (WEP), Advanced Encryption Standard (AES) and Wi-Fi Protected Access (WPA) support. Please note that some security solutions may not be supported by every PC manufacturer. These features combine to offer the most secure wireless networking solution currently available.
Intel® Intelligent Scanning Technology helps Intel® Centrino™ Mobile Technology computers reduce power consumption by regulating the frequency with which the computer scans for available wireless access points (APs). Scanning for APs can be power-intensive. In much the same way that constantly scanning for a cellular tower can reduce a cell phone’s battery life, continually scanning for APs can eventually wear down a mobile computer’s battery. Intel® Intelligent Scanning Technology helps improve battery life by controlling access port scanning activity. This power savings can be significant when a computer is out of range of a wireless AP or it is in range of multiple APs, as the figure on page 13 illustrates.

Intel and Cisco Systems are working together to extend Intel® Centrino™ Mobile Technology’s wireless LAN capabilities with Cisco Compatible Extensions, including LEAP (Lightweight Extensible Authentication Protocol) and CKIP (Cisco Key Integrity Protocol). Notebooks based on Intel® Centrino™ Mobile Technology offer compatibility with industry standards and leading third-party solutions for wireless networking deployments.

**Practical Applications**

Intel® Centrino™ Mobile Technology is an excellent choice for any mobile computing application that demands the power of an Intel® Pentium® Processor, wireless connectivity and a high degree of energy efficiency. Rather than blending disparate components from multiple vendors, Intel® Centrino™ Mobile Technology offers a complete package of power-optimized technologies, wired and wireless connectivity options, wireless security support and powerful processors. This complete solution makes PCs featuring Intel® Centrino™ Mobile Technology excellent choices for:

- **Field agents**—Notebooks and Tablet PCs based on Intel® Centrino™ Mobile Technology are available in smaller form factors and extended battery life that make them excellent for use in the field, at site locations and on the go.
- **Students**—Enable connectivity to class resources at any Wi-Fi “hot spot,” multimedia presentations and videoconferencing to help students succeed.
- **Technology professionals**—Demonstrate software and correct software bugs on the go and easily carry code projects back and forth between the home and the office.
- **Event services and recruiting professionals**—Keep in touch with the office and co-workers while attending events and create and display presentations on the road.

Any mobile PC user who travels frequently can benefit from the integrated wireless LAN connectivity built into Intel® Centrino™ Mobile Technology. The growing availability of Wi-Fi “hot spots” at coffee shops, public...
libraries, hotels, convention centers and other locations allow you to stay connected to your network resources even when you are out of the building. The lightweight, small-form factors enabled by Intel® Centrino™ Mobile Technology make it easier to take a powerful, full-featured computer almost anywhere.

**Mobile Intel® Pentium® 4 Processor Supporting Hyper-Threading (HT) Technology**

**Processor Overview**

Notebooks based on the Mobile Intel® Pentium® 4 Processor provide near-desktop performance, allowing notebook manufacturers to supply notebook computers that are viable alternatives to full-sized desktop models. These notebooks offer larger screens, full-sized keyboards and built-in media drives. They provide better responsiveness for high-end applications, including demanding multimedia applications and multithreaded, processor-intensive applications, such as intensive graphics and multimedia content creation.

Designed to power full-sized notebook computers capable of acting as desktop replacements, the Mobile Intel® Pentium® 4 Processor focuses on performance while maintaining a large set of features designed to minimize power consumption under various circumstances. Notebooks based on the Mobile Intel® Pentium® 4 Processor with Hyper-Threading Technology provide better responsiveness when using multiple demanding applications, and allow users to take advantage of multithreaded and processor-intensive multimedia applications such as video encoding and digital media.

The Mobile Intel® Pentium® 4 family is supported by the Intel® 852GME and Intel® 852PM Chipsets. Mobile Intel® Pentium® 4 Processors provide a 533MHz front side bus, USB 2.0 (with backward compatibility for USB 1.0) and dual independent display output. The processors also include on-die Level-2 cache of 512K8 for faster memory operations.

The Mobile Intel® Pentium® 4 Processor supporting Hyper-Threading Technology provides additional features that improve performance and help reduce power consumption in mobile computers including:

- Enhanced Floating-Point Operations
- Streaming SIMD Extensions 2 (SSE2)
- Enhanced Intel® SpeedStep® Technology

These features help improve processor efficiency, which, in turn, helps to reduce the processor's power consumption and heat production. These efficiencies allow the processor to offer near-desktop performance with dramatically less heat production, enabling smaller form factors and tighter integration of onboard peripherals, such as media drives.

**Technical Specifications**

Mobile Intel® Pentium® 4 Processors that support Hyper-Threading Technology are available in 3.20GHz, 3.06GHz, 2.80GHz and 2.66GHz clock speeds. Models without Hyper-Threading Technology are available at 3.06GHz, 2.80GHz, 2.66GHz and 2.40GHz clock speeds.

The available Intel® 852PM chipset, optimized for the Mobile Intel® Pentium® 4 Processor, features a 533MHz front side system bus and support for as much as 2GB of high-speed DDR 333/266 memory. It provides an integrated AGP 4X graphics interface, enabling over 1Gbps of graphics bandwidth for high-quality 2-D, 3-D and streaming video. The chipset also provides for deeper sleep states, enabling dynamic power-management modes that operate at lower voltages than deep sleep mode, prolonging notebook battery life. The chipset's onboard IDE controller is Ultra ATA/100 compliant, providing the fastest possible throughput for the notebook's onboard hard drive.
The other chipset is the Intel 852GME chipset, optimized for the Mobile Intel Pentium 4 Processor. Like the 852PM, the 852GME provides a 533MHz system bus, support for as much as 2GB or fast DDR 333/266 memory and integrated graphics. The graphics capabilities of the 852GME chipset utilize Intel Extreme Graphics 2 technology, offering an AGP 4X interface with more than 1GBps of graphics bandwidth. The chipset provides native video resolutions of as sharp as 1600 x 1200 (UXGA+) and dual independent displays. It also includes built-in display image rotation, allowing the chipset to automatically create a portrait or landscape image as required. This feature is important in the new generation of high-end Tablet PC notebooks, which feature a rotating display.

Practical Applications

Larger, full-featured notebook computers—up to and including portable notebooks that are larger than traditional units—are becoming more popular among technology professionals and graphics artists. Rather than taking the traditional approach of compromising on performance and features in order to provide a smaller, more portable form factor, this category of desktop replacement notebooks pack every conceivable feature into a highly portable format. Ideal users include:

- **Technology professionals**—Take work from home to the office and to branch sites easily because the Mobile Intel Pentium 4 Processor family has enough power to run both demanding integrated development environments such as Microsoft Visual Studio .NET and the powerful applications these environments are capable of producing.

- **Professors**—Work travels easily between the office, lecture hall and home without compromising on memory capacity, fast disk throughput, powerful graphics capabilities and fast processor speeds. The Mobile Intel Pentium 4 Processor family has the power to run the most intensive software, including demanding video encoders, illustration packages and more.

- **Emergency response teams**—Federal, state, and local governments must respond quickly to their constituents in times of crisis or emergency. Notebooks based on the Mobile Intel Pentium 4 Processor, and incorporating wireless connectivity, help keep vital webs of communication open between the front-line and directors in a secure location. Emergency response teams experience an increase in productivity by creating a fully functioning office in any environment without the need for paper forms and files. Mobile Intel Pentium 4 Processor-based notebooks provide users with complete access to electronic files through a variety of network connection options while in the field.

- **Occasional travelers**—Workers in any profession can benefit from the full-powered, full-featured capabilities of notebooks powered by the Mobile Intel Pentium 4 Processor while enjoying ready portability when they travel. These professionals can have all the advantages of a desktop computer without maintaining a separate notebook computer for their travels, which requires tedious and error-prone data synchronization between the two computers.

**Intel Celeron M**

**Processor Overview**

Combining the power and versatility of Intel's microarchitecture with exceptional price points, the Intel Celeron M Processor also offers good mobile performance for the entry-level notebook computer market. These users don’t require highly advanced power management features or cutting-edge processor performance. However, they do require value, small form factors and sleek, light notebook designs. The Intel Celeron M Processor balances the requirements of this market by providing a mobile-optimized processor with good mobile performance and power management in a high-value package.

**Technical Specifications**

Standard-voltage versions of the Intel Celeron M Processor are available in speeds of 1.30GHz and 1.20GHz, while an ultra-low voltage version is available at 800MHz. All three versions feature a 400MHz processor system bus and 512KB of Level-2 cache. They also support advanced battery management, including the deep sleep state, which helps enable longer battery life by minimizing the power consumption of the processor during brief periods of inactivity by the user. These features combine to offer a processor suitable for thinner, lighter notebooks that support good mobile
CDW·G stocks a wide variety of Intel Processor-based notebooks and Tablet PCs to meet your mobile computing needs.
Founded a quarter-century ago, Full Sail Real World Education is a media arts college in Winter Park, Florida. Full Sail offers an associate of science degree in five areas: computer animation, digital media, film, recording arts and show production and touring. The college also offers a bachelor of science degree in game design and development and most recently added its bachelor of science completion program in entertainment business. With an enrollment of over 4,300 students, the school's semesters are four weeks long and about 250-300 new students start each semester.

Full Sail's media complex comprises sixty-plus labs including everything from recording studios to editing suites and sound stages. In addition, the institution features the same equipment used by active industry professionals, like large-format recording consoles, digital video editing workstations, virtual reality environments and concert sound systems.

PCs—Key to Classroom, Homework and Teaching

The Entertainment Business Bachelor of Science degree program provides students interested in professional-management careers in entertainment/media production—for the audio, film and digital arts industries—with a fast track, hands-on education taught by seasoned industry professionals.

Not surprisingly, Full Sail's students are using personal computers for work in classes, homework, and a growing number of their projects. In short, the computer is an integral part of student life.

For example, in the school's new entertainment business curricula, “Students use Web design programs like Macromedia Dreamweaver to create Web sites. And, in courses like Business Venture and Financing, Entertainment Law and Contract Negotiations, Intellectual Property, and Product and Artist Management, they create business plans and other financial models with help from a variety of computer programs,” according to Jennifer Hill, program director for the new degree program.

Similarly, professors are using computers to create and give Microsoft PowerPoint, video and other presentations, prepare assignments, grade papers and communicate with students. “Everyone uses networked computers—both wired and wireless technology—for Web access and other research, as well as for e-mail,” notes Hill.

Tablet PCs Play a Role

To ensure that students in the new entertainment business degree program, started last January, have adequate and appropriate tools to accomplish their work, Full Sail decided to assume the responsibility for providing students and faculty with portable computers. “We wanted to make sure they could have the programs at their fingertips on and off campus,” says Hill.

Full Sail decided on Acer TravelMate Convertible Tablet PCs, which combine the convenience of a “tablet,” allowing students and faculty to write and draw directly on the screen using the pen-like stylus, while also having an attached keyboard for traditional typed text entry. According to Hill, “This lets students take notes, do homework and work on projects. We wanted something that would be easy to carry around and easy to use.”

A Combination of Convenience, Mobility and Flexibility

Robert Wehman; CDW•G’s account manager for Full Sail, notes that the Acer Convertible TravelMate Tablet PC is based on Intel® Centrino™ Mobile Technology. The technology is designed specifically for use in mobile computing. It provides seamless use of 802.11 “Wi-Fi” networking as well as Bluetooth wireless communications. It also makes more efficient use of the computer's battery—making it possible to use smaller and lighter batteries without compromising on runtime.

Integrated wireless capabilities and better battery life were key factors in Full Sail’s choice of a Tablet PC brand and model, according to Hill. “We chose the Acer Tablet PCs for many reasons. We were mostly impressed with the size—they’re easy to put in a backpack and take it wherever you go.”
Desktops and Workstations

Desktops and workstations represent a more powerful category of personal computers than notebook and Tablet PCs. Desktops offer larger chassis than notebooks, meaning they require fewer compromises. Power management isn’t as important and heat management is easier; thus, performance and raw computing power are the primary focus for these computers.

Intel® Pentium® 4 Processors with Hyper-Threading Technology

Processor Overview

Intel's latest-generation processor family is the Intel® Pentium® 4 Processor. Available in a variety of speeds with varying integrated features, this processor family is ideal for power users, high-end office workers, video editors and other users who demand the best performance from their desktop computers.

The Intel® Pentium® 4 Processor family is the first to be manufactured using Intel's new 90-nanometer process. This technology offers a more efficient manufacturing process that yields faster, more efficient processors.

Intel® Pentium® 4 Processors that support Hyper-Threading Technology provide users with a more powerful computing experience at a lower cost than multiprocessor workstations. Hyper-Threading Technology is ideal for any multitasking user, including office workers, graphic illustrators and so forth.

The processors in the Intel® Pentium® 4 family are supported by a wide array of Intel Chipsets, many of which provide integrated networking capabilities, integrated RAID controllers, as much as 4GB memory support, integrated graphics and many other computing functions.

In This Chapter:

- Intel® Pentium® 4 Processors
- Intel® Celeron® Processors
- Intel® Xeon™ Processors

Technical Specifications

Intel® Pentium® 4 Processors support system bus speeds of 800MHz, 533MHz and 400MHz, as well as Hyper-Threading Technology (the system bus delivers up to 6.4GB of data per second into and out of the processor). The highest processor clock speed currently available is 3.60GHz. Extreme Edition processors, with a maximum core speed of 3.40GHz, include an integrated 2MB of Level-3 cache and an advanced 800MHz system bus.

Intel® Pentium® 4 Processors also support a 1MB Level-2 cache, 16KB Level-1 data cache and Streaming SIMD Extensions 3 (SSE3). These processors are available in core speeds of 3.60GHz, 3.40GHz, 3.20GHz, 3GHz and 2.80GHz, and are supported by several Intel Chipset families. Intel® Pentium® 4 processors with Hyper-Threading Technology are supported by the following chipsets: Intel 925X Express, 915G Express, 915P Express, 875P, 865G, 865PE, 848P and 845GV. The following table summarizes the available Intel® Pentium® 4 processors.
# Intel® Chipset Capabilities

<table>
<thead>
<tr>
<th></th>
<th>Intel® 925X Express</th>
<th>Intel® 915G Express</th>
<th>Intel® 915P Express</th>
<th>Intel® 875P Express</th>
<th>Intel® 865G</th>
<th>Intel® 865P</th>
<th>Intel® 865PE</th>
<th>Intel® 848P</th>
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<tbody>
<tr>
<td><strong>Host</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Processor</td>
<td>Pentium® 4</td>
<td>Pentium® 4</td>
<td>Pentium® 4</td>
<td>Pentium® 4 and Celeron®</td>
<td>Pentium® 4 and Celeron®</td>
<td>Pentium® 4 and Celeron®</td>
<td>Pentium® 4 and Celeron®</td>
<td>Pentium® 4 and Celeron®</td>
</tr>
<tr>
<td>Hyper-Threading Technology</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Front-Side Bus</td>
<td>800/533MHz</td>
<td>800/533MHz</td>
<td>800/533MHz</td>
<td>800/533MHz</td>
<td>800/533/400MHz</td>
<td>800/533/400MHz</td>
<td>800/533/400MHz</td>
<td>800/533/400MHz</td>
</tr>
</tbody>
</table>

| **Memory Controller Hub** | | | | | | | | |
| Memory Type        | Dual-Channel DDR2 533/400 SDRAM | Dual-Channel DDR2 533/400 SDRAM | Dual-Channel DDR2 533/400 SDRAM | Dual-Channel DDR 400/333 SDRAM | Dual-Channel DDR 400/333/266 SDRAM | Dual-Channel DDR 333/266 SDRAM | Dual-Channel DDR 333/266 SDRAM | Dual-Channel Single-Channel DDR 400/333/266 SDRAM |
| Memory Slots       | 4                    | 4                    | 4                    | 4                    | 2                    | 4                    | 4                    | 2                   |
| Max Memory         | 4GB                  | 4GB                  | 4GB                  | 4GB                  | 2GB                  | 4GB                  | 4GB                  | 2GB                 |

| **Graphics**       | | | | | | | | |
| External Graphics Interface | PCI Express x16 | PCI Express x16 | PCI Express x16 | AGP 4X or 8X | AGP 4X or 8X | AGP 4X or 8X | AGP 4X or 8X | AGP 4X or 8X |
| Integrated Graphics Type | N/A | Intel® Graphics Media Accelerator 900 | N/A | Intel® Extreme Graphics 2 | N/A | N/A | N/A |

| **I/O Controller Hub** | | | | | | | | |
| PCI Support         | PCI Express x1 and PCI | PCI Express x1 and PCI | PCI Express x1 and PCI | PCI | PCI | PCI | PCI |
| PCI Masters         | 1-2/2-4              | 2/4                   | 1-2/2-4              | 5   | 3-6 | 3   | 5   | 3   |
| IDE                | ATA 100/66           | ATA 100/66            | ATA 100/66           | ATA 100/66 | ATA 100/66 | ATA 100/66 | ATA 100/66 | ATA 100/66 |
| Serial ATA/Ports    | SATA 150/4           | SATA 150/4            | SATA 150/4           | SATA 150/2 | SATA 150/4 | N/A | SATA 150/2 | SATA 150/4 |
| RAID Technology     | Intel® Matrix Storage Technology | Intel® Matrix Storage Technology | N/A | RAID 0 Support and ATA 100/66 | N/A | N/A | 0/1 Support | N/A |
| USB Controllers/Ports | USB 2.0/8            | USB 2.0/8             | USB 2.0/8            | USB 2.0/8 | USB 2.0/8 | USB 2.0/8 | USB 2.0/8 | USB 2.0/8 |
| IEEE 1394 Ports     | 3                    | N/A                   | 3                    | N/A | N/A | N/A | 3 | N/A |
| On-Board LAN        | Gigabit LAN Solution | Gigabit LAN Solution, Intel PRO 10/100 or No-LAN | Intel PRO 10/100 | Intel PRO 10/100 | Intel PRO 10/100, Intel PRO 10/100/1000 or No-LAN | Intel PRO 10/100 | Intel PRO 10/100 or Intel PRO 10/100/1000 | Intel PRO 10/100 or No-LAN |
Understanding the 90-Nanometer Process

The bulk of Intel's processors are manufactured using a 0.13-micron process. The benefit of this process is that it creates exceptionally small electrical pathways within the processor, allowing components in the processor to be packed more tightly. By assembling these components closer together, Intel helps to reduce heat output and increase processor efficiency.

New Intel® Pentium® 4 Processors are built with an even more advanced, 90-nanometer (billionths of a meter) process. This process also utilizes strained silicon, a technique that improves the flow of electricity through a processor's silicon-based transistors. Improved electrical flow results in faster transistor switching and, ultimately, faster processor performance. The technique also reduces heat production. Other manufacturers' techniques for improving transistor efficiency require a more complex approach that involves special silicon-germanium wafers. This technique benefits only one major type of transistor (there are two major types used in processors), and may result in a higher level of defects and a less-efficient manufacturing process.

The 90-nanometer process also features the smallest, highest-performance transistors used in production today, low-power transistors that are only 50 nanometers in size. One thousand of these transistors could fit within the width of a single human hair. The transistor gate oxide—an insulating material—in these transistors is only about five atoms thick, making the oxide extremely efficient and improving transistor speed.

The new 90-nanometer process integrates seven layers of high-speed copper interconnects, one layer more than the previous manufacturing process. The extra layer provides additional logic density, packing more processor power into a smaller space. A new low-k insulator, which means it has a low resistance to electrical current, sits between each copper interconnect layer, reducing wire-to-wire capacitance (which is an electrical characteristic closely related to the circuit's resistance to the flow of electricity), speeding up intra-chip communications and reducing processor power consumption.

Practical Applications

Intel® Pentium® 4 Processors, particularly those that support Hyper-Threading Technology and the Intel® Pentium® 4 Processor Extreme Edition, are suitable for a wide variety of practical applications. Target users include:

- **Software developers**—The Intel® Pentium® 4 Processor's fast clock speeds and high levels of efficiency make it perfect for demanding software development tasks, which often require strong multiprocessing capabilities.
- **Office workers**—These users frequently work with multiple applications at once, such as a word processor, personal information manager, graphics presentation software, spreadsheet and task-specific applications. The advanced multiprocessing capabilities of the Intel Pentium 4 Processor with Hyper-Threading Technology allow users’ applications to continue working efficiently in the background without reducing the performance of foreground applications.

**Next Generation Computing Support**

The newest Intel Chipsets, designed to support the Intel Pentium 4 Processor family, incorporate the latest computing developments for increased performance. The Intel 925X, 915G and 915P incorporate DDR2 RAM, PCI Express system bus architecture, Intel Matrix Storage Technology, Intel Graphics Media Accelerator 900 Graphics, Intel High Definition Audio and Intel Wireless Connect Technology.

Dual Channel DDR2 memory delivers 8.5GB per second for the most responsive system performance. DDR2 provides a 20 percent increase in memory performance over DDR333. The DDR2 standard reduces power consumption, thereby lowering system temperature.

The first major system bus architecture change in ten years is the new PCI Express standard. PCI Express delivers increased I/O performance for the next decade’s interconnect requirements including the transition to 10GBps data center interconnects. PCI Express reduces the system latency of traditional PCI systems by eliminating the I/O bridge. The new system bus permits true simultaneous data streaming in both directions, which allows for “glitch-less” video playback and recording at the same time.

The new Intel Matrix Storage Technology increases overall storage performance for media-rich applications such as video editing and CD and DVD authoring.
### Pentium 4 Processor Models

<table>
<thead>
<tr>
<th>Speed</th>
<th>Cache size</th>
<th>Hyper-Threading Technology</th>
<th>System Bus</th>
<th>Product name</th>
</tr>
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<tbody>
<tr>
<td>3.60GHz</td>
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<tr>
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<td>512KB</td>
<td>No</td>
<td>400MHz</td>
<td>Intel® Pentium® 4 Processor 2.50 GHz</td>
</tr>
</tbody>
</table>
Real-time mirroring of data ensures that your important and sensitive documents are protected from the dangers of a hard drive crash. Intel® Matrix Storage technology supports the latest Advanced Host Controller Interface (AHCI) storage technologies that increase overall disk access times and hot plug capability.

Realistic, seamless graphics support is made possible by the Intel® Graphics Media Accelerator (GMA) 900. The Intel® GMA 900 is the first DirectX9 integrated solution for high-definition media playback. The new graphics core architecture is optimized for media application to deliver incredible visual quality including support for PVR (personal video recording) applications, high-definition playback and improved 3D rendering. The Intel® GMA 900 supports dual independent display options to provide multi-monitor capabilities to support media output and application at the same time, helping organizations prolong the life of aging second monitors for a larger desktop viewing area.

Intel® High Definition Audio provides an immersive theater quality sound experience, including Dolby 7.1 audio capability, for presentations and advanced video and film production. Improved system audio stability is made possible with Microsoft Unified Audio Architecture (UAA) support. This permits the system to natively use Intel® High Definition Audio without needing additional third-party drivers. Higher bandwidth supports new usages such as speech recognition and Voice over IP (VoIP).

Wireless technology advances to the next level with the Intel® Wireless Connect Technology. This networking advancement allows desktop users a flexible wireless solution for simpler connectivity to existing wireless networks. Intel® Wireless Connect Technology enables desktop computers to serve as access points to help establish new wireless networks or to expand existing networks. Connectivity with Intel® Centrino™ Mobile Technology-based notebooks, Tablet PCs and other Wi-Fi enabled devices is easier than ever with an easy-to-use software wizard to configure network settings.

**Intel® Celeron® Processors**

**Processor Overview**

The Intel® Celeron® Processor provides a balance of proven technology and value to entry-level PC desktops. The Intel® Celeron® family includes several advanced processor features that help improve performance. The following is a highlight of these features:

- **Data Flow Analysis**—Creates an optimized flow of instructions by analyzing data dependencies between instructions
- **Non-Blocking Level-1 (L1) Cache**—Provides faster processor access to recently used data
- **128KB Level-2 (L2) Advanced Transfer Cache**—Offers a higher data bandwidth interface between the Level-2 cache and the processor core, reducing latency
- **Internet Streaming SIMD Extensions (SSE)**—Improve performance for handling high-resolution images, MPEG2 video, MPEG2 encoding and decoding, speech recognition and other multimedia applications

**Technical Specifications**

The Intel® Celeron® Processor family includes processors running at a variety of clock speeds, from 2.40GHz to 2.80GHz. They are supported by six Intel chipsets: 865G, 865P, 865PE, 848P, 845E and 845G. These chipsets also support the Intel® Pentium® 4 Processor. Detailed information about these chipsets is located in the chart on pages 20 and 21.

**Practical Applications**

Desktops powered by Intel® Celeron® Processors are perfect for:

- **Office users**—Light- to moderate-computer users who don’t require a more expensive computer to perform their daily office tasks can experience the full range of computing applications within a cost-conscious budget. Celeron processors are fully Pentium-compatible, meaning they run the latest versions of Windows and Windows applications.
The Intel® Xeon™ Processor family is available at speeds of as fast as 3.60GHz with a 1MB on-board cache and an 800MHz system bus, providing outstanding performance in high-end workstations. The Intel® Xeon™ Processor is specifically designed for multiprocessing applications, such as dual-processor workstations.

The Intel® Xeon™ Processor includes many of the advanced features of the Intel® Pentium® 4 Processor, including Hyper-Threading Technology support. Available processor versions include:

- 3.60GHz, 3.40GHz, 3.20GHz, 3GHz and 2.80GHz—all with an 800MHz system bus and 1MB of cache
- 3.20GHz, 3.06GHz, 2.80GHz, 2.66GHz, 2.40GHz and 2GHz—all with a 533MHz system bus and either 512KB, 1MB or 2MB of cache
- 3GHz, 2.80GHz, 2.60GHz, 2.40GHz, 2.20GHz and 2GHz—all featuring a 400MHz system bus speed and 512KB of cache

Intel® Xeon™ Processors are optimized for symmetric multiprocessing (SMP). As the following figure illustrates, SMP allows processors to work on multiple threads of execution simultaneously, including threads related to the OS itself. SMP contrasts with asymmetric multiprocessing, in which one processor handles the OS and other service, user and application threads.

Technical Specifications

The Intel® Xeon™ Processor is supported by the Intel® E7525 Chipset (800MHz system bus versions) and the Intel® E7505 Chipset (533MHz and 400MHz system bus versions). The E7525 Chipset supports 2 processors, a maximum of 8GB of DDR-266/333 memory, one PCI Express x4, one PCI Express x16, two PCI-X (64 bit) and two PCI (32 bit) expansion capabilities. The E7505 provides support for dual-channel DDR-266MHz memory, advanced integrated AGP 8X graphics and an integrated USB 2.0 controller. The 533MHz system bus allows for as fast as 4.3GB per second data transfer rates, which is a major performance benefit for memory-intensive applications. The 400MHz system...
bus provides for as fast as 3.2GB per second data transfer.

**Practical Applications**

Intel® Xeon™ Processors are ideal for high-performance workstation applications, including:

- **Architectural and engineering**—Demanding CAD/CAM applications benefit from dual-processor support, fast system bus speeds and integrated advanced graphics.
- **Graphic design and modeling**—In particular, 2-D and 3-D rendering benefits from dual-processor workstation configurations and the Intel® E5725 Chipset’s faster system bus speed, which moves data between the processor and memory much faster than other chipsets.

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**Intel® Extended Memory 64 Technology**

Intel® Extended Memory 64 Technology is one of a number of innovations being added to Intel’s IA-32 Server/Workstation platforms in 2004. It represents a natural addition to Intel's IA-32 architecture, allowing platforms to access larger amounts of memory. Processors with Intel® EM64T will support 64-bit extended operating systems from Microsoft, Red Hat and SuSE. Processors running in legacy* mode remain fully compatible with today’s existing 32-bit applications and operating systems.

*Legacy mode consists of a 32-bit application running under a 32-bit operating system.

See CDWG.com for a complete selection of Intel Processor-powered desktop and workstation computers.
Servers and blades require a different kind of processor than other computers. In addition to being fast, server and blade processors need to support multiprocessing capabilities and have fast access to memory and peripheral devices such as network adapters. Two Intel processors, the Intel® Itanium® 2 Processor and Intel® Xeon™ Processor, are designed specifically for server and blade applications.

A typical server is a single physical chassis containing a single motherboard. A blade server is a single chassis containing multiple motherboards. Each motherboard—referred to as a blade—is a completely independent server. By housing these blades in one chassis, rather than in their own chassis, multiple servers can be made to fit in much less space, which is perfect for high-density applications such as terminal servers and application servers.

In This Chapter:

- Understanding servers and blades
- Intel® Itanium® 2 Processors—64-bit processing power
- Intel® Xeon™ Processors
- Fast access to network data critical at Riverview Hospital

Instruction Set Computing (CISC) technology. CISC processors come at a generally lower-cost than Reduced Instruction Set Computing (RISC) processors, which represent the other generally available 64-bit processor choices.

The Intel® Itanium® 2 Processor with 6MB Level-3 cache provides a massive performance improvement—30 to 50 percent—over the original Intel® Itanium™ Processor, while remaining completely compatible with software written for the Intel® Itanium™ Processor family. The new Intel® Itanium® 2 Processor features 6.4GB per second of system-bus bandwidth and a 1.50GHz core speed.

Included in the Intel® Itanium® 2 product line are the Intel® Itanium® 2 Processor, which runs at 1.40GHz with a 1.5MB Level-3 cache, and the Low Voltage Intel® Itanium® 2 Processor. Both the Intel® Itanium® 2 and Low Voltage Intel® Itanium® 2 Processors are tailored for dual processor applications. The Intel® Itanium® 2 Processor line is supported by OSs such as Microsoft Windows Server 2003, HP-UX and Linux.
Intel® Itanium® 2 Processors also support an entirely new system architecture, power-on self-test environment and expansion busses. These new architectural components allow Intel® Itanium® 2 Processor systems to move far beyond 32-bit systems in terms of performance. Intel® Itanium® 2 Processor systems can also be built to support the common PCI expansion bus, providing backward compatibility with existing hardware investments.

Technical Specifications

Various versions of the Intel® Itanium® 2 Processor are now available. Core speeds include 1.50GHz, 1.40GHz, 1.30GHz and 1GHz; Level-3 cache sizes include 1.5MB, 3MB, 4MB and 6MB. In addition, all Intel® Itanium® 2 Processors support SMP. The Level-2 cache size is 256KB, while Level-1 instruction and data caches are 32KB.

The Intel® Itanium® 2 Processor is supported by the Intel® E8870 Chipset, which is specifically designed for high-end, 2- and 4-processor servers. This chipset connects the Intel® Itanium® 2 Processor to a 400MHz, 128-bit system bus, and supports as much as 128GB of memory using 4GB memory modules. The chipset includes a high-performance PCI/PCI-X bridge, which allows Intel® Itanium® 2 Processor systems to include all PCI/PCI-X expansion devices, from legacy PCI cards to higher-performance PCI-X cards running at 133MHz.

The E8870 also supports advanced platform features including:
- Hot-plug memory, allowing memory to be changed or added while the server is running
- Hot-plug processors
- Error-correcting memory
- Memory Device Failure Recover (MDFR)
- Multiple redundant I/O paths

Combined, these features offer a system that is remarkably resilient to failure.

Practical Applications

Intel® Itanium® 2 Processors are ideal for high-performance computing applications, including:
- Simulation and rendering—Servers supporting complex environment simulations or graphics rendering benefit from the Intel® Itanium® 2 Processor’s enormous Level-3 cache size, which speeds access to system memory, as well as the processor’s fast operation and multiprocessor support.
- Databases—High-end databases can be scaled up more easily with the Intel® Itanium® 2 Processor, taking advantage of its multiprocessor support, fast system bus speeds and massive memory support.

Intel® Xeon™ and Intel® Xeon™ Processor MP

Processor Overview

The Intel® Xeon™ Processor MP is optimized for multiprocessor servers and blades. The processor features Intel’s Hyper-Threading Technology and is available in a variety of core processor speeds. The regular Intel® Xeon™ Processor is suitable for dual-processor applications.

The Intel® Xeon™ Processor MP supports multiprocessor server designs with four or more processors, offering increased performance and scale-up capabilities. Core processor speeds include 3.20GHz, 3.06GHz, 3GHz, 2.80GHz, 2.70GHz, 2.50GHz, 2.20GHz, 2GHz, 1.90GHz and 1.50GHz, with all versions supporting at least a 400MHz system bus and Hyper-Threading Technology. Integrated Level-3 cache sizes include 4MB, 2MB and 1MB options; Level-2 cache is 512KB; and the Level-1 cache is 8KB (data) and 12KB (instructions).

The Intel® Xeon™ Processor is available at core speeds as fast as 3.20GHz, with as large as a 2MB Level-3 cache and a 533MHz system bus speed. The Intel® Xeon™ Processor is well-suited for dual-processor applications.
Advancing Computing With Intel® NetBurst® Microarchitecture

The Intel® NetBurst® Microarchitecture is binary compatible with previous generation Intel® Architecture (IA-32) processors. It adds new features, beginning with techniques that enhance processor execution, such as Higher Core Frequencies, Rapid Execution Engine and Advanced Dynamic Execution.

Higher Core Frequencies are capable through the Intel® NetBurst® Microarchitecture, which doubles the pipeline depth compared to the P6 Microarchitecture used on Intel® Pentium® III Xeon® Processors. One of the key pipelines, the branch prediction/recovery pipeline, is implemented in 20 stages in the Intel® NetBurst® Microarchitecture, compared to 10 stages in the P6 Microarchitecture. This technology significantly increases the performance, frequency and scalability of the processor.

Two ALUs on the Intel® Xeon® Processor MP are clocked at twice the core processor frequency. This allows basic integer instructions such as Add, Subtract, Logical AND, Logical OR, etc. to execute in a clock cycle. For example, the Rapid Execution Engine on a 3GHz Intel® Xeon™ Processor MP runs at 6GHz.

The Advance Dynamic Execution Engine is a very deep, out-of-order speculative engine that keeps the execution units executing instructions. The Intel® Xeon™ Processor MP can also view 126 instructions in flight and handle up to 48 loads and 24 stores in the pipeline. It also includes an enhanced branch prediction algorithm that has the net effect of reducing the number of branch mis-predictions by about 33 percent over the P6 generation processor’s branch prediction capability. It does this by implementing a 4KB branch target buffer that stores more detail on the history of past branches, as well as by implementing a more advanced branch prediction algorithm.

Technical Specifications

The Intel® Xeon™ Processor MP is supported by the ServerWorks GC-HE Chipset. In server platforms, the Intel® Xeon™ Processor is supported by the Intel® E7501 and E7500 Chipsets, ServerWorks GC-LE Chipset and ServerWorks GC-HE Chipset. The following list highlights the features that the E750x Chipsets support:

- Two processors (ServerWorks Chipsets are required for three or more processors)
- 533MHz system bus (E7501) or 400MHz system bus (E7500)
- PCI and PCI-X expansion capability
- Dual-channel DDR-200 (E7500) or DDR-266 (E7501) memory, with memory bandwidth of as fast as 3.2GB per second

HP’s ProLiant BL20p G2 server blade series delivers the power of Intel® Xeon™ Processors, SAN Storage, DDR memory and Gigabit Ethernet.
Fast access to network data critical at Riverview Hospital

Pete Williams never went to medical school, never tried to cure a potentially fatal disease or close a gaping wound, nevertheless the IT project manager for Riverview Hospital just north of Indianapolis, Indiana knew that lives were on the line when he went to buy new servers.

Just like the 350 physicians at the hospital, Williams had zero margin for error. If the servers couldn’t handle usage beyond the normal peak, if the processors experienced bottlenecks and cache glitches when they were supposed to be delivering critical information, patient care could suffer.

Ultimately he found the speed and reliability he needed in a variety of HP models running on Intel® Xeon® 2.8 GHz chips.

“If a clinician is forced to wait five or six seconds for information to appear, that’s technology people aren’t going to use,” Williams says. “It doesn’t matter what kind of application we build if they have to wait. Time is not something clinicians have available to waste.”

“We’re porting many applications via our Intranet,” Williams says. “Everything we do is focused on making the proper information accessible to the right people, as fast and as user-friendly as possible.”

As the backbone for those applications, Williams chose a selection of 1U servers with 36GB hard drives running at 10,000 RPM, multiple gigabytes of memory and dual Intel® Xeon™ Processors.

The dual processors in particular were the key.

“We have to have hot-swappable everything,” Williams says. “We’re a mission-critical, 24 x 7 operation. We don’t have room for downtime. Our systems cannot go offline.”

Scalability was another issue of paramount importance. Many of the older servers at the hospital have been running on Intel® Pentium® II and III Processors.

“Many of those boxes would be okay if they ran one Web page or a small application, but we’re going to go well past that in the near future,” Williams says.

Anticipation is Key

Williams’ relative inability to take servers offline means he has to anticipate larger workloads and scale issues when he’s configuring and designing the architecture. As a municipally-owned facility Riverview can’t throw money at bad architecture, so the Intel® Xeon™ Processor’s ability to scale out to eight-way or greater configurations should enable Williams to build and buy more state-of-the-art applications.

“Once we get a system running, we can’t afford to shut it down and start over,” he says. “We need boxes that can grow with us.”

He also notes that the fundamentals of Moore’s Law apply. The latest SQL database technology has been built with the assumption of more processing power and Riverview needs that extra processing muscle in order to plumb the depths of those databases.

“Some of the applications require that we move large amounts of data through the enterprise,” Williams says. “A slow processor can have a substantial impact on a system’s response time.”

Virus detection and prevention has also become a response-time issue. All of the Intel® Xeon™ Processor’s performance, speed, scale and dependability advantages on other applications won’t mean much if the facility’s virus detection server reacts slowly or crashes at a crisis moment.

“With the latest generation of viruses that have hit some institutions, we need a stable system that can react instantly,” Williams says.

Timely Information is Essential

As much as any other, health care is an information-driven industry. In fact, Williams says, “These servers are the core of the information systems business.”

These days patient information is accessed via Web-based applications and databases. Lab results are posted via Web applications. Physician’s desk references come in an electronic format. Even the fetal monitoring system used to study the heart readings of infants at the 156-bed, county-owned Riverview Hospital come with dedicated servers.

Caregivers at Riverview Hospital in Indiana provide prompt and reliable patient care, thanks in part to Intel® Xeon™ Processor-powered servers running the hospital’s IT network.

Caregivers at Riverview Hospital
802.11 Standard
A family of IEEE standards for wireless LANs, currently specifying three distinct communication standards

Advanced Encryption Standard (AES)
A symmetric 128-bit block data encryption standard used in wireless networking implementations to improve wireless security

Advanced Graphics Port (AGP)
A graphics interface, similar to Peripheral Component Interconnect (PCI), that provides for advanced, high-speed graphics subsystems

Blade
A high-density computer, where a single chassis contains multiple independent server motherboards which function as complete, independent computers. Typically used for high-density server applications.

Chipset
A collection of microchips that support and connect a computer’s processor; chipsets often include memory management functions and might include integrated graphics subsystems, network adapters and more.

Clock Speed
The speed at which a microprocessor executes instructions

Deep Sleep
A low-power state in which a processor consumes less voltage, thereby increasing battery life in mobile devices

Deeper Sleep
An especially low-power state in which a processor consumes significantly less voltage, thereby increasing battery life in mobile devices

Extreme Graphics 2
A graphics subsystem included in many Intel Chipset families; provides accelerated 2-D and 3-D graphics and sharp images while balancing memory usage between the graphics subsystem and the main system for optimal performance

GHz
A measure of processor speed. A 1GHz processor completes one billion cycles per second; each cycle allows the processor to complete one instruction, fetch information from memory or some other basic task.

Hyper-Threading (HT) Technology
An Intel technology, implemented in some versions of the Pentium® 4 and Mobile Pentium® 4 Processor families, that improves processor performance. Essentially allows a single processor to act as two virtual processors, processing instructions in parallel.

Instruction Set
A processor’s native language, which modern operating systems (OSs) employ to ask the processor to perform complex mathematical and logical operations, which, in turn, make the OS operate

Intel® Centrino™ Mobile Technology
A set of Intel technologies designed to enhance mobile computing; includes power-management technologies, wireless networking and mobile performance enhancements

Intel® NetBurst® Microarchitecture
An Intel technology that provides several performance improvements, including Hyper-Threading Technology and 800MHz, 533MHz and 400MHz system buses. Available in many Pentium® 4 and Mobile Pentium® 4 processors.
Intel® SpeedStep® Technology
An Intel technology that allows processors to run at different voltages and clock frequencies. Lower voltages and frequencies consume less power, allowing the computer’s end user to determine the balance between performance and power consumption (and therefore, battery life).

Intelligent Scanning Technology
Helps computers with Intel® Centrino™ Mobile Technology reduce power consumption by regulating the frequency with which the computer scans for available wireless access points.

Level-2 (L2) Cache
A small memory cache with a high-speed connection to the computer’s microprocessor. Designed to speed up processor access to data and instructions.

Low Voltage (LV)
Refers to a microprocessor that runs at a lower voltage; generally reduces processor performance compared with full-voltage processors, but also produces less heat and provides for a longer battery life in mobile devices.

Microprocessor/Processor
The central processing unit (CPU) of a computer, which executes the computer’s operating system, applications and other software code; also called the “brains” of a computer.

Mobile Voltage Positioning
An Intel technology that dynamically lowers processor voltage based on processor activity. Lower voltages produce less heat, so this feature can help reduce the thermal output of processors in small-form-factor computers, such as notebooks and Tablet PCs.

Moore’s Law
Originally posited by Intel engineer Gordon Moore, this “law” states that the number of transistors in a processor (a key component of raw processor power) doubles every two years.

Motherboard
A single, multilayered collection of electrical paths and electronic components that combine chips, the processor and many other core functions to form the basis for a computer.

Strained Silicon
A manufacturing technique that improves electron flow through the silicon that comprises a microprocessor, improving performance.

Streaming SIMD Extensions 2 and 3 (SSE2 and SSE3)
Additional processor-level instructions that improve the performance and thread synchronization in multimedia-heavy applications such as gaming, video, audio and more.

Thermal Management
Manufacturing processes and processor design techniques that help reduce electrical inefficiencies and thermal production.

Transportable Notebook
A large, (usually weighing between 8-15 lbs.) portable notebook that offers additional ports, a larger keyboard and more expansion opportunities than lightweight notebook PCs.

Ultra-Low Voltage (ULV)
Refers to microprocessors that run at a substantially lower voltage; generally places an upper limit on processor performance, but also produces significantly less heat and provides for longer battery life in mobile devices.

Universal Serial Bus (USB)
Available in lower-speed 1.0 and higher-speed 2.0 versions, this peripheral connection bus allows computers to interface with a variety of external devices, including digital cameras, storage devices, printers, keyboards and mice.

Wi-Fi
An industry organization that defines wireless networking protocols and tests devices for standards compliance. Wi-Fi-CERTIFIED wireless networking equipment, for example, complies with defined wireless networking standards.

Wi-Fi Protected Access (WPA)
A newer technology for encrypting and securing wireless network access. Considered superior to WEP.

Wired Equivalent Privacy (WEP)
A security protocol for wireless local area networks (WLAN) defined in the 802.11b standard. Originally designed to provide the same level of security as a wired LAN, WEP has been found to be not as secure as once believed.
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