Notebook Basics – The CPU

Foreword

The Central Processing Unit (CPU for short) is the soul of the computer. That goes for both the desktop computer and the notebook computer. The notebook CPU is categorized into the X86 and the Apple Power PC architectures, but for the purpose of this article we will be focusing on how to select the X86 processor that is best suited to our individual needs.

Generally speaking, the best-performing CPU in a given series of CPUs (e.g. Intel Pentium 4) is the one with the highest core frequency. In desktop computers, adopting a faster CPU is naturally the simplest way of boosting system performance, budget-permitting. It is much complicated in term of select processors for notebooks. In the current status quo, higher frequencies come at the cost of greater power consumption and heat; both areas of great concern in notebook computers.

Notebook Processor Development and Special Characteristics

The installation of desktop CPUs into notebook computers posed very few challenges prior to the Pentium II era; due mostly to the relatively cool nature of CPUs of the time. Come the Pentium II era, however, and the sheer size of the Slot 1 processor meant a huge increase in the number of transistors and therefore the heat generated in use. This meant that the Slot 1 Pentium II processor was not a viable choice for direct installation into notebooks.

Intel’s answer was the Mobile Pentium II processor. It used proprietary packaging different from desktop Pentium II processor, and its power consumption and TDP (Thermal Design Power) were greatly reduced through evolutionary design. The end result was a processor far more suited for integration into the notebook environment.

The arrival of Intel’s Mobile Pentium II notebook processor set the stage for subsequent notebook processor development. Lower power consumption meant extended battery time as well as less heat and a reduced dependency on cooling systems, which also meant less weight. Importantly, this also had the benefit of a reduced tendency for uncomfortable “burnt” hands and laps.

Thereafter, the rapid increase in Mobile Pentium II processor frequencies and the release of the Pentium III processor meant that notebook processor frequencies had leapt from 200MHz to 500MHz. While enhanced designs were adopted to reduce power consumption and TDP of notebook processors, this did not mean that power consumption and TDP were necessarily lowered. The fact was that power consumption and TDP were both climbing.

While the cooling systems of the time were able to keep heat levels well within control, battery time was on a clear downward trend. Intel's timely release of SpeedStep technology helped to curb the problem by decreasing CPU frequencies in battery mode in order to reduce power consumption and prolong battery time. SpeedStep is still being used to this day by Intel platform notebooks, and has been emulated by archrival AMD in the form of the PowerNow! technology that works in much the same way.

While the earliest form of SpeedStep allowed for just two frequency operating points: the CPU frequency stated in the tech specs and reduced frequency under battery mode; today's Enhanced SpeedStep technology allows SpeedStep compatible processors to work in conjunction with Advanced Power Management to automatically adjust frequencies to the optimum (performance) level to maximize power savings.

Before the arrival of the now-legendary Pentium M processors, notebook processors from both Intel and AMD were simply desktop processors re-optimized for notebook implementation. You might say that they were not built specifically for notebook use. Over the years we have also seen the Transmeta Crusoe processor which has the features of very minute power consumption and TDP, allowing notebooks incorporating this processor to be extremely thin and light. Unfortunately, performance is hardly on the level of notebook processor offerings from Intel and AMD. After a few years of the rough and tumble, the company has finally announced its decision to leave the notebook processor manufacturing market.

Intel's follow up to SpeedStep technology was a momentous masterstroke. In 2003, Intel officially launched what it calls Centrino Mobile Technology where processor, chipset and WLAN card are unified on a single platform. Here our interest switches to the Pentium M processor, which is Intel's one and only true-to-the-word notebook processor. What make it special are the all-new marchitecture and large L2 cache, as well as the ability to maintain performance at much lower power consumption and heat levels.

A 1.3GHz Pentium M processor delivers the same computing abilities of a Pentium 4 2.0GHz processor, while the newest 2.1GHz Pentium M 770 is comparable to the Pentium 4 3.6GHz monster.

Introduction to Contemporary Notebook Processors

The above focused on the history of the notebook processor, so the following will focus on what's available in the market at this point in time

The Intel Camp

Intel Mobile Pentium 4-M Processors

Actually, “just” Pentium 4 processors optimized for reduced power consumption and TDP, they support SpeedStep technology and 400MHz FSB. Owing to higher core frequencies, they are able to perform video compression at high speed and have higher computational abilities, but at the cost of high power consumption and TDP compared to mainstream Pentium M processors.

Production has basically ceased, with implementation into mainstream products non-existent.

Intel Mobile Pentium 4 Processors

Like the Pentium 4-M processors, these are “just” Pentium 4 processors optimized for reduced power consumption and TDP. They support SpeedStep technology and 533MHz FSB. Some models offer support for Hyper-Threading technology in accordance with the abilities of their desktop counterparts. Owing to higher core frequencies, they are able to perform video compression at high speed and have higher computational abilities, but at the cost of high power consumption and TDP compared to mainstream Pentium M processors.

For these reasons, they are mainly found in Desktop Replacement notebook computers.

Intel Pentium 4 Processors

Often found in Desktop Replacement models, they do not support SpeedStep technology at all, but pricing undercuts Mobile Pentium 4 processors massively making it an easy choice for manufacturers. These Desktop Replacement models often have unplugged times of just 1 hour (or less). Computing performance, however, is no different to full-fledged desktop computers.

Intel Pentium 4 Extreme Edition Processor

An ultimate-end processor, it is installed primarily in ultimate-end notebook computers such as Dell’s XPS. This CPU has the benefit of an L3 cache allowing it to perform at a very high-level in most multimedia and gaming applications. Made for the desktop, SpeedStep technology is not supported. The serious TDP and power consumption mean that notebook

computers containing one must have extreme levels of cooling, which causes size and weight to be quite massive. Typical battery time is in the region of notebooks containing Pentium 4 processors.

Intel Mobile Celeron Processors

The simplified versions of the Mobile Pentium 4-M processors, they feature the same performance gap found between the Pentium 4 and Celeron desktop processors. FSB speed for the Mobile Celeron processors is 400MHz; L2 cache is just 256KB. The market positioning also causes the deletion of SpeedStep support. For this reason, notebook computers installed with equal-frequency Mobile Pentium 4 and Mobile Pentium 4-M that lower the working frequency in battery mode will produce longer unplugged times than Intel Mobile Celeron processors. The lower cost of a Mobile Celeron processor, however, means that a notebook installed with one will most likely be positioned as an entry-level model.

Intel Pentium M Processors

The heart of the Intel Centrino Mobile Technology is the Pentium M processor, the 1st generation of which featured the Banias core with 400MHz frequency and 1MB L2 cache, as well as TDP and power consumption that were relatively low. SpeedStep technology is obviously supported.

Although the Pentium M processor's frequency was quite a bit lower than the Mobile Pentium 4-M and Mobile Pentium 4 processors of the time, the Pentium M enjoyed a big advantage in performance thanks to the advanced marchitecture of the processor core and a large L2 cache. Remember our example about the 1.3GHz Pentium M standing up to the Pentium 4 2.0GHz processor?

By the middle of 2004 and early 2005, Intel had produced two new versions of the Pentium M processor; first the 400MHz FSB, 2MB L2 cache Dothan core Pentium M processor in mid-2004, and second with the 533MHz FSB, 2MB L2 cache Sonoma Pentium M processor in early-2005. In each new version we witnessed a significant increase in performance; the Dothan due to an increase in L2 cache, and the following Sonoma once more due to both an increase in FSB speed and doubled L2 cache

Intel Celeron M Processors

These are the simplified versions of the Pentium M processors. The arrival of the Dothan-cored Celeron M processors meant the existence of two lines of Celeron M processor: The Banias core Celeron M gifted with 512KB L2 cache; and the Dothan core Celeron M with 1MB L2 cache. The low-middle segment positioning means no SpeedStep support. All have 400MHz FSB.

New Naming Rules for Intel Processors

Intel had previously used an alphabetical letter + frequency number combination as a means to name its CPUs. Under new rules, Intel notebook processors are classified under the 3XX, 5XX, and 7XX series.

Mainstream Intel Notebook Processor List	Frequency (GHz)
Pentium M 770(2M L2 Cache,533MHz FSB)	2.13
Pentium M 765(2M L2 Cache,400MHzFSB)	2.1
Pentium M 760(2M L2 Cache,533MHz FSB)	2
Pentium M 755(2M L2 Cache,400MHzFSB)	2
Pentium M 750(2M L2 Cache,533MHz FSB)	1.86
Pentium M 745(2M L2 Cache,400MHzFSB)	1.8
Pentium M 740(2M L2 Cache,533MHz FSB)	1.73
Pentium M 735(2M L2 Cache,400MHzFSB)	1.7
Pentium M 730(2M L2 Cache,533MHz FSB)	1.6
Pentium M 725(2M L2 Cache,400MHzFSB)	1.6
Pentium M 715(2M L2 Cache,400MHzFSB)	1.5
LV Pentium M 758(2M L2 Cache,400MHzFSB)	1.4
LV Pentium M 738(2M L2 Cache,400MHzFSB)	1.3
ULV Pentium M 753(2M L2 Cache,400MHzFSB)	1.2
ULV Pentium M 733(2M L2 Cache,400MHzFSB)	1.1
ULV Pentium M 723(2M L2 Cache,400MHzFSB)	1
ULV Pentium M 713 (1M L2 Cache,400MHzFSB)	1.1
Mobile Pentium 4 552(1M L2 Cache,533MHz FSB)	3.46
Mobile Pentium 4 548(1M L2 Cache,533MHz FSB)	3.33
Mobile Pentium 4 538(1M L2 Cache,533MHz FSB)	3.2
Mobile Pentium 4 532(1M L2 Cache,533MHz FSB)	3.06
Mobile Pentium 4 518(1M L2 Cache,533MHz FSB)	2.8
Celeron M 370(1M L2 Cache,400MHzFSB)	1.5
Celeron M 360/360J(1M L2 Cache,400MHzFSB)	1.4
Celeron M 350/350j(1M L2 Cache,400MHzFSB)	1.3
Celeron M 340(512k L2 Cache,400MHzFSB)	1.5

Celeron M 330(512k L2 Cache,400MHzFSB)	1.4
Celeron M 320(512k L2 Cache,400MHzFSB)	1.3
Celeron M 310(512k L2 Cache,400MHzFSB)	1.2
ULV Celeron M 333(512k L2 Cache, 400MHzFSB)	0.9
ULV Celeron M 353(512k L2 Cache, 400MHzFSB)	0.9
ULV Celeron M 373(512k L2 Cache, 400MHzFSB)	1

The AMD Camp

AMD Turion 64 Processors

Launched in March 2005, the AMD Turion 64 mobile technology has the Intel Centrino firmly in its sights. Nicknamed the “Centrino Killer”, the heart of this technology is none other than the Turion 64 processor which fortunately has no trace of AMD’s longtime high power consumption. Naturally, it supports the AMD’s PowerNow! technology and Enhanced Virus Protection.

The Turion 64 are separated into the ML and MT categories. The ML have a TDP of 35W and are designed specifically for mainstream notebook usage. The MT, on the other hand, have a TDP of 25W, and are made with ultra thin and lights in mind. High-end Turion processors (ML and MT) are shipped with 1MB L2 cache, while middle and low-end models are equipped with 512KB L2 cache.

Of course, the Turion 64 are notebook processors capable of 64-bit computations, so the time when Microsoft finally releases the Windows XP 64-bit OS will be the moment where 64-bit computing on mainstream ultra thin and light notebooks becomes reality!

AMD Athlon XP-M Processors

Basically Athlon XP processors optimized for reduced power consumption and TDP. Unfortunately, the Athlon XP do rather poorly in these departments, so notebook computers installed with AMD Athlon XP-M processors are still far from ideal despite the presence of PowerNow! technology. For that reason, only a select few manufacturers decided on using the Athlon XP-M processors. Production has now ended, and notebook computers featuring these processors are rare in the market.

AMD Athlon 64 Processors

There are currently three types of Athlon 64 notebook processor: the first for desktop replacement notebooks, the second for full-size notebooks, and the last for thin and lights. The differences between them can, of course, be found in power consumption and TDP. Still, all of them support PowerNow! technology, Enhanced Virus Protection and are fully capable of 64-bit computations.

The appearance of the AMD Turion 64, however, is an indication that notebook-specific AMD Athlon 64 processors are on their way out.

AMD Mobile Sempron Processors

Like most other notebook processors, the Mobile Sempron processors too, are mobile computing oriented and optimized Sempron processors fro that purpose. Currently designed for integration into full-size and ultra thin and light notebooks, they too are categorized by power consumption and TDP. As things stand, it is very difficult to find notebook computers installed with the Mobile Sempron due to the price-performance value and market positioning of the processors.

Others

VIA C3 Processors

VIA's notebook processor, the C3, is excellent in terms of TDP and power consumption, but poor core frequency (has a hard time keeping up with even the Pentium III) and computational ability hurt it. It is currently found only in a handful of entry-level notebooks.

Transmeta TM Series Processors

From the Crusoe to the Efficieon, Transmeta's processors have displayed a delightfully light appetite for power and a TDP that is more than respectable. Notebooks installed with the Crusoe have shown incredible unplugged running time, thanks to Transmeta's LongRun technology. Unfortunately, these processors also suffer from relatively low frequencies, so computational ability is relatively weak. Therefore, only a very small number of ultra thin and light notebooks incorporate the Transmeta processors.

Making things worse was the arrival of the low voltage and ultra-low voltage Pentium M processors, making it an even tougher task for the Transmeta processors to survive. In the end, the Transmeta company withdrew from the notebook processor domain.

Parting Words

We hope this article has helped our readers gain a better understanding of contemporary notebook processors and has made the notebook selection process a bit easier. Of course, the notebook is made up of much more than a CPU; for the other areas of importance, please see the other reports available in Newegg Intelligence.