

# **Pentium 4 Platform Shootout**

## **DDR SDRAM Versus Direct RDRAM**

**By Johan De Gelas – March 2002**

If you're in the market to build a Pentium 4-based system, you may find that it is not easy to decide on a particular platform. The general consensus on the web seems to be that VIA's P4X266 and Intel's i845D are only slightly slower than the dual-channel DRDRAM-based i850 chipset the Pentium 4 made its debut with. The SiS645, with its support for PC2700 DDR SDRAM, does not seem to do much for Rambus' case. According to some reports, this budget chipset performs nearly as well as the i850 again.

Add to this VIA's upcoming P4X333, SiS' SiS655 dual-channel DDR SDRAM chipset, and Intel's own upcoming dual-channel chipsets, and it becomes clear that Rambus has an uphill battle ahead of it if the memory technology is to retain a foothold on the Pentium 4 platform. While it may seem the wind is no longer at Rambus' back, the upcoming i850E may yet prove this grim picture inaccurate.

We thought it is time to get to the bottom of this. We would like to help the Pentium 4 buyer to make up his or her mind regarding which platform to buy, but that is not the only purpose of this article. The Pentium 4 platform, with its fast FSB and support for almost any memory technology available, can us help us to get a better understanding of memory and chipset technology.

In this series of articles, we'll go in search of the best platform for the Pentium 4. In the first article, we will evaluate the current state of memory and Pentium 4 motherboard and chipset technology. The benchmark results may offer up some surprising results, but of course this wouldn't be Ace's Hardware if we didn't try to find out more. In the next article we will take a close look at the technology itself to determine which chipset/memory solution is superior from a technical point of view. By knowing the technical aspects better, we can clarify the often-unclear future of RAM and chipset technology.

But first, we'll investigate the situation today. The objective of this first article is to find out which platform is best for the Pentium 4. Therefore, we will have to investigate chipset and memory performance. Such chipset comparisons can be a dire undertaking: some motherboards disable some of the performance features of the chipset for better stability. To minimize this problem, we tested at least two motherboards for each chipset. This should give us a more accurate view of the differences between the different chipsets.

## Benchmark Configuration

All systems were tested with NVIDIA's Detonator 21.85 drivers. The desktop was set at a resolution of 1024x768x32bpp, 85 Hz refresh rate. Our testbed still runs Windows 2000 SP2, as most professionals and hardcore hardware enthusiasts prefer the mature Windows 2000 SP2 environment.

### **Pentium 4 2.0 GHz SDRAM & Pentium 4 2A GHz Northwood SDRAM**

- Super Micro P4SBA
- 512 MB PC133 Corsair CAS 2

### **Pentium 4 2.0 GHz & 2.0 A GHz Northwood P4X266**

- Tyan Trinity 510 (S2266) BIOS Revision 1.04 (VIA P4X266 chipset)
- VIA P4X-R BIOS Revision 1.01
- 512 MB Corsair PC2700 XMS (DDR-RAM) CAS 2

### **Pentium 4 2.0 GHz & 2.0A GHz Northwood (SIS645 Chipset)**

- Soyo P4S Dragon Ultra BIOS Revision 01/09/2002
- MSI 645 Ultra (SIS645 chipset) BIOS Revision 1.4
- 512 MB Corsair PC2700 XMS (DDR-RAM) CAS 2

### **Pentium 4 2A i845 DDR and 2.2 GHz Northwood**

- ASUS P4B266 (i845 DDR chipset) BIOS Revision 1.005
- 512 MB Corsair PC2700 XMS (DDR-RAM) CAS 2

### **Pentium 4 2.0 GHz & 2.0A GHz Northwood DRDRAM (4x128 MB)**

- ASUS P4T-E (BIOS Revision 1.05)
- 512 MB Corsair PC800 - 45 (4 x 128 MB)

### **Athlon 1400**

- ASUS A7V266-E (VIAKT266A) BIOS Revision 1.004
- 512 MB Corsair PC2700 XMS (DDR-RAM) CAS 2

### **Athlon XP 2000+**

- ASUS A7V266-E (VIAKT266A) BIOS Revision 1.004
- 512 MB Corsair PC2700 XMS (DDR-RAM) CAS 2

### Common Hardware

- Seagate Barracuda ATA III ST320414A Model ST320414A (7200 RPM, ATA-100)
- ASUS GeForce 3 Ti500 64 MB
- AT 2700 10/100 NIC
- Sound Blaster Live!

### Software

- Via 4 in 1 Drivers 4.37A
- SiS AGP Driver 1.08D
- Intel Chipset INF Update 3.10.1011
- Windows 2000 Service Pack 2
- DirectX 8.1

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Thanks to Augustine Chen, Carol Chang ([ASUS](#)) and Sharon Tan ([BAS computers Netherlands](#)) for the ASUS motherboards.

Joe James and Mat Vernon of [Tyan](#) sent us the Tyan S2266.

Mickey Liaw of [SOYO Computer Inc.](#), who sent us the P4S Dragon Ultra.

We also thank Cameron Rogers from the [VIA Taiwan office](#) for sending P4XB-RA.

Angelique Berden of [MSI](#) was provided us with the MSI i850 Pro 5, and the MSI 645 Ultra.

Doncevski B. Robert sent us the [Lucky Star i845DDR P4A845D](#).

Jurgen Heymbrechts ([Intel](#)) and Marieke Leenhouts ([MCS](#)) made sure we could test the 2.0 and 2.2 GHz Northwood Pentium 4.

Robert Pearce of [Corsair](#), provided us with Corsair's [PC2700 XMS](#) and PC133 CAS2 SDRAM

Damon Muzny ([AMD](#)) made sure we were able to test an Athlon XP 2000+.

## The Motherboards

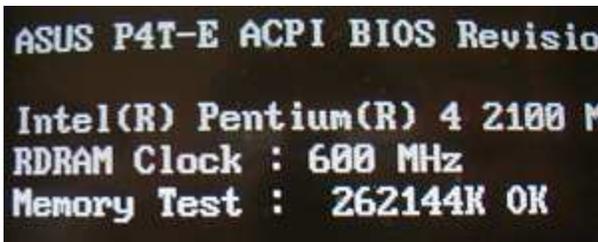
First let's start off by taking a look at the different motherboards we tested in this review, grouped by chipset.

### i850 Chipset

As mentioned previously in our PC1066 review (see URL at the end of this document), most boards with an i850 chipset can be overclocked to 533 MHz (133 MHz QDR FSB). The DRDRAM clock generators on most boards, however, are not able to run reliably at 533 MHz. Our PC1066 review is four months old, and so we were curious to see what the current batch of i850 motherboards is capable of. To make this possible, we used an unlocked 2.0 GHz Willamette Pentium 4.

### ASUS P4T-E (BIOS Revision 1.05)

The ASUS P4TE comes with few extras, but the quality of the board itself is nothing short of astonishing.



ASUS P4T-E ACPI BIOS Revision  
Intel(R) Pentium(R) 4 2100 M  
RDRAM Clock : 600 MHz  
Memory Test : 262144K OK

The newer versions of the ASUS P4T-E use the ICS 9212AF-13 clock generator instead of the slower Cypress clock generator. On top of that, the board comes with very high quality three-phase power regulation. The three power connectors connect in well thought-out places and everything is designed to get the best signal integrity. The result is that the ASUS P4T-E was able to POST at a 600 MHz (150 MHz quad-pumped) FSB, which is truly amazing! We used high quality PC800 RIMMs that were, however, four months old!

The board was able to boot into Windows 2000 with the FSB at 592 MHz, and we could run benchmarks at 580 MHz. So far, the P4T-E is running stable at 580 MHz, but we have only tested the board for a few days now. My impression is that the board is limited by our PC800 DRDRAM RIMMs, and it is not unlikely that it can be pushed even higher with true PC1066 modules. However, to overclock this high you need a genuine ATX-12V supply, because when we forgot to connect the auxiliary connector, the board couldn't get past 120 MHz.



### Pentium 4 Platform Shootout: DDR SDRAM Versus Direct RDRAM

To get past 133 MHz (FSB at 533 MHz), you can no longer use the BIOS, but instead must manually set a switch panel. The settings are well documented in the manual of the Asus P4T board (423 pin socket). The board comes with an AGP Pro connector and an extra dual-port USB connector, but doesn't have any integrated sound.

## MSI 850 Pro 5

Although it comes with a beautiful Ferrari red PCB, MSI's i850 board is no Ferrari. The board performed acceptably well, but it unfortunately fares quite poorly as an overclocker. We could achieve only a top FSB setting of 440 MHz (110 MHz QDR).

<http://www.msi.com.tw/products/mainboard/mainboard.php?model=MS-6545>

The layout is also rather sloppy. One RIMM slot close to the AGP slot, the AUX Connector is way too close to the second RIMM slot, and the same can be said about the ATX12V connector and the AGP slot. This board is most likely targeted at another market than the hardcore tweaker, as it comes with an attractive price and extras like a USB bracket with diagnostic LEDs and a C-Media CMI8738 6 channel sound chip. Most importantly, this board survived all our benchmarks and stability tests.

Nevertheless, we are a bit disappointed considering that MSI has had many great overclocking motherboards in the past, like the KT266A Pro-2.

## ABIT TH7-II

We didn't have the opportunity to test the ABIT TH7-II, but a very good friend of Ace's Hardware has tested this board in depth. So, we'd like to share his experiences with you:

The ABIT TH7-II is one of the few boards that have the RDRAM clock generators of very high quality so that they can run the RDRAM at 1066 MHz stable.

When running the ABIT TH7-II, it's best to set the AGP and PCI buses to be ratios of the FSB speed. In other words, don't use the "fixed" setting in the BIOS, which forces AGP to 66 MHz, and PCI to 33 MHz, independent of FSB speed. While the "fixed" setting seems like a good idea, in reality it sacrifices performance, and I think the reason is that the AGP/PCI buses are not synchronous - not a clean ratio of the FSB - with the FSB. For a 133 MHz FSB, the ABIT board has a predefined ratio of 2/4, so this supports a 66 MHz AGP bus perfectly.

## **SiS645 Chipset**

The SiS645 chipset is a very strong offering in the chipset market at a bargain price with support for PC2700 DDR SDRAM. Only one small weakness could be detected: even the best PC2700 XMS memory had to run at CAS 2.5.

## **Soyo P4S Dragon Ultra (BIOS Revision 01/09/2002)**

When I first opened the box for this motherboard, I was stunned. Soyo is extremely generous: a HighPoint 372 RAID IDE controller, decent 3D-sound from a CMEDIA 8738 5.1 chip, on board LAN (10/100 Ethernet), an audio connector card (SP/DIF In/Out), 3 ATA-66 cables, a 3.5 inch box with 2 additional USB ports, heatsink compound, and a USB 2.0 card. Add to all of this a very detailed manual, 6 PCI slots, 1 AGP Pro slot and a BIOS that allows you to configure almost every imaginable setting. Soyo's P4S Dragon Ultra is without a doubt the most feature-rich board on Earth.



## Motherboard Feng Shui, Anyone?

Concerning overclocking and performance, our first impressions were very good: a decent three-phase voltage regulator and quality capacitors. The ATX 12V connector is, however, very close to the main ATX connector. The main purpose of the square ATX12V connector is that this connector must avoid that too much current is drawn from the 12V line of the main ATX connector as both the Pentium 4 and AGP (Pro) card draw current from this line.



But the second purpose is to get a very clean power signal. Without the 12V connector, the power must be distributed over relatively long distances to the CPU, RAM, AGP card, and so forth, thus degrading the quality of the power distribution. Intel, for instance, recommends spreading out the placement of the ATX power and ATX-12V connectors for maximum stability on the i845D platform.

CAS Latency Setting	2.5T
RAS Active Time	7T
RAS Precharge Time	4T
RAS To CAS Delay	3T
ACT To ACT Delay	3T
Write Recovery Time	2T
R/W Turn Around Time	safe
Read Latency Control	safe
Time Constraint Control	slow
GW-Write Mask AGP Request	Enabled
AGP Fast Write Capability	Disabled
Refresh Cycle Time	tRAS+tRP+1T
DRAM Addr/Cmd Rate	AUTO Mode

Unfortunately, despite the otherwise seemingly solid design and tons of extras, we experienced some difficulty in getting the P4S Dragon Ultra to run reliably with anything other than the most conservative of settings. We are not sure if the placement of the ATX-12V connector has anything to do with it, but the board could not run our Corsair PC2400 and PC2700 XMS DIMMs at 333 MHz, despite the fact that we have in the past run these modules at up to 180 MHz CAS 2.5 and 167 MHz CAS 2 without any trouble whatsoever.

As you can imagine, the performance increase associated with 166 MHz (333 MHz DDR) memory is largely negated by the overly conservative timings we had to specify in order to achieve stability while benchmarking. The performance was therefore rather mediocre and the board itself was not 100% reliable during our relatively intensive stability test suite, consisting of professional applications and benchmarks like 3D Studio Max, SPEC ViewPerf, and Content Creation 2002. In particular, rendering under 3D Studio Max was quite troublesome.

### Pentium 4 Platform Shootout: DDR SDRAM Versus Direct RDRAM

Rendering in 3D Studio Max resulted in spontaneous reboots and hard locks. Gaming was possible at 333 MHz PC2700 with conservative BIOS settings. At 133 MHz DDR (PC2100), everything seemed peachy keen, but we still experienced the occasional lockup.

Vcore	1.44V
+3 V	3.32V
+5 V	5.10V
+12 V	12.03V
DDR Voltage	2.46V
AGP Voltage	1.48V

Closer inspection of the core and memory voltages revealed that Soyo's voltage regulation was delivering lower than normal voltages. Once we set the CPU core voltage to 1.6V and the DDR voltage to 2.7V, the board ran all our benchmarks reliably (RAM at 133 MHz DDR). This also improved the stability when the PC2700XMS were set at 166 MHz, but lockups in 3D Studio Max still happened from time to time. If we dared to setup the BIOS at anything better than the conservative settings above, stability was lost.

To sum it all up: the Soyo P4S Dragon Ultra is an attractively priced motherboard with every feature that you can dream of, but until we can verify the nature of the problem we experienced with PC2700 DDR SDRAM, we cannot recommend this board to those seeking this feature. The P4S Dragon Ultra has received many favorable reviews across the Internet, something that cannot be overlooked, but at the same time, we cannot overlook our own experience either. That experience tells us there are issues to be ironed out, perhaps related to the voltage supply, or perhaps something else. Rest assured, however, we will work with Soyo to get to the bottom of the situation.

## MSI 645 Ultra (BIOS revision 1.4)

After experiencing so much trouble with PC2700, we began to wonder if this issue was typical to the SiS645 platform. MSI's 645 Ultra answered this question with a resounding "no." As long as the CAS latency was set to 2.5, MSI's 645 behaved very well. All other settings (RAS to CAS, Precharge etc.) can not be configured, but we were able to set "timings settings mode" to "Turbo." In other words, the RAM timings were quite a bit more aggressive, and it was no surprise that MSI's SiS645 board performed quite a bit better than Soyo's.

The fact that MSI has placed the ATX12V connector close to the CPU, while the main ATX connector was close to the DIMM slots, strengthened our suspicion that the awkwardly placed connectors on Soyo's board might be the culprits for the many PC2700 problems.



MSI's 645 was able to clock to 110 MHz (440 MHz) without any major stability issues, so long as the "CPU:DRAM" ratio was set to 3:4 instead of 3:5. The setting should have been called "FSB:DRAM," however. At "3:4," the memory is running at 133 MHz DDR, while at "3:5," the memory is running at 166 MHz if the FSB is not overclocked (4 x 100 MHz).

Contrary to other MSI offerings, which come with SmartKey, USB 2.0, and D-bracket (Diagnostic Leds + extra USB 1.1 ports), the MSI 645 comes with fewer extra features in order to keep the price down. One last positive note: MSI allows you to assign all IRQs from 3 to 15 manually, which is less important now that ISA is dead, but can still be handy for troubleshooting purposes.

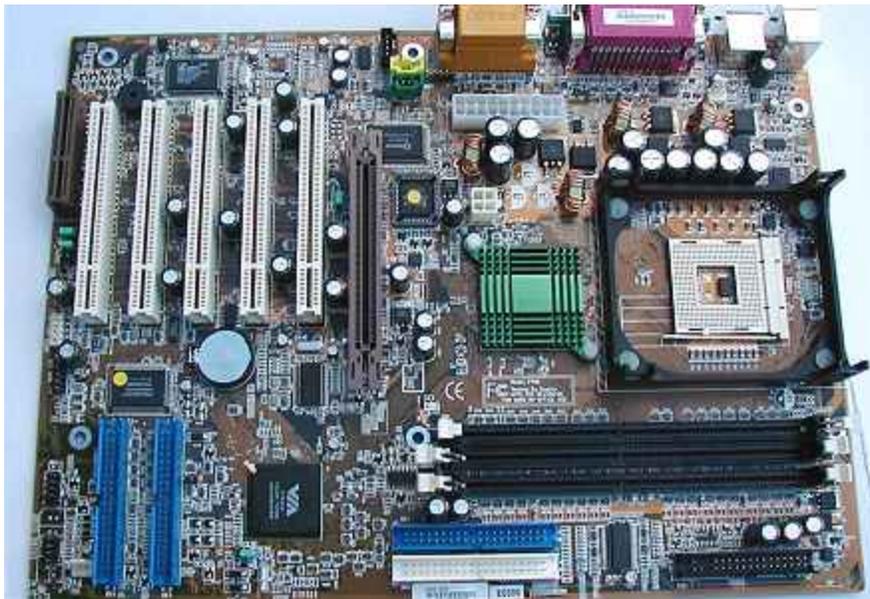
## VIA P4X266

The P4X266 is the archenemy of Intel's i845-SDRAM chipset: quite a bit faster and cheaper. The P4X266 was no success, however, as many legal squabbles with Intel have prevented a number of motherboard makers from building products around VIA's P4 chipset. Please note that we have only tested boards based on the P4X266. We have yet to test the P4X266A, which is - according to the reports floating around on the web - anywhere from 1 to 3 percent faster than the P4X266. Here in Europe, I have yet to see a P4X266A-based motherboard.

## VIA P4XB-R

Last year, on October 15th, VIA announced a new division: VPSD. VPSD stands for *VIA Platform Solutions Division*, which should ensure that VIA can sell the P4X266 chipset. VIA does not produce the motherboards themselves, however, but instead markets the boards under this brand.

The VIA P4XB-R includes a C-Media CMI8738 audio driver, a Promise IDE RAID chip and a separate 2 port USB module. The layout is, contrary to many boards described in this article, good. It is possible to add or remove DIMMs without removing the AGP card and the AGP card is being held in its position by a rather innovative system.



The all-important memory timings can be configured, core voltages and memory voltages can be specified, and the FSB can be overclocked. Yes, VIA's first attempt at the motherboard market is well designed. The board comes - contrary to Tyan's offering - with an ATX-12V connector, and this clearly improves stability and overclocking possibilities. The board ran stable with a 110 MHz FSB. Performance is decent, but slower than the Intel i845 champion, the ASUS P4B266.

VIA's claim that the board supports up to 3 GB of DDR SDRAM is interesting, but perhaps not all that realistic for the time being. 1 GB DDR SDRAM modules are very rare and expensive, and there are reports that even 3 x 512 MB might be a bit too much for the memory controller. We could not verify this, but we can report that the stability at overclocked speeds was much lower when three DIMMs were used. Again, the problems came to light while rendering in 3D Studio Max: at overclocked speeds, the system would almost always hang after 20 to 30 minutes. This also happened occasionally, though less often, with a 2 x 256 MB configuration.

Nevertheless, VIA's P4XB-R is a high quality board for the desktop: with 512 MB of RAM (2 x 256), it delivered good performance, decent overclocking possibilities, and reasonable stability.

## Tyan Trinity 510 (S2266) (BIOS Revision 1.04)

With the Trinity 510, Tyan aims at the budget Pentium 4 PC. This board sells for less than \$90, and therefore, it is no surprise that you get no gadgets or integrated sound. Even a 12V connector is not available, though Tyan compensates by accompanying its two-phase voltage regulation with large 3300 MF capacitors. Many KT266, P4X266, and KT266A tend to lock up sporadically during intensive rendering, but the Trinity is one of the few VIA-based boards that could run our stability mix of professional applications without any trouble.

However, this rock stable configuration can only be achieved if you follow the rules. First of all, if we tried to set the memory setting manually instead of using the default "memory timing by SPD," but the system became unstable, even if we used only 2 x 256 MB and more conservative settings than advised by the SPD.



What's most remarkable about Tyan's board is that it comes with 4 DIMM slots, allowing up to 2 GB of DDR. Contrary to many other manuals for i845 DDR and VIA P4X266 boards, Tyan is, however, honest about the configuration requirements for these 4 DIMMS:

[http://www.tyan.com/support/html/pc2100\\_tr\\_510.html](http://www.tyan.com/support/html/pc2100_tr_510.html)

Due to the chipset loading characteristics, all motherboard vendors can only make three PC2100 DIMMs to work using the VIA P4X266. Due to Tyan's commitment to high quality and performance standards Tyan has been able to push this limitation to 4 sticks of PC2100 DDR memory. To this date Tyan has SPECIFIC qualifications that must be met in order for this configuration to be stable. Please follow the memory compatibility guidelines at [www.tyan.com](http://www.tyan.com) when running 4 sticks of PC2100. **Please note that when running 4 sticks of PC2100 the BIOS will automatically adjust speed to PC1600.** User may manually adjust the speed back to PC2100 but stability will be an issue unless customer follows memory compatibility list. An alternative option is to run 4 sticks of PC1600 DDR memory, which is completely supported by Tyan.

### Pentium 4 Platform Shootout: DDR SDRAM Versus Direct RDRAM

Tyan has always specialized in server and workstation hardware, and as such, overclocking options are a low priority. The board allows you to set the FSB, but no voltage adjustment is possible. As a result, the board overclocks pretty poorly, and we could not achieve decent stability beyond 107 MHz.

This might not be your hardcore tweaker's desktop system, but the Tyan Trinity 510 might make a decent low-end (FreeBSD/Linux) webserver. Intel's Northwood, with its large 512 KB cache, should do fine in these kind of applications and Tyan's board is - in practice - the only DDR board that allows 2 GB of DDR SDRAM. As Brian clearly pointed out in his webserver article (URL on page x), the amount of memory of a webserver influences the performance and capacity of the webserver more than pure number-crunching power. Therefore, the fact that Tyan's board is one of the slower P4 DDR boards on the market might not be so important to somebody in search of low-end webserver.

## Intel i845D

As you know the Pentium 4 is quite a bandwidth hungry beast. Therefore, Intel's i845D chipset has incorporated many improvements which the i850 chipset did not have to compensate for the fact that PC2100 can not deliver enough bandwidth to the superb 3.2 GB/s FSB.

Intel's i845D can keep 24 memory pages open, while the i850 supports only 8. Also, the in-order depth queue has been increased from the 850's 8 to 12 on the i845D to more efficiently manage read requests. These enhancements are made possible because Intel's i845D is being produced on a 0.18 process, while - as far as we know - Intel's i850 is still being produced on a 0.25-micron process.

The i845D can only support 2 double-sided DDR SDRAM DIMMs, however, which limits the maximum amount of memory to 2 GB. As the i845D does not support registered modules, it is questionable that it will even be able to support 2 x 1 GB modules.

We'll investigate these matters in the next article.

## ASUS P4B266 (BIOS Revision 1.05)

The ASUS P4B266 lives up to the reputation of ASUS: feature rich, an extremely stable overclocker, and pricey. The board comes on-board (CMEDIA) 6-channel sound, a 4-port USB 2.0 module, 6 PCI slots, an extra 2-port USB 1.1 bracket, and an S/PDIF card. We already discussed this board in our Northwood review (URL on page x), and it became clear then that this is one of the highest-performance DDR SDRAM motherboards available.

The ASUS P4B266 is also an overclocking champion. With both our Northwood (2 GHz - Locked) and Pentium 4 Willamette (2 GHz - Unlocked), we were able to run stable at 20 x 118 MHz. Once we lowered the multiplier of our Willamette and used the jumpers instead of the BIOS settings (Jumper-free mode), the board ran rock stable at 133 MHz FSB, with the Corsair 2700XMS clocked at 177 MHz, CAS 2.5. No DDR SDRAM Pentium 4 board could rival this overclockability.

## **Lucky Star P4A845D (BIOS Revision 1.01)**

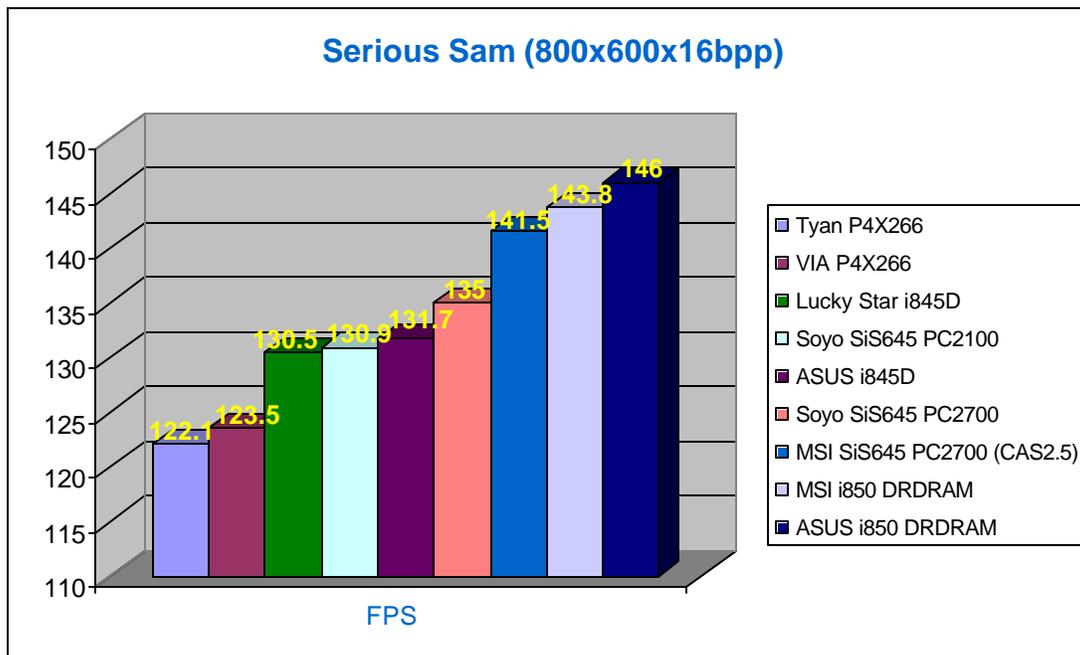
Of course not everybody wants to pay a price premium for superb overclockability and the latest gadgets. Lucky Star's P4A845D comes with a very clean layout. The DIMM slots come with big handy clips and are located far enough away from the AGP slot. A huge heatsink without any fan (point of failure) keeps the i845D Northbridge cool.



Lucky Star seems to have followed Intel's guidelines closely: only two DIMM slots are available and the board behaves well in all circumstances. Performance was only slightly worse than the ASUS P4B266. Lucky Star's support, however, should be improved: the website contains many dead links and the Driver CD contained many old drivers.

## Benchmarks

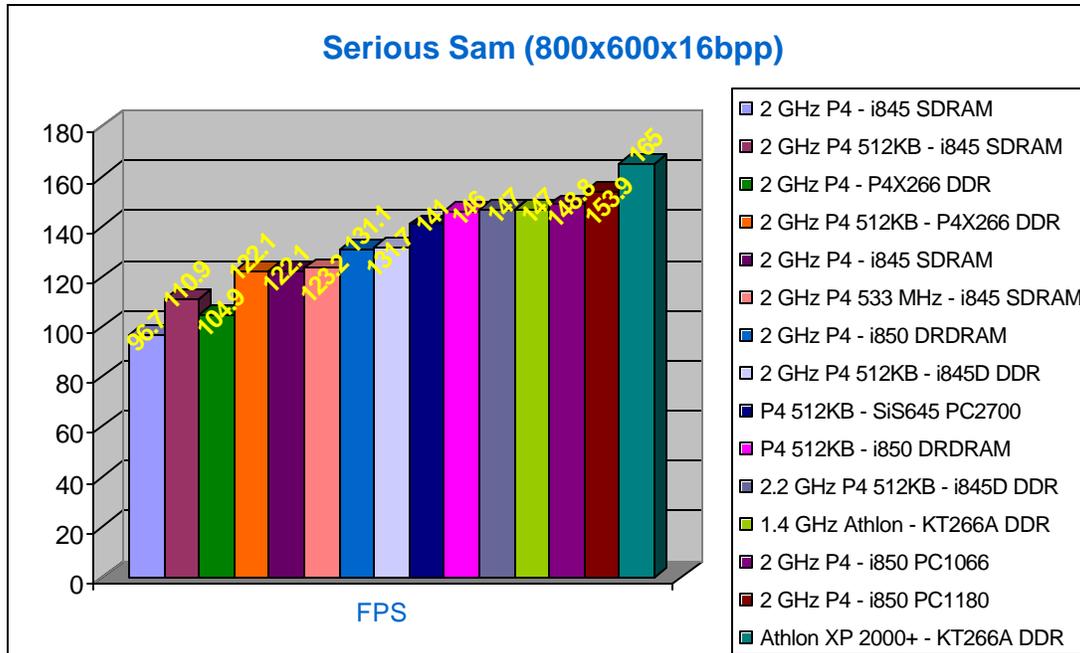
All boards were tested with a Pentium 4A 2.0 GHz (Northwood). Serious Sam auto-detects the CPU speed and the type of video card, and applies various preset settings based upon its findings to ensure the game runs fast and still looks reasonably well on almost every recent PC. So, we used the special BeyondNormal.INI file that Anthony "Reverend" Tan wrote. This "Normal quality" configuration is actually based on what the game uses for its "Normal" setting. Anisotropic filtering is not used in this test and texture compression is enabled. We tested at 800x600x16 with the built-in demo "Dunes" which displays a very open desert area.



At stock speed, the SiS645 performs only 3% slower than the i850 chipset. As the boards based on the SiS645 are cheaper, SiS definitely has the best price/performance ratio here. The VIA P4X266 is up to 6% slower than the best Intel i845D board.

However, this conclusion only makes sense if you are not planning on doing any overclocking. Considering that both ASUS boards run absolutely rock stable at 533 MHz FSB, most of our readers will make use of this superb potential. How do RDRAM and DDR fare when coupled with a 533 MHz FSB? We decided to find out, but unfortunately, our 2 GHz Northwood was locked and refused to run at more than 120 MHz FSB (2.4 GHz). So, we resorted to our unlocked Willamette 2 GHz to get some extra data. It is very interesting to see how this 533 MHz FSB Willamette compares to the Northwood at 400 MHz FSB, considering the cache differences.

One last note: Our ASUS P4B266 board was the only i845 board that could overclock to a 533 MHz FSB. However, when we clocked the FSB to 133 MHz QDR, the DDR SDRAM modules were still clocked at 133 MHz DDR. So the i845D still uses PC2100 DDR SDRAM at 533 MHz.

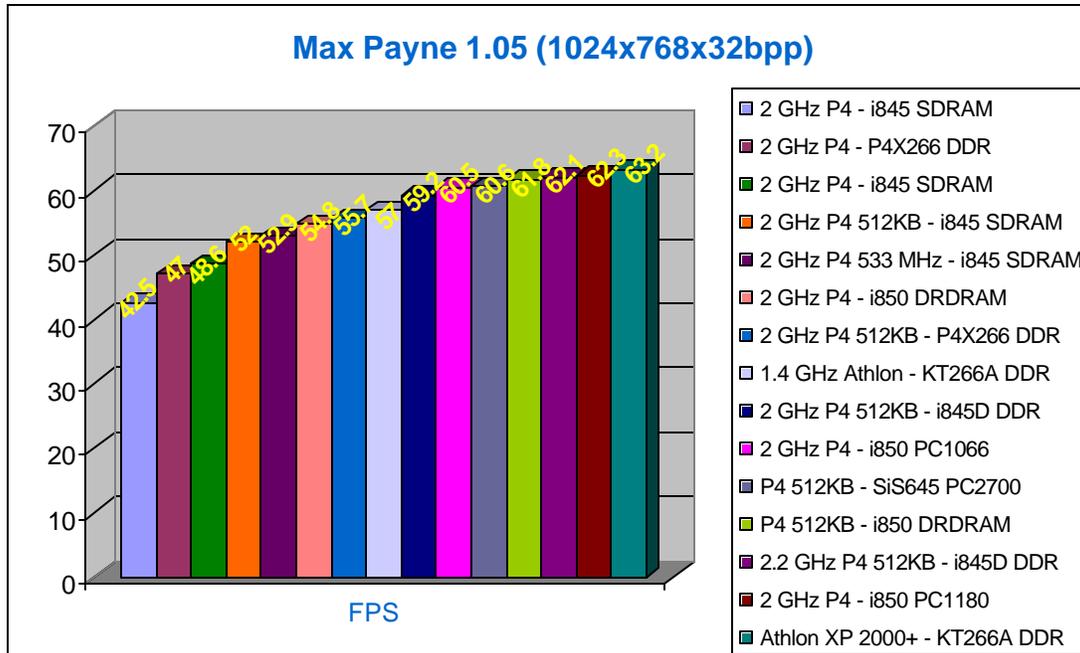


The Athlon sweeps the floor (35% faster!!) with the 400 MHz FSB and DDR SDRAM-equipped Pentium 4 Willamette. But once the latter gets a 533 MHz FSB and PC1066 RDRAM, the performance is pretty amazing! The turbo-charged PC1066 RDRAM Pentium 4 Willamette beats the Northwood 2.2 GHz with DDR SDRAM. This is even more surprising if you consider that the latter has 256 KB more cache and a 200 MHz higher clockspeed!

## Max Payne

Is Serious Sam nothing but a weird exception? We were very curious if Max Payne 1.05 would confirm our findings. To benchmark Max Payne, the PCGH CPU Demo was used. You can download this benchmarking mod from the URL below. I set the resolution to 1024x768x32bpp and every slider was set to maximum, with trilinear filtering and 16 bit textures enabled. As you know, Max Payne is one of the most CPU intensive games out there.

[http://www.3dcenter.de/artikel/maxpayne\\_benchmarking/index2\\_e.php3](http://www.3dcenter.de/artikel/maxpayne_benchmarking/index2_e.php3)



When we first benchmarked Serious Sam, we repeated the benchmarks at least 5 times to be sure. The Max Payne benchmark, however, confirmed that PC1066 is really fast: watch the PC1066 RDRAM charged Willamette fly again! Beating two Northwood systems with DDR and equaling the PC2700 system, it underlines the importance of a fast memory subsystem once again.

The benchmark graphs contains tons of info, let us try to summarize some of that info. Let us see how much performance is gained by upgrading a 2 GHz P4 Willamette SDRAM system.

Compared to P4 2 GHz + SDRAM	Serious Sam	Max Payne
512 KB Cache instead of 256 KB (Northwood upgrade)	+15%	+22%
PC2100 DDR instead of SDRAM (RAM upgrade)	+8%	+14%
PC2100 DDR + 512 KB cache (RAM + Northwood)	+36%	+39%
533 MHz FSB + PC1066 RDRAM (RAM + chipset upgrade)	+54%	+42.5% (!)

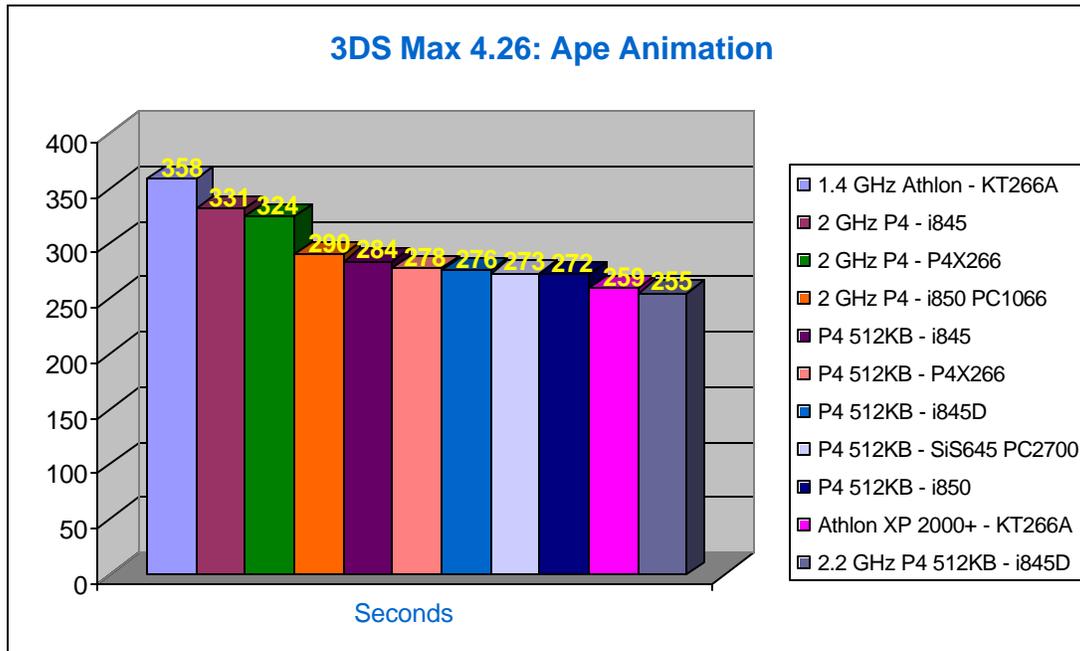
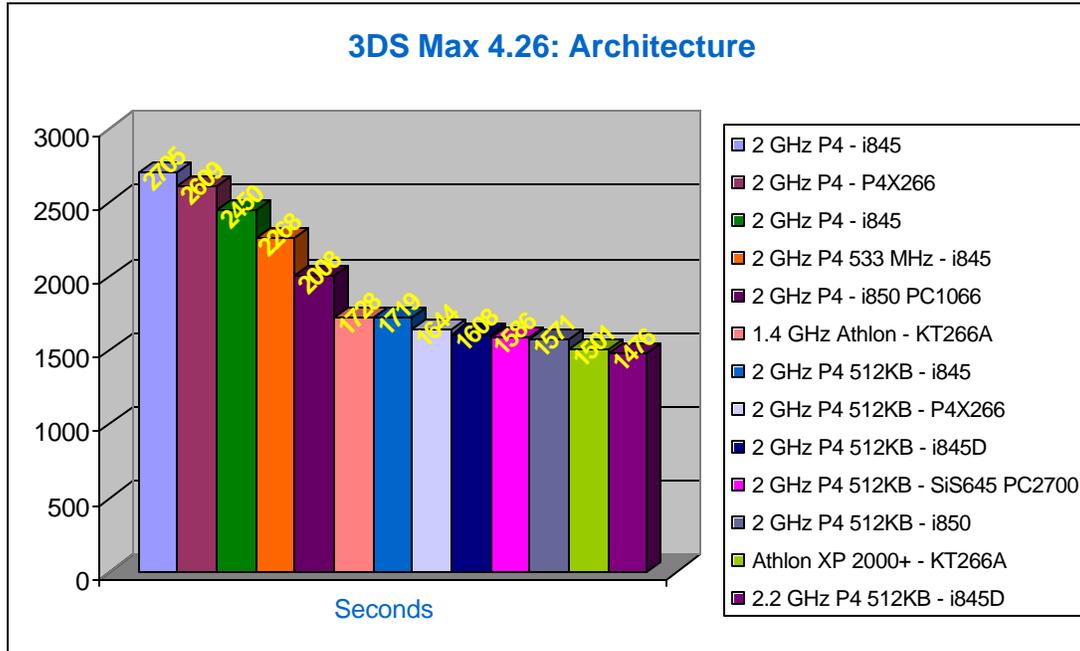
To be honest, before benchmarking, I would never have guessed that a PC1066 + chipset upgrade would make a bigger difference than upgrading to a Northwood and DDR SDRAM. Also interesting, but less surprising, is the fact that the Northwood can lower the impact of the memory system thanks to its larger cache. PC800 RDRAM is 8% (Serious Sam) to 12% (Max Payne) faster than the i845/Willamette system, but Northwood lowers that advantage to 3-5%. That is only a temporary reprieve, as the recent reports at Tom's Hardware indicate that as clock speeds get higher, the memory subsystem gets more and more important.

To understand this, consider the following: a 2 GHz Northwood can - compared to the Willamette - lower the number of cache misses from 7% to 4%, courtesy of the 512 KB cache. That makes the memory subsystem less important. Now let us look at the Northwood at 3 GHz with the same memory subsystem. Cache misses still happen 4% of the time, but filling the cache takes 50% longer as the CPU is now 50% faster and the memory subsystem is still running at the same speed (for example i845D chipset with PC2100). As the CPU has to wait longer for the requested data, the effect of the larger cache is negated.

### 3D Rendering

As usual, we used the Architecture scene and Ape animation for our rendering benchmarks. You can read more details about these benchmarks at the link below. 3DSMax rendering is incredibly CPU intensive, so at first sight, 3DSMax should be relatively immune to the memory subsystem.

<http://www.aceshardware.com/read.jsp?id=45000283>



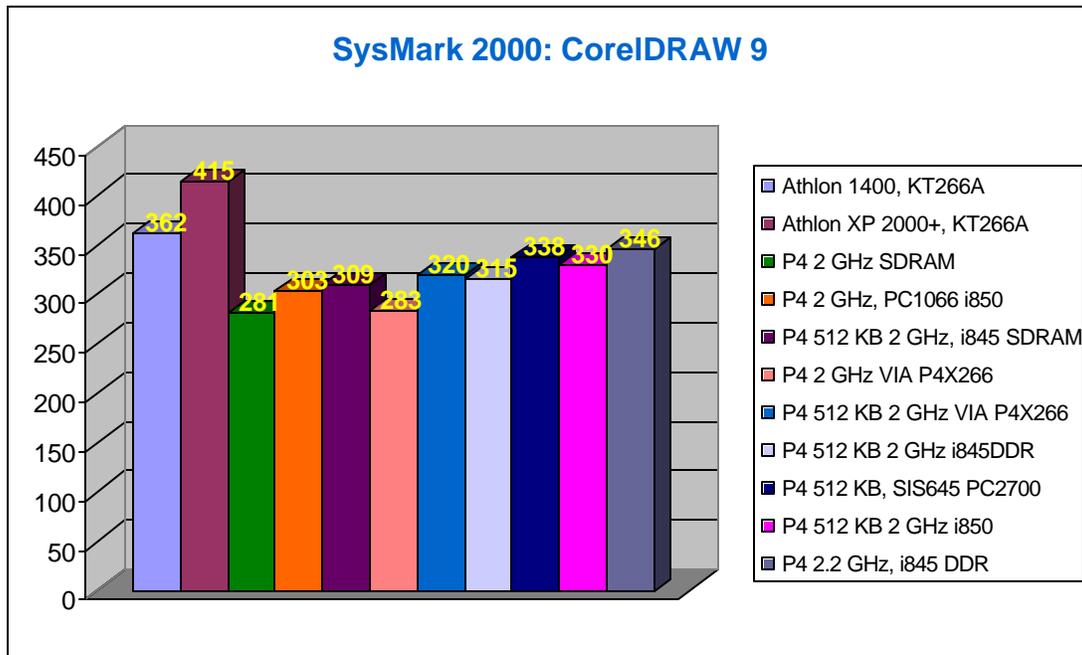
**Pentium 4 Platform Shootout: DDR SDRAM Versus Direct RDRAM**

The highest-clocked systems are the best performers and 3DS Max benefits more from a large cache than from a fast memory system. Still, the PC1066 equipped Pentium 4 Willamette comes very close to the Northwood equipped with SDRAM. The i850 chipset is once again and despite its age, the fastest chipset.

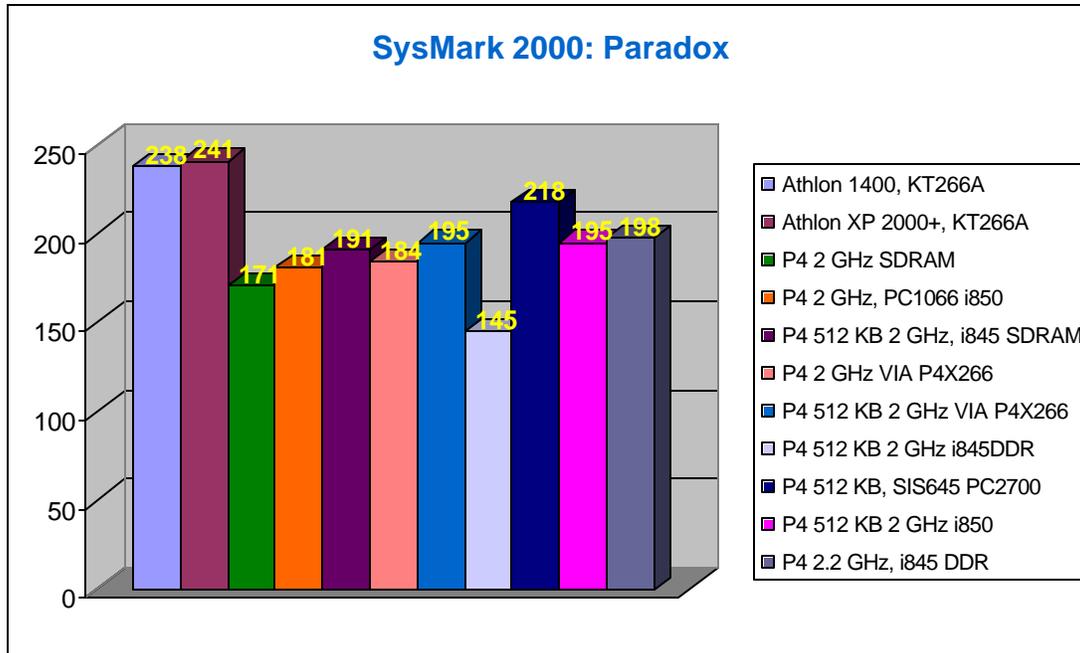
Notice that the architecture scene with its 600k polygons depends much more on the memory subsystem. The PC1066 interface is 25 to 30 percent faster than the DDR SDRAM chipsets and 35% faster than the i845 SDRAM systems.

**SysMark 2000**

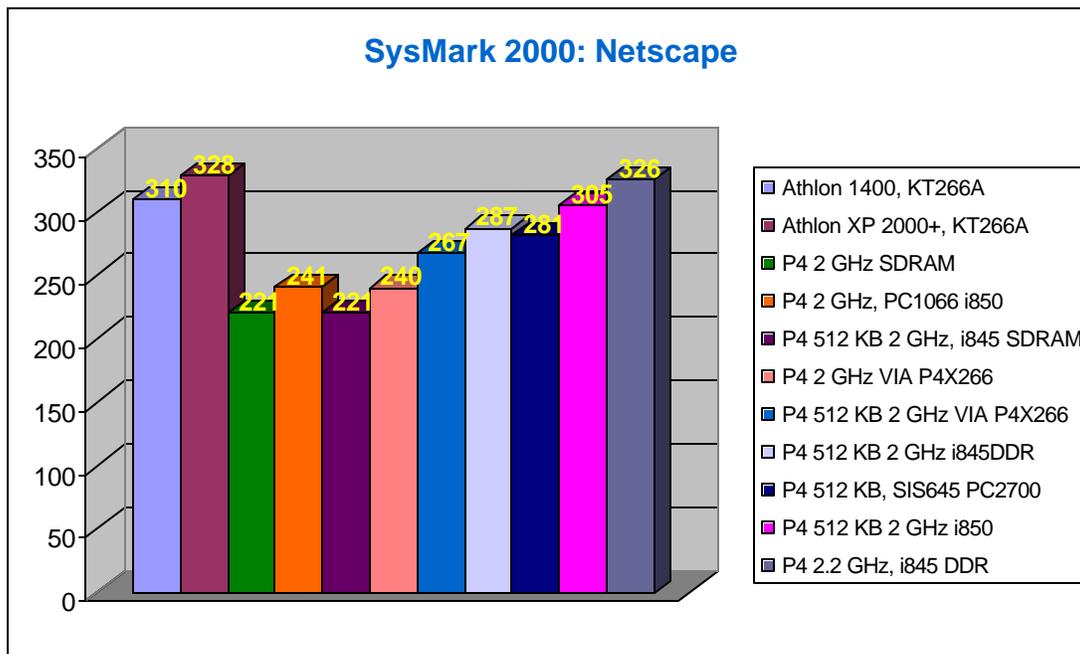
To get more insight in other workstation applications, we tested with SysMark 2000. It is a somewhat older benchmark, but it is one of the few benchmarks to provide individual scores for each application.



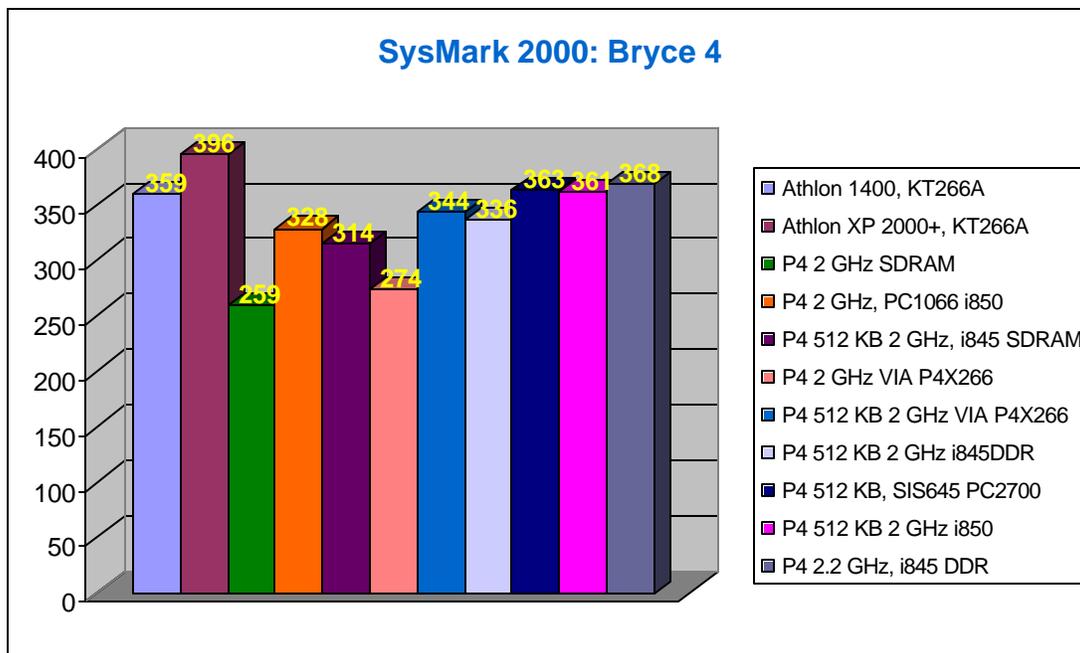
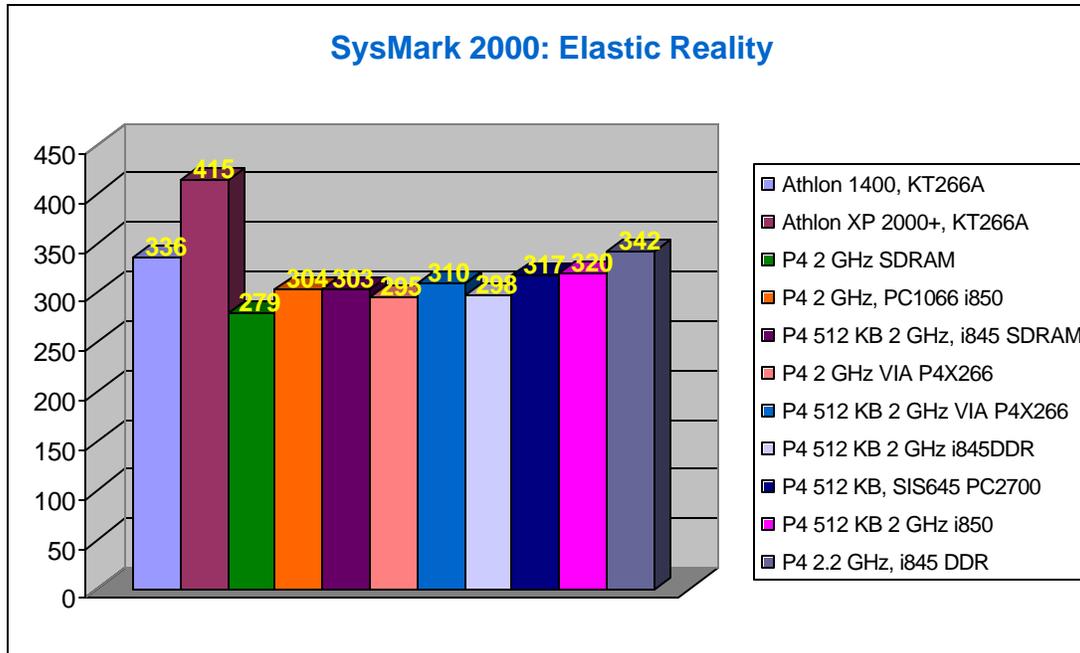
CoreIDRAW longs for a sturdy FPU and low latency memory. This is the first benchmark where the SIS645 can beat the i850 chipset.



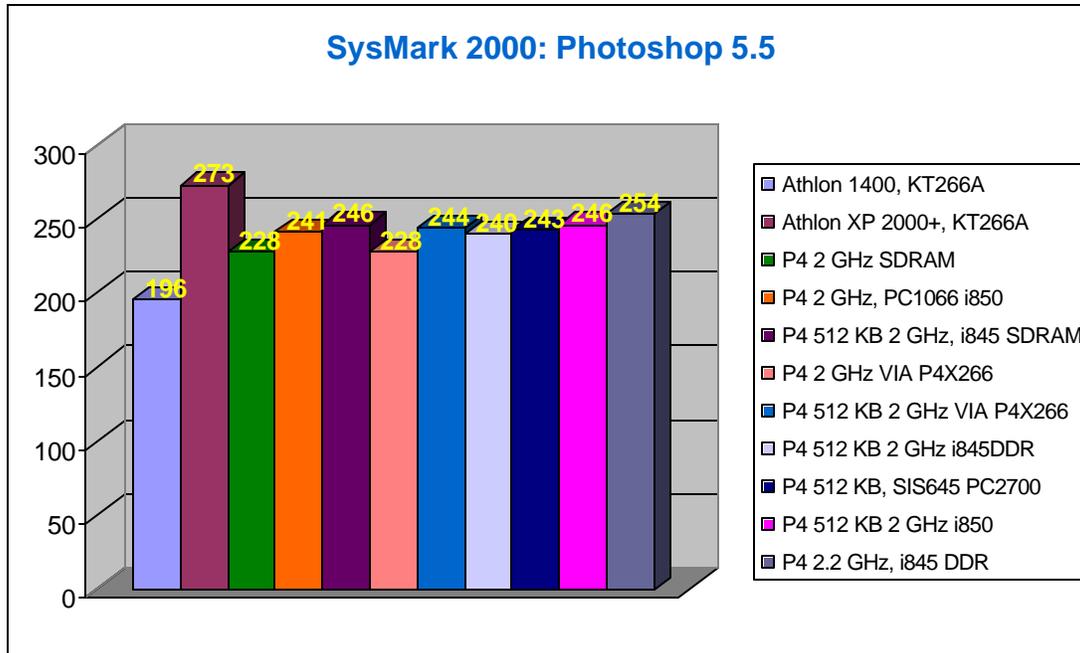
Paradox, an end-user relational database, is very sensitive to the latency of the memory subsystem. Database systems are clearly not fond of DRDRAM's higher (pointer chasing) latency.



The Athlon XP 2000+ still ranks at the top of the heap here, but only by two points as the 2.2 GHz Pentium 4 has a strong showing on the i845D DDR SDRAM platform. While the Northwood on the SiS645 outperformed the 2.2 GHz i845D platform in Paradox and came very close to it in CoreIDRAW, it doesn't do so well here, as it falls behind the i845D and i850 systems.

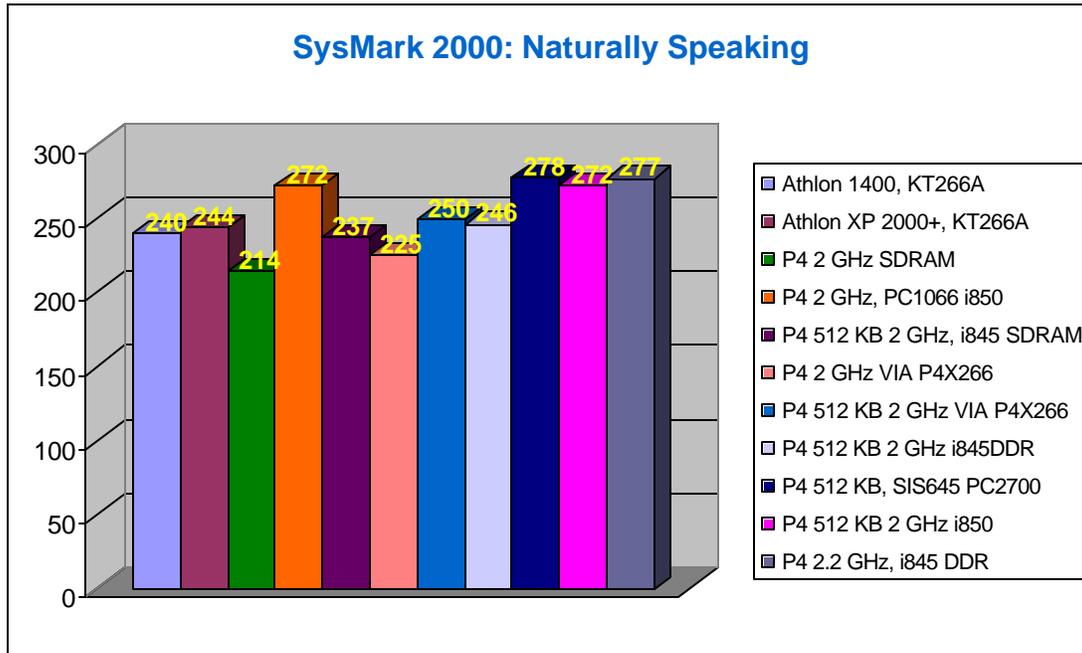


Here we have Elastic Reality and Bryce 4, two professional graphics applications (one a 3D modeler and the other a landscape renderer), and as you can clearly see, SDRAM and the Pentium 4 do not mix very well. The Athlons and the Northwoods again rank near the top. The DRDRAM-based i850 Northwood system is slightly faster than the SiS645 PC2700 DDR SDRAM solution in Elastic Reality, though that tiny margin of victory trades places in Bryce 4, with the i850 trailing by a tiny amount. In both cases, the 2.2 GHz i845 system remains above both, while trailing behind the top Athlon.

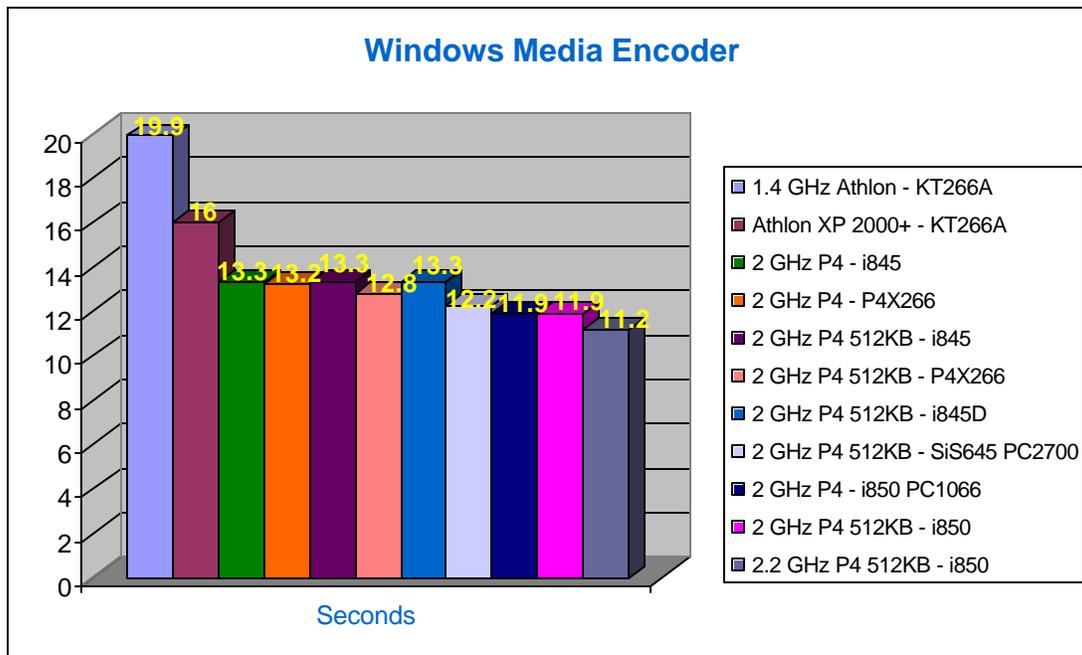


Wrapping up our round of office benchmarks, we have Photoshop. As you can see here, the 1.4 GHz Athlon makes a very poor showing compared to its previous performance in other benchmarks. The Athlon XP 2000+ leads and all the Pentium 4 systems are grouped closely together. The DRDRAM-based Northwood system edges out the SiS645 again, but it cannot beat the 2.2 GHz Pentium 4.

# Streaming Applications



For the next benchmark, we used Windows Media Encoder 7.1 to encode a 24 MB AVI file to a streaming 1 MB WM8 video with a bitrate of 242 kbps. Due to the fact that we use Windows 2000, we were limited to WME 7.1. The Athlon should perform better with WME 8.0, which is available for Windows XP.



The PC1066 system does very well, and beats every DDR-based Northwood. Not really surprising of course, as streaming video is pretty bandwidth intensive.

## Conclusion

When the Athlon XP was released, the Pentium 4 Willamette cut a rather foolish figure and was beaten in almost every benchmark. This humiliation wouldn't have taken place if the Willamette had access to a PC1066 DRDRAM platform. Our benchmarks strongly point out that the Pentium 4 performs competitively in modern game engines and many workstation applications when paired with this technology. Apart from databases and 2D graphics, the performance of the turbo-charged PC1066 Willamette is extremely good.

Our loyal readers might not be surprised as our PC1066 review already pointed this out. However, back then, we tested with a 1.6 GHz Willamette. The higher the clock speed, the more the DRDRAM solution lives up to its promise. However, once paired with the larger cache of Northwood, the DDR chipsets are not outperformed by a great margin. The SiS645, with its support for PC2700 can even beat the i850 chipset in a few benchmarks.

However, the DDR SDRAM technology is clearly reaching its signal integrity limits. Consider this:

- Intel only supports 4 banks of PC2100 memory or maximum 1 GB to ensure the best stability (signal integrity!).
- With two DIMMs, the SiS645 chipsets can run the best DDR SDRAM on the market only with a CAS latency of 2.5
- With three DIMMs, the SiS645 boards have to throttle back to PC2100. See: <http://usa.asus.com/mb/socket478/p4s333/specification.htm>
- With four DIMMs, the VIA's P4X266 has to throttle back to PC1600 for stability reasons (VIA chipsets natively only supports 6 physical banks of memory)
- Many of the DDR boards experienced stability problems when we tried to run with three DIMMs.
- PC2100 clearly lacks bandwidth when it must feed 2.6 to 3 GHz Pentium 4s and it becomes clear that DDR-I is not the best choice for an intensive workstation that needs huge amounts of memory. It is very doubtful that any current chipset is able to drive more than 1.5 GB of PC2100 memory, let alone PC2700.

So while PC2100/2700 is a good choice for the average desktop, it is clear that DDR doesn't cut it for the power user, especially if this power user prefers a highly clocked Northwood processor. Registered (buffered) DDR is a solution for the workstation user who needs a lot of RAM, but it is not really a high-performance solution (higher latencies, bandwidth limited to 2.1 GB/s).

So what is the solution? DDR-400? DDR-II? Can we expect a comeback by RDRAM (PC1066, RIMM4200) or dual-channel DDR SDRAM? We have only scratched the surface. To explain the benchmarks that we have seen today, and to understand what the challenges that future memory technology must face, we must go in-depth. In the next article we will discuss the technical pros and cons of all these solutions. Stay tuned...

## **Related Articles**

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**Socket A Shootout**

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<http://www.aceshardware.com/read.jsp?id=45000280>

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