# Camino Continues Chip Set Evolution

## *PCs Based on Intel's 820 Will Be Fastest Yet—But Also Late and Expensive*

*by Peter N. Glaskowsky*

Intel's 820 was slow to arrive, and systems will be slow to ship, but the chip set itself is fast. The 820 is the first Intel chip set to support both a 4× AGP interface and a 133-MHz front-side bus that matches the bus speed of new 600-MHz ($615) and 533-MHz ($369) Katmai Pentium III processors.

Despite prerelease concerns over the performance of its Direct RDRAM memory, preliminary testing shows the 820 is considerably faster than its predecessor, the 440BX (see MPR 4/20/98, p. 18). With all these improvements, the 820 will be found at the heart of next year's fastest mainstream PCs.

The 820's performance improvements come at a substantial cost, however, and Direct RDRAM is to blame. It will be more than a year before RDRAM can match the price-per-bit of today's PC100 SDRAM. PC makers are notorious penny pinchers. With 128M of RDRAM costing about $200 more than the same amount of PC100 SDRAM, OEMs are sure to position 820-based systems at the top of their product lines, where prices are high but sales volumes are low.

The price and performance differences between Intel's new 810E (see sidebar) and the 820 create a hole in Intel's chip-set family and a problem for OEMs. Major system makers, including Dell and HP, will fill this gap by keeping 440BX-based systems in production through much of 2000. Others will adopt third-party chip sets, such as Via's Apollo Pro133, (see MPR 6/1/98, p. 6) with slightly lower performance but a much lower system price.

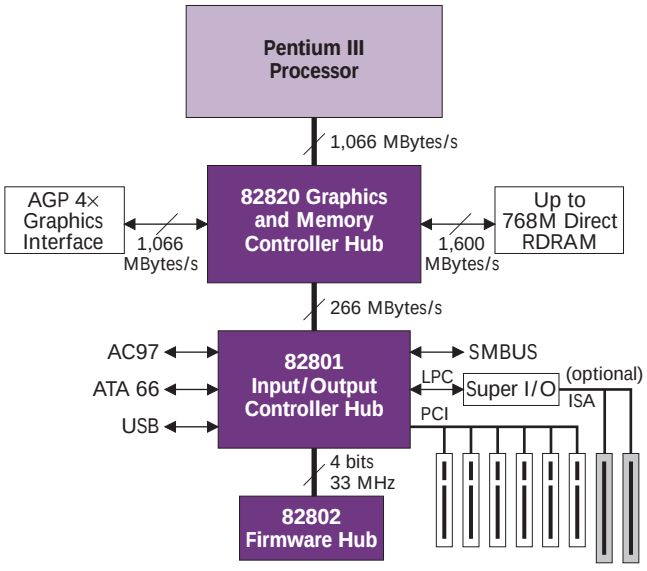


**Figure 1.** Intel's 820 chip set supports Direct RDRAM memory, a 4× AGP interface, and the same peripherals used in the 810.

Intel said that last-minute problems with the Direct RDRAM electrical interface delayed the 820 announcement. OEM testing of initial-production systems revealed memory-reliability issues on systems with three RIMM slots. These issues will delay shipments until they can be resolved. We now expect the 820 announcement, and system shipments, later in 4Q99. Some makers may offer systems with two-RIMM motherboards, but this implementation cuts maximum memory size to 512M until higher-capacity RIMMs arrive in mid-2000.

### New Set Shares 810's Hub-Based Hierarchy

As Figure 1 shows, the 820 shares its architecture—and two of its three chips—with its low-end siblings, the 810 (see MPR 5/10/99, p. 17) and 810E. The 820's memory controller hub (MCH) builds on the 800-series architecture with several new features. Direct RDRAM replaces the PC100 SDRAM, found on the 810 and earlier chip sets. Where the 810 has an integrated graphics controller, the 820 has a 4× AGP port. Though the 820 is midway between the 440BX and the 810E in complexity, we expect it to be more expensive than either.

The 820 is the only chip set in the 800 family to support dual processors. The 82820DP version of the MCH, which adds to the cost of the chip set, provides the necessary signals to control a second Pentium III. Though few desktop PCs use dual processors, this feature is important for low-end PC workstation makers. Without it, the 820 could not supplant the 440BX at these OEMs.

### Direct RDRAM Triples Memory Bandwidth

The PC100 SDRAM found on previous PCs has a peak bandwidth of 800 MBytes/s, but due to protocol overhead its sustained bandwidth is only about 500 MBytes/s. The 820 uses one channel of Direct RDRAM memory with up to 1.5 Gbytes/s of sustained throughput.

Less obvious are improvements to the 820's memory controller. Intel has done extensive work in simulating and modeling the memory-access patterns of popular PC applications. This work has been used to improve the efficiency of each successive generation of chip sets. The 820's buffering and prefetching logic is highly refined, giving the new chip set a substantial advantage over the 440BX even before the effects of Direct RDRAM are considered.

Though Direct RDRAM offers no significant latency reduction compared with SDRAM, processor memory read requests are completed sooner (on average) by the 820 using Direct RDRAM than by the 440BX using PC100 SDRAM. The difference varies according to the application but ranges from a few percent on SPECfp95 to as much as 35% for a

### Pricing and Availability

Intel has not yet announced the 820 chip set, and pricing is not yet available. MDR expects the 820, and 820-based systems, to ship by the end of the year. More information will be available on Intel's Web site at *developer.intel.com/design/chipsets*.

data-streaming benchmark. The 820's lower latency, combined with the greater bandwidth of Direct RDRAM, gives the 820 platform its superior performance.

This performance advantage depends on the use of the fastest available (400 MHz) Direct RDRAM, but DRAM makers are seeing low yields for this speed grade. Slower Direct RDRAM speed grades (300 and 350 MHz) will be widely available and more affordable. At these lower speeds, latency is higher, bandwidth is lower, and much of the potential performance edge of the 820 platform is lost.

## SDRAM Translator Cuts Cost, Performance

Intel's optional 82805AA memory translator hub (MTH) offers another way to lower the performance of the 820. The MTH performs an electrical translation between a Direct RDRAM channel and a PC100 SDRAM array up to 1G in size. The 820's MCH includes a complete SDRAM memory controller that communicates with the MTH over the RDRAM channel. This communication precludes the use of RDRAMs on the same channel. If the SIMM slots are used, there must be no RIMMs installed—and vice versa.

Use of the under-$5 MTH cuts memory speed below that of the 440BX and eliminates most of the performance benefit from the 820's 4× AGP interface. We advise OEMs to ignore the MTH option and use a 440BX or third-party chip set in systems that must use SDRAM for cost reasons.

## Finally, 4× AGP

Version 2.0 of the AGP specification defines a 4× speed for transfers between the graphics chip and main memory, as well as an optional fast-write mode for CPU-to-graphics writes at the same 1-GByte/s speed. The new speed is a pin-compatible upgrade, so the same board can work in a 2× or a 4× slot. Some PC graphics-card makers have been shipping 4× AGP-compatible products since June, but no systems have been available to take advantage of the new speed.

The 820 platform finally gives these vendors a chance to strut their stuff. Since the AGP interface is rarely a bottleneck, 4× AGP doesn't make much of a difference in application-level performance, but its marketing value is substantial. Intel points to a few applications that can overload a 2× AGP interface, but these programs appear to be designed to ignore local texture storage on graphics cards. Most 3D software developers take advantage of local storage where possible, reducing the effect of AGP speed.

### 810E Extends 810 to 133 MHz

Intel has announced the 810E chip set, essentially an 810 chip set that supports Pentium III's faster 133-MHz front-side bus. Like the 810 (see MPR 5/10/99, p. 17), the 810E uses PC100 main memory, though it can use PC133 SDRAM in the 3D display cache.

(This marks Intel's first official support for PC133 memory. Intel recently said that it plans to support PC133 main memory in a chip set to be released in 1H00.)

The 810E, like the 810, uses a unified memory architecture (UMA). In the 810, UMA reduces system performance by 3% to 6%—the equivalent of one to two CPU speed grades. In the 810E, the performance penalty should be even higher. Pentium III's front-side bus runs at twice the speed of Celeron's, yet the 810E has the same main-memory bandwidth as the 810, just 800 MBytes/s—and some of this bandwidth is used by the graphics core. As a result, the 810E will be slower than the 440BX on many applications.

Intel expects the 810E to outsell the 820—and we agree—but this popularity will owe more to the high cost of Direct RDRAM memory than to any technical merit of the 810E design. The 810E chip set is priced at $39.50, several dollars less than the 440BX, which remains in production.

## Peripheral Interfaces Match Those of the 810

The 820 has the same I/O controller and firmware hub used in the 810 family. These provide an ATA-66 disk controller, manageability features (such as remote wakeup), support for six PCI slots, and an integrated hardware random-number generator. Like the 810, the 820 provides an integrated audio controller with an AC-97 audio-codec interface. This controller cuts about $5 off the cost of a system.

The 810 and 820 lack direct support for ISA-bus peripherals, instead of using a low-pin-count (LPC) bus interface to communicate with a third-party super-I/O chip. Though super-I/O chips with LPC–ISA bridges are available, Intel hopes that most 820 systems will be built without ISA slots—and we agree.

## Performance Provides Proof of the Pudding

Preliminary testing shows that the 820's performance is not dramatically better than that of its competition, but it appears sufficient to establish the 820 as the fastest PC platform on the market. The 820 also provides headroom for future faster processors and more-demanding applications. Combined with Coppermine-based Pentium III processors, which we expect to debut at speeds of 733 MHz or greater, the unmatched throughput of the 820 should keep Intel competitive at the top end of the PC market—if only for a few well-heeled buyers. M