X-ray Vision: RDRAM vs. DDR

It has all the trappings of a great heavyweight boxing match: evenly matched foes with different skills, an ongoing war of words, and the backing of powerful promoters. In the tussle between the RDRAM and DDR computer memory technologies, though, you won't see any boxing gloves or crooked judges. The preference of computer users will determine the eventual winner of these competing memory technologies as the industry standard.

In geek speak, the RDRAM vs. DDR competition might go down as one of the greatest digital fights of all time, right along with Garry Kasparov vs. Deep Blue, Windows vs. Macintosh, and Lara Croft (animated version) vs. Lara Croft (Angelina Jolie version). All that's missing is the "let's get ready to rumble" guy.

The Key Players

You'll need a scorecard to get all the necessary information about the key players in this competition.

SDRAM. Synchronous dynamic RAM is the current industry standard. However, its architectural and speed limitations will eventually push other memory technologies to the forefront.

DDR. Double-data-rate memory is a direct descendant of SDRAM. DDR, introduced in 1999, can move memory twice as fast as SDRAM by moving 2 bits of data per clock cycle. DDR is short for DDR SDRAM.

RDRAM. Rambus dynamic RAM provides a different memory architecture than SDRAM. RDRAM uses a narrower bus, but its architecture includes separate control and address buses, which help it move data at a faster clock cycle than SDRAM architecture. RDRAM, introduced in 1997, can also move data at 2 bits per clock cycle.

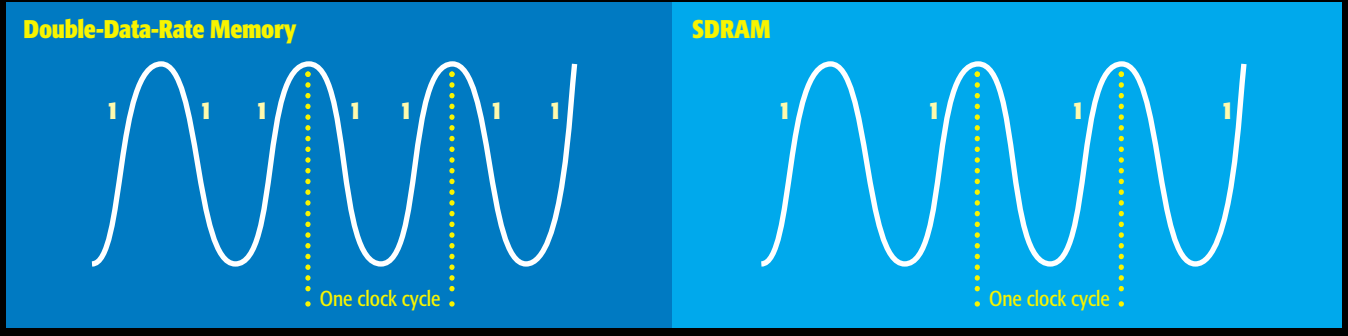
The bus. The size and width of the data bus connecting the memory with the microprocessor architecture determines the amount of data the memory can move per second. DDR and RDRAM each require their own proprietary bus architectures.

Rambus. This Los Altos, Calif., company developed RDRAM and other forms of memory. Rambus demands exacting manufacturing requirements to create the RDRAM architecture, as well as high royalty payments, which has sparked fears of high prices for RDRAM. Manufacturers can use DDR technology royalty free.

Intel. This microprocessor giant initially threw its full support behind Rambus and RDRAM, deciding to make Pentium 4 architectures using

Introducing Double-Data-Rate

Double-data-rate memory can move data twice as fast as traditional memory because it moves one bit of data on the rising and the falling edges of each clock cycle. Traditional SDRAM can only move one bit of data on the rising edge of each clock cycle. Using double-data-rate technology, a memory module with a clock speed of 133MHz gains an effective clock speed of 266MHz. Both DDR-SDRAM (usually shortened to DDR) and RDRAM are forms of double-data-rate memory.



only RDRAM. However, Intel later announced support for DDR and SDRAM in its Pentium 4 architecture because of worries over high costs and limited availability of RDRAM.

AMD. AMD has created its Athlon processors to work with DDR and SDRAM, rather than RDRAM . . . as if AMD and Intel need something else to disagree about.

Controversy, Clock Speed & Benchmarks

Rambus and Intel began cooperating around 1997 on RDRAM; others in the industry accused Intel of trying to monopolize memory and microprocessors. Rambus further ruffled industry feathers by causing several controversies—and costly lawsuits—over patents for memory technology. Claiming it owned patents to SDRAM technology, Rambus sued several SDRAM and DDR memory manufacturers a few years ago, seeking steep royalty payments. However, judges have dismissed a few of Rambus' suits, leading to several PR disasters for Rambus. During a time when memory prices are in the toilet, the high legal fees among memory manufacturers have made Rambus less popular in the industry than a Metallica appearance at a Napster rally.

Because RDRAM can currently offer significantly faster clock speeds than DDR, it potentially can come closer to keeping pace with the continually growing clock speeds available in microprocessors. RDRAM has one major problem: DDR currently appears faster from a sheer statistical standpoint. DDR architecture makes use of a 64-bit bus for moving data, which gives it an advantage over RDRAM's current 16-bit bus. It's this narrow bus architecture, though, that lets RDRAM achieve the higher clock speeds.

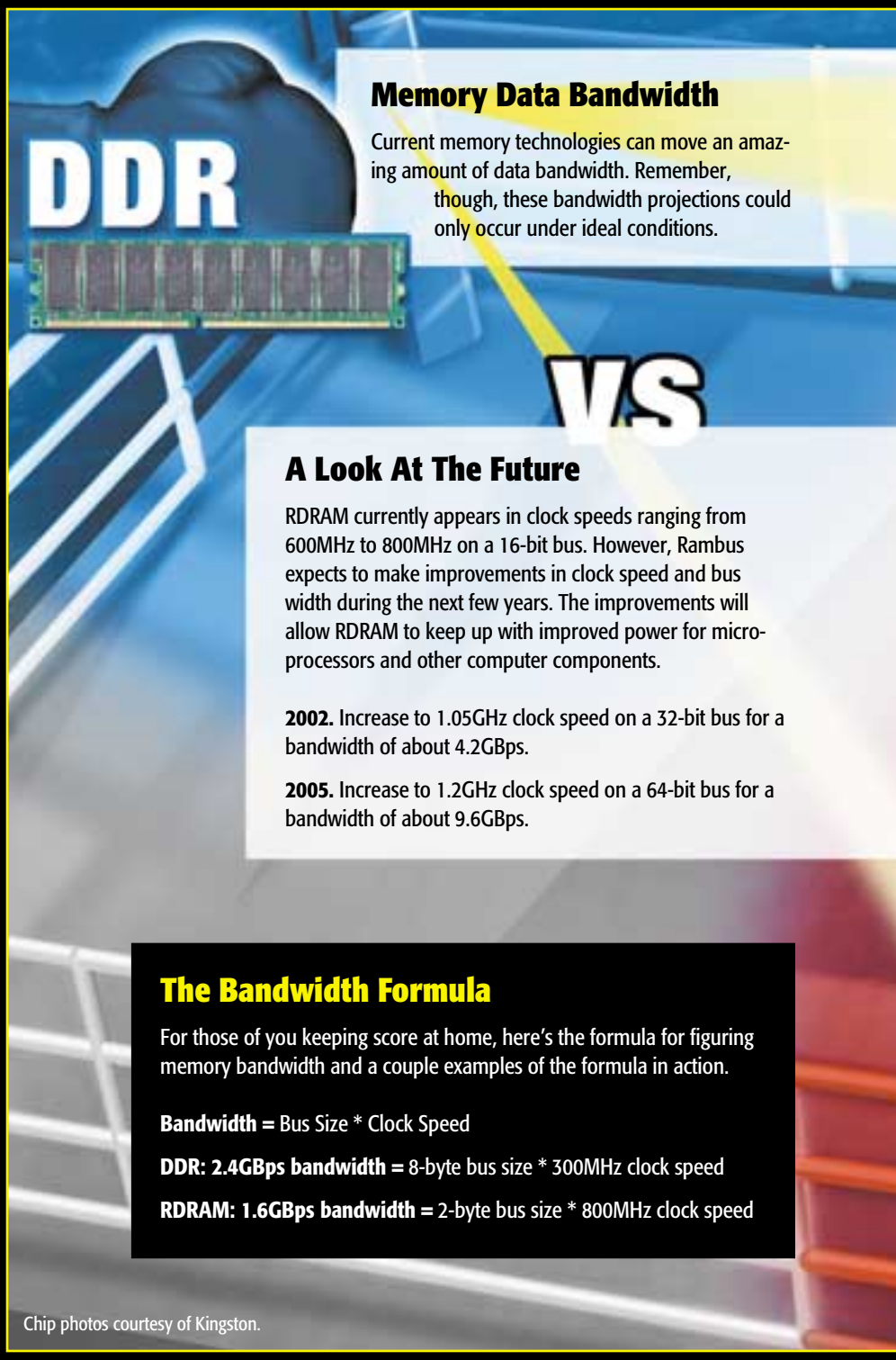
RDRAM proponents say DDR's real-world performance comes nowhere near meeting its lofty statistical standards. Use of a wider bus means DDR must move memory in larger

Tale Of The Tape

Here's a breakdown of some of DDR and RDRAM's vital stats.

	DDR	RDRAM
Bus Size	64-bit	16-bit*
Top Bus Speed	300MHz	800MHz
Top Bandwidth	2.6GBps	1.6GBps

*Rambus has announced plans for 32-bit and 64-bit buses in the future.



Memory Data Bandwidth

Current memory technologies can move an amazing amount of data bandwidth. Remember, though, these bandwidth projections could only occur under ideal conditions.

A Look At The Future

RDRAM currently appears in clock speeds ranging from 600MHz to 800MHz on a 16-bit bus. However, Rambus expects to make improvements in clock speed and bus width during the next few years. The improvements will allow RDRAM to keep up with improved power for microprocessors and other computer components.

2002. Increase to 1.05GHz clock speed on a 32-bit bus for a bandwidth of about 4.2GBps.

2005. Increase to 1.2GHz clock speed on a 64-bit bus for a bandwidth of about 9.6GBps.

The Bandwidth Formula

For those of you keeping score at home, here's the formula for figuring memory bandwidth and a couple examples of the formula in action.

Bandwidth = Bus Size * Clock Speed

DDR: 2.4GBps bandwidth = 8-byte bus size * 300MHz clock speed

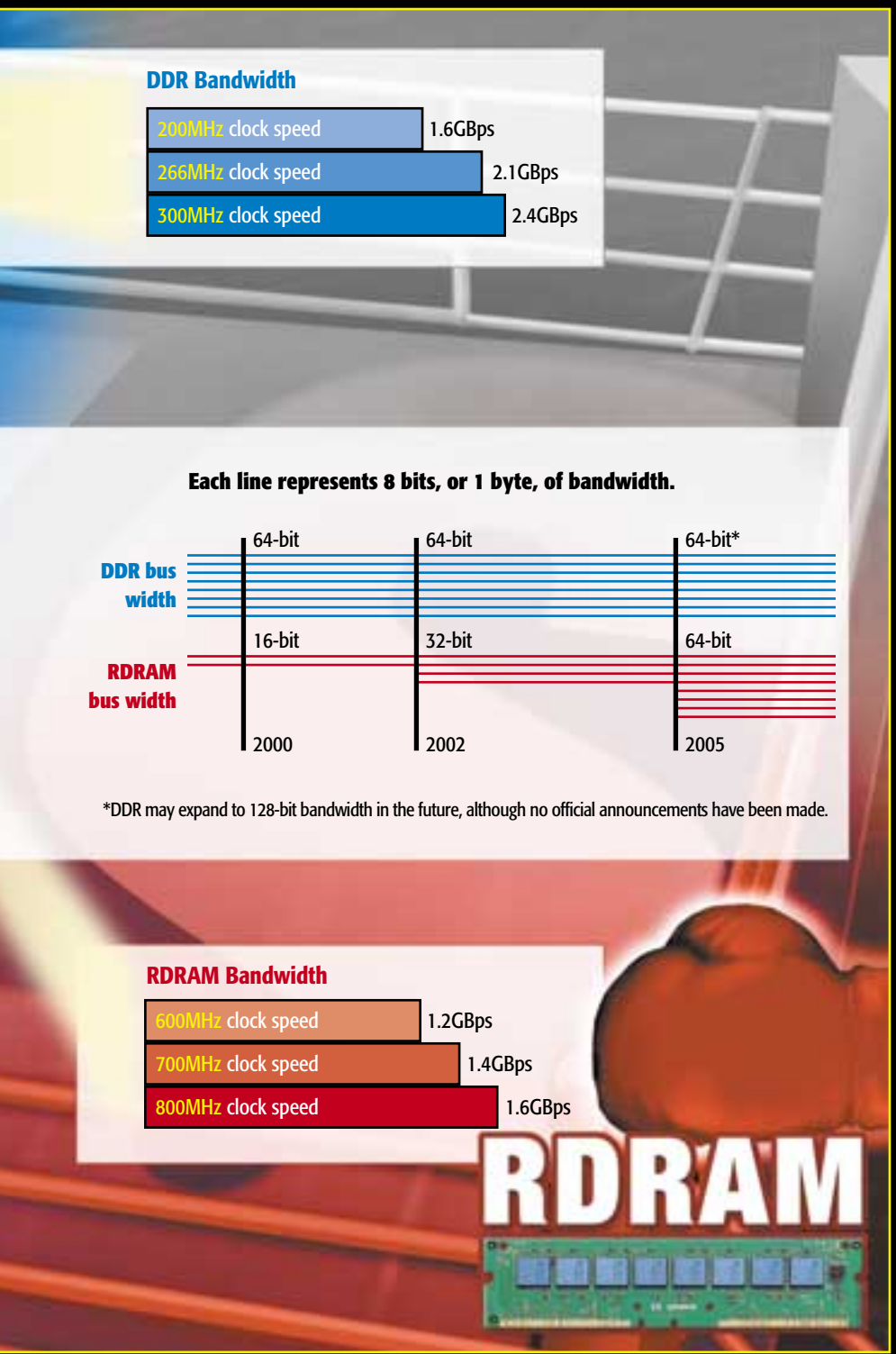
RDRAM: 1.6GBps bandwidth = 2-byte bus size * 800MHz clock speed

Chip photos courtesy of Kingston.

chunks to fill the bus completely. Small chunks of data don't use the full capacity of the bus. DDR proponents point to RDRAM's high price and shaky benchmark results for CAS latency measurements as good reasons for jumping to DDR.

Benchmark measurements for the new memory technologies are confusing at best. They seem to indicate that a host of factors, such as the overall computer architecture and the type of software in use, go a long way toward determining whether a particular type of memory reaches its maximum potential bandwidth. Most experts agree that RDRAM's benefits might not be readily apparent unless you're running high-end multimedia software, for example.

Keep in mind that a maximum potential bandwidth for memory is just that, a potential. Conditions must be perfect for memory chips to reach their full potential.



Graphics & Design: Carrie Benes & Jason Codr

In Search Of The Sweet Spot

At this time, it appears neither RDRAM nor DDR will disappear any time soon, which is good news for consumers. It may take a few rounds of future technological improvements before a winner emerges from this fight. Rambus is planning to increase its bus width and overall clock speed in the next few years, while DDR proponents are working on a new memory spec, called DDR 2, that will provide improved clock speeds and a potentially wider bus.

While RDRAM probably delivered the first hit in the memory battle, thanks to having microprocessor powerhouse Intel in its corner, DDR has shown resiliency. DDR (and DDR 2) have enough promise that Intel is hedging its bets by splitting its allegiances and offering support for both memory types. Gaining support from Intel was a big step forward for DDR manufacturers.

Bottom line: Consumer preferences will eventually decide this battle. If RDRAM lives up to its high-speed promises, allowing it to work more in tandem with microprocessors for superior performance, users will probably be willing to pay a premium for it. However, if DDR's evolution lets it keep pace with RDRAM in performance, its lower price and greater availability will leave it standing alone in the end.

As with almost any computing component, finding the sweet spot in the price and performance combination will help one of these memory types deliver a KO punch. CPU

by Kyle Schurman