SERIAL ATA INTERFACE ON CLIENT SYSTEMS

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An association of leading PC technology companies developed the Serial Advanced Technology Attachment (ATA) storage interface for hard drives and ATA Packet Interface (ATAPI) devices. Beginning this year, the industry is transitioning from the legacy parallel ATA interface to Serial ATA. Dell recently launched Serial ATA-ready Dell™ OptiPlex™, Dimension™, and Dell Precision™ Workstation systems and plans to complete the transition on these client systems in 2004.

Serial ATA is the foundation of a new storage interface replacement architecture that is as cost-effective as parallel ATA and has greater performance improvement potential. Compared to parallel ATA, Serial ATA has lower signaling voltages and pin counts, is faster and more robust, and uses a thinner and longer cable. Serial ATA 1.0 is also software compatible with parallel ATA.

In this white paper, we discuss the new technology and Dell's transition plans for client systems. We begin with a brief review of the current parallel ATA interface technology and describe its strengths and weaknesses. The paper then describes the Serial ATA interface and discusses upcoming enhancements. We conclude with the transition plans for Dell client systems.

Overview of the ATA Interface

Introduced in the 1980s, the parallel ATA (also known as IDE) interface became the dominant PC storage interface protocol for desktop and portable computers. Parallel ATA's relative simplicity, high performance, and low cost enabled it to meet and maintain the cost/performance ratio that is essential in the mainstream desktop and portable computer systems market.

Parallel ATA's longevity can be attributed to frequent improvements in the interface's speed and overall performance. For example, ATA's data transfer speed increased steadily from an initial rate of less than 3 megabytes per second (MB/sec) to its current maximum burst data transfer rate of up to 133 MB/sec. In addition, evolutionary improvements helped the interface to keep up with overall internal system data rate requirements.

Evolutionary Improvements

Despite a number of limitations, constant evolutionary improvements in the ATA interface enabled it to remain competitive with other storage interface technologies. These improvements included:

- Enhanced Integrated Drive Electronics (EIDE) extensions for faster hard-drive access and logical block addressing (LBA)
- ATAPI for support of other peripheral devices, such as CD-ROM, DVD-ROM, CD-RW, and DVD+RW drives
- Multiple data-transfer modes, including Programmed Input/Output (PIO), direct memory access (DMA), and Ultra DMA (UDMA)
- Backward compatibility with older ATA devices
- Cyclic redundancy checking (CRC) for improved data protection and greater overall data integrity

Limitations of the Parallel ATA Interface

In spite of its success, the parallel ATA interface has a long history of design issues. Most of these issues were successfully worked around, overcome, or simply ignored. They include:

- 5-volt signaling requirement and high pin count (40-pin cable connectors)
- 18-inch cable length limitation; cable width and cable routing problems
- Data integrity issues

5-Volt Signaling Requirement

Parallel ATA's 5-volt signaling requirement has been increasingly difficult to meet as the chip core voltages have declined. Parallel ATA has 26, 5-volt signals per ATA channel, requiring the use of large physical chip pads to accommodate the high pin count. As chip sizes have declined, the large pads will ultimately dominate the chip. Smaller silicon geometries also require lower voltages, making the 5V parallel ATA requirement more difficult to support.

Cable Issues

The 18-inch cable length limitation can be a serious issue with the current parallel ATA interface. Depending on PC chassis size and the design and location of internal media bays, the limited cable length complicates peripheral expansion choices, making some internal drive configurations impossible to implement.

The wide, flat ribbon cables of the parallel ATA bus are difficult to route, and their shape and bulk can restrict air flow and create hot spots inside the chassis. This is especially problematic with today's increasing processor and graphics subsystem power requirements.

Data Integrity

Data integrity has been a long-standing issue with parallel ATA. No form of data checking was designed into the parallel ATA interface during its early development. However, when the first UDMA mode was introduced, a degree of data protection was added in the form of CRC, which enabled the verification of interface data for the first time. Unfortunately, ATA command data is still not checked and remains a potential error source.

The Serial ATA Solution

Serial ATA eliminates the limitations of the current parallel ATA interface. Because the initial Serial ATA architecture changes the physical interface layer only, it maintains register and software compatibility with parallel ATA. No device driver changes are necessary and the Serial ATA architecture is transparent to the BIOS and the operating system. (See "Future Evolution" for a discussion of extensions to the base Serial ATA 1.0 specification that provide advanced features that may require device driver support.)

Strengths of Serial ATA

Serial ATA offers a number of improvements over parallel ATA, including:

- Reductions in voltage and pin count
- Smaller, easier-to-route cables; elimination of the cable-length limitation
- Improved data integrity

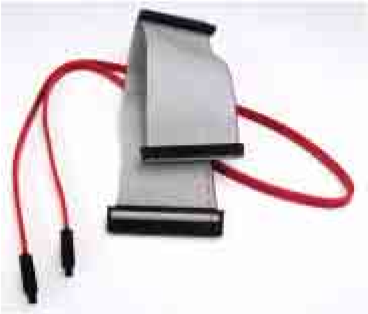
Voltage Reduction

Serial ATA's low voltage requirement—500 millivolts (mV) peak-to-peak—will effectively alleviate the increasingly difficult-to-accommodate 5-volt signaling requirement that hampers the current parallel ATA interface.

Cabling

The Serial ATA architecture replaces the wide parallel ATA ribbon cable with a thin, flexible serial cable that can be up to 1 meter in length. This increased length enables more flexible placement of storage devices in the chassis. The cable's smaller size makes it easier to route inside the chassis. Air flow is improved and smaller PC system designs are possible.

Figure 1 compares the parallel ATA ribbon cable to the Serial ATA cable.



Source: Seagate Technology LLC

Figure 1. Comparison of Serial ATA and Parallel ATA Cables

The lower pin count of the smaller Serial ATA connector replaces the large and cumbersome 40-pin connectors required by parallel ATA.

Improved Data Integrity

Serial ATA offers more thorough error checking and correcting capabilities than parallel ATA. The end-to-end integrity of both transferred commands and data can be guaranteed across the serial bus.

Current Serial ATA Solutions

The current standard is Serial ATA 1.0, which was released in August 2001. It specifies communications between the host and the Serial ATA drive. It also defines a maximum transfer rate of 1.5 gigabits per second (Gb/sec) or 150 MB/sec, a modest increase over the current parallel ATA top transfer rate of 133 MB/sec.

Current hard drives on the market conform to the 1.0 standard.

Because the industry has just begun its conversion to Serial ATA, most initial hard drives are bridge solutions. They are ATA hard drives with a Serial ATA conversion chip. Native Serial ATA drives are expected to become more common by the end of 2003 and early 2004. Higher volumes of native Serial ATA drives are expected to enable cost parity with parallel ATA drives.

Intel introduced chip set support for Serial ATA in the new I/O Controller Hub 5 (ICH5), which supports two Serial ATA devices. The ICH5 is included in the new Intel® 875P and 865G/865PE/865P chip sets.

Future Evolution

Work has begun on a follow-up standard, Serial ATA II[1], which specifies extensions to Serial ATA 1.0. These extensions include a higher data transfer rate of 3 Gb/sec (or 300 MB/sec). Follow-on specifications are expected to define transfer rates up to 6 Gb/sec (or 600 MB/sec). There are also extensions under way that specify features such as command queuing that are mainly aimed at enterprise storage applications. These extensions are designed to address storage environments requiring configuration simplicity or optimal cost/capacity.

Like ATA, a serial version of parallel SCSI technology is also under development. Serial-Attached SCSI (SAS) is designed for storage environments that require high performance, scalability, and reliability. In addition, SAS systems will support both SAS and Serial ATA drives.

A key goal of the Serial ATA II working group is to maintain Serial ATA drives as low-cost hard drives similar to parallel ATA today. For this reason, none of the extensions will change the Serial ATA 1.0 specification or require changes to a Serial ATA 1.0 hard drive.

Serial ATA on Dell Client Systems

Initially, Dell is launching mid- and high-end OptiPlex, Precision, and Dimension systems that are "Serial ATA-ready." These systems can be ordered with either IDE or 120-GB Serial ATA drives. A two-drive Serial ATA RAID 0 or RAID 1 solution is also available on high-end Dimension and Precision Workstation systems. All future OptiPlex, Dimension, and Precision systems will be Serial ATA-ready.

As native Serial ATA drives become more widely available and chip set support expands, Dell will eventually replace legacy parallel ATA drives altogether. Dell plans to begin migrating Dell notebook computers, as well as desktop optical drives (such as DVD drives), to Serial ATA in 2004.

Conclusion

Over the coming year, Dell will help customers migrate their client systems from legacy parallel ATA to Serial ATA drives. Dell's Serial ATA-ready systems are "futured-proofed." They can be ordered with Serial ATA drives or they can be ordered with IDE drives and easily upgraded later.

Serial ATA will enable future client system performance increases that are required to keep pace with other system enhancements. The transition will also ease implementation, power consumption, and design issues for computer systems companies such as Dell.

For More Information

- Serial ATA Working Group: **www.serialata.org**

1. Serial ATA 1.0 was developed by the Serial ATA Working Group. When the specification was published, the group included Dell, Intel, Maxtor, Seagate, and APT Technologies. This working group disbanded after publishing the specification. A follow-up industry group, the Serial ATA II Working Group, was formed to develop the extensions to the 1.0 specification. For legal reasons, these extensions could not be named Serial ATA 2.0. Instead, they are referred to as Serial ATA II. Membership of the Serial ATA II Working Group is essentially the same group of companies, which includes Dell, Intel, Maxtor, Seagate, and Vitesse (which acquired APT Technologies).