# Serial ATA Interface for Mobile Hard Disk Drives

Fujitsu is a worldwide leader in the development and production of mobile storage solutions, with over 35 years of experience in the hard disk drive (HDD) industry. The first manufacturer to market single 2.5" Serial ATA-based HDDs, Fujitsu has been a pioneer in promoting Serial technology. The benefits of SATA are many, and the interface is expected to take a strong foothold in the industry through 2006.

Background

Parallel ATA (PATA) has been the primary internal storage interconnect for notebooks, connecting the host system to peripherals such as hard disk drives, optical drives, and removable magnetic media devices. PATA is an extension of the original Parallel ATA interface introduced in the mid-1980's.

The next-generation internal storage interconnect, Serial ATA (SATA), is designed to replace Parallel ATA technology. SATA is the proactive evolution of the ATA interface from a parallel bus to a serial bus architecture. Current Parallel ATA (PATA) supports up to 133MB/s data transfers; however, this will soon become an inhibitor for the types of data transfer required by today's applications and usage models. By moving to SATA, the problems of limited input/output (I/O) performance that occur with the Parallel ATA interface technology can be avoided. As consumers embrace new usage models such as video, audio and file sharing through high-speed connections, better performance from the hard disk drives will be required.

The SATA architecture also overcomes the electrical constraints that are increasing the difficulty of continued speed enhancements for the Parallel ATA bus. While Serial ATA was introduced at 150Mbytes/sec., future SATA speed enhancements will move to 3G, eventually transitioning to 6G, supporting up to 10 years of storage evolution based on historical trends. Although Serial ATA will not be able to directly interface with legacy Parallel ATA hardware, it is fully compliant with the ATA protocol and thus is software compatible.

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THE POSSIBILITIES ARE INFINITE
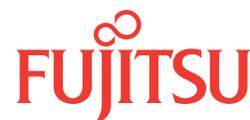
The adoption of SATA has definitely taken place in the market, with shipments of SATA having steadily increased each year since it was introduced. (See Figure 1)

There are numerous benefits to be realized by using SATA, including:

‣ Connector type
‣ Native Command Queuing
‣ Hot plugging
‣ Staggered spin-up
‣ Asynchronous notification
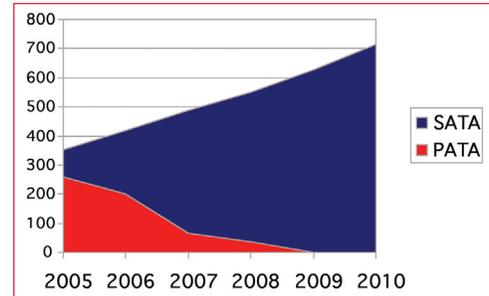‣ Interface power management
‣ Increased speeds

Figure 1: SATA unit shipment projection (All Form Factors)
Source: TrendFOCUS 2006 Annual Study

Connector Type

Improvements for the connector type for SATA have been realized in both size and performance. The 0.5" wide 7-pin data connector requires little area on the board or device, an important criteria for 2.5" hard disk drives. To illustrate the reduced board space requirement, note that in a four-drive system, Serial ATA connectors use 25% of the board space required by Parallel ATA.

In addition, with the current 40-pin (PATA) type of connector, crosstalk becomes a problem when transferring data at rates required by today's applications. Crosstalk occurs when noise from one signal being transferred corrupts other data being transferred. The new type of 7-pin SATA connector directly connects the four signal wires and three ground lines to the receiving terminal in a single row. Because the connector includes the shielding ground pins, very little crosstalk is introduced.

SATA connector

PATA connector
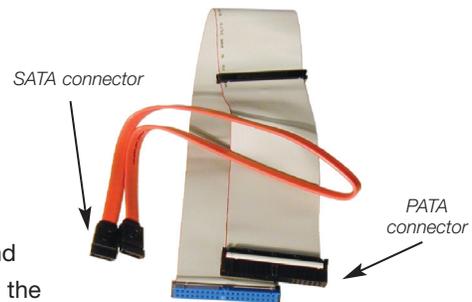
Hot Plugging

Hot plugging is the ability to connect and disconnect devices without prior notification to the system. Having this ability provides better system flexibility and ease of use. In multi-drive environments, it provides an easy way to replace, upgrade or expand storage without downtime; there is no need to power down the interface prior to replacing the device. Hot plugging is also supported by the external cables and backplane connectors.

Native Command Queuing (NCQ)

NCQ enables the device to reorder commands for more efficient data transfer, thereby improving performance and reliability, resulting in less mechanical wear and tear on the hard disk drive. The higher performance is realized when your workloads increase. NCQ involves intelligent data handling from system boot to application loading.

Staggered Spin-up

Staggered spin-up is a simple mechanism by which the storage subsystem controller can sequence hard disk drive initialization and spin-up. Having this feature not only provides greater reliability, but it allows the system to avoid power surges if all of the HDDs spin up simultaneously during system power up (in a multi-drive environment). Another benefit to having staggered spin-up is the use of more cost-effective power supplies, which prevents power supply damage and system brownouts.

Asynchronous Notification

Asynchronous notification allows the device to notify the host that it requires attention, one being a hot plug initiated in a multiple port environment. Command overhead is also eliminated, providing faster system response times and power savings. These features allow the device to remain in low power modes.

Interface Power Management

Controlled by the hardware, the interface power management system is beneficial in power sensitive applications, providing a mechanism to improve battery life and reduce heat generation. Interface power management does not require software intervention and is initiated by either the host or device.

Fujitsu has been the industry leader with regards to power management on 2.5" SATA hard disk drives. With advancements in Serial ATA power management, Fujitsu has been at the forefront in reducing power consumption and significantly improving overall battery life. With the latest generation of Fujitsu hard disk drives, Fujitsu has been able to reduce the power consumption to below 0.6W (idle) and 0.1W (standby).

Increased Speed Capability

As stated earlier in this paper, the traditional PATA interface is capable of doing 133Mbytes/sec. On the other hand, SATA interface speeds have reached 3Gb/sec., allowing for up to 300MB/s data transfer rates. The 3Gb/sec SATA enables the highest level of performance in a PC environment and facilitates bandwidth aggregation for multiple devices, enabling maximum throughput for the enterprise. In addition, 3Gb/sec SATA is 100% backward compatible with 1.5Gb/sec (the 1st generation of SATA interface speed). Reaching 3Gb/sec from the previous SATA 1.5Gb/sec requires no drivers or cable upgrades, thus helping to ensure a smooth transition from one generation to the next. Serial ATA uses a point-to-point connection topology, meaning that each source is connected to one destination. Each channel is capable of working independently so there is no contention between the HDDs, and thus no sharing of interface bandwidth.

Interface Speed Roadmap	2004	2005	2006	2009
PATA MB/s	133	133		
SATA MB/s	150	300		600

Source: The Serial ATA International Organization

Five reasons to choose Fujitsu 2.5" SATA hard disk drives

Through 2006, the mobile SATA hard disk drive market is expected to grow rapidly as major host chipsets start supporting the SATA interface. (See Fig.2) In 2004, Fujitsu was the first company to ship 2.5" SATA hard disk drives; today we are on our 3rd generation of SATA HDDs. SATA technology is simply another example of how Fujitsu has been at the forefront with the newest technologies.

▸ Top market share in 2.5" SATA in 2005
▸ Over 2 years SATA experience in mobile market
▸ SATA mobile power management expertise
▸ Highest capacity of 200GB
▸ Best-in-class power consumption
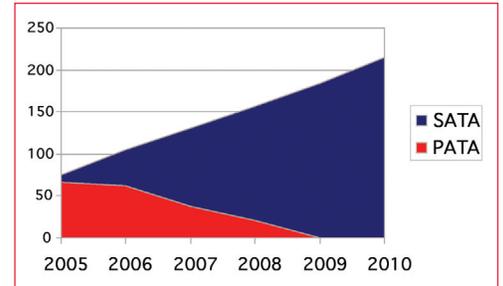
Figure 2: 2.5" Notebook SATA unit projection
Source: TrendFOCUS, 2006 Annual Study

Parallel ATA	Serial ATA	SATA Advantage
Up to 133 Mbytes/sec	Up to 150 Mbytes/sec (1.5 Gbits/sec)	Faster, and room for expansion
Tiny jumpers	No master/slave, point to point	Ease of use
Eighteen-inch cable	Up to 39-inch (1 meter) cable	Ease of integration
Two-inch-wide ribbon cable	Thin cable (1/4-inch)	Improved system airflow
80 conductor	7-wire thin cable	Eliminates data integrity problems
40 pin and socket	Blade and beam connector (snap in)	Ease of use
Two-inch-wide data connector	1/2-inch wide data connector	Ease of integration
Onboard DMA controller	First-party DMA support	Performance enhancement
Limited (legacy command queuing)	Native Command Queuing	Performance enhancement
—	Hot Swap	Ease of integration/use
CRC on data only	CRC on data, command, status	Enhanced data protection

References:
SATA-IO Materials: www.sata-io.org, TrendFOCUS

About Fujitsu Computer Products of America, Inc.

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