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Ultra320 SCSI: The Next Generation of SCSI Technology

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introduction

This paper describes the benefits of Ultra320 SCSI. For the past 20 years, SCSI technology has continuously evolved to meet the increasing demand for storage system throughput while maintaining backward compatibility with the previous generations of SCSI technology. The newest technology, Ultra320 SCSI, delivers new levels of performance by doubling the data transfer rate to 320 MB/s while enhancing the SCSI protocol to reduce command overhead and improve bus utilization.

Ultra320 SCSI also introduces new technologies for maintaining signal integrity. Transmitter pre-compensation and Active Adaptive Filtration ensure signal integrity is maintained as the bus bandwidth is increased to support data transfer rates up to 320 MB/s.

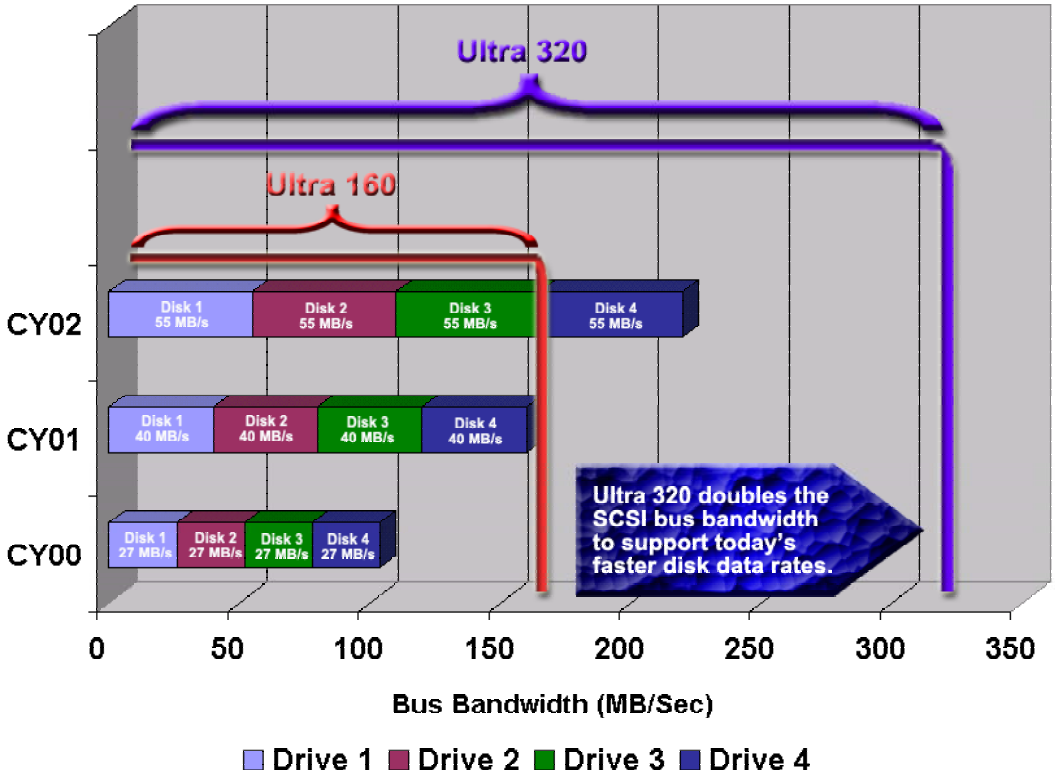
Ultra320 SCSI will improve today's data-intensive applications like high-definition video editing, transaction processing, database systems, web servers, and web caching servers. Throughput improvements are achieved while maintaining complete backward compatibility with previous generations of SCSI technology.

why Ultra320

The maximum sustained transfer rate of hard disk drives has been increasing to meet the performance requirements of new systems and applications. One of the primary benefits of the SCSI interface is its ability to support multiple devices on a single bus. By supporting more devices on the bus, RAID configurations using SCSI provide better throughput by spreading the load across multiple drives, aggregating these drives' data rates and capacities. In 2002, a typical SCSI hard drive sustained about 55 MB/s.

As shown in Figure 1, the combined bandwidth of as few as four drives exceeds the bandwidth capabilities of an Ultra160 SCSI bus.

Figure 1



As the speed at which data is transferred over the SCSI bus increases, SCSI command overhead becomes a more significant issue. This is especially true for small file data transfers seen in applications like transaction processing and database systems. With the addition of Packetization and Quick Arbitration and Select (QAS), Ultra320 significantly reduces command overhead, improving throughput in systems running these applications.

technology enhancements

Improved performance.

In shorter-block length I/O intensive applications, the bus overhead associated with transferring SCSI commands and negotiating the arbitration process becomes a significant factor limiting overall data throughput. Packetization and QAS are two technologies that reduce this overhead.

Packetization enables a SCSI device, such as a RAID controller, to send multiple packets of commands, data, and status to a target device across the SCSI bus at the full 320 MB/s bus rate. This lowers the time spent on the bus processing SCSI commands.

QAS reduces the time required for devices to arbitrate for control of the SCSI bus. Together, Packetization and QAS dramatically improve SCSI bus utilization. These technologies were initially introduced as optional features within the Ultra160 specification published by the ANSI T10 committee. However, most manufacturers chose not to implement these features in their Ultra160 devices.

The Ultra320 SCSI specification published by the T10 committee makes Packetization and QAS a requirement for all Ultra320 SCSI devices. This ensures that all devices adhering to the Ultra320 SCSI specification will implement these important new technologies.

Improved signal and data integrity.

Increasing the bandwidth from 160 MB/s to 320 MB/s requires doubling the frequency of data and clock signals. Several new technologies have been introduced with Ultra320 SCSI to ensure signal and data integrity are maintained at these higher data rates. These new technologies include a training pattern, transmitter pre-compensation, Active Adaptive Filtration (AAF), free-running clock, and Cyclic Redundancy Check (CRC).

Training pattern. A training pattern is a pre-determined data pattern that is transmitted from the sender to the receiver at a specified time. The receiver can use portions of this pattern to perform skew compensation and adjust active adaptive filters. Skew compensation aligns clock and data signals in time to ensure data is transferred correctly across all data lines.

Transmitter pre-compensation. With transmitter pre-compensation, the transmitting device boosts the signal at the beginning of a signal transition to compensate for the typical signal line loss seen during this phase of the signal transition.

Active Adaptive Filtration. With AAF, the receiving device monitors the training pattern and adjusts the amplitude of an incoming signal to match the known data pattern to compensate for signal line loss due to variances in the impedance of cables or transmission lines. These adjustments are then applied to all signals until the transmitting device sends a new training pattern.

Skew compensation, transmitter pre-compensation, and AAF have been introduced with Ultra320 SCSI to maintain signal and data integrity as the bus bandwidth is doubled

from 160 to 320 MB/s.

Free running clock. Used to improve integrity of the clock signal by removing inter-symbol interference (ISI), a free-running clock enables a pulse to interfere with the placement in time of its adjacent pulses. The ISI, the effect that a transition on a signal line has on transitions immediately before or after it on the same line, is neutralized by using a free-running clock running at constant frequency and a separate lower speed signal for qualification of data. A free-running clock is restricted for use with DT information unit transfers at 320 megabytes per second.

Cyclic Redundancy Check. CRC provides improved data protection for a parallel SSCI bus. An algorithm check byte comparison, CRC is used to determine if two check bytes match, indicating that the information is correct. This proven algorithm, used by the FDDI, Ethernet, and Fibre Channel interfaces, can detect all single-bit errors, all double-bit errors, all odd number of errors, and all burst errors up to 32-bits long. The SCSI CRC has an error rate of approximately one in 2 x 1032 for random error patterns. CRC is designed for DT transfers only and provides extra data protection for marginal cable plants, and external devices.

applications that will benefit from Ultra320

Large File Transfers and Video Systems. In a high-definition digital video editing system, video is captured to tape, transferred to hard disk, and then edited on hard disk using a computer editing application. The hard disk storage and data transfer rate requirements are dependent on the color depth and frame size of the source video.

A high definition video utilizes 1920 x 1080 pixels or 2,072,600 pixels per frame. In a case where the video is to be edited at 24 frames per second with a color depth of 4 bytes per pixel, a video editing system will be required to support a sustained data rate of 199 MB/s.

Figure 2 shows some typical high definition video formats. With Ultra320 SCSI, a single SCSI bus can now sustain the data rates necessary to support these video formats.

Figure 2

Uncompressed YUV 16-bit 4:2:2	Sustained Data Rate (MB/sec)
720p/60	221
1080i24	100
1080p/24	199
1080i/30	248
1080p/30	124

High Definition Uncompressed Video Formats

Other video applications such as video on demand, streaming media servers, advertising insertion systems for local cable television, and audio editing systems will benefit from the improved performance in large file transfers provided by Ultra320 SCSI.

Small File Transfers in Business Critical Applications. The workloads of business critical applications like transaction processing, database systems, enterprise resource planning, customer relationship management, data warehousing, and data mining usually contain a large number of read and/or write commands transferring a small number of blocks of data per command.

In these applications, bus overhead often becomes a significant factor in limiting system throughput. If the load for an I/O intensive application is striped across enough disks, the mechanical latency of the disks becomes negligible. In this case, the maximum sustained throughput for an array with Ultra320 SCSI will be significantly higher due to the reduction in overhead from Packetization and QAS and the faster bus speed. The addition of Packetization and QAS can significantly improve performance in these I/O intensive applications.

summary

Ultra320 SCSI, the latest backward compatible technology, provides technology enhancements for improving performance and signal and data integrity, transmitter pre-compensation, and Active Adaptive Filtration. With the maximum sustained transfer rate, Ultra320 SCSI will meet the increasing performance requirements of new systems and applications.

for more information

If you would like to provide feedback please mail to: Levi.Norman@hp.com or Richard.Scruggs@hp.com

Ultra 320 SCSI information is located at
http://www.hp.com/products/harddiskdrives
http://www.hp.com/products/smartarray and
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