07-416r1 T10 USB Queuing Transport (UQT) study group introduction

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USB and other external desktop interfaces

- USB dominates the market - 6.2 billion USB ports shipped as of 2007 (2.1 in 2006)
  - Pat Gelsinger, Intel, at Intel Developer forum 19 Sep 2007

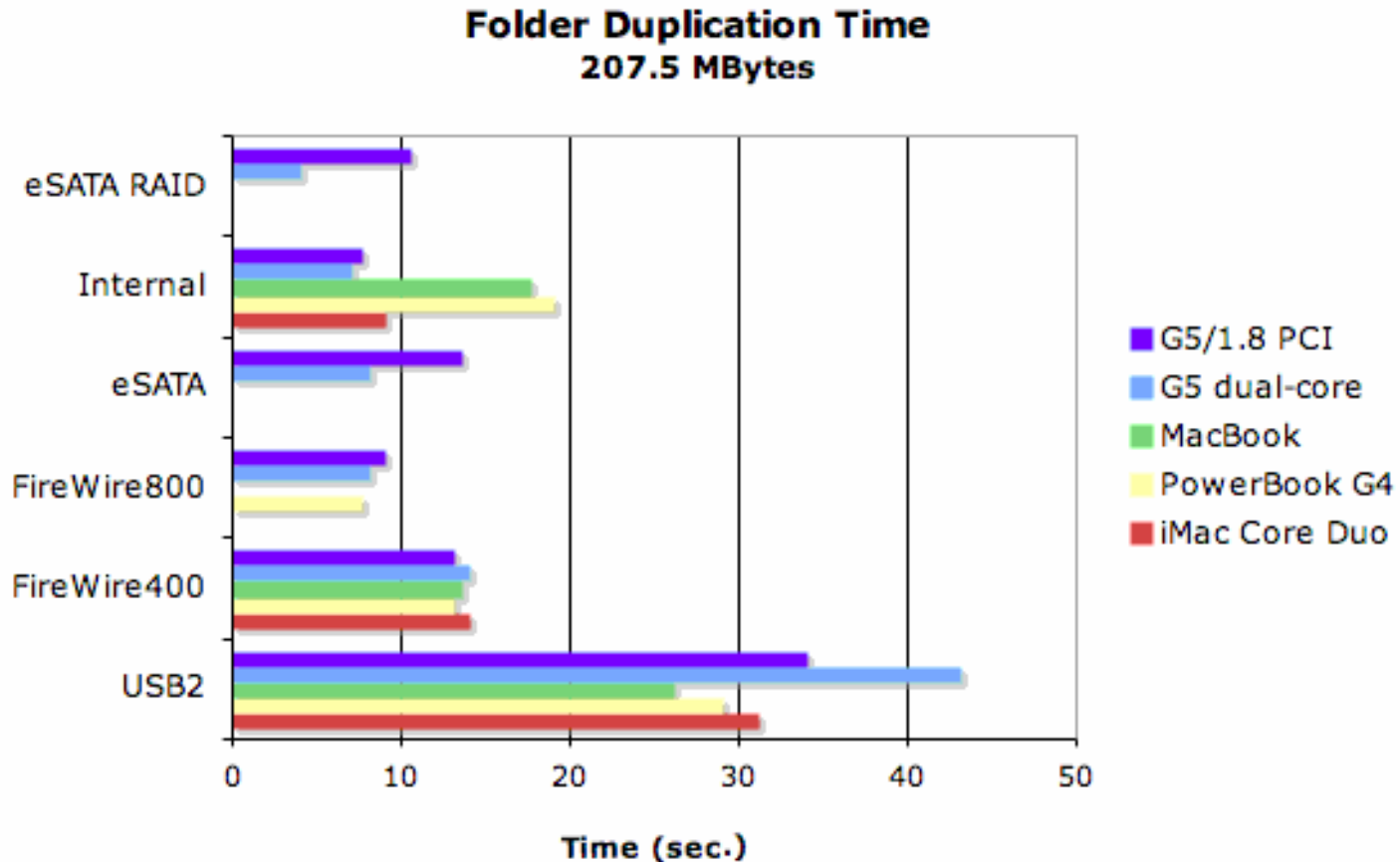| External interface	Line rate	Throughput
USB Low Speed	1.5 MBit/sec	192 KB/sec
USB Full Speed	12 MBit/sec	1.5 MB/sec
USB 2.0 Hi-Speed	480 MBit/sec	60 MB/sec
1394	100 MBit/sec 200 MBit/sec 400 MBit/sec	12.5 MB/sec 25 MB/sec 50 MB/sec
1394b	800 MBit/sec	80 MB/sec
eSATA	1.5 Gbit/sec 3 Gbit/sec	150 MB/sec 300 MB/sec

USB storage performance

- USB Mass Storage Class Bulk-Only Transport is a SCSI transport protocol (not ATA)

- USB 2.0 mass storage performance is becoming an issue

  - Theoretical limit around 48 MBps (bus is half duplex and host-polled)

  - Disk drives max out around 30-35 MBps with standard Microsoft Windows drivers

  - Protocol may not scale well to USB 3.0

Disk and flash drive bandwidth demands

- Desktop-class disk drive bandwidth faster than USB
  - WD Caviar: 54.4 to 97 MBps
  - WD Raptor: 55.4 to 88.3 MBps
  - Hitachi Deskstar: 46.4 to 86.9 MBps
  - Samsung SpinPoint: 41.5 to 83 MBps
  - Seagate Barracuda: 44.3 to 78.5 MBps
  - (Miminum to maximum read bandwidth per benchmarks on http://www.storagereview.com)
- Flash (solid state) drives still have headroom
  - Up to 10 MBps reads, 3 MBps writes in 2004 (http://arstechnica.com/reviews/hardware/flash.ars/6)
  - Up to 29.4 MBps reads, 19.23 MBps writes in 2006 (http://www.xbitlabs.com/articles/memory/display/10usbflash-roundup_9.html)

USB performance vs. other interfaces

- June 2007 comparison on
  http://www.macintouch.com/specialreports/perfpack02

Folder Duplication Time
207.5 MBytes

Categories (y-axis): eSATA RAID, Internal, eSATA, FireWire800, FireWire400, USB2

Time (sec.) — x-axis: 0 to 50

Legend:
- G5/1.8 PCI
- G5 dual-core
- MacBook
- PowerBook G4
- iMac Core Duo

Performance limitations of USB MSC Bulk-Only

- Some protocol limitations impair performance
  - Polled interface
    - No XFER_RDY like notification that drive is ready for write data
    - Possibility: advise host how long to wait before polling
      - cache lookup -> short wait
      - cache miss, seeking -> long wait
  - No queuing
    - eSATA now supports NCQ (native command queuing)
  - Data transferred in-order
    - When adding queuing, need to let commands finish out of order
    - Out-of-order data within a command not as important

Other limitations of USB MSC Bulk-Only

- Only 16 LUNs
  - SCSI architecture requires 16,384 LUNs (2-byte LUN field)
- No bidirectional commands
- 16 byte maximum CDB size
  - Object Storage Device (OSD) command set requires bidirectional long CDBs
- No SCSI status values
  - just Passed, Failed, and Phase Error
  - no BUSY, TASK SET FULL, etc. and no Retry Delay field
- No SCSI autosense data
  - REQUEST SENSE command required – CA concept obsolete after SAM-2
- No task attributes (SIMPLE, ORDERED, HEAD OF QUEUE)
- No task priority field
  - Serial ATA 2.6 includes a Priority feature
- No task management functions (ABORT TASK, LOGICAL UNIT RESET, etc.)
- Redundant transfer length field in command block wrapper
  - both good and bad

Proposal

- Start a new T10 project for a new USB Queued SCSI transport protocol
  - Support queuing and be SAM-4 compliant
  - Compatible with USB 2.0 and forward-looking
  - Devices and hosts must be able to implement both the current MSC and the new protocol for software compatibility
- Define the protocol in INCITS T10
  - T10 WGs open to all; T10 plenary votes for T10 members only
  - INCITS/ANSI patent policy only requires RAND (not RAND-Z)
  - USB Device WG members can participate
  - Avoid reusing existing USB MSC material to avoid need for a copyright release
    - T10 can reference USB specifications, just not quote extensively from them

References

- USB Mass Storage Class Specification Overview, Revision 1.2, 23 June 2003
- USB Mass Storage Class Control/Bulk/Interrupt Transport, Revision 1.1, 23 June 2003 (used by floppy drives only)
- USB Mass Storage Class Bulk-Only Transport, Revision 1.0, 31 September 1999
  - USB mass storage specifications are available at the USB Implementers Forum at http://www.usb.org
- SCSI Architecture Model – 4 (SAM-4), latest working draft on http://www.t10.org/drafts.htm
- T10/07-263 proposes a SAM annex listing the choices about optional features that each SCSI transport protocol has made (see http://www.t10.org/doc07.htm)
  - highlights some of the areas that this protocol will have to cover
- USB 3.0 – announced at Intel Developer Forum 18 September 2007