

# Advances in USB Storage

**USB Attached SCSI Protocol**

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# USB Storage Convenient and Easy to Use

- USB is a ubiquitous interface for external storage solutions
  - External HDD,
  - Thumb drives,
  - Mobile phones,
  - Portable media players
- Convenience and ease of use make it the interface of choice for many applications
  - System back ups
  - Casual file storage
  - Sneaker-net transfers
  - Synchronization of media and data files for phones, MP3 and other PMPs
- However, USB storage throughput has become an issue as device capacities have grown

# Customers Want More

- As storage capacities have increased, so have the bandwidth demands
  - System back-ups of 500 GB and larger are common
  - Synchronization of 32 GB and larger MP3 and PMPs are typical
- USB 3.0 greatly improves customer experience
  - Increase in raw transfer speed dramatically increases USB storage throughput
  - However, the existing Mass Storage Class driver (Bulk Only Transport) still does not provide native device performance at SuperSpeed

# A Historical Perspective of USB Mass Storage

- Bulk Only Transport (BOT) originally designed to support USB 1.1
  - Floppy drives, CD-ROMs and flash readers were the primary external mass storage devices
  - Speed and capacity requirements were in-line with device capabilities
  - Queuing and large transfer sizes were not necessary
- USB 2.0 speed improvements enabled larger capacity devices including hard disk
  - BOT performance was acceptable, even for hard disk
- Capacity and bandwidth of mass storage devices continue to increase
  - User experience not ideal, USB 2.0 is the limiting factor

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# Historical Perspective of USB Mass Storage (cont.)

- USB 3.0 provides necessary speed
  - USB throughput now greater than typical devices
  - However, BOT protocol places limits even at SuperSpeed
- Single threaded command execution
  - Latency between commands issued can be longer than actual data packet transfer
  - Does not allow devices to optimize execution order, e.g. based on head position, and/or cache availability
- Transfer size limited in some stacks
  - Increases overhead for typical data transfers
- Conclusion: Bulk Only Transport (BOT) was not designed to accommodate the needs of today
  - Limitations are obvious in USB 2.0, and even more so with USB 3.0 (SuperSpeed)
  - A new protocol is needed

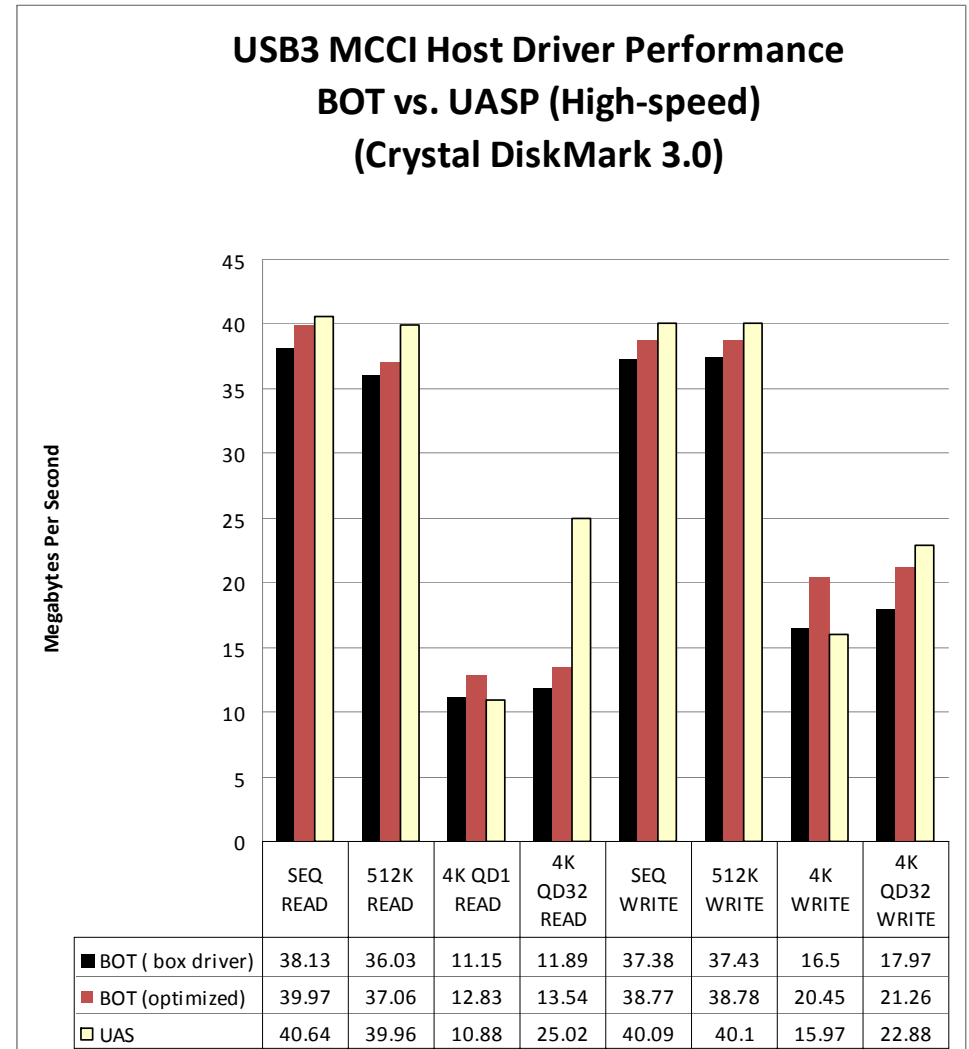
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# USB Attached SCSI

- USB Attached SCSI (UAS) addresses the limitations imposed by BOT
- Improves efficiency of devices
  - Enables queuing
    - Allows drives to determine command execution order
      - Optimizes latency based on cache status, head position, etc.
  - Optimizes transfer size to minimize transport overhead
- Support for current command and transport standards
  - SPC-4, SBC-3, SAM-5
  - Allows OS to take advantage of high performance storage stacks, e.g. storport on Windows
- Provides lowest latency and maximum bandwidth for USB storage
  - Efficient for RAIDs and even tape drives

# High-speed Performance Comparisons

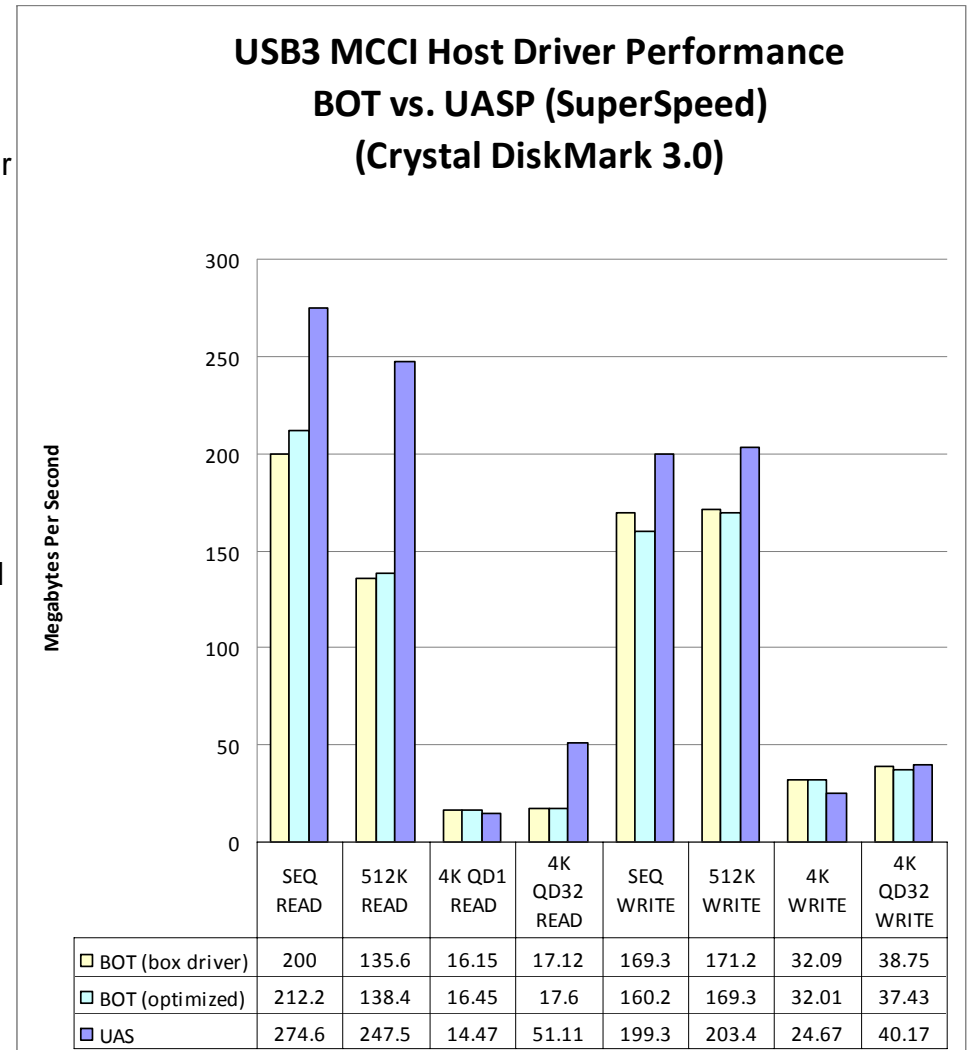
- Small performance gains for large transfers
  - Reaching limits due to USB High-speed transfer rates and bus overhead.
  - Benefits greater compared to non-optimized BOT transfers
- Large performance for small transfers with queuing
  - More than 100% performance increase for 4 KB reads over standard BOT
  - Small penalty when queuing not enabled due to protocol overhead, but latency between command execution greatly reduced.
- Test Configuration
  - USB 3.0 SSD
    - TUSB9260 with Intel X25-E SSD
  - Host Stack
    - NEC xHCI with MS BOT (box driver)
    - MCCI xHCI with optimized BOT
    - MCCI xHCI with UASP



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# SuperSpeed Performance Comparisons

- UAS benefits performance more pronounced for both read and writes with SuperSpeed
  - Maximum read performance reaching disk transfer limits
  - Benefits from lower bus protocol overhead for SuperSpeed and lower latency between commands for UASP
- Small transfers receive large performance gains with UAS queuing
  - Nearly 200% performance increase for 4 KB read with queue depth of 32
  - Small penalty when queuing not enabled due to protocol overhead, but latency between command execution greatly reduced.
- Test Configuration
  - USB 3.0 SSD
    - TUSB9260 with Intel X25-E SSD
  - Host Stack
    - NEC xHCI with MS BOT (box driver)
    - MCCI xHCI with optimized BOT
    - MCCI xHCI with UASP



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# USB 3.0 Benefits for End User and Manufacturer

- SuperSpeed improves end to end performance
  - Faster backups and synchronizations
  - Less waiting, “sync and go”
  - Less time imaging devices in manufacturing
- Lower transfer times mean lower power
  - More opportunity to place the interface into low power states
  - Improved battery life for portable devices

# USB 3.0 and UAS Are Reality Today

- USB 3.0 certified products shipping today
  - Over 75 SuperSpeed products certified by USB-IF
    - <http://www.usb.org/kcompliance/view>
  - Includes host adapters, notebooks, desktop motherboards, hard drives, enclosures, and silicon building blocks
- UASP specification approved
  - [http://www.usb.org/developers/devclass\\_docs/uasp\\_1\\_0.zip](http://www.usb.org/developers/devclass_docs/uasp_1_0.zip)
  - <http://www.t10.org/cgi-bin/ac.pl?t=f&f=uas-r04.pdf>
  - Hardware and software solutions available now from TI and MCCI

# TI and MCCI Delivering Solutions to Meet Market Needs

- TUSB1310
  - USB 3.0 discrete physical layer
  - Production available now
- TUSB9260
  - USB 3.0 to Serial ATA bridge including UASP support
  - Production available August 2010
- TUSB8040
  - Four port USB 3.0 hub controller
  - Contact your local TI representative for sample and production availability
- TUSB7320 and TUSB7340
  - Two and four port USB 3.0 xHCI Host Controller
  - Contact your local TI representative for sample and production availability
- [SN65LVPE502](#)
  - SuperSpeed USB re-driver with adjustable equalization and de-emphasis
  - Production available now
- [TPD2EUSB30](#)
  - Two channel ESD protection for SuperSpeed USB differential signals
  - Production available now
- USB 3.0 host stacks with UASP from MCCI for Windows and Linux platforms

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# Call to Action

- Evaluate how USB 3.0 and UAS can enhance your products
  - See [www.usb.org](http://www.usb.org) for specifications and presentations on USB and UAS
  - USB 3.0 Specification at [http://www.usb.org/developers/docs/usb\\_30\\_spec\\_060910.zip](http://www.usb.org/developers/docs/usb_30_spec_060910.zip)
  - Lots of information on SuperSpeed USB from the Developer's Conference at <http://www.usb.org/developers/presentations/pres0410>
- Join the USB-IF and work with industry to develop the class specification infrastructure
  - [https://www.usb.org/members\\_landing](https://www.usb.org/members_landing)
- Contact MCCI and TI for information or help on how to enable USB 3.0 and UAS on your products
  - <http://focus.ti.com/analog/docs/microsite.tsp?sectionId=590&tabId=2207&micrositeId=11>
  - [www.mcci.com](http://www.mcci.com)

# Thank You

- TI would like to thank
  - Terry Moore and MCCI for inviting us to participate in Wireless Japan
  - The attendees for taking time to visit this forum