"Overclocking Data Storage Subsystems:

A SATA-IV Proposal"

Paul A. Mitchell, B.A., M.S.
Systems Development Consultant

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Author's Brief Bio

began using computers in 1971, U.C. Irvine, grad school

published author, computer graphics, Harvard 1977

frequent contact with system performance issues

biased for singular enthusiasts, DIY builders,
 low-end budgets, human productivity

 high-performance should NOT
    require top dollar -or- special expertise
    be limited to large organizations

U.S. patent pending on very high-speed storage device

Human Productivity: Small Changes Add Up

Example: **save 1 ½ seconds every working minute**

FTE = 2,000 hours x 60 minutes = 120,000 minutes/year

120,000 @ 1.5 = 180,000 seconds saved

180,000 / 3,600 = 50 human hours saved

100 people @ 50 hours = 5,000 human hours / year

5,000 / 2,000 = **2 ½ FTE**

The Legacy PCI Slot

33 MHz clock rate

x 32 bits per cycle =

1,056 Megabits per second ("1G")

/ 8 bits per byte transmitted =

132 Megabytes per second   (one direction)

NOTE equivalence with **ATA-133**   (aka "PATA")

SATA-III

6.0 GHz clock ("6G")

/ 10 bits per byte =

600 MB per second   (one direction)

SATA-II

3.0 GHz clock ("3G")

/ 10 bits per byte =

300 MB per second   (one direction)

SATA-I

1.5 GHz clock

/ 10 bits per byte =

150 MB per second   (one direction)

PCI Express 3.0

8.0 GHz clock

/ ~8 bits per byte = **(note change to "8" here)**

1.0 GB per second (one direction)

PCI Express 2.0

5.0 GHz clock

/ 10 bits per byte =

500 MB per second (one direction)
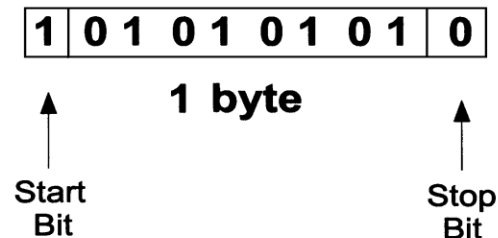
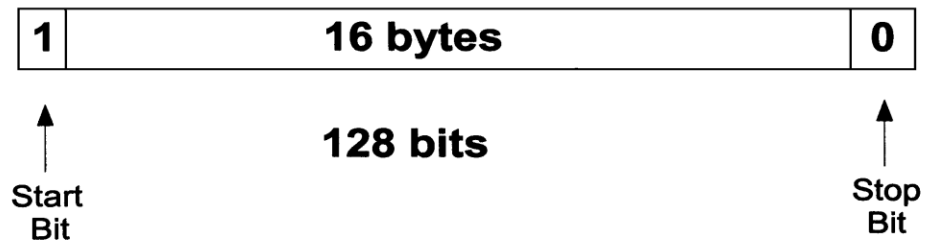**PCI Express 1.0**

2.5 GHz clock

/ 10 bits per byte =

250 MB per second (one direction)

Why change from 10 bits / frame to 130 bits / frame?

8b/10b "Legacy Frame":

| 1 | 0 1 0 1 0 1 0 1 | 0 |

1 byte

↑ Start Bit   ↑ Stop Bit

128b/130b "Jumbo Frame":

| 1 | 16 bytes | 0 |

128 bits

↑ Start Bit   ↑ Stop Bit

Western Digital Corporation: "Advanced Format Technology"

Figure 1

Legacy Architecture

Sync/DAM

Sector Gap

ECC

| 512 Bytes | 512 | 512 | 512 | 512 | 512 | 512 | 512 |
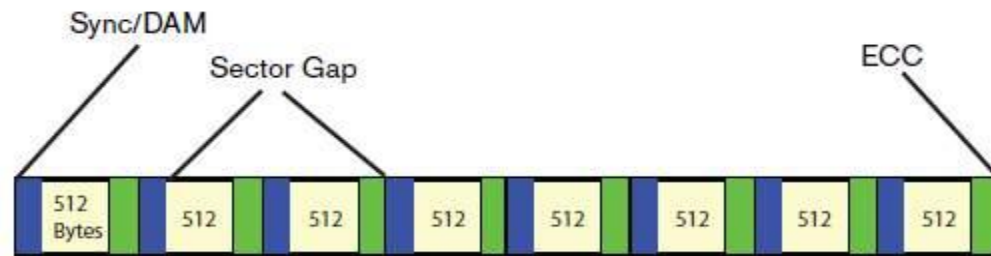
Figure 2

Advanced Format Architecture

Sync/DAM

Longer ECC

4096 Bytes (4K) Data

ECC
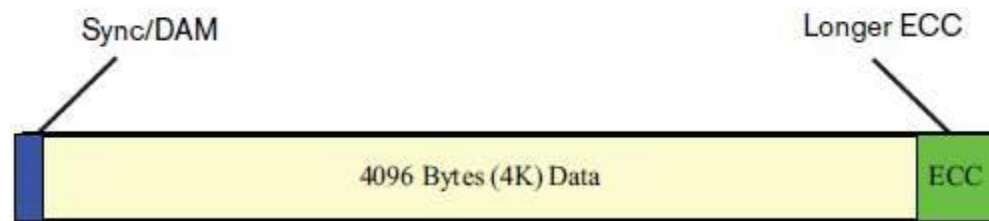
SATA-IV Proposal

"Sync" with PCIe 3.0 "jumbo frame":

1 start bit + 16 data bytes + 1 stop bit ("128b/130b")

6.0 G / 8 = **750.0 MB per second**

3.0 G / 8 = **375.0 MB per second**

1.5 G / 8 = **187.5 MB per second**

Exact Divisor is:

130 bits / 16 bytes = **8.125**

16.0 G / 8.125 = 1,969 MB/s

12.0 G / 8.125 = 1,477 MB/s

8.0 G / 8.125 = 985 MB/s   **SATA-IV default**

6.0 G / 8.125 = 738 MB/s

Visible Present Workstation

5.25" 4-in-1 enclosures proliferate for 2.5" devices
(*e.g.* Icy Dock, Thermaltake, Enhance Technology, etc.)

4 x SATA-IV channels in RAID 0 mode

 @ 984.6 MB/s =   3,938 MB/s

controller efficiency x (500 / 600) (assumed)

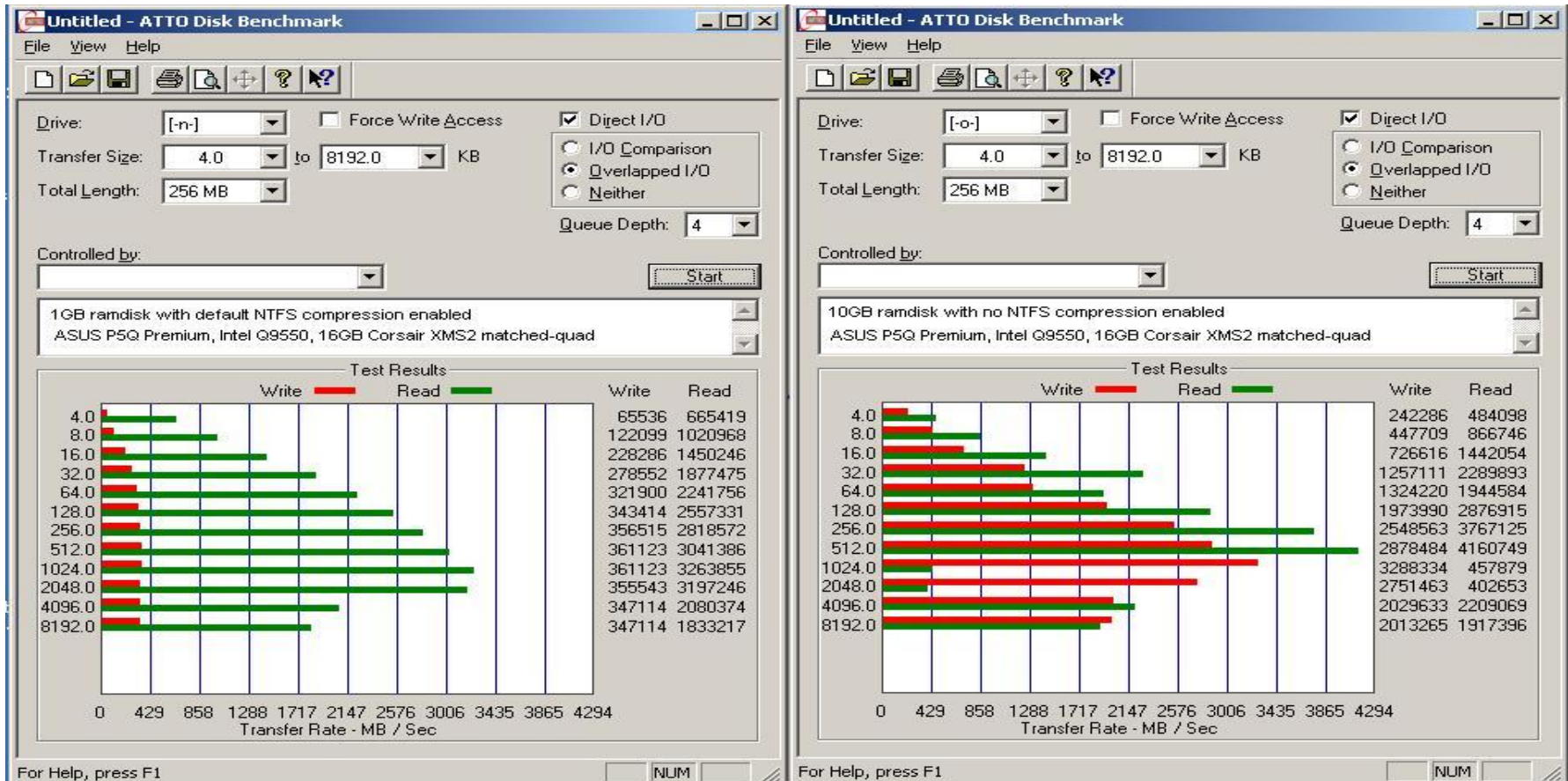
3,282 MB/s   **3.2 GB/s**

Compare "Raw Read" Results with *RamDisk Plus*

10GB ramdisk, 16GB dual-channel DDR2-800 matched quad

ASUS P5Q Deluxe motherboard, Intel Q9550 quad-core CPU

ATTO Results with *RamDisk Plus:*

compare NTFS compressed   *-and-*   <u>un</u>compressed ramdisks

Deluxe Future Workstation

2 x 5.25" 4-in-1 enclosures =

8 x SATA-IV channels in RAID 0 mode

@ 984.6 MB/s = 7,877 MB/s

controller efficiency x (500 / 600) (assumed)

6,564 MB/s   **6.5 GB/s**

controller efficiency x (0.760)   (measured)

5,986 MB/s   **5.9 GB/s**

Existing Hardware Examples

Highpoint RocketRAID 2720SGL

x8 PCIe 2.0 edge connector
2 x SFF-8087 ports
8 x 6G SATA/SAS ports
4.0 GB/s upstream bandwidth

ICY DOCK model MB994SP-4SB-1
4 x 2.5" SSD/HDD in 1 x 5.25" Bay
SATA Hot-Swap Backplane Cage

Adaptec 2236600-R mini SAS x 4 (SFF-8087)
to (4) x 1 Serial ATA fan-out Cable - 0.5M

Conclusion

The SATA-IV Standard should include support for:

variable channel speeds, perhaps with pre-sets:

6, 8, 12 and 16 GHz (and so on, beyond the horizon)

optional "jumbo frames" identical to PCIe 3.0 spec:

1 start bit + 16 data bytes + 1 stop bit ("128b/130b")

Further Reading:

"Overclocking Data Storage Subsystems: One Approach to Variable Channel Bandwidth,"
by Paul A. Mitchell, July 27, 2010
http://benchmarkreviews.com/index.php?option=com_content&task=view&id=11178&Itemid=21

"Visible Computer Futures," by Paul A. Mitchell, October 31, 2010
http://benchmarkreviews.com/index.php?option=com_content&task=view&id=12508&Itemid=21

"Technical Review and Evaluation of RamDisk Plus Software," October 1, 2009
http://benchmarkreviews.com/index.php?option=com_content&task=view&id=8479&Itemid=23

"A Major Performance Enhancement to the Industry-Standard SATA Protocol," May 26, 2010
http://benchmarkreviews.com/index.php?option=com_content&task=view&id=10291&Itemid=22

"Advanced Format Technology White Paper," by Western Digital Corporation
http://www.wdc.com/wdproducts/library/WhitePapers/ENG/2579-771430.pdf

"HighPoint 2720SGL RocketRAID Controller Review – Amazing 3GB/s Recorded With 8 Crucial C400 SSDs,"
by Paul Acorn, February 14, 2012
http://thessdreview.com/our-reviews/highpoint-2720sgl-rocketraid-controller-review-amazing-3gbs-recorded-with-8-crucial-c400-ssds/

PCI Express® 3.0 Frequently Asked Questions
http://www.pcisig.com/news_room/faqs/pcie3.0_faq/

Highpoint website:	http://www.highpoint-tech.com
Icy Dock website:	http://www.icydock.com
Adaptec website:	http://www.adaptec.com

Reader's Notes: