“Overclocking Data Storage Subsystems: A SATA-IV Proposal”

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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

\[ \times 32 \text{ bits per cycle} = 1,056 \text{ Megabits per second} \left( "1G" \right) \]

\[ \div 8 \text{ bits per byte transmitted} = 132 \text{ Megabytes per second} \text{ (one direction)} \]

NOTE equivalence with ATA-133 (aka “PATA”)
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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)
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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

128 bits

Start Bit

Stop Bit
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Western Digital Corporation: “Advanced Format Technology”

Figure 1
Legacy Architecture

Figure 2
Advanced Format Architecture
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
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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)

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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
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ATTO Results with RamDisk Plus:
compare NTFS compressed -and- uncompressed 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)

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6,564 MB/s 6.5 GB/s

controller efficiency x (0.760) (measured)
5,986 MB/s 5.9 GB/s
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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
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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”)
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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


“Advanced Format Technology White Paper,” by Western Digital Corporation

"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: