Smashing Bits: Comparing Data Compression Techniques in Storage

Juan Deaton, Ph.D.
Research Scientist and Engineer
AHA Introduction

• Moscow, ID

• Relevant History
  - 1988 NASA Startup
  - 2006 First GZIP Compression IC
  - 2014 80Gbps PCIe GZIP Accelerator
    ▪ Fastest GZIP Accelerator

• Coding Technology Experts
  - Error Correction
  - Data Compression
  - Encryption
Are you prepared for the future?

• **Flash is the Future**
  - Lower Cost, High Performance

• **Biggest Data: Industrial IoT**
  - $225 billion by 2020
  - Biggest of all Data

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**Trillion Sensor Visions**

- “Abundance”
- QCOM Swarm Lab, UCB
- Bosch
- Hewlett-Packard
- Intel
- TI Internet devices
- Yole MEMS Forecast, 2012
- T Sensors Bryzek’s Vision
- 10 year slope
- Mobile Sensors Explosion

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*Source: © Wikibon 2015. 4-Year Cost/TB Magnetic Disk & SSD, Including Packaging, Power, Maintenance, Space, Data Reduction & Data Sharing*
Data Compression Challenge

- **Top Speed w/ LZ4 & 20 cores**
  - 20 Cores X 2.618 Gpbs = 52.4 Gbps
  - 100% of server processing
data compression

- **Options**
  - Customer buys more servers
  - High performance, lower cost?

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**Single Core Performance**

Average over Silesia, Canterbury, and Calgary corpora

<table>
<thead>
<tr>
<th>Method</th>
<th>Compression Ratio</th>
<th>Speed in Gbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZIP-1:</td>
<td>0.099, 3.904</td>
<td></td>
</tr>
<tr>
<td>GZIP-1:</td>
<td>0.456, 2.862</td>
<td></td>
</tr>
<tr>
<td>LZO-1:</td>
<td>2.421, 2.118</td>
<td></td>
</tr>
<tr>
<td>LZ4-1:</td>
<td>2.618, 2.120</td>
<td></td>
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</tbody>
</table>
AHA37X Family

• Interface
  - PCIe interface

• Algorithms
  - GZIP/ZLIB

• Board by Compression Speed
  - AHA371 – 10 Gbps
  - AHA372 – 20 Gbps
  - AHA374 – 40 Gbps
  - AHA378 – 80 Gbps
Experiments Summary

• Compression Techniques Examined
  - LZO, LZ4, AHA374, GZIP-1

• Compared 40Gbps/8GBps Speed Match
  - CPU Utilization
  - Power Consumption
  - Compression Ratio

• Block Sizes
  - 4kB, 16kB, 64kB, 256kB

• Hardware
  - Server: HP Proliant DL380 Gen8
  - CPU: E5-2660v2 @ 2.20GHz
    ▪ Dual 10 Core
Reduced CPU Utilization

• 40 Gbps (8GBps) Speed Match
  - Normalized for Comparison

• %Utilization of 20 Cores
  - 40% = 8 cores
  - 50% = 10 cores
  - 70% = 14 cores

• GZIP/BZIP CPU Not Shown
  - GZIP 410% - 309%
  - BZIP 4247% - 2098%

AHA 374 offloads CPU resources
Lower Average Power

- **40 Gbps (8GBps) Speed Match**
  - Normalized for Comparison
- **Power Calculations**
  - Subtracted Idle Power
- **LZO/LZ4 Power**
  - Modeled from experiments
- **AHA374 Power**
  - Direct Measured

### Power Speed Match Comparison

<table>
<thead>
<tr>
<th>Block Size</th>
<th>Power in Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4kB</td>
<td>120.00</td>
</tr>
<tr>
<td>16kB</td>
<td>100.00</td>
</tr>
<tr>
<td>64kB</td>
<td>80.00</td>
</tr>
<tr>
<td>256kB</td>
<td>60.00</td>
</tr>
</tbody>
</table>

**Lower is Better**

- LZO-1
- LZ4-1
- AHA374

At >4kB blocks AHA374 uses less power
Summary

• **Industrial IoT**
  - Biggest Ephemeral Data
  - High Data Rates

• **AHA374 GZIP Accelerator**
  - High Compression Speed
  - Frees CPU Resources
  - Increases Capacity and Cycle Life
Increased Capacity

- Average over Corpora
  - Silesia, Canterbury, Calgary
- 4kB BZIP 2.68:1
  - AHA374 2.66, 99% of BZIP
- AHA374~GZIP-5
  - GZIP-1 lowest GZIP CR
- Longer Cycle Life
  - Higher Compression Ratio

AHA374 provides almost 50% more capacity than LZ4/LZO
Contact Information

• Website
  - www.aha.com

• Contact
  - jdeaton@aha.com
  - sales@aha.com