How To Be A Part of the Real World Workload Revolution

A SNIA Solid State Storage Initiative Webcast

July 9, 2019
Today’s Presenters

Eden Kim
Calypso Systems

Jim Fister
The Decision Place
SNIA Legal Notice

- The material contained in this presentation is copyrighted by the SNIA unless otherwise noted.
- Member companies and individual members may use this material in presentations and literature under the following conditions:
  - Any slide or slides used must be reproduced in their entirety without modification
  - The SNIA must be acknowledged as the source of any material used in the body of any document containing material from these presentations.
- This presentation is a project of the SNIA.
- Neither the author nor the presenter is an attorney and nothing in this presentation is intended to be, or should be construed as legal advice or an opinion of counsel. If you need legal advice or a legal opinion please contact your attorney.
- The information presented herein represents the author's personal opinion and current understanding of the relevant issues involved. The author, the presenter, and the SNIA do not assume any responsibility or liability for damages arising out of any reliance on or use of this information.

NO WARRANTIES, EXPRESS OR IMPLIED. USE AT YOUR OWN RISK.
About SNIA

185 industry leading organizations

2,000 active contributing members

50,000 IT end users & storage pros worldwide

Learn more: snia.org/technical

@SNIA
Today’s Agenda

• Real World Workloads, Comparisons to Synthetic Workloads
• Measuring and Visualizing Real World Workloads
• Real World Workload Demonstration
• Testing and Sharing
• Benefits of Joining the Program
What are Real-World Workloads?

Real World Workloads are:
• A constantly changing sequence of
• IO Stream Combinations and QDs
• Captured from point A to B
• In the SW/HW Stack during actual use

Synthetic Benchmark Workloads are:
• A fixed and constant workload
• Applied to storage
• To test performance
• Outside the Range of Normal Usage
Synthetic vs. Real-World Workloads

Synthetic SQL Workload:
• Typically defined as random 8K R/W
• 65:35 R/W ratio
• Limited I/O threads to storage

Actual Real-World Workload:
• 72:28 R/W ratio
• 10% 8K Read, 2.8% 8K Write
• Over 5000 unique I/O streams
• Factors in additional workloads on the system (i.e. Backup)
Why are Real World Storage Workloads (RWSWs) Important?

RWSWs are key determinants in storage performance and have a significant impact on SW and storage optimizations

- Solid State Storage Performance depends, in large part, on RWSWs
- Unlike lab test workloads, RWSWs are comprised of dynamically changing combinations of IO Streams & Demand Intensity
- IO Stream content affects Optimization, Design, Validation & Failure Analysis
- IO Streams change at each layer of software abstraction in the SW Stack
What are Real World Storage Workloads?

A collection of IO Streams seen by Storage

Generated in Application space

During Real World computer usage

Now, Let’s look at some Definitions:
An IO Stream\(^1\) is an Input/Output Operation (IO) that has a unique:

- Random or Sequential Access
- Block Size or Data Transfer Size
- Read or Write IO
- Queue Depth (QD)

A single IO Stream can occur many times during an IO Capture Step

Other Secondary Metrics can be associated with IO Streams

\(^1\) Workload IO Stream definitions used here differ from SSD Endurance Streams where similar write operations are associated with a group of associated data
What is an IO Capture?

An IO Capture is the tabulation of statistics on IO Streams that are observed during a capture period

- IO Capture Tools gather statistics and metrics on IO Streams
- An IO Capture is NOT an IO Trace
- No data or private information is collected
- Only binary numeric tables are gathered
What is the Software Stack?

The Software (SW) Stack refers to the layers of software (OS, APIs, programs, drivers and abstractions) that exist between User space and storage.

- IO Streams are generated in User space by software applications, run everywhere.
- IO Streams traverse the SW State back and forth to storage.
- IO Stream composition is different at different levels of the SW Stack.
Why do RWSWs Affect Performance?

Solid State Storage Performance depends on how well storage responds to constantly changing combinations of IO Streams and Demand Intensity

- RWSWs are constantly changing combinations of IO Streams and QDs; Synthetic Lab tests are a fixed and constant
- IO Streamsvary by Block Size, Accesses and R/W IOs
- Solid State Storage responds differently to the type of access (RND/SEQ), Block Size, and whether the IO is a Read/Write
- The type and combination of RWSW IO Streams and the Demand Intensity determines, in large part, the storage performance that is provided
What do RWSWs Look Like?

RWSW can be visualized by creating an IO Stream Map that shows the changing combinations of IOs and metrics over Time:

- IO Stream % probability of occurrence - different color data series
- IOPS - dominant black line
- Time - X-axis: 24-hour capture at 2 minute steps
- Secondary metrics captured by the Capture tool can be displayed
Secondary IO Metrics captured by the IO Capture tool can be viewed on an IO Stream Map

- IO Capture tools can capture various Secondary Metrics
- IO Streams can be listed by RND/SEQ access, Block Size, R/W IO
- Average and Maximum Response Times and QDs are shown to the left
- Several additional IO Metrics can be shown
Viewing IO Streams by a Specific Application

IO Streams can be filtered, extracted or presented by specific Application IOs

- Here we extract only the sqlservr.exe IOs
- sqlservr.exe IOs that occur > 3% of the time over the 24-hours
  - The Cumulative workload - 395 Streams & 36 separate Processes
  - sqlservr.exe – 6 IO Streams are 78% of the Total IO Streams
  - sqlservr.exe application IOs - 79.9% of the Total IO Streams
What can RWSWs Tell Us?

RWSWs let us extract specific application IOs to analyze the IO Composition, Metrics and Performance that occur on the target server during the IO Capture. We can see:

- IO Stream Distribution of the selected Process(es)
- Changing combinations of IO Streams over time
- IO Process Average & Maximum Response Times
- IO Process Throughput and Avg/Max Queue Depth
- Secondary IO Metrics
Demonstration
RWSW Test Examples

1. **Multi-WSAT** – applies fixed 6 IO Stream composite workload for each test step to Steady State.

2. **Individual Streams-WSAT** – tests each individual IO Stream as a separate Steady State item.

3. **DIRTH** (Demand Intensity Response time Histogram) - applies fixed 6 IO Stream composite workload across a range of 1 to 1,024 Users to measure IOPS & Response Time saturation.

4. **Replay-Native** - reproduces each capture step combination of IO Streams, Queue Depths and Idle Times for storage comparison to the original IO Capture server storage.
SNIA SSSI Reference IO Capture Workloads

Example 3. 24-Hr Retail Web Portal
Windows Server 2012R2
Drive 0 & Drive 1
Block IO Level Captures

Example 4. SNIA Green Storage TWG Workload
Linux OS - Block IO Level
IO capture of Synthetic Test Workload

Example 6. 24-Hr GPS Navigation Portal
Windows Server 2012R2
File System & Block IO Level
Benefits Across the Industry

Hardware Manufacturers

- Build/utilize an expanse of tests
- Characterize true needs of Solid State Storage/Memory
- Tune driver development

Software Developers

- Provide workloads to get hardware tuned for your performance
- Provide tools for purchasing decision makers
- Find race conditions and test new hardware more quickly

IT Organizations

- Provide your workload to get better results for your work
- Make the right choices in hardware/system specifications
Conclusions

• Understanding Your RWSW is critical for Datacenter, Storage Server and SSD Design and Optimization

• Know what you are optimizing (IO Streams & SW Stack levels)

• Find out what IO Streams are presented to Storage

• Try Demos, Free Captures & Analysis at TestMyWorkload.com

• See SNIA Reference Captures at TestMyWorkload.com

• View the SNIA Whitepaper and Calypso Whitepaper

• www.TestMyWorkload.com
Thanks for Attending

More Information:

Webcast slides:  https://www.snia.org/forums/sssi/knowledge/articles-presentations

How To Be a Part of the Real World Workload Revolution white paper (English and Chinese versions): https://www.snia.org/forums/sssi/knowledge/whitepapers

Webcast Q&A:  http://sniasssiblog.org

Visit www.snia.org/sssi for information on Solid State Storage