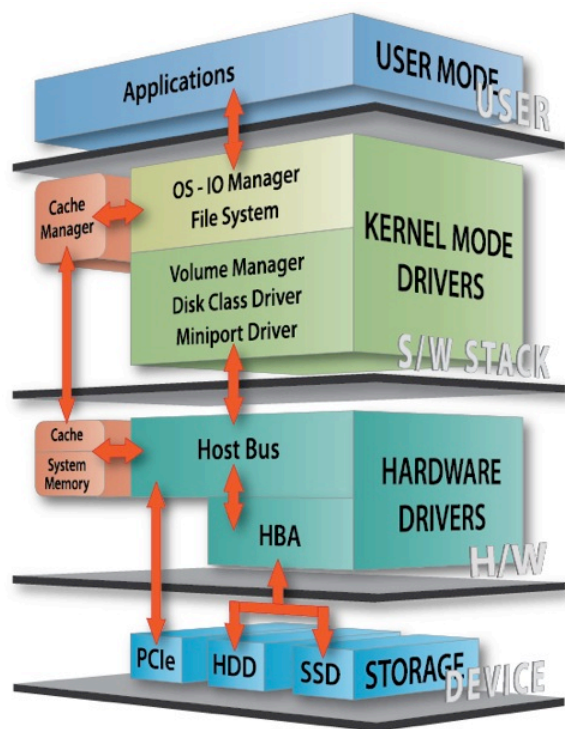# How will your Data Center SSD Handle Real World Workloads?

Eden Kim, Calypso Systems, Inc.

What are Real World Datacenter Workloads?


- ❖ Real World Workloads are a **collection of IO Streams** that occur on **a deployed server** at a specific **software stack level** over a given **period of time**

- ❖ Real World Workloads are a **constantly changing combination** of **many, many IO Streams** and **Queue Depths**

- ❖ IO Streams are generated by **Applications, Operating System activities, software abstractions, User activities** and more

- ❖ **IO Streams change** as they **traverse the Software and Hardware Stack**

Why are Real World Workloads Important?

- **Workload Composition** – IO Stream Content
- **Load Balancing** – IO Traffic & Performance
- **Software Optimization** – Validate SW Abstractions
- **Interoperability** – Standard Replay Scripts
- **Failure Analysis** – Workload Capture & Replay
- **Server & Storage Qualification** – Replay Test Qualification
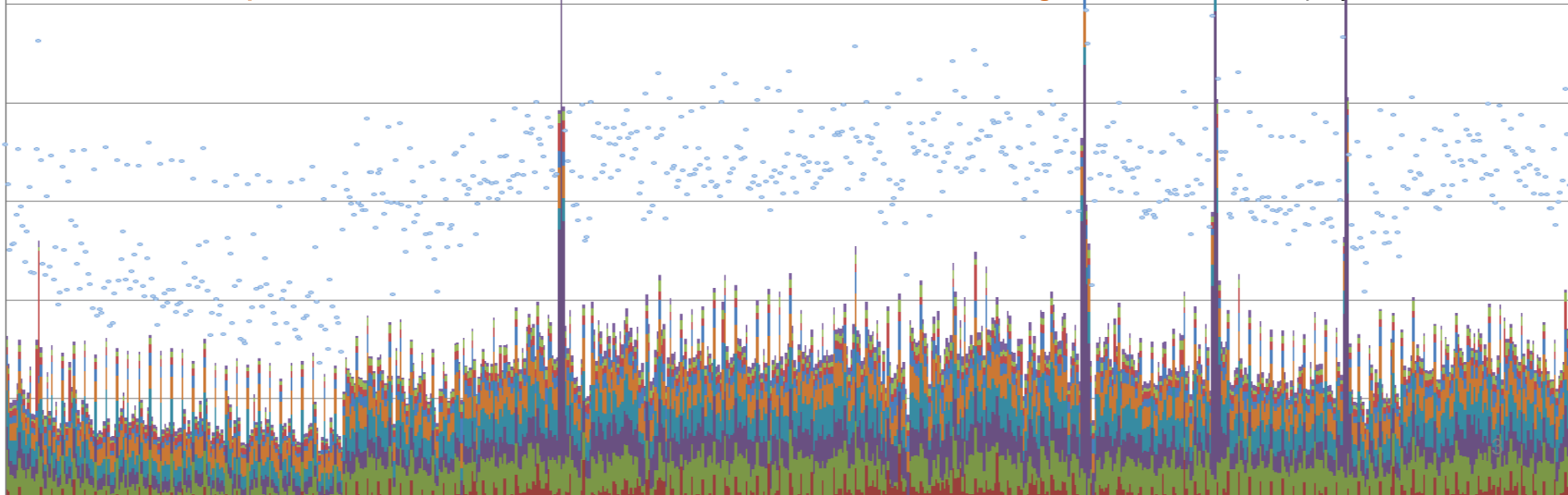
Viewing a Datacenter Real World Workload:
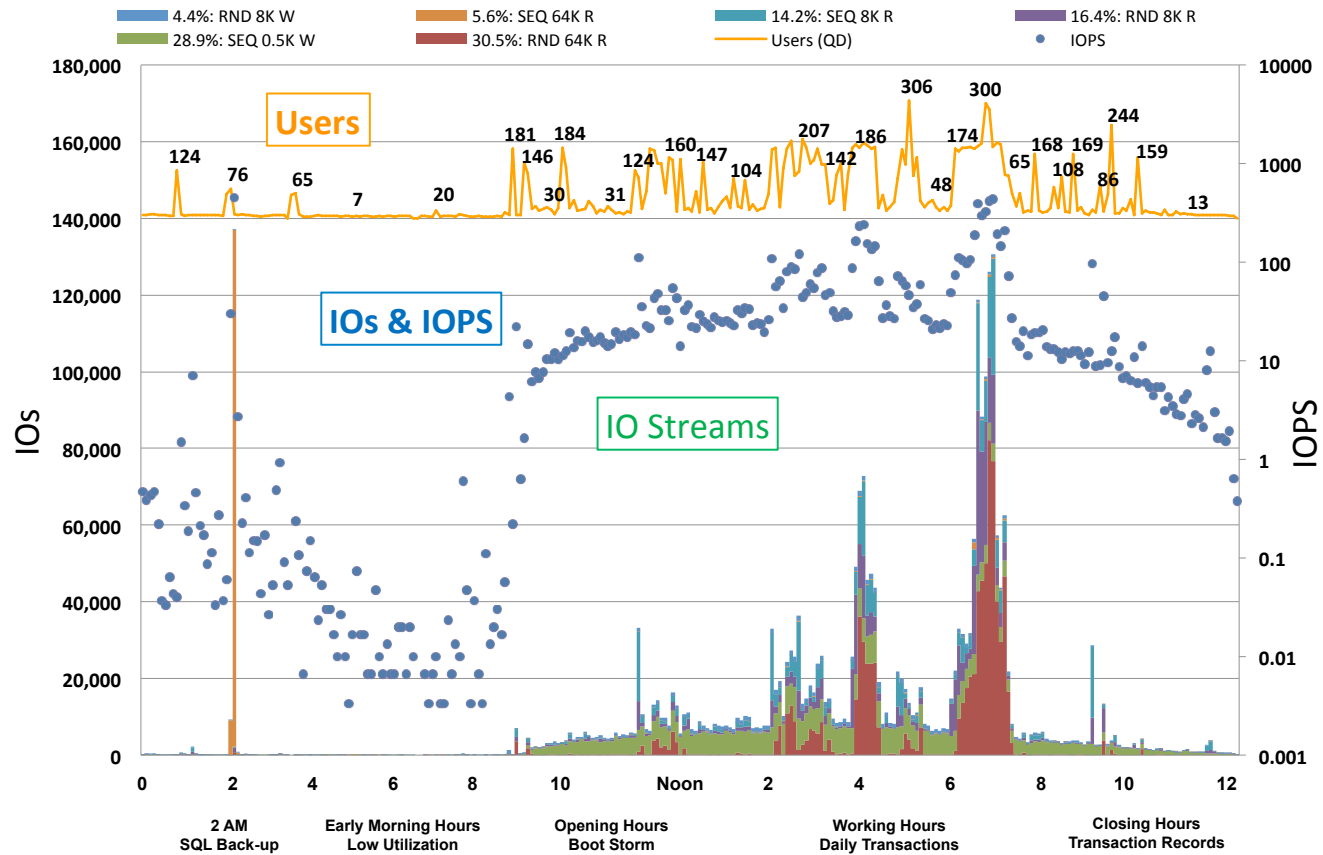
New SNIA Spec for Datacenter Real World Workloads

SNIA
®
Advancing storage &
information technology

Real World Storage Workload (RWSW)
Performance Test Specification for
Datacenter Storage

Version 1.0.7

ABSTRACT: This document describes a Real-World Storage Workload (RWSW) IO capture,
characterization, methodology, test suite and reporting format. It is intended to provide standardized
analysis of in-situ target server application storage performance and standardized comparison and
qualification of Datacenter storage when using Reference IO Capture Workloads as the test stimuli in
RWSW tests.

This document has been released and approved by the SNIA. The SNIA believes that the ideas,
methodologies and technologies described in this document accurately represent the SNIA goals and are
appropriate for widespread distribution. Suggestions for revisions should be directed to
http://www.snia.org/feedback/.

SNIA Technical Position

May 25, 2018

- ❖ **SNIA Technical Position**
- ❖ **RWSW PTS Spec**
- ❖ **IO Capture Process**
- ❖ **IO Stream Analysis**
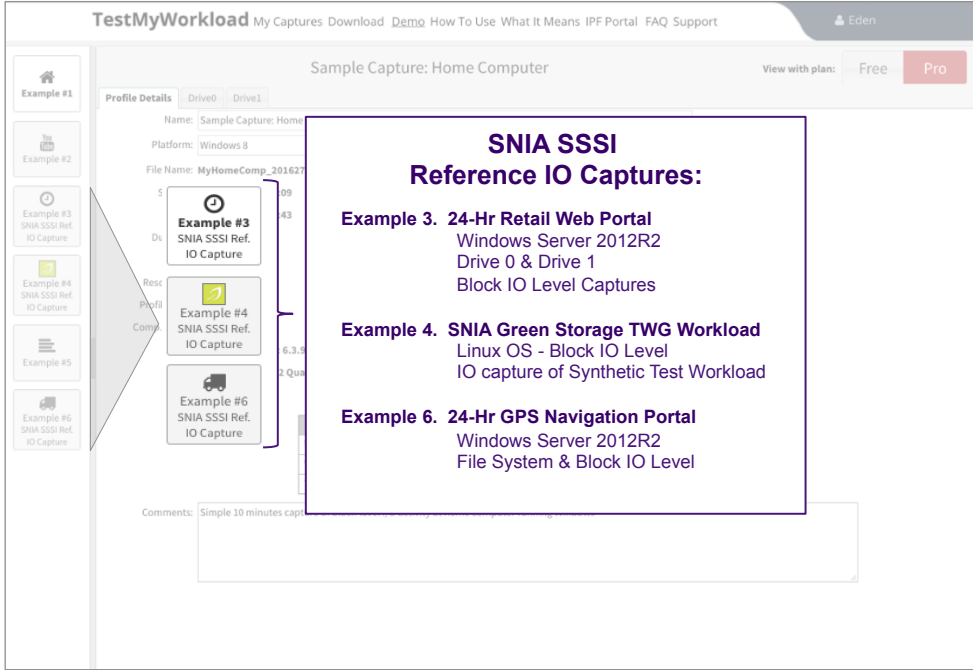- ❖ **Datacenter Storage**
- ❖ **Standard RWSW Tests**
- ❖ https://www.snia.org/rwsw

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Free Capture Tools & Demos at TestMyWorkload.com
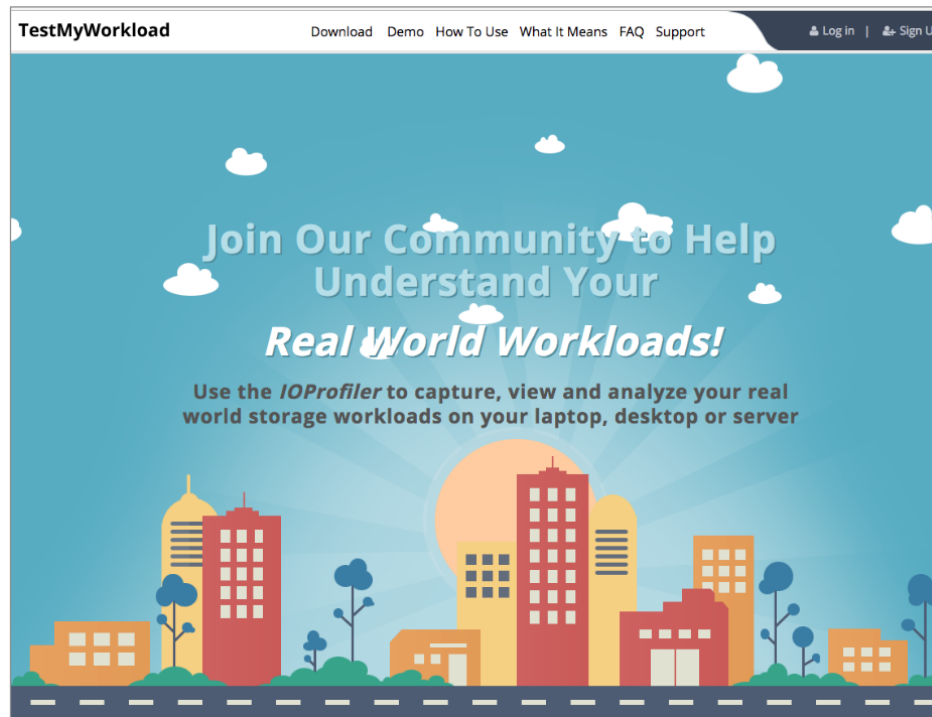
www.TestMyWorkload.com

- ❖ **www.TestMyWorkload.com** – **SSSI reference** site for Real World Workload **captures** and free cross platform **IO Capture tools**

- ❖ **Free Capture Tools include:**
  - ◆ Blk-Trace, Perfmon, D-trace, IOProfiler

- ❖ **Free IOProfiler Capture tools at www.TestMyWorkload.com:**
  - ◆ Windows, Linux, MacOS
  - ◆ Free visualization of captured workloads
  - ◆ Free export of IO data for use in 3d party software

SSSI Reference Captures No. 3, 4 & 6

SNIA SSSI
Reference IO Captures:

**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

- **Example 3:** 24 Hr Retail Web Portal

- **Example 4:** SNIA Green Storage TWG Workload

- **Example 6:** 24 Hr GPS Navigation Portal

www.testmyworkload.com/info/demo

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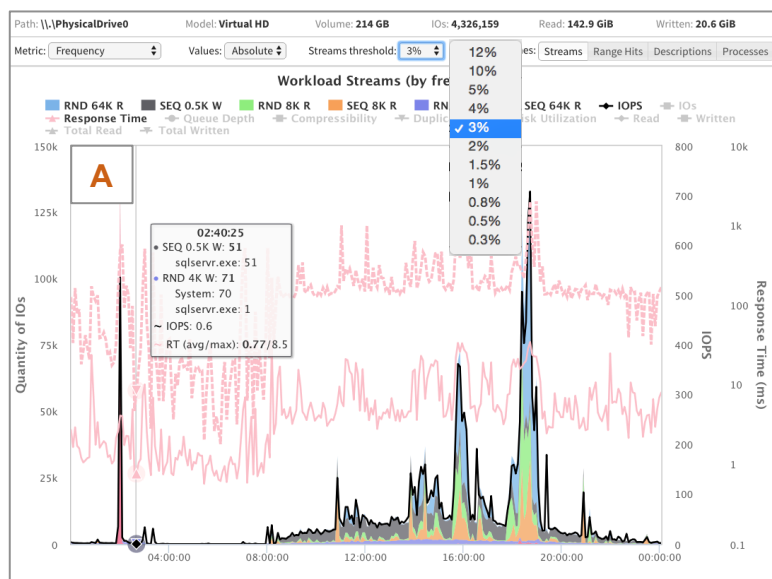# IO Stream Map, Processes, Cumulative Workload
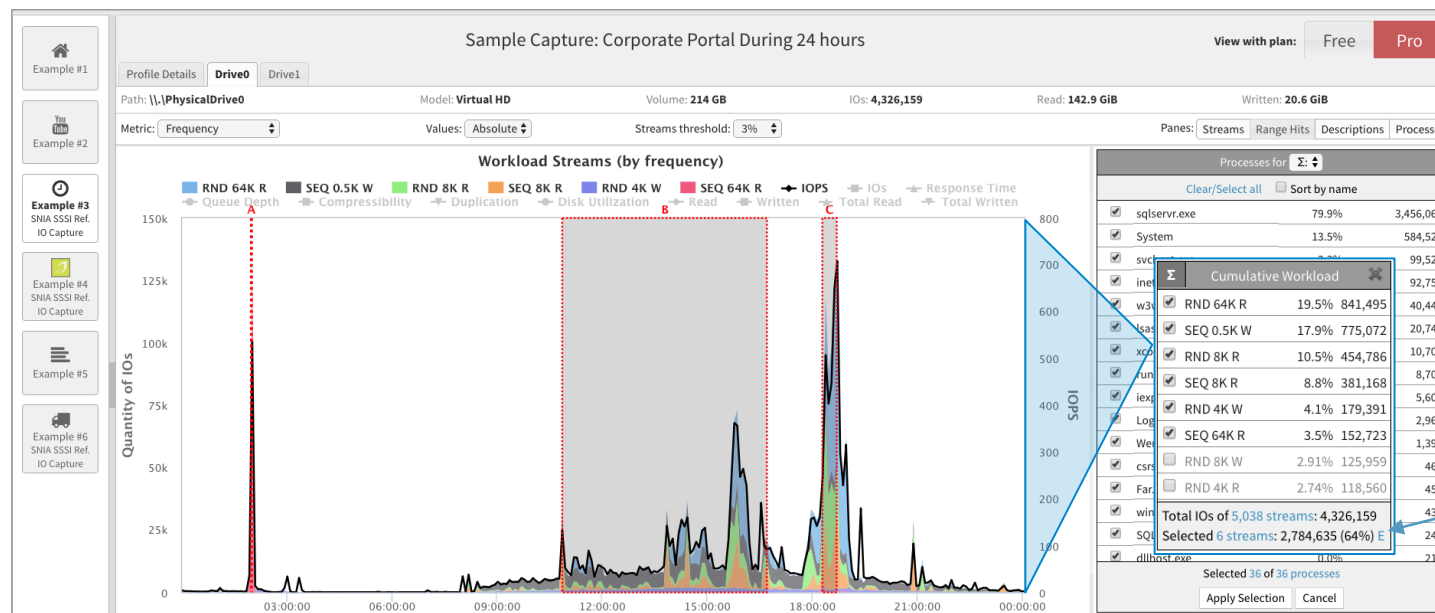
◆ **Example No. 3:** IO Stream Map and Process IDs

◆ **Cumulative Workload:**
6 IO Streams of 5,038 IO Streams 64% of IOs 2,784,635 IOs of 4,326,159 IOs

◆ **Export IO Stream Steps** to csv file

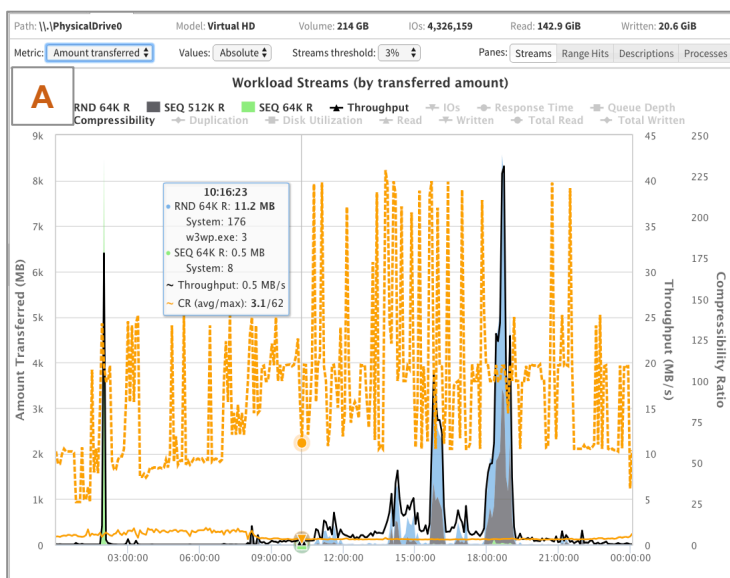# Analytics: IOPS or MB/s, Latency, Queue Depth

A IO Stream Map by Frequency – IO Rate in IOPS
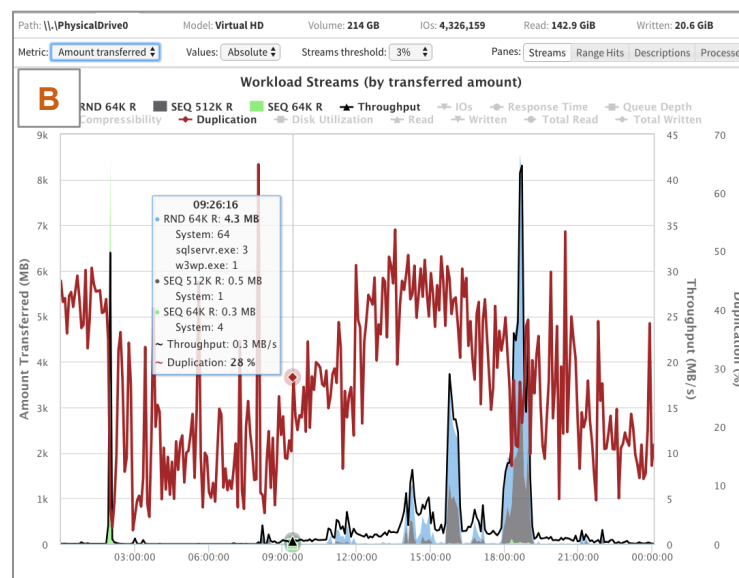
IOPS, Ave/Max Response Times, 3% Threshold

B IO Stream Map by Amount Transferred – Throughput in MB/s

MB/s, Ave/Max Queue Depth
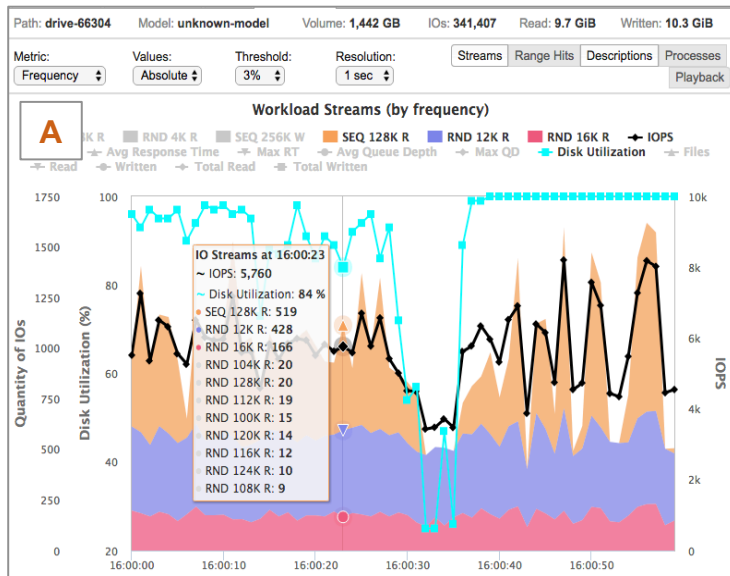
Analytics: Compression & Duplication Ratios

A **Compression Ratio: How much more compressible is data**

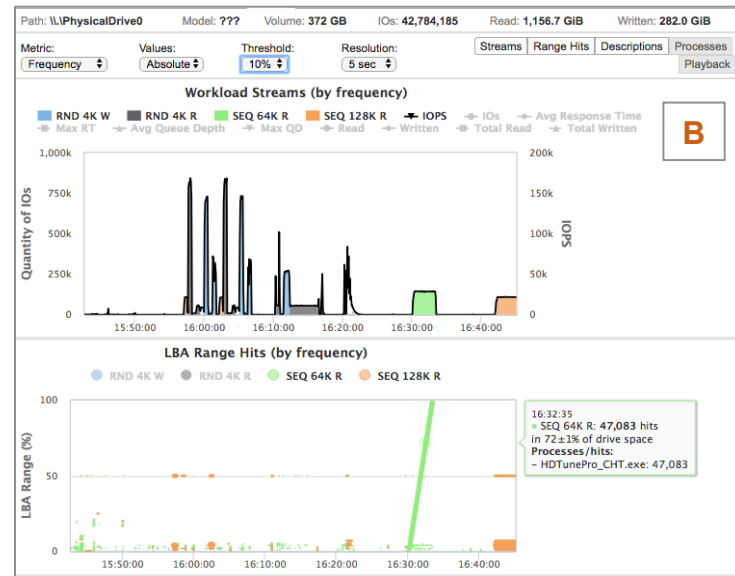**CR of 3.1 means data can be compressed 3.1 Times MORE**

B **Duplication Ratio – How many duplicative blocks are written**

DR of 28% means that 28% of written blocks are duplicates

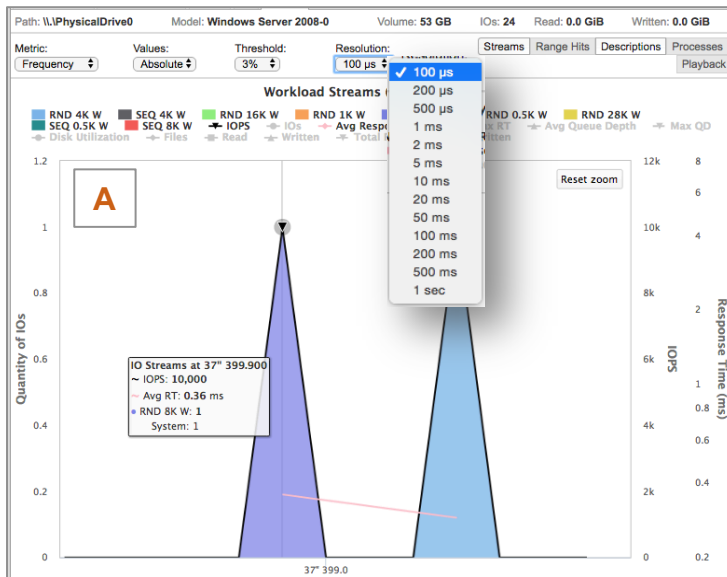# Analytics: Disk Utilization & IO Sequentiality

A Disk Utilization: IOs and Disk IO Idle Times

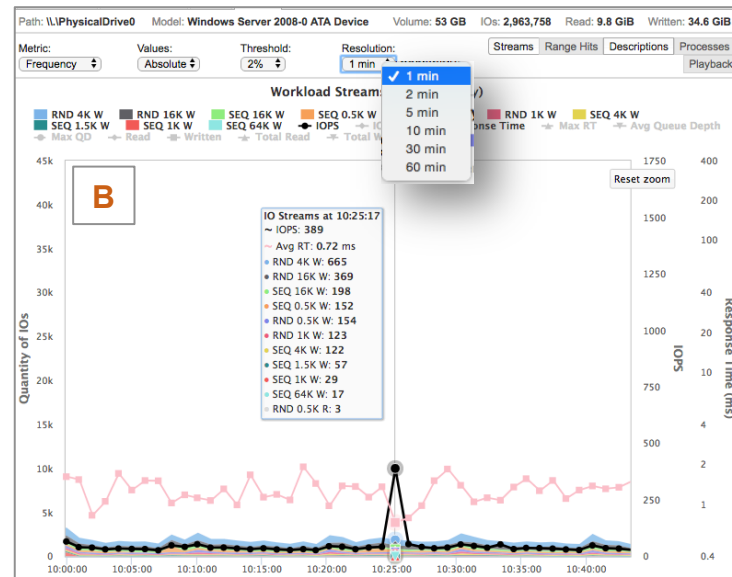   Disk Utilization of 84% = 16% Disk IO Idle

B IO Sequentiality – Adjacent LBA Range Hits

    Diagonal LBA Range Hit lines indicate Sequential IOs
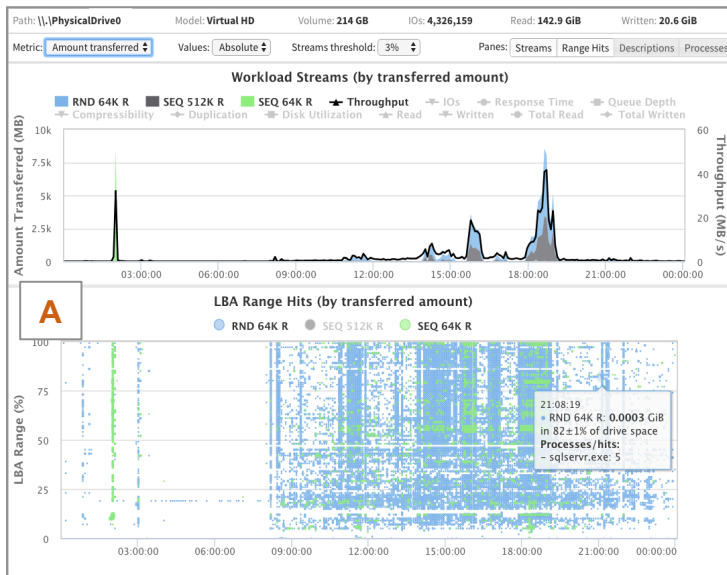
Temporal Granularity: IO Capture Step Resolution

A **Fine Grain: 100 uS; 1 min Capture; Single IOs**

   IO Bursts, Disk Utilization, IO Specificity

B **Coarse Grain: 1 Min; 24 hr Capture; 100's of IOs**

   Long Term workload characterization

LBA Range Hit Map: Spatial Locality of Reference
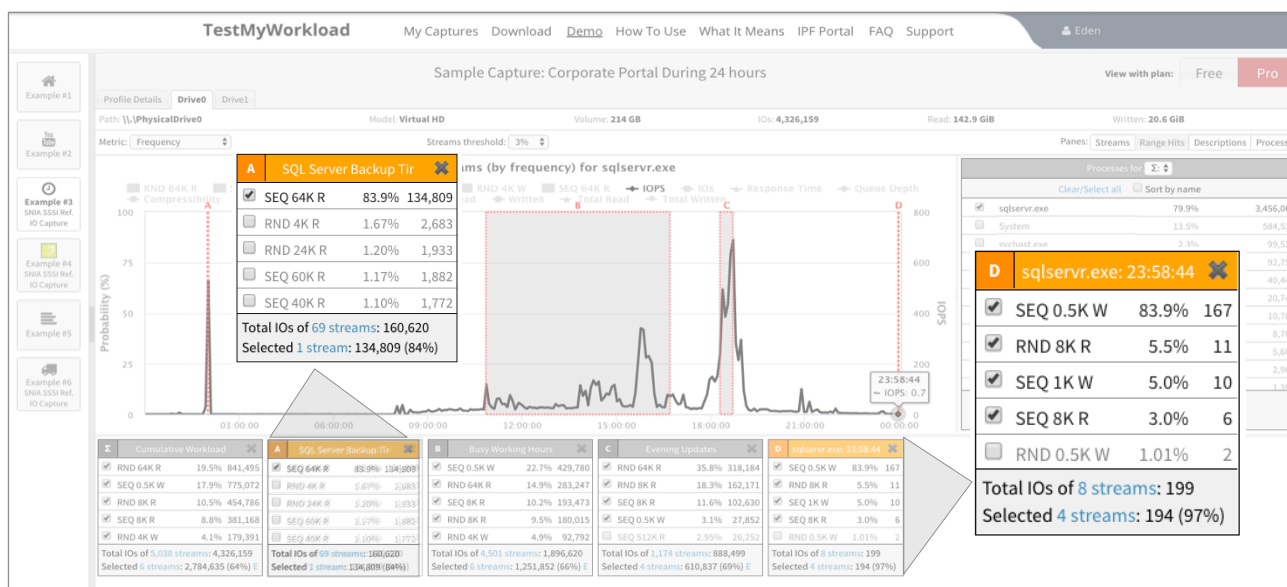

A LBA Hit Range – by Transferred Amount (MB/s)
   IO Hits selected by Size (Amount Transferred)

B LBA Hit Range – by Frequency (IOPS)
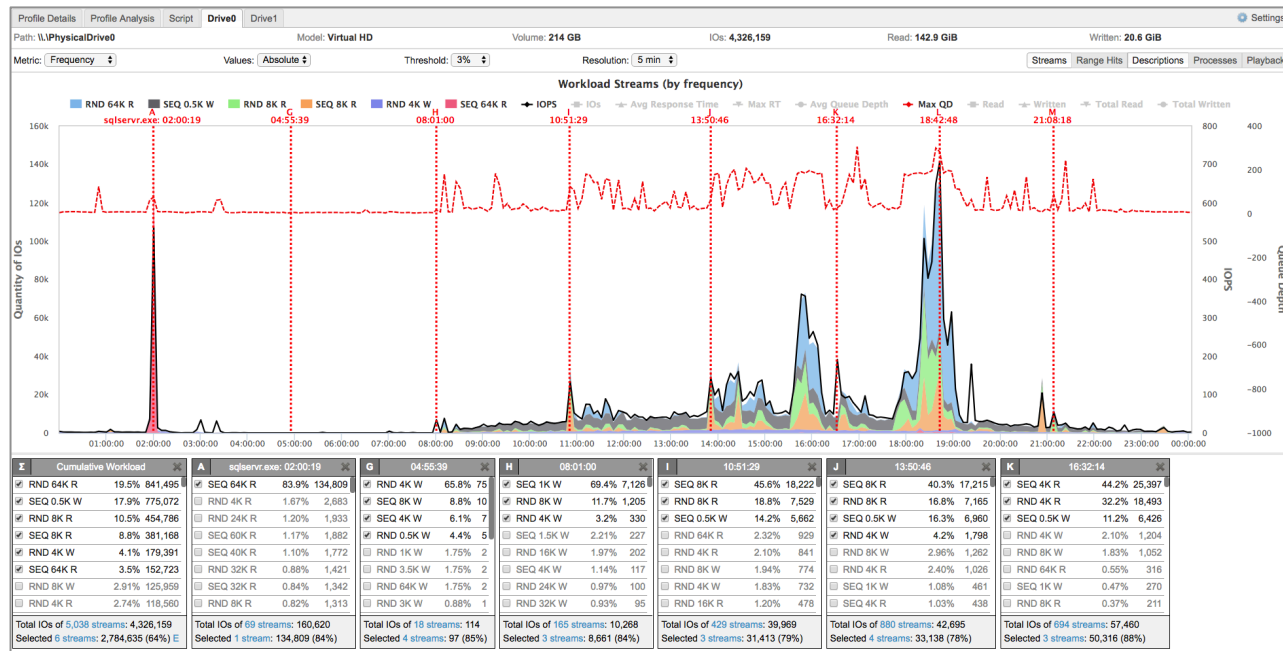   IO Hits selected by IO Rate (Frequency)

Defining Workload Segments

- ❖ **A: SQL Server Back up** – 83.9% SEQ 64K R; 1 of 69 IO Streams

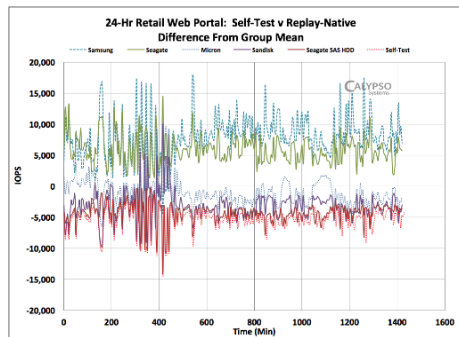- ❖ **D: 24 hr sqlserver.exe** – 79.9% of Total IOs, 4 of 194 IO Streams
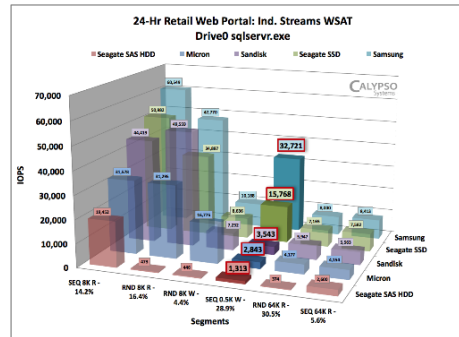
Creating a Workload & Script

- ❖ **Filter & Select the IO Stream Workload**
- ❖ **List IOs and Metrics for each Capture Step**
- ❖ **Selected points illustrate changing IO Streams & QDs for each Step of the Capture**
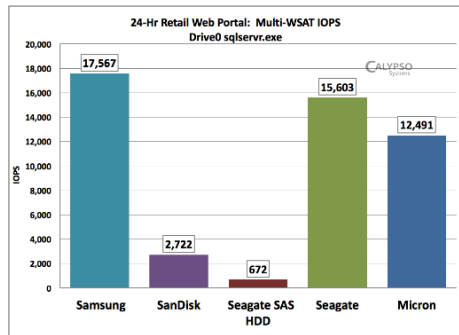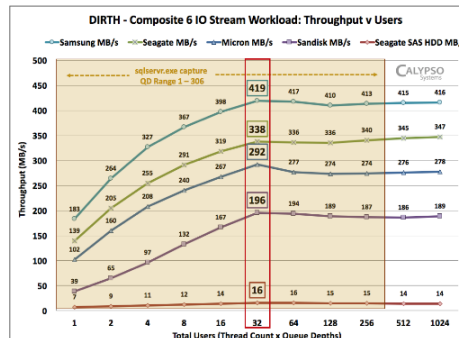
Tests from RWSW PTS

Replay-Native

Individual Streams-WSAT

Multi-WSAT

DIRTH

1. **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

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

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

4. **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

Flash Memory Summit

Questions?

Thank You!

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Chair SNIA SSS Technical Working Group

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www.TestMyWorkload.com