STORAGE PERFORMANCE BENCHMARKING: PART 5 – WORKLOADS

Mark Rogov, Dell EMC
Chris Conniff, Dell EMC

Feb 14, 2018
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.
SNIA at a glance

170 unique member companies

3,500 active contributing members

50,000 IT end users & storage pros worldwide

Learn more: snia.org/technical

@SNIA
About The Speakers

Chris Conniff
Dell EMC
Global Storage Portfolio
Business Manager
@chris_conniff

Mark Rogov
Dell EMC
Regional Storage Portfolio
Business Manager
@rogovmark

Tim Lustig
Mellanox
Director of Marketing
@tlustig
Storage Performance Benchmarking

METRICS AND TERMINOLOGY

FILE COMPONENTS

WORKLOAD DEFINITIONS

JULY 30, 2015

OCT 20, 2015

MARCH 8, 2016

OCT 20, 2016

IOPS MB/S RESPONSE TIME

SOLUTION UNDER TEST

BLOCK COMPONENTS

FILE COMPONENTS

INTRO CHAR COMMON FUN END

© 2018 Storage Networking Industry Association. All Rights Reserved.
<table>
<thead>
<tr>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
</tr>
<tr>
<td><strong>CHARACTER</strong></td>
</tr>
<tr>
<td><strong>COMMON</strong></td>
</tr>
<tr>
<td><strong>FUN</strong></td>
</tr>
<tr>
<td><strong>END</strong></td>
</tr>
</tbody>
</table>
Session 1 – Terminology and Context

**Terminology And Basic Concepts**

- **OPS**
  Count every protocol operation per second

- **IOPS**
  Count every IO operation per second

- **RESPONSE TIME**
  Time target takes to reply to an IO

- **MB/S**
  Payload sum of every operation per second

**Graph Fun**

- **CONTEXT MAKES METRICS MATTER**

© 2018 Storage Networking Industry Association. All Rights Reserved.
Session 2 – The Slowest Component Matters Most

**Slow Component Matters Most**

**Bottlenecks Always Exist**

**3 Performance Principles**

- Do Less Work
- Do Work Faster
- Increase Parallelism

**Components**

- Physical Storage
- Back-end Connect
- Storage Controller
- Front-end Connect
- Clients / Hosts

**Bottlenecks**

- **Disk Bound**
- **Client Bound**
Session 3 – Block Is The Foundation

- Random vs. Sequential Workloads
- Flash vs Disk Drive
- RAID Performance Implications
Session 4 – File Is More Complex

**FILESYSTEM BASIC METADATA STRUCTURE**

**FILE OPERATIONS RELATIONSHIP WITH BLOCK OPS**
What is a Workload?

APPLICATION WORKLOAD CHARACTERIZES HOW APPLICATIONS INTERACT WITH STORAGE
Agenda

INTRODUCTION

WHAT CHARACTERIZES A WORKLOAD?

COMMON WORKLOADS

GRAPH FUN WITH PERFORMANCE

SUMMARY
IO Size

APPLICATION

STORAGE

Data Flow

© 2018 Storage Networking Industry Association. All Rights Reserved.
LARGER IO SIZE = LESS IOPS
Read vs. Write

SSD or Flash

- **Write**: EVERYTHING IS RANDOM IO FOR FLASH
  - **Erase + Write**
  - **Read**

HDD or Disk Drive

- **Write**
  - **Sequential**: SEEK/SPIN
  - **Random**: SEEK/SPIN + WRITE

- **Read**
  - **Sequential**: SEEK/SPIN
  - **Random**: SEEK/SPIN + READ

RAID OVERHEAD

SLOWER PERFORMANCE
Read vs. Write

SSD OR FLASH

EVERYTHING IS RANDOM IO FOR FLASH

Erase + Write

Read

HIGHER WRITE % = MORE RAID OVERHEAD IMPACT

RAID OVERHEAD

SLOWER PERFORMANCE

HDD OR DISK DRIVE

SEEK

SPIN

WRITE

READ

SEQUENTIAL WRITE

READ

SEEK/SPIN + WRITE

SEEK/SPIN + READ

RAID OVERHEAD

SLOWER PERFORMANCE

© 2018 Storage Networking Industry Association. All Rights Reserved.
Random vs Sequential

Two Random Workloads

One Random, One Sequential

Workload 1

Workload 2

Workload 1

Workload 3
Detour: Game of prediction w/ numbers

Continue the sequence

7, 8, 9, … 10

2, 4, 8, … 16

3, 16, 8, … 5?

SEQENTIAL

SEQENTIAL

RANDOM
Random vs Sequential

Two Random Workloads

One Random, One Sequential

**MORE SEQUENTIALLY = LESS RANDOMNESS = BETTER PREDICTABILITY & HIGHER IOPS**
Workload Characteristics

- **IO**
- **Block Size**
- **R/W %**
- **Random vs. Seq %**
INTRODUCTION

WHAT CHARACTERIZES A WORKLOAD?

COMMON WORKLOADS

GRAPH FUN WITH PERFORMANCE

SUMMARY
Many Different Workloads

- **Database (OLTP)**
- **Virtual**
- **Data Warehouse (OLAP)**
- **Industry Specific**
- **VDA**
- **IoT**
- **VDI**
- **Software Build**
OLTP Database Workload

Design focus: Response Time (max transactions at min time)

STORAGE ARRAY

~80%
~20%

RANDOM

SEQUENTIAL

~8KB Block Size

25R% 75W% ~80% Random

TABLE SPACE

W W R W W

Most Frequent IO Size 8KB

Log

© 2018 Storage Networking Industry Association. All Rights Reserved.
OLAP Database Workload

Design focus: MB/s (read as much data as possible)
Virtual Workload

Hypervisor passes through OS & Application Workloads unchanged
Other Workloads

**VDA**

- **Large Block Size**
- **Mostly Writes***
- **Mostly Sequential**

*2 component workloads: one high writes, another high reads

**IoT**

- **Mix Block Size**
- **Mostly Writes***
- **Mostly Sequential**

*100s to 1000s component workloads: all writes coming from sensors

**VDI**

- **4-16KB Block Size**
- **50/50 Read/Write**
- **Very Random**

*VDA: Virtual Desktop Infrastructure, IoT: Internet of Things, VDI: Virtual Desktop Infrastructure*
## Agenda

<table>
<thead>
<tr>
<th>INTRO</th>
<th>INTRODUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARACTER</td>
<td>WHAT CHARACTERIZES A WORKLOAD?</td>
</tr>
<tr>
<td>COMMON</td>
<td>COMMON WORKLOADS</td>
</tr>
<tr>
<td><strong>FUN</strong></td>
<td>GRAPH FUN WITH PERFORMANCE</td>
</tr>
<tr>
<td>END</td>
<td>SUMMARY</td>
</tr>
</tbody>
</table>
What workload is this?

Storage Performance

Response Time, ms vs IOPS
What workload is this?

Storage Performance

Time, hours

Response Time, ms

IOPS
IO data

Average IO size may not be the predominant IO size
Avg. Writes 5817 or 75%
Avg. Reads 1822 or 25%
Randomness

Random vs. Sequential

Percentage, %

Time

Random

Seq

Avg. 75%
What workload is this?

8KB Block Size

25R%

75W%

75% Random

Database (OLTP) Workload
Agenda

INTRO  INTRODUCTION
CHARACTER  WHAT CHARACTERIZES A WORKLOAD?
COMMON  COMMON WORKLOADS
FUN  GRAPH FUN WITH PERFORMANCE
END  SUMMARY
After This Webcast

- A PDF and a PPT of the slides for this and all previous parts of this Webcast series will be posted to the SNIA Ethernet Storage Forum (ESF) website and available on-demand
  - PPT and PDF: [http://www.snia.org/forums/esf/knowledge/webcasts](http://www.snia.org/forums/esf/knowledge/webcasts)
  - Presentation Recording: [https://www.brighttalk.com/webcast/663/297859](https://www.brighttalk.com/webcast/663/297859)
  - A full Q&A from this webcast, including answers to questions we couldn't get to today, will be posted to the SNIA-ESF blog [http://sniaesfblog.org/](http://sniaesfblog.org/)

- Follow us on Twitter @SNIAESF, @RogovMark, @KenCantrellJr, @alextangent, @DrJMetz, @Chris_Conniff, @tlustig

- Please rate this webcast. We value your feedback.
- Thank you!
THANK YOU!