Workload Acquisition for the Enterprise Data Center

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Hard Problems You’re Trying to Understand

- How to most accurately test all solid state storage arrays
- Approaches for assessing storage performance
- How to select the best methodology for YOUR application(s)
- Find proven strategies to help avoid over-spending
Application Emulation

- The best way to test all solid state arrays is to emulate real applications
- Important application stream characteristics
  - Temporal locality
    - When data is written/read
  - Spatial locality
    - Where data is written/read
  - Data content patterns
    - Random or compressible
    - Some patterns repeat more than others
- These characteristics are critical to understanding SS array performance
The Journey: How Did we Get Here?

- Storage testing was black art
- Testing programs derived from disk drive utilities
  - Did not represent actual applications
  - Could not emulate spatial temporal or spatial locality
  - Did not emulate Data Content
- Difficult to emulate the varying load on many LUNs
- Difficult or impossible to configure the metadata and structure required to emulate file-based apps
The World has Changed – Don’t Miss It

- Before flash, disk drives were the storage performance bottleneck
  - Short-stroking and other techniques helped but were inadequate
  - Data reduction rarely used because it added to transaction times

- Solid state memory technologies change this model
  - Read access time is unaffected by data location
  - Any location can now be accessed as quickly as any other
Writing to Solid State Arrays

- Solid state memory has a limited number of write cycles
- Therefore, modern solid state storage arrays avoid writing
- Write access is very different than read access
- Flash write access time is implementation dependent
  - Sequential writing may be impacted
  - Random writing can impact garbage collection
- Data reduction processing may require post-processing
  - But typically does not affect write speed
How is Flash Different?

- Addressable storage space is likely less than raw space
  - May help avoid performance issues during garbage collection
  - Other methods are available to avoid performance issues
  - Can help increase flash life
- Deduplication & compression decrease storage requirements for an app
  - More storage per nominal byte
  - But, performance may be impacted
- Advanced metadata processing & workload profiles at scale make it harder to saturate an array
  - Test at near full capacity to understand array performance
- Testing with hotspots helps model application behavior
  - Garbage collection or metadata processing may affect performance
- Software services & protocols – software runs differently on SSD than on HDD
SS Arrays Require New Storage Testing Methods

- Applications exhibit spatial and temporal locality
  - Modern solid state arrays are designed with this in mind
- Application traffic contains data content
  - Data is random or compressible
  - Data may also be de-duplicatable
  - All content types are present in most applications
- Some all solid-state storage arrays must be tested with locality
  - Data reduction is a key feature - can’t be turned off
  - Legacy testing apps cannot emulate the locality, content or content flocking present in applications
- New thinking and testing applications are mandatory!
Storage Performance

- Vendors have good stories, but don’t confuse marketing with reality
- Vendors endorse performance testing with your workloads, derived from production environments, via synthetic workloads
- Vendors and standards organizations produce benchmarks, but they are guidelines at best
- Benchmarks don’t offer configuration guidance – and don’t represent your workloads
Why Performance Testing is Important

- Which is the best technology for my needs?
- Which is the best vendor / product for my needs?
- What is the optimal configuration for my array?
- Does performance degrade with enterprise features:
  - Deduplication
  - Compression
  - Snapshots, Clones, Replication
- What are the performance limits of a potential configuration?
- How does an array behave when it reaches its performance limit?
- Does performance degrade over time?
- Which workloads are best for an AFA? A hybrid storage array?
Why Performance Testing is Important

CAUTION

THIS SIGN HAS SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN

ALSO, THE BRIDGE IS OUT AHEAD
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Traditional Storage Testing Approaches

- Limits finding
- Functional testing
- Error Injection
- Soak testing
Storage Performance Validation
2 core methodologies

- **Workload Modeling**
  - Simulate the I/O profiles of your production environment

- **Performance Profiling**
  - Fully characterize performance of arrays under wide variety of load parameters
Performance Profiling for Vendors

Performance Profiling

- Characterization under a wide range of workload conditions
- Understand sweet spots and weaknesses of an array
- Sometimes referred to as “4 corners” or “limits” testing, but you can do much more than that
- Vendors need these tests to validate portions of a storage array
- IT customers do not generally benefit from this testing
  - Applications don’t act like performance profiles
  - Some exceptions; e.g. queue depth or outstanding commands
## Performance Profiling

### Iteration Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>Selected Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Pattern - Read %</td>
<td>0, 20, 40, 60, 80, 100</td>
<td>X</td>
</tr>
<tr>
<td>I/O - Constant Request Size</td>
<td>4KB, 8KB, 16KB, 32KB, 64KB</td>
<td>X</td>
</tr>
<tr>
<td>Port - Tx Queue Depth (FC only)</td>
<td>1, 2, 4, 8, 16, 32, 64, 128</td>
<td>X</td>
</tr>
<tr>
<td>Load - Throughput Value</td>
<td>1MB, 5MB, 10MB</td>
<td>X</td>
</tr>
<tr>
<td>Data Reduction - Uncompressed to compressed ratio</td>
<td>2.0, 1.5</td>
<td>X</td>
</tr>
</tbody>
</table>

Number of configured iterations: 1440
Performance Profiling

Fibre channel performance

Started by admin

1:00:05:15

Last Log Record: 2015-01-26 11:38:35 AM | Success | Test Suite finished

Iteration Results

<table>
<thead>
<tr>
<th>#</th>
<th>Status</th>
<th>Duration</th>
<th>Access Pattern - Read %</th>
<th>I/O - Constant Request Size</th>
<th>Port - Tx Queue Depth (FC only)</th>
<th>Load - Throughput Value</th>
<th>Data Reduction - Uncompressed to compressed ratio</th>
<th>SCSI Throughput (average)</th>
<th>SCSI I/Os Succeeded/sec (average)</th>
<th>SCSI Average Response/Latency Time (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>Finished</td>
<td>01:01</td>
<td>0</td>
<td>4KB</td>
<td>128</td>
<td>10MB</td>
<td>1.5</td>
<td>8.3 MB/sec</td>
<td>2115.387</td>
<td>6 ms</td>
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<tr>
<td>47</td>
<td>Finished</td>
<td>01:00</td>
<td>0</td>
<td>4KB</td>
<td>128</td>
<td>10MB</td>
<td>2</td>
<td>8.0 MB/sec</td>
<td>2044.602</td>
<td>.7 ms</td>
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<tr>
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<td>0</td>
<td>4KB</td>
<td>64</td>
<td>10MB</td>
<td>1.5</td>
<td>7.5 MB/sec</td>
<td>1921.051</td>
<td>.5 ms</td>
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<td>10MB</td>
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<td>7.2 MB/sec</td>
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<td>.9 ms</td>
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<td>32</td>
<td>10MB</td>
<td>2</td>
<td>6.5 MB/sec</td>
<td>1663.073</td>
<td>.3 ms</td>
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<td>0</td>
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<td>10MB</td>
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<td>6.3 MB/sec</td>
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<td>6.2 MB/sec</td>
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<tr>
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<td>64</td>
<td>10MB</td>
<td>2</td>
<td>6.1 MB/sec</td>
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<td>.1 ms</td>
</tr>
<tr>
<td>287</td>
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<td>01:01</td>
<td>20</td>
<td>4KB</td>
<td>128</td>
<td>10MB</td>
<td>2</td>
<td>6.1 MB/sec</td>
<td>1545.593</td>
<td>.7 ms</td>
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</tbody>
</table>
Workload Modeling

Performance Profiling
Fully characterize performance of arrays under wide variety of load parameters

Workload Modeling
Simulate the I/O profiles of your production environment
Workload Modeling

▸ Stresses an array using a realistic simulation of the specific production workload/s
  • For IT customers, from your current environment
  • For vendors, using customer examples or “dog food”

▸ Realism is paramount – realistic I/O profiles

▸ Packet traces offer limited utility in testing
  • Huge volume of data
  • Short Duration
  • Security concerns
Workload Modeling

Performance Comparison: NAS Vendor A vs. NAS Vendor B

Vendor A: Shallow Tree Structure (2014-03-21: 11:05:05 AM)
Vendor B: Shallow Tree Structure (2014-03-20: 12:48:12 AM)
Vendor B: Deep Tree Structure (2014-03-20: 12:45:36 AM)
Where Does Workload Modeling Come From?

- Customers ask for workload models
  - IT customers want models of their workloads
  - Vendors want “the” workload
    - Oracle, Exchange, etc.
- IT customers ask to help make better decisions about:
  - Upgrading storage hardware or software
  - Changing storage network configuration
- Vendors ask for help to:
  - Test customer examples/issues
  - Find realistic scaling limits to test app growth over time
Result: A New Modeling Method

- Cloud-based workload modeling
- Community-based workload sharing
- Workload model that can be ingested into Virtual Networks load generation
- More realistic and scalable than benchmarks
Workload Central is a free cloud-based analytics platform and community that allows you to understand analyze, create and share workloads.

Available at: www.workloadcentral.com

- Key Features:
  - Free workload analysis & creation
  - Advanced workload analytics
  - Workloads for validation, testing & benchmarking
  - Workload Library, community & discussion
Uploading Your Workload Data

The Workload Importer offers:

- Ability to upload data from any vendor or environment
- Out of the box import policies
- Analysis policies provide flexibility to define different workloads
A free downloadable, printable report and dashboard that provides:

- Workload access pattern
- Workload behavior characteristics
- Workload performance
- Workload creation
Running a Block-Based Workload Model

Workload Modeling
Simulate the I/O profiles of your production environment
1. Characterize Workload I/O

- **Per-LUN I/O:**
  - Read-Write Mix
  - Random or sequential access
  - Hot spots and hot spot drift

- **Data Content**
  - Randomness
  - Compressibility
  - Unique vs. duplicated blocks
2. Determine Data Content Patterns

- **Data content patterns**
  - Created during preconditioning

- **Data content streams**
  - Created during preconditioning
  - Replayed during testing

- **Consist of repeating and non-repeating patterns**
  - Random
  - Compressible

- **Consist of varying pattern lengths**
3. Build I/O Models

- Decide when to model
- Boot storm
- Everyday office load
- Backups
- End of period processing
  - Month, Quarter, year end
- Test primary models individually
- Test periodic models on top of everyday load
- Magnify load to test expected maximums
4. Run Workload Models

- Run most common model(s) first
  - Determine baseline performance
- Add periodic models to common model
- Combine apps if appropriate and test together
5. Test Array Features

- Test effect of MPIO
- Test effect of maintenance / other management activities
- Test at or near full capacities
- Test effect of QoS
Test in an Iterative Manner

- Run
- Analyze
- Repeat as necessary
  - Change testing to reflect business conditions
Summary

- Performance assurance
- Reduced storage costs
- Increased uptime
- Acceleration of new application deployments
Summary

- Application Testing is now mandatory
  - Black art has become repeatable
- No synthetic workload is perfect
  - But is the best approach available
  - This will only improve over time
- Customers can see:
  - How closely the model emulates apps
  - A realistic view of how an array operates
- This new model is changing storage testing
Company Overview

Global Leader in Infrastructure Performance Analytics

- Founded in 2008
- HQ in San Jose, CA
- Global 2000 Customers
- Every Major Vertical
- 44 of the Fortune 100
- Merged with Load DynamiX in April 2016