LSI MegaRAID Controller Benchmark Tips

November 6, 2012
v9.0 Preliminary

Benchmark Review Requirements

- Providing the following information will improve our ability to support product evaluations
  - Summary of test cases you will be performing
  - System details and benchmark parameters listed on slide 3

- Questions regarding configuration and benchmark results should be addressed to:
  - LSI Technical Support
    - support@lsi.com
  - (For Product Evaluations)
  - Craig McCombs
    - craig.mccombs@lsi.com
  - James Evans
    - james.evans@lsi.com

Elements that Affect Performance

- System
  - Motherboard, Chip Set, BIOS, Processor, Memory
    - System chip set and memory speed can impact benchmark performance
    - Recommend 8-wide (x8) PCIe Generation-2 slot for all 6 Gb/s SAS benchmarks
  - Operating System with latest Service Pack and Updates
- RAID controller
  - Firmware, BIOS, driver version
  - Disk write cache policy setting
  - RAID level
  - Stripe size
  - Read and write caching policies
- Drives
  - Total number of drives/Drives per channel
  - Enclosure model + firmware
  - Drive interface (SATA, SAS) and Speed (i.e. 1.5Gb/s, 3Gb/s, 6Gb/s)
  - Make, model & firmware of drive
  - Class of the drive (e.g., HDD disk drive, SSD solid state, etc.)
- Benchmark Tool
  - Test profile (Request Size, Sequential Read or Write, Random Read or Write)

Tips

- Use the latest firmware & driver
  - Latest software can be downloaded from MegaRAID Downloads
- To configure the RAID Adapter and create logical arrays use either
  - CTRL-H utility during BIOS POST
  - Use MegaRAID Storage Manager™ (MSM) running from OS
- To achieve maximum sustained RAID controller throughput
  - For maximum bandwidth (MB/s) use 64KB or larger sequential requests
  - For maximum operations (IO/s) use 0.5KB to 8KB random requests
  - Connect enough drives to saturate the RAID controller to achieve maximum performance.
    - For example use 20 or more 15K SAS drives to achieve maximum bandwidth performance
  - Use all SAS channels connected to drives or drive enclosures
    - With multiple drive enclosures make sure drives evenly distributed across enclosures
  - Drive technology and cache size can significantly impact performance
  - Benchmark queue depth will impact performance. Recommend queue depth of 16 or greater

Standard Benchmark Tool

- IOmeter is a I/O performance analysis tool for servers and workstations
- Obtain latest IOmeter from Source Forge
  - IOmeter User's Guide IOmeter.org
  - Windows 32-bit and 64-bit versions available
  - Recommend using 2006 or later version
  - Different IOmeter versions use different data patterns and compressibility
- Throughput is measured in IO/sec and MB/sec
  - I/Os per second for random/transactional workloads
  - Megabytes per second for sequential/streaming workloads
- IOmeter performance testing article and test script examples
  - LSI Knowledge Base Article on IOMeter scripts
    - Link to knowledge base article http://mycusthelp.info/LSI/_cs/AnswerDetail.aspx?inc=8274
    - Article Includes links to IOmeter script examples
  - See also Appendix for basic IOmeter workload configuration examples

Recommended Settings For HDD Performance Testing

HDD DISK ENVIRONMENTS		RECOMMENDED SETTINGS		
RAID Type	I/O Benchmarking	RAID Write Cache	RAID Read Cache	Stripe Size
0	Transactional	Enabled	No Read Ahead	64KB - 256KB
1/10	Transactional	Enabled	No Read Ahead	64KB - 256KB
5/50	Transactional	Enabled	No Read Ahead	64KB - 256KB
6/60	Transactional	Enabled	No Read Ahead	64KB - 256KB
0	Streaming	Disabled	Always Read Ahead	256KB or higher
1/10	Streaming	Disabled	Always Read Ahead	256KB or higher
5/50	Streaming	Enabled	Always Read Ahead	256KB or higher
6/60	Streaming	Enabled	Always Read Ahead	256KB or higher

Recommended Settings For SSD Performance Testing

SSD DISK ENVIRONMENTS		RECOMMENDED SETTINGS		
RAID Type	I/O Benchmarking	RAID Write Cache	RAID Read Cache	Stripe Size
0	Transactional	Disabled	No Read Ahead	64KB
1/10	Transactional	Disabled	No Read Ahead	64KB
5/50	Transactional	Disabled	No Read Ahead	64KB
6/60	Transactional	Disabled	No Read Ahead	64KB
0	Streaming	Enabled	Always Read Ahead	64KB
1/10	Streaming	Enabled	Always Read Ahead	64KB
5/50	Streaming	Enabled	Always Read Ahead	64KB
6/60	Streaming	Enabled	Always Read Ahead	64KB

Read Policies

- **Always Read Ahead**
  - This specifies that the controller uses read-ahead if the two most recent disk accesses occurred in sequential sectors. If all read requests are random, the algorithm does not read ahead, however all requests are continually evaluated for possible sequential operation.

- **No Read Ahead**
  - Only the requested data is read and the controller does not read ahead any data

Write Cache Policies

- **Write-Through**
  - Caching strategy where data is committed to disk before a completion status is returned to the host operating system
  - Considered more secure, since a power failure will be less likely to cause undetected drive write data loss with no battery-backed cache present
  - Data is moved directly from the host to the disks, avoiding copying the data intermediary into cache which can improve overall performance for streaming workloads if Direct IO mode is set.

- **Write-Back**
  - A caching strategy where write operations result in a completion status being sent to the host operating system as soon as data is in written to the RAID cache. Data is written to the disk when it is forced out of controller cache memory.
  - Write-Back is more efficient if the temporal and/or spatial locality of the requests is smaller than the controller cache size.
  - Write-Back is more efficient in environments with “bursty” write activity.
  - Battery backed cache can be used to protect against data loss as a result of a power failure or system crash.

Data Placement Policies

- **Direct IO**
  - All read data is transferred directly to host memory bypassing RAID controller cache. Any Read Ahead data is cached.
  - All write data is transferred directly from host memory bypassing RAID controller cache if Write-Through cache mode is set
  - ***Recommended for all configurations***

- **Cached IO**
  - All read and write data passes through controller cache memory on its way to or from the host (including write data in write-through mode.)
  - ***Required ONLY for CacheCade v1.1 read-only caching, not recommended for CacheCade v2.x and higher or any other configurations***

Advanced Software Testing

- **MegaRAID Fast Path Software**
  - In order to use Fast Path software, the following requirements must be met:
    - The array must not have any cache enabled
      - No Read Ahead
      - Write Through
      - Direct I/O
    - The array must be in good health
      - Cannot be degraded or currently under rebuild
    - The Fast Path software key must be enabled

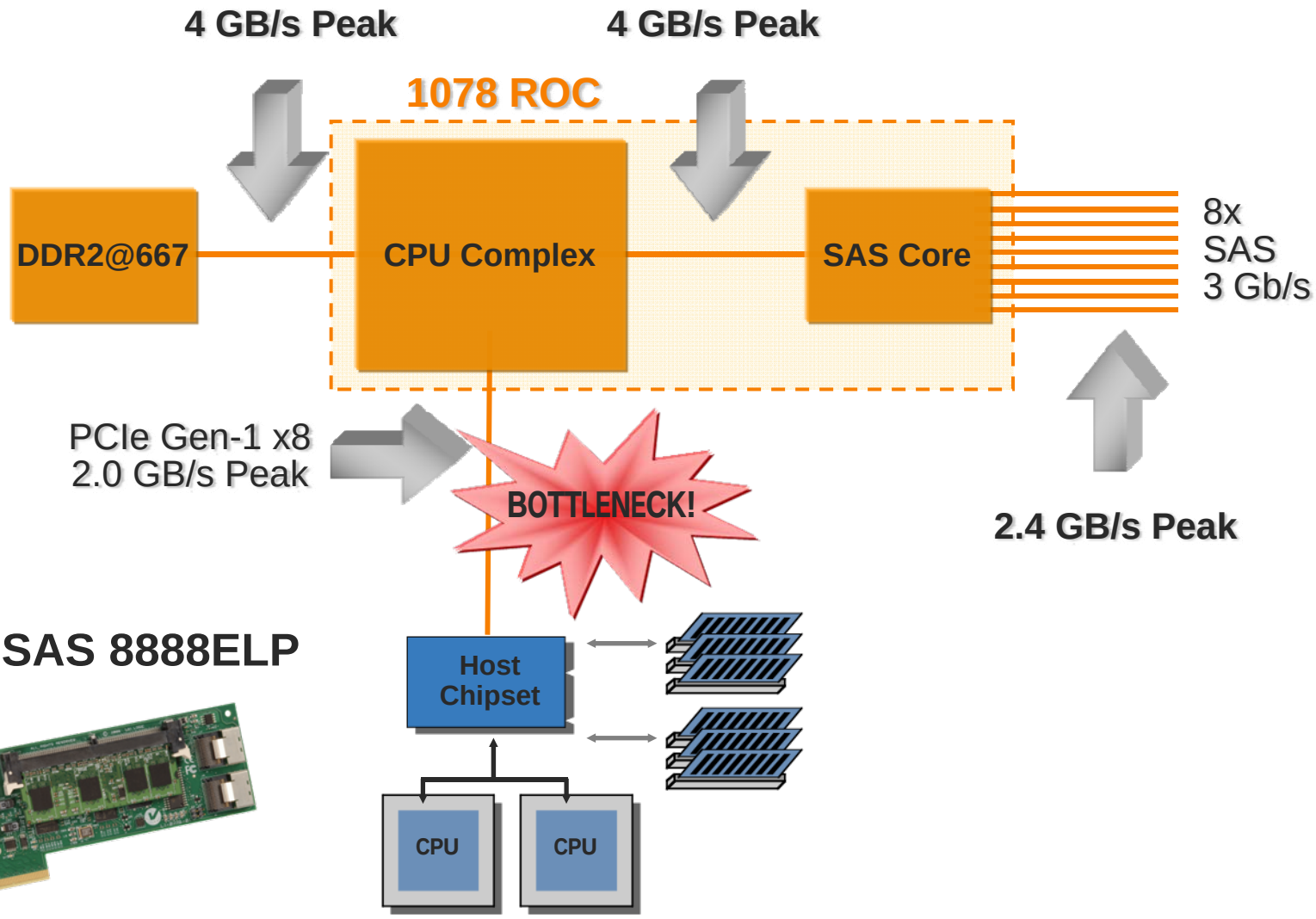
- **MegaRAID CacheCade™ Software**
  - In order to use CacheCade software, the following requirements must be met:
    - CacheCade software key must be enabled
    - Use recommended VD settings for drive type and IO workload profile
    - Only exception is use CIO (cached I/O mode) to enabled CacheCade v1.1 read-only caching

Performance Limits & Bottlenecks

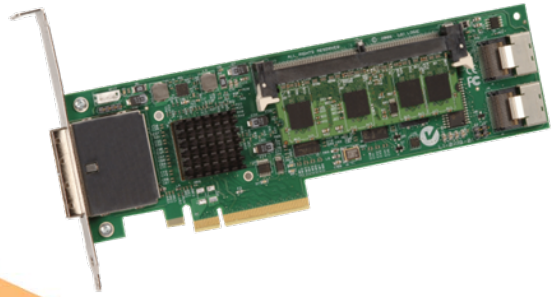
INTERCONNECT			
PCI Express	Lanes	Theoretical Bandwidth (Uni-Directional)	Practical Bandwidth (Uni-Directional)
Gen1	x4	1000	880
Gen1	x8	2000	1760
Gen 2	x4	2000	1600
Gen 2	x8	4000	3200
SAS	PHYs	Theoretical Bandwidth (Uni-Directional)	Practical Bandwidth (Uni-Directional) SAS/SATA
Gen 1	x1	150	105/130
Gen 1	x4	600	420/520
Gen 1	x8	1200	840/1040
Gen 1	x1	300	240/285
Gen 1	x4	1200	990/1140
Gen 1	x8	2400	1975/2280
Gen 2	x1	600	520/570
Gen 2	x4	2400	1975/2280
Gen 2	x8	4800	3950/4560
Disk Interface	Rotational Rate	Random IOPs	Media Rate (Sustained Sequential) MB/s
SATA	7200 RPM	70 - 175	60 - 150
SAS	10K RPM	275 - 300	100 - 175
SAS	15K RPM	350 - 450	125 - 200
SSD	N/A	15K - 180K	30 - 400

* Note: Disk IOPs and sustained MB/s are estimates and will change with host system, disk models, technology & drive revisions.

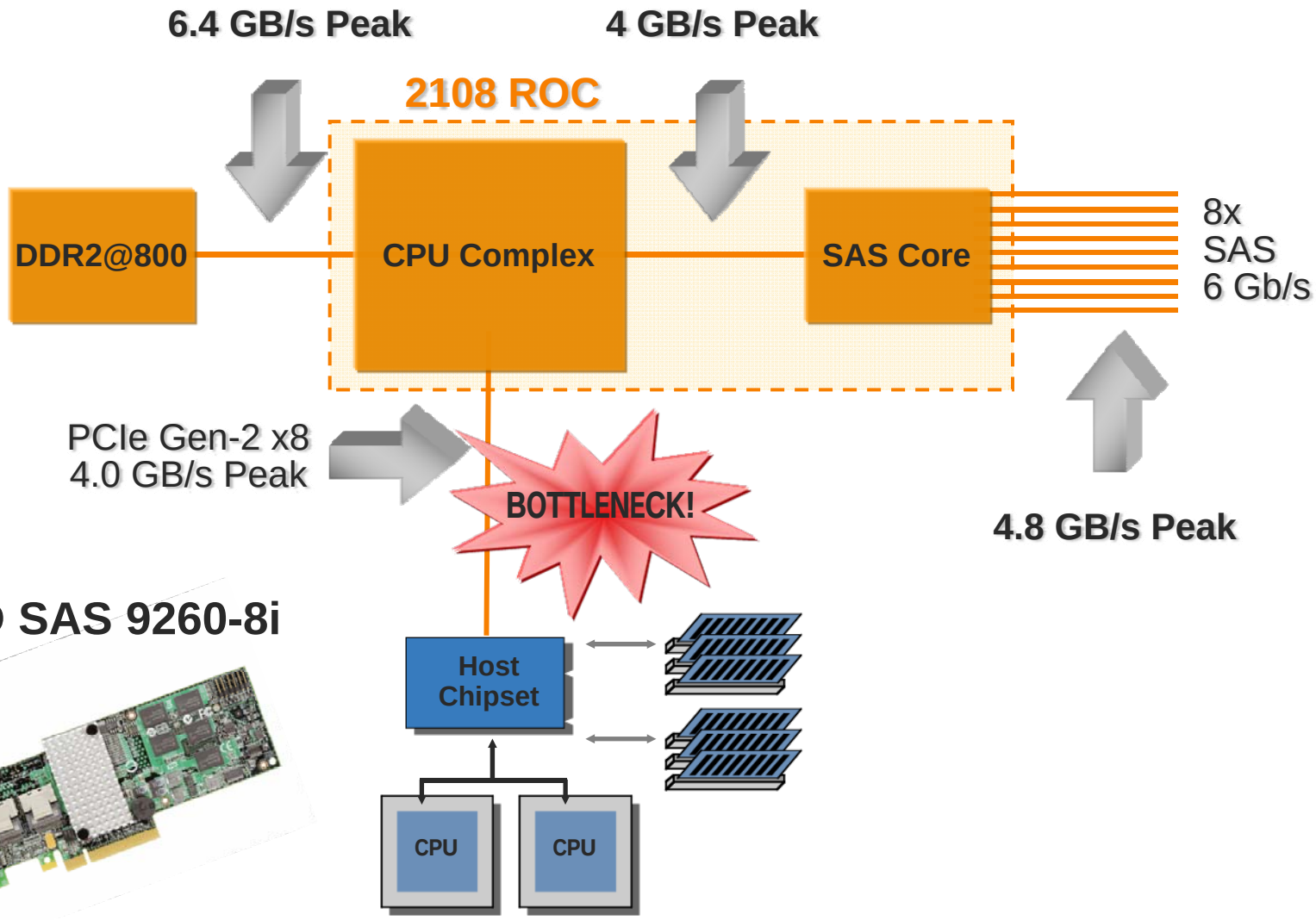
SAS 3Gb/s: 1078 ROC architecture



MegaRAID SAS 8888ELP

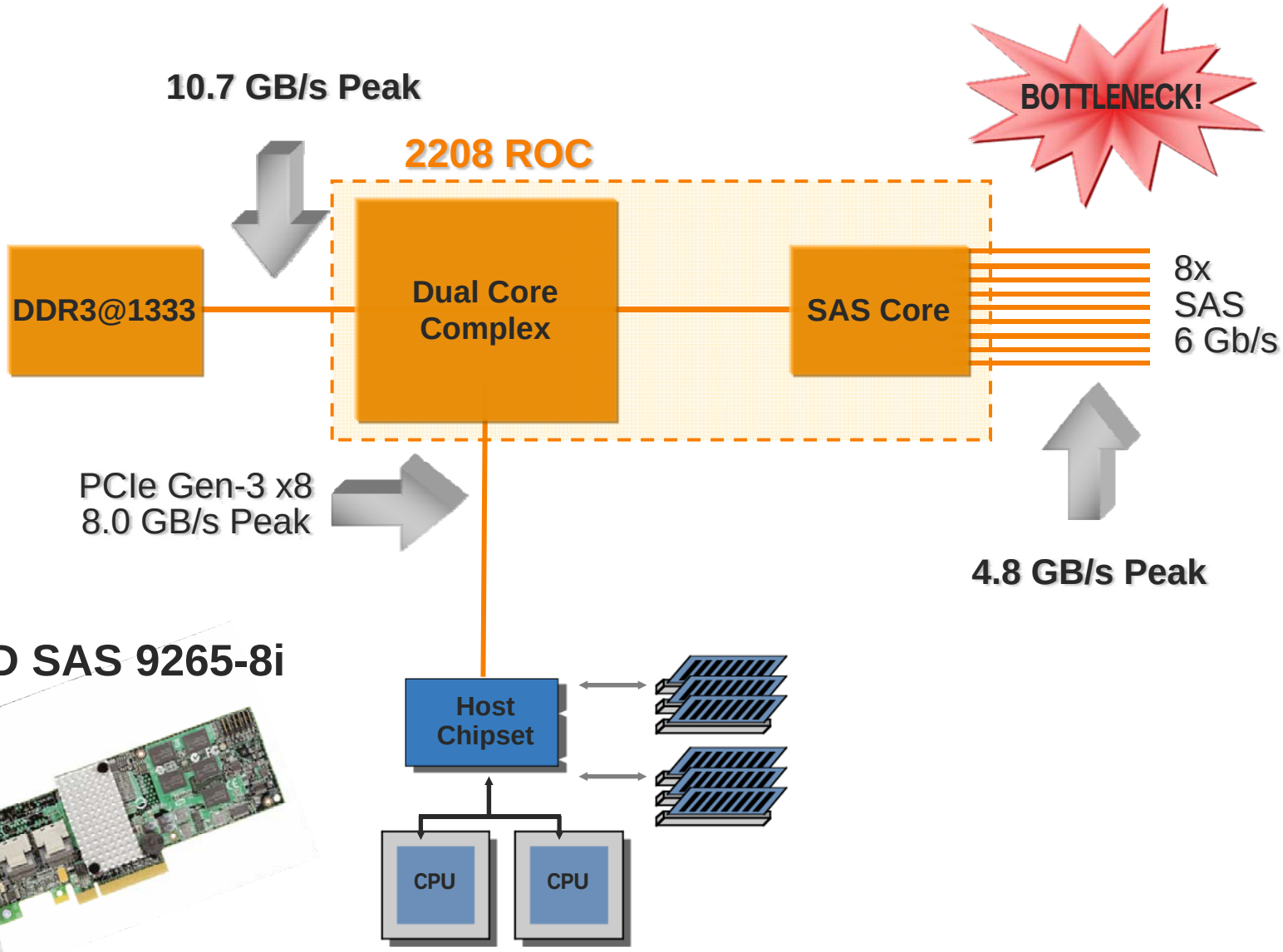


SAS 6Gb/s: 2108 ROC Architecture (Liberator)



MegaRAID SAS 9260-8i

SAS 6Gb/s: 2208 ROC Architecture (Thunderbolt)

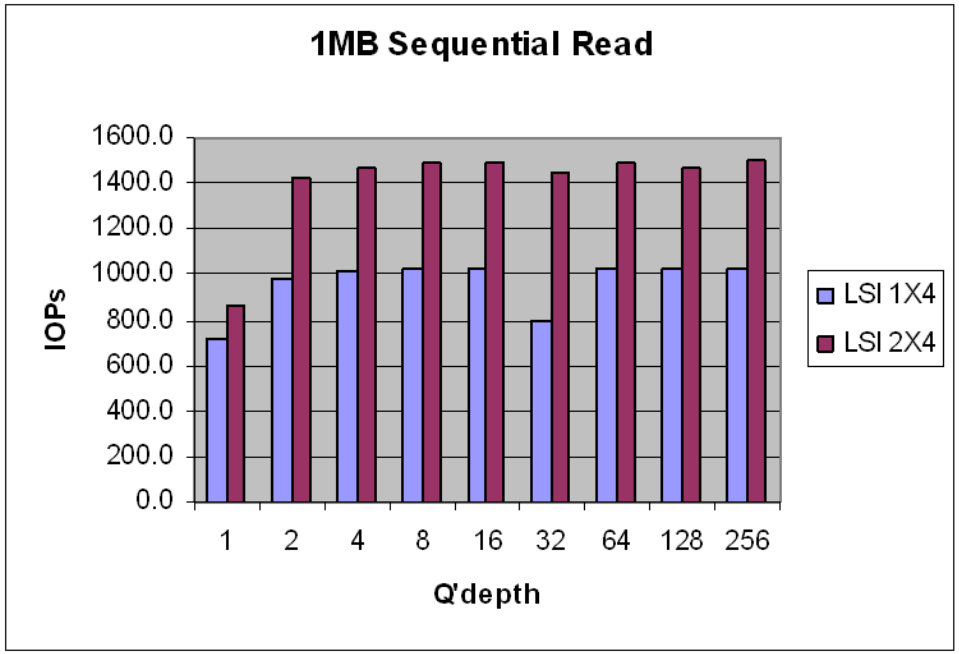


Multipath

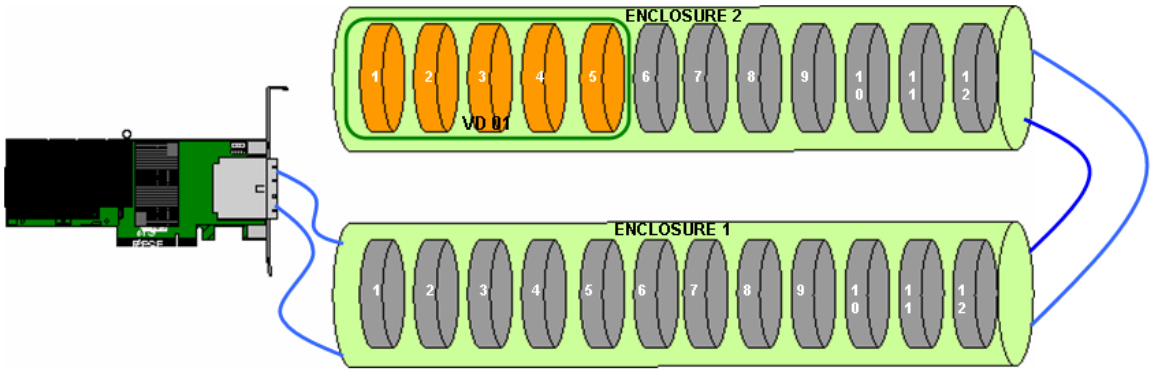
- Most of SAS drives have 2 SAS ports. Presence of more than one data path between SAS drive and RAID adapter is called multipath.
- SATA drive enclosures either alternate connection between two channels or utilize interposer devices providing multipath.
- Multipath can significantly increase performance for some applications (e.g., VTL/Backup and Media Streaming)

Performance Measurement with and without Multipath I/O (LSI 8888EM2 with 3Gb SAS)

•This chart of 3Gb/s MegaRAID controller benchmark results demonstrates dramatically improved performance in multipath environments.



Multipath Example



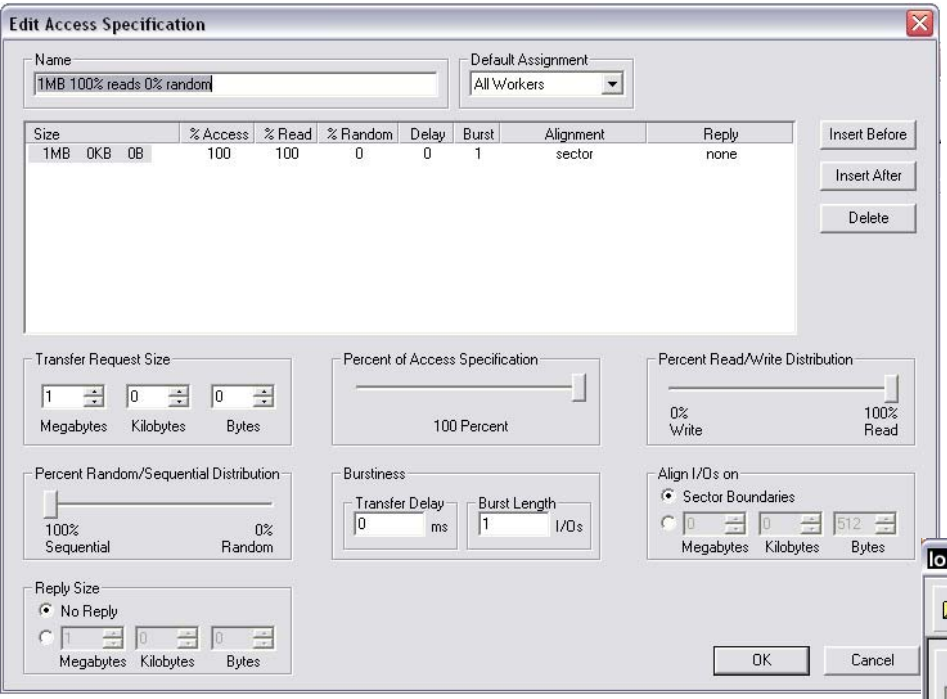
- Multipath provides two paths to each drive
- RAID controller utilizes both channels for transferring data
- RAID controller balances workload across both channels

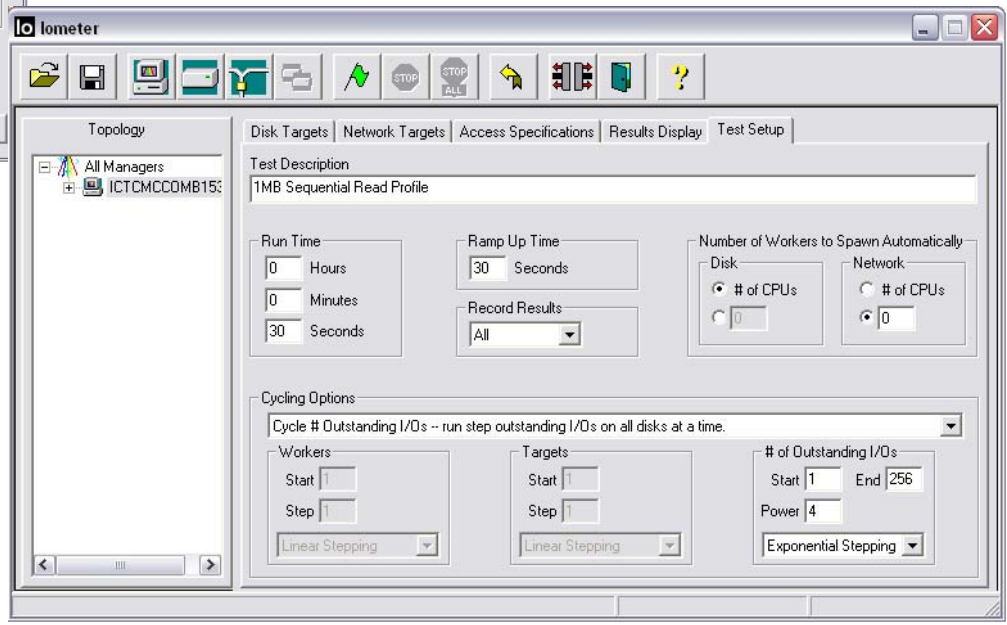
Multipath Impact

- Sequential IO
  - Significant performance gain on the sequential writes
  - Dual path configuration outperformed single path on big block (64K or bigger) sequential reads by 40%
- Random IO
  - Dual path configuration outperforms single path one by 5% on small block writes
  - No difference is seen on random reads
- Summary
  - Dual path implementation increases IO performance for VTL/Backup and Media Streaming applications.

Appendix: IOmeter Workload Profile Examples

1MB Sequential Read Profile



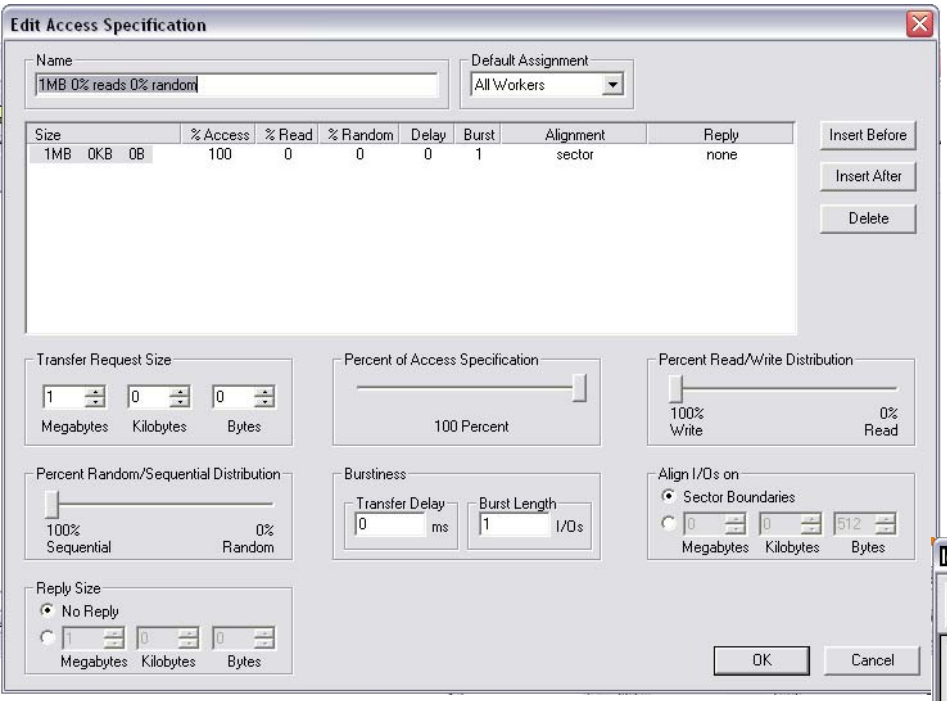


1. Use a single worker

2. Use IOmeter Maximum Disk Size (sectors) sufficiently large enough to ensure all volume drives are accessed

3. Use 64KB to 1MB transfer size

1MB Sequential Write Profile



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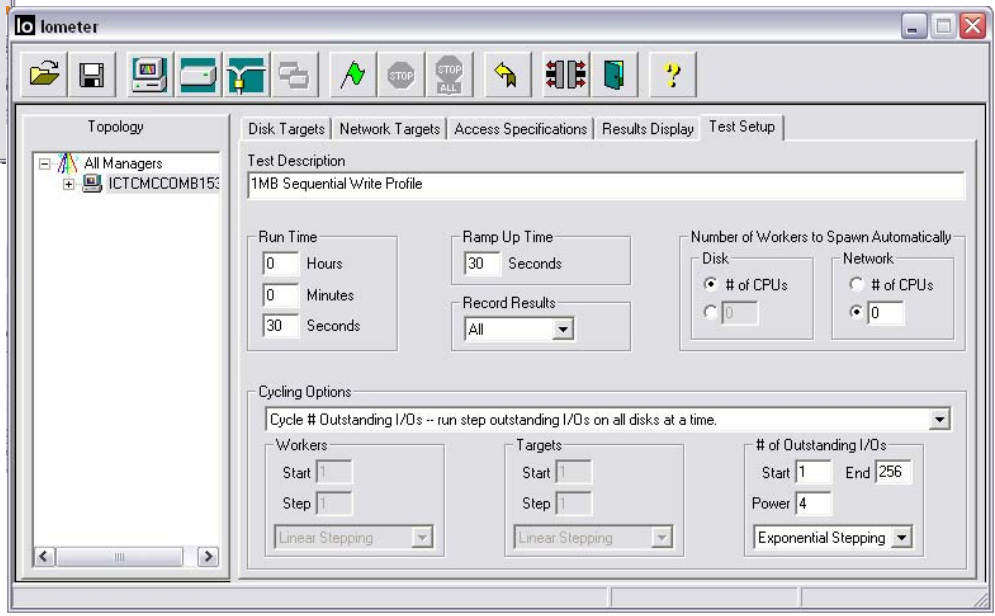
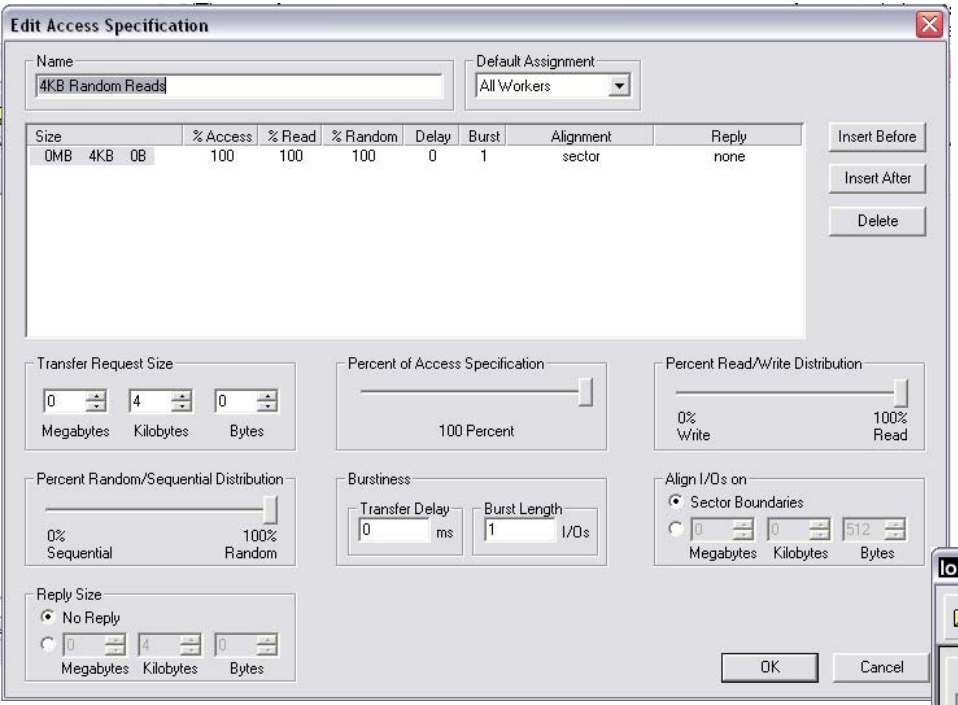
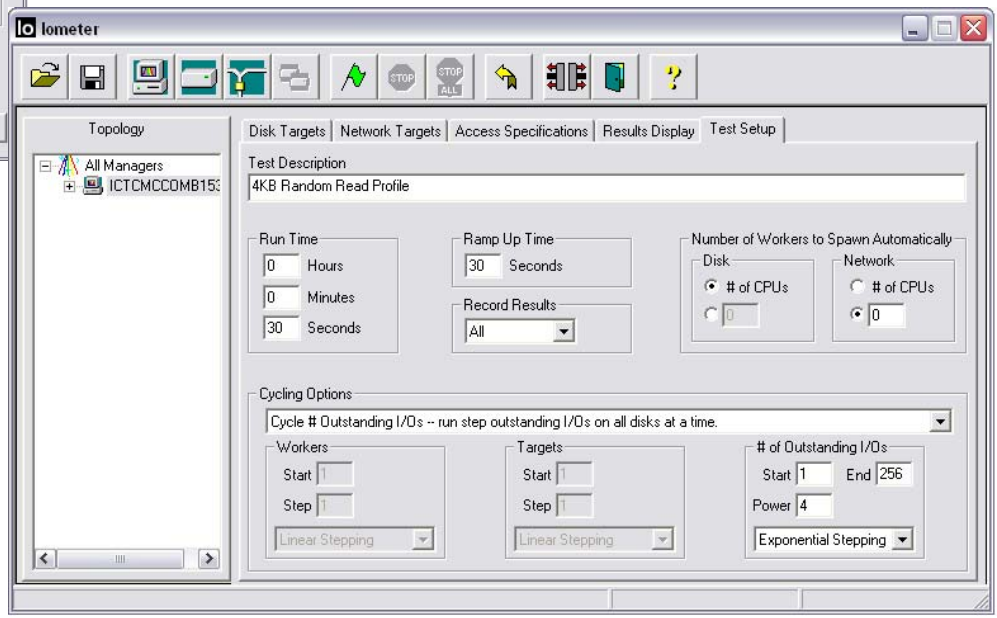


4KB Random Read Profile





1. Use one or more workers

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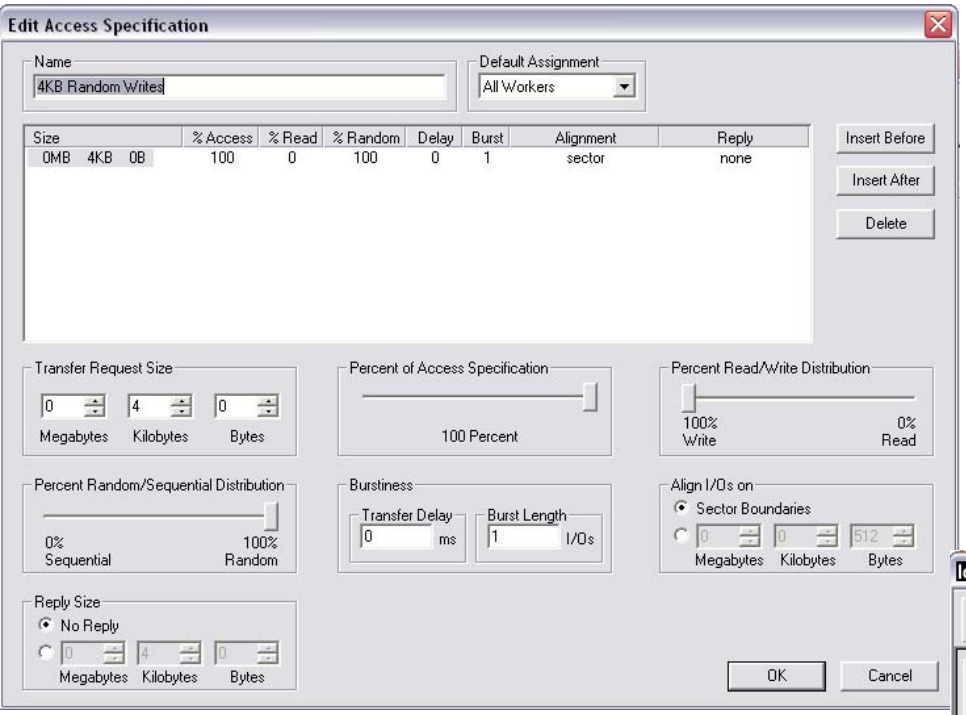
4KB Random Write Profile



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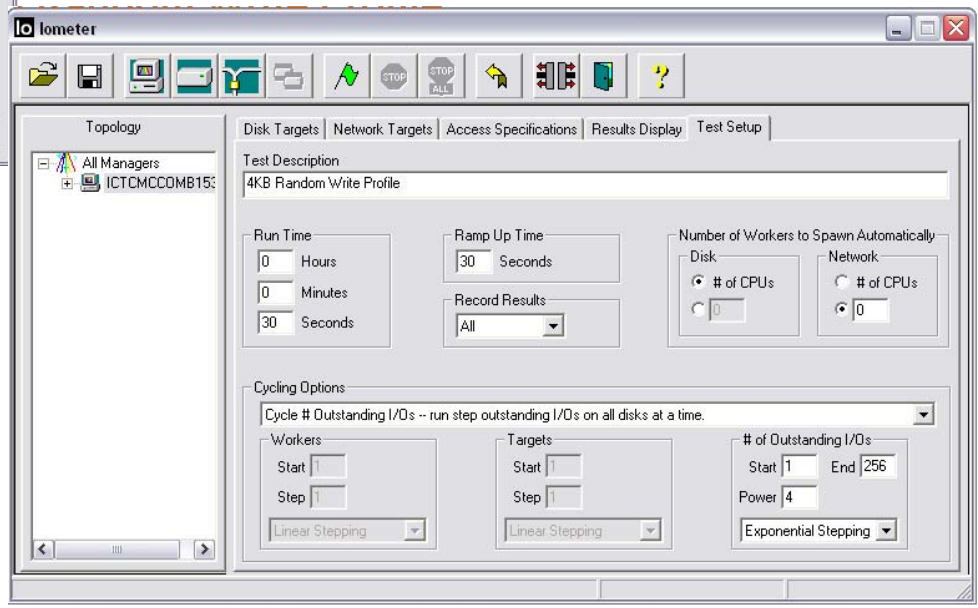
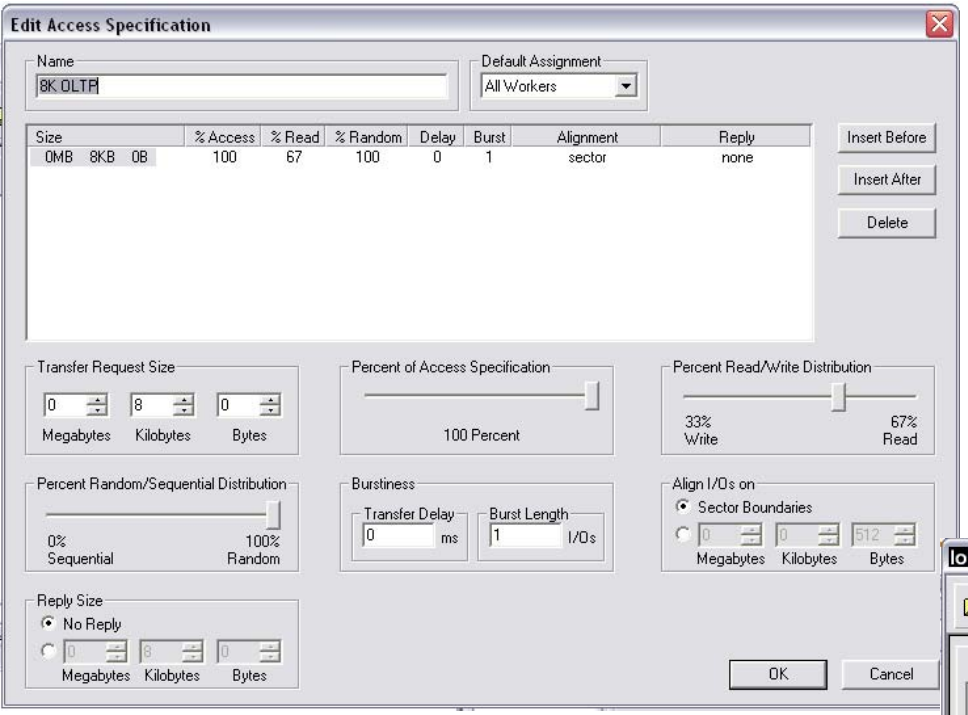


8KB Online Transaction Processing (OLTP)



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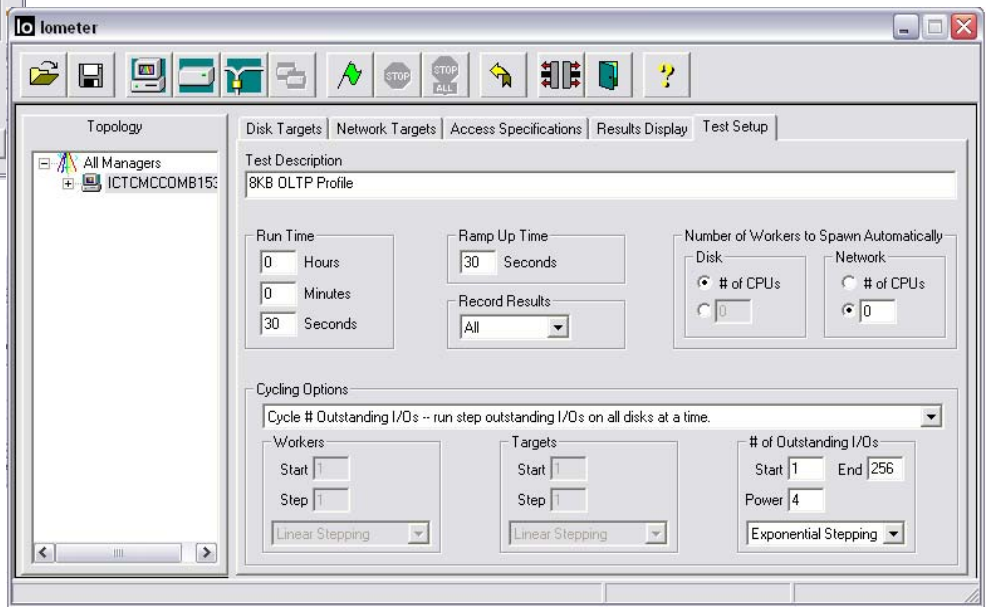
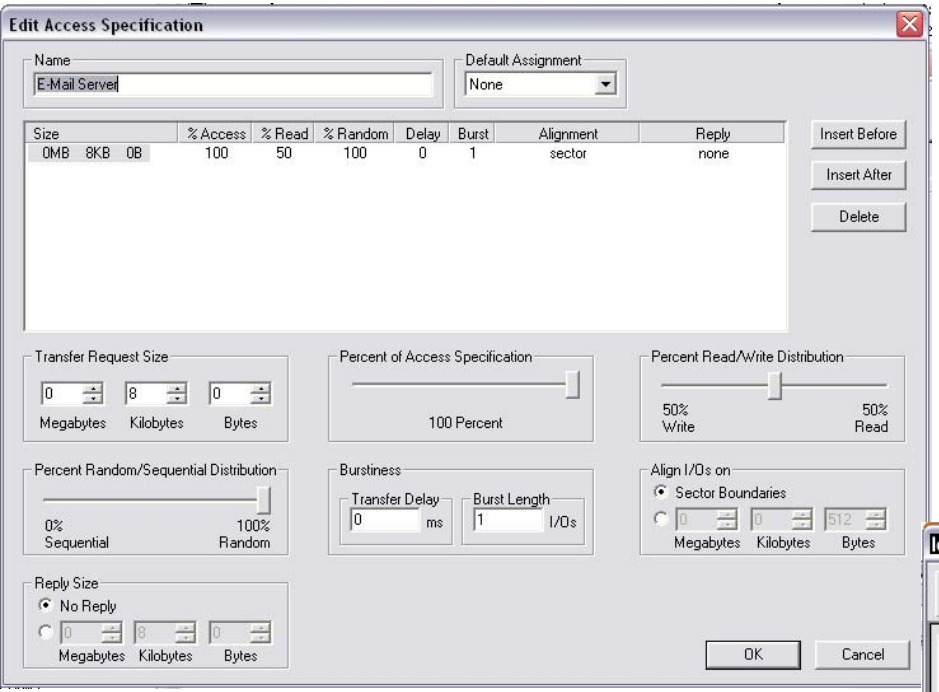


Email Server Profile



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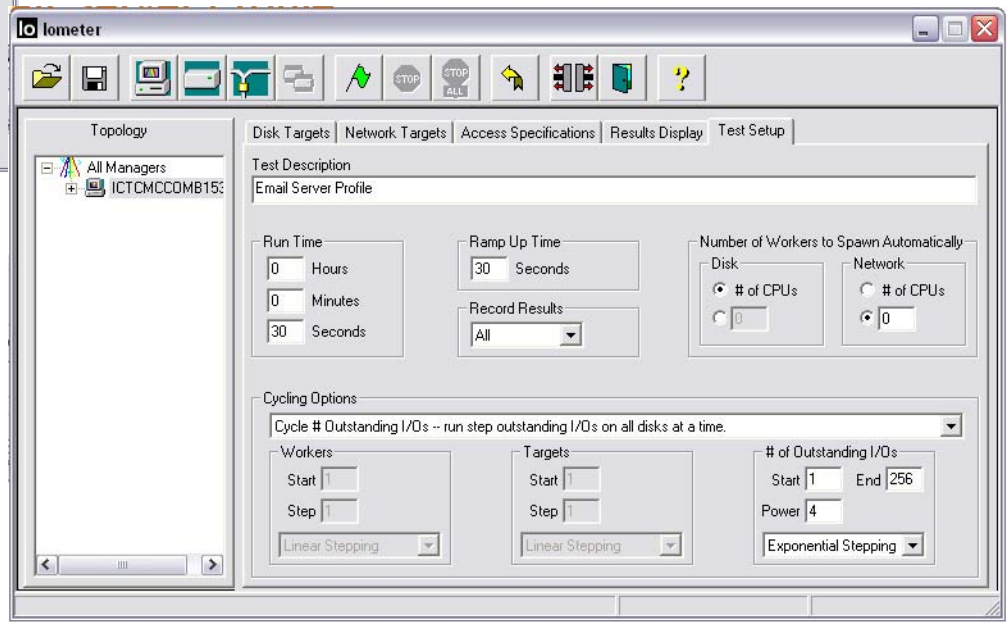
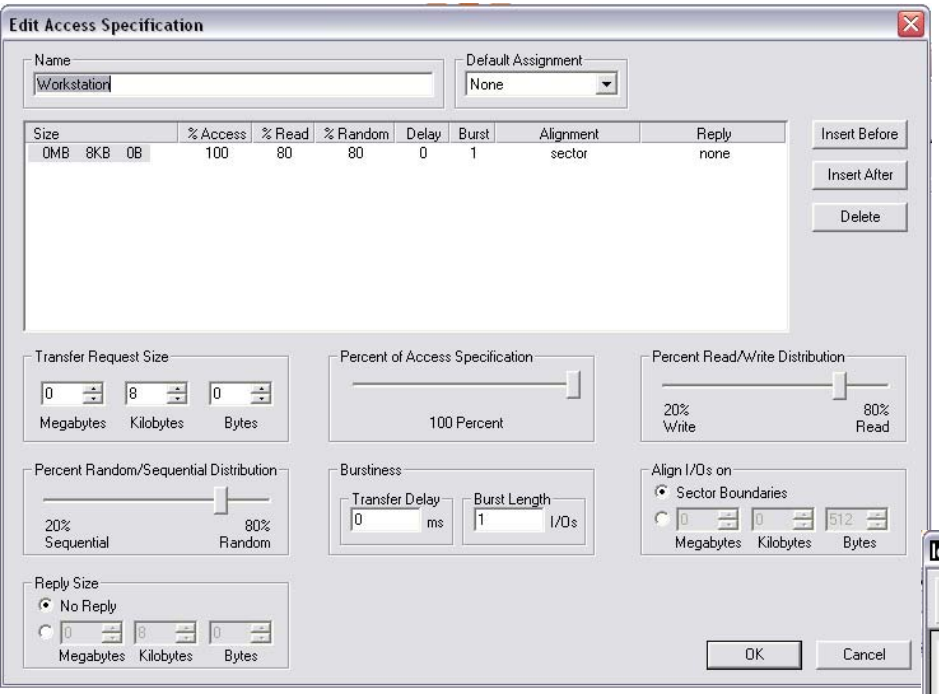


Workstation Profile



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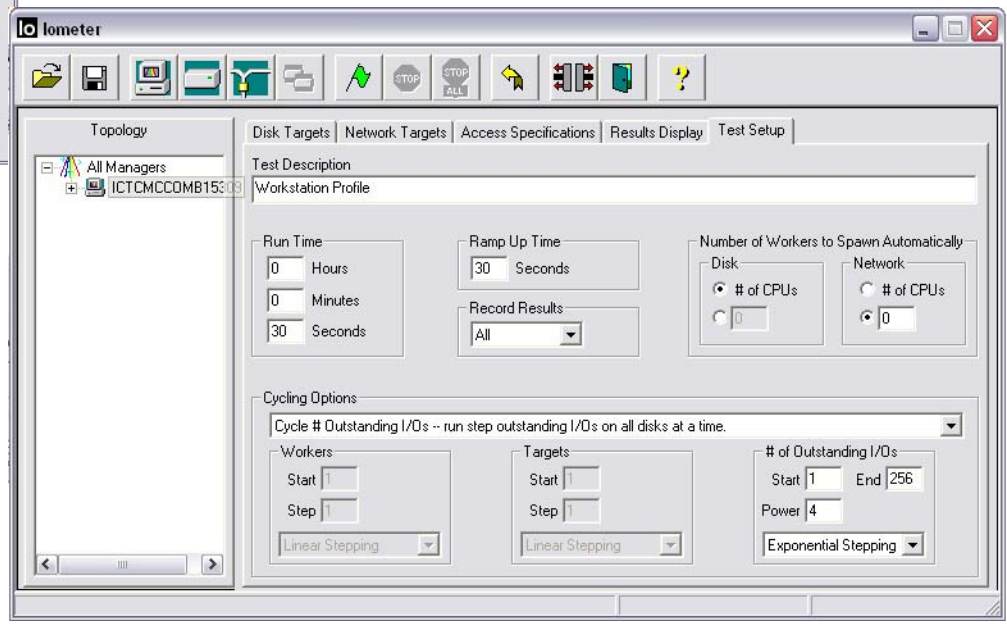
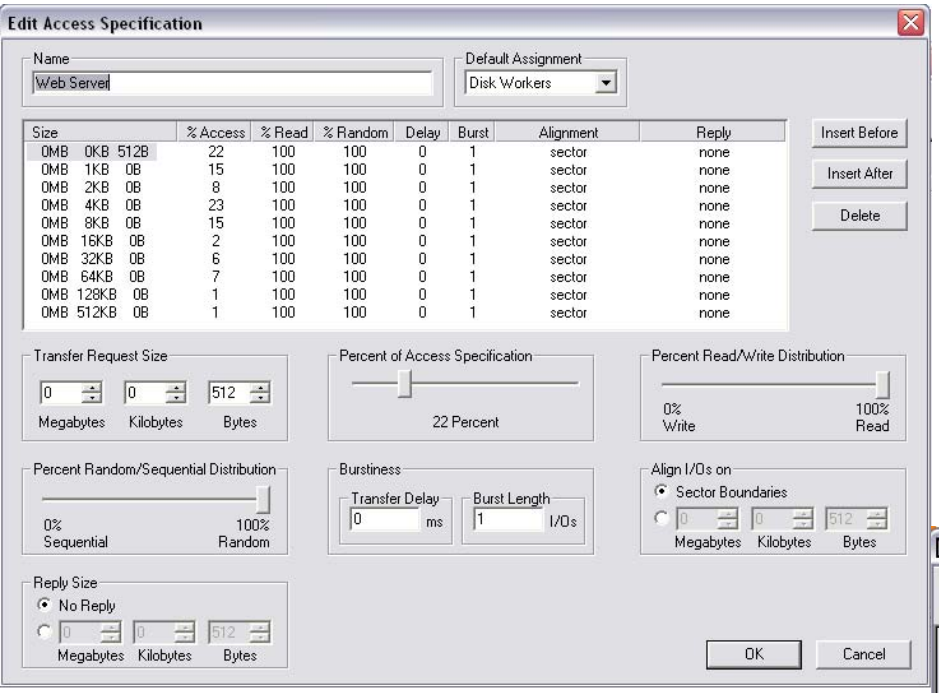


Web Server Profile



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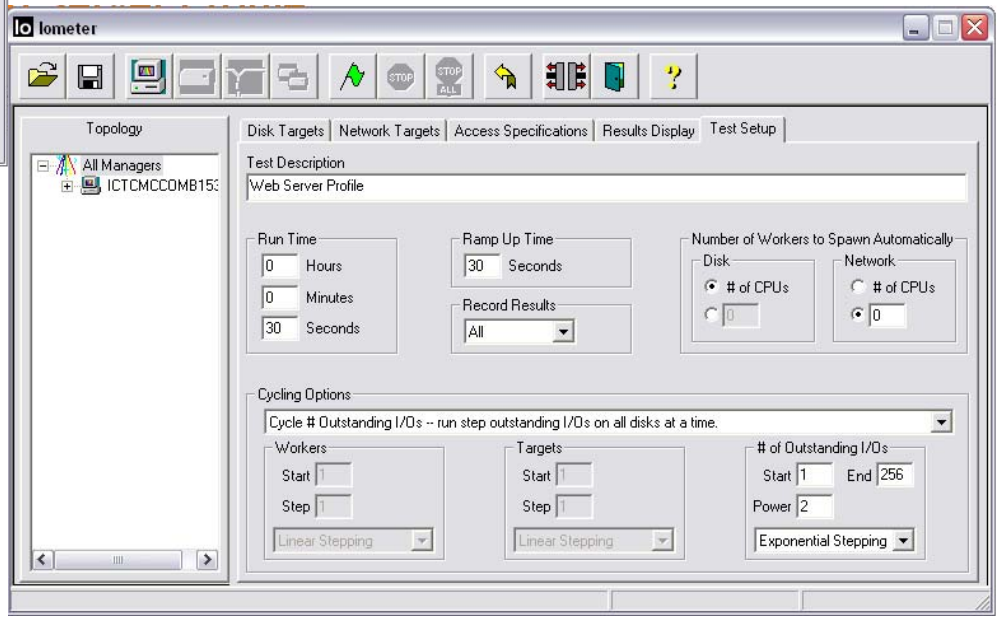
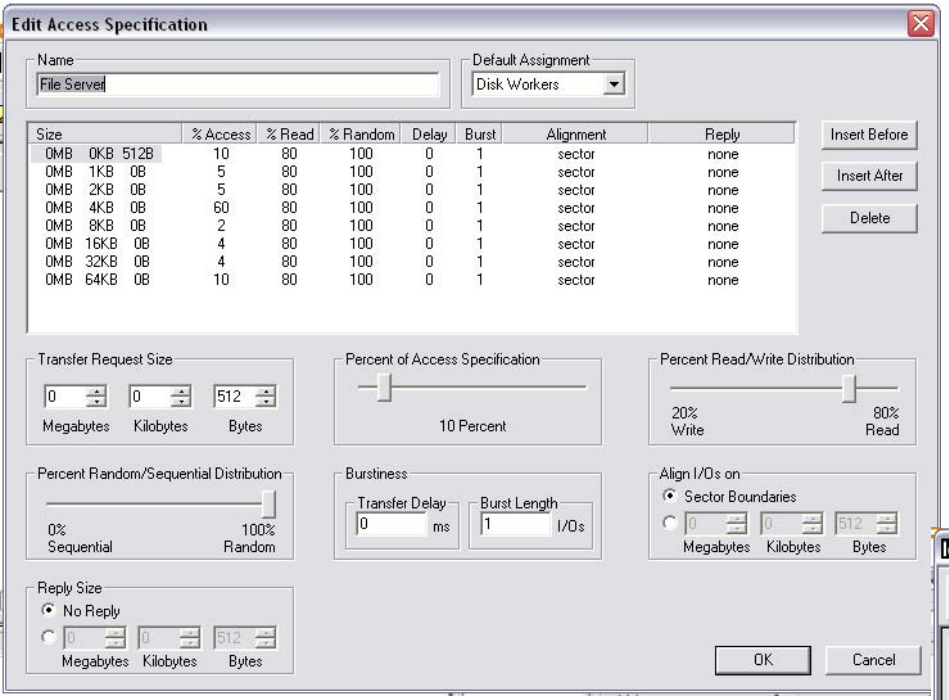


File Server Profile



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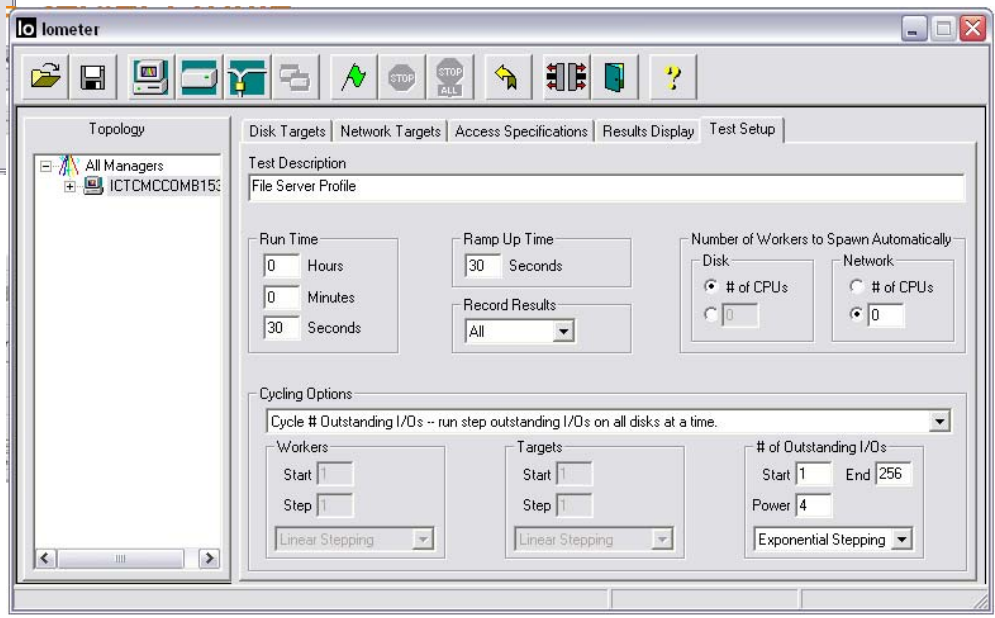
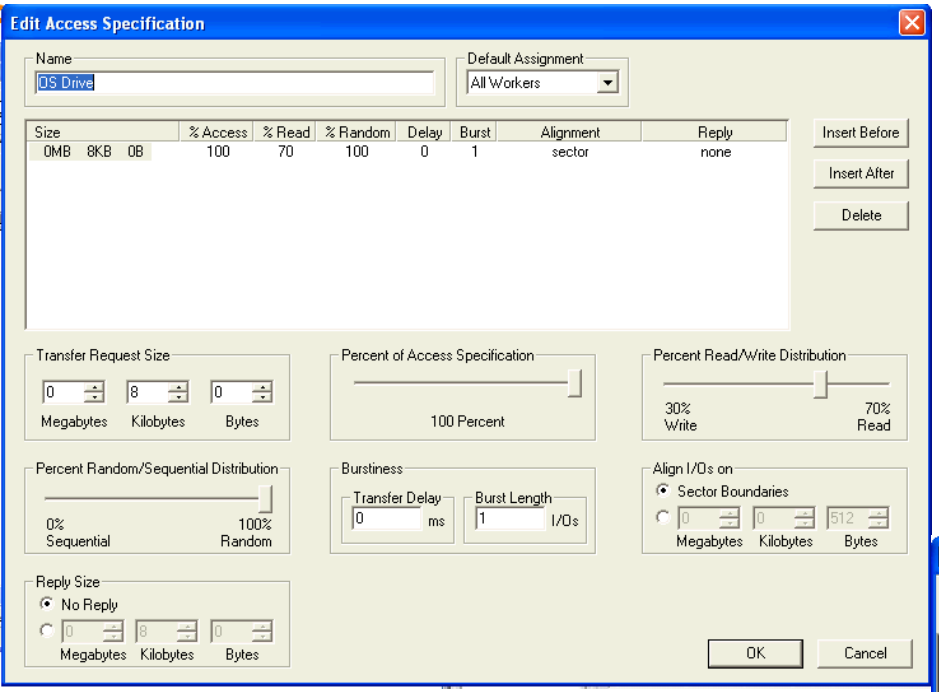


OS Drive



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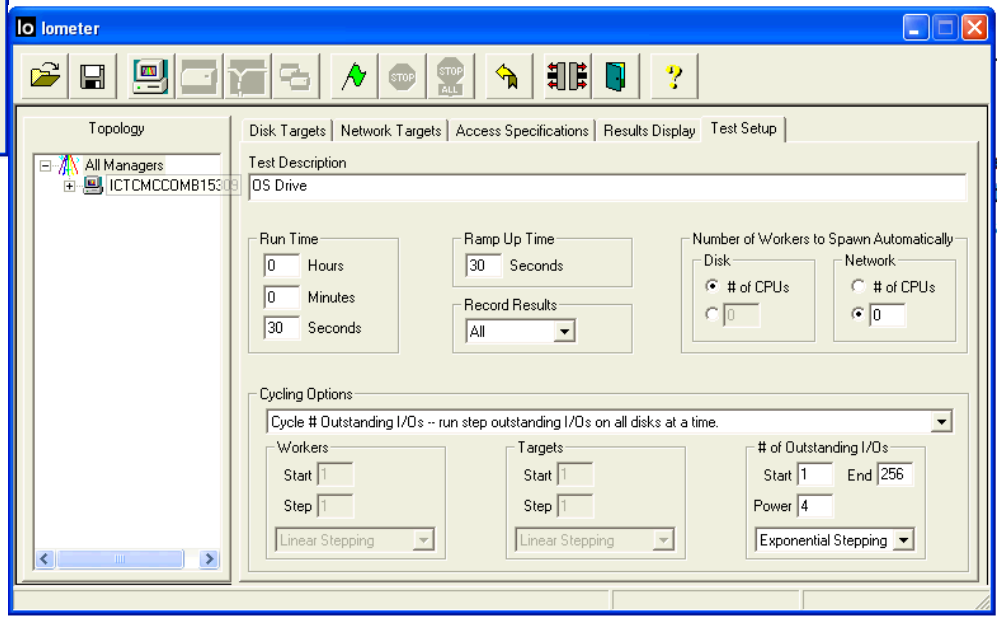
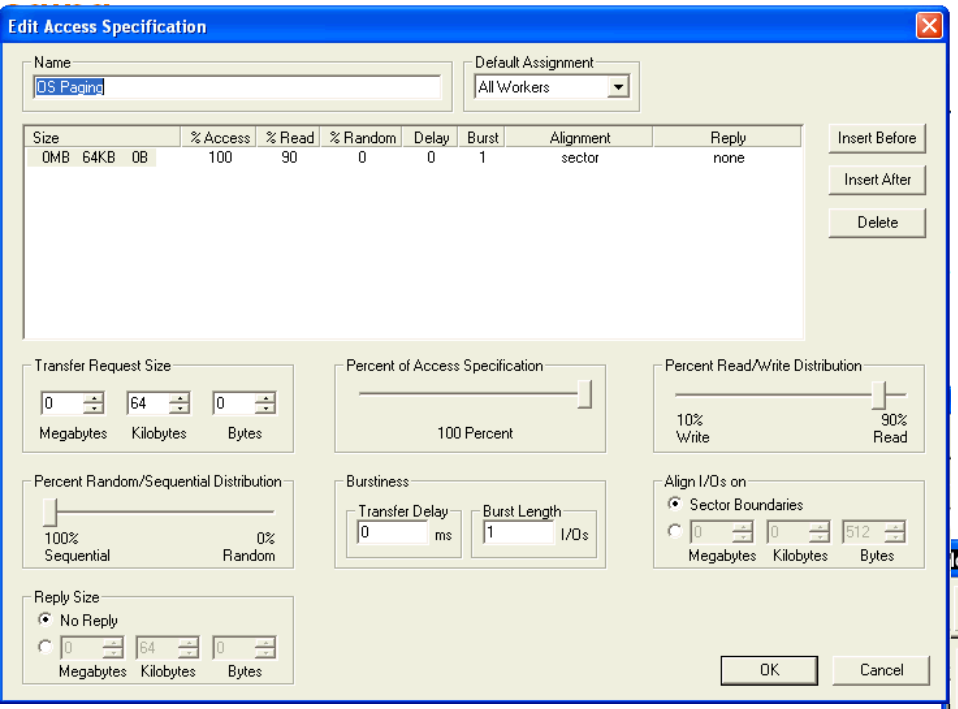


OS Paging



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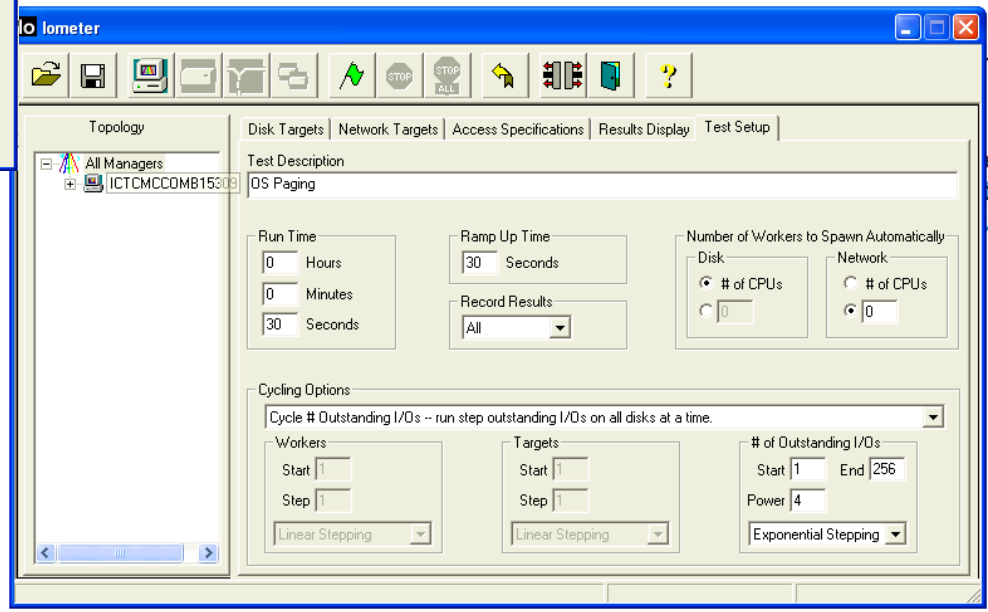


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TM