# Lustre 1.8.9 - 2.x Client Performance Comparison and Tuning

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# Agenda

- Benchmark Setup
- IOR Parameters and Settings
- Lustre Clients and Methodology
- Single Thread Performance
- Throughput Performance Results and Data
- Summary

# Benchmark Setup

- Storage Architecture
  - A Cluster 6000 SSU with GridRaid OSTs
    - Rated Storage Performance ≥ 6 GB/s Read or Write with IOR
  - InfiniBand FDR Interconnect
  - Xyratex Lustre 2.1.0.x4-74
- Client Hardware
  - 8 Clients, each configured with QDR IB, 48GB Memory and 12 Cores
  - Scientific Linux 6.5 with Stock OFED

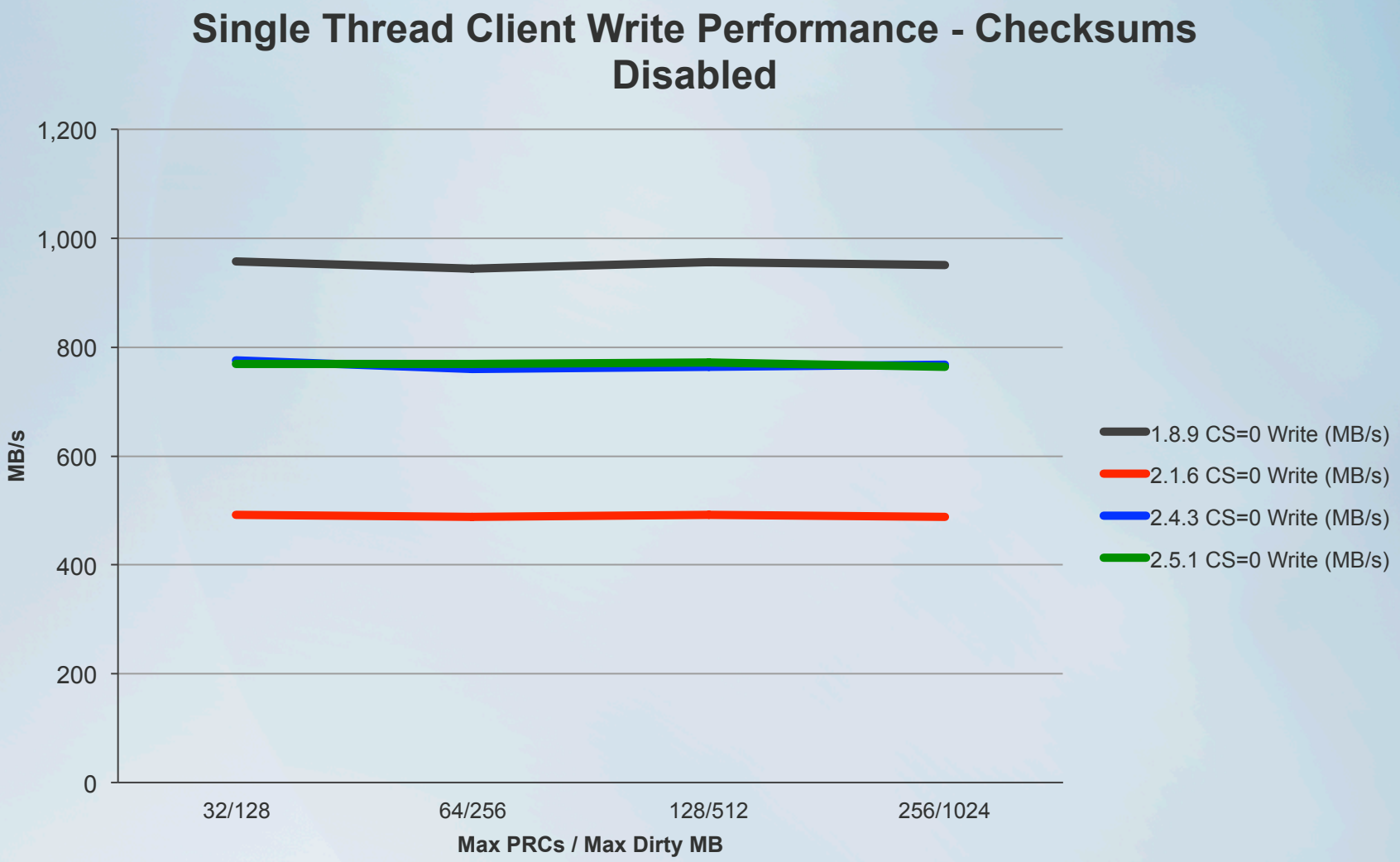
# IOR Parameters and Settings

- Used mpirun to execute IOR with --byslot distribution
- IOR Parameters that were constant:
  - -F :  File Per Process
  - -B : Direct IO Operation
  - -t 64m:  64m Transfer Size per Task
  - -b:  1024g for Single Thread and 512g for multiple tasks
  - -D:  stonewall option, write for 4 minutes, and read for 2 minutes
- Lustre Settings
  - Stripe Count of 1
  - Stripe Size of 1m

# Lustre Clients

- Compared the following clients:
  - 1.8.9, 2.1.6, 2.4.3, and 2.5.1
- Collected raw performance data using the following client settings with and without checksums enabled
  - max_rpcs_in flight / max_dirty_mb
    - 32 / 128
    - 64 / 256
    - 128 / 512
    - 256 / 1024

# Single Thread Write Performance



# Single Thread Read Performance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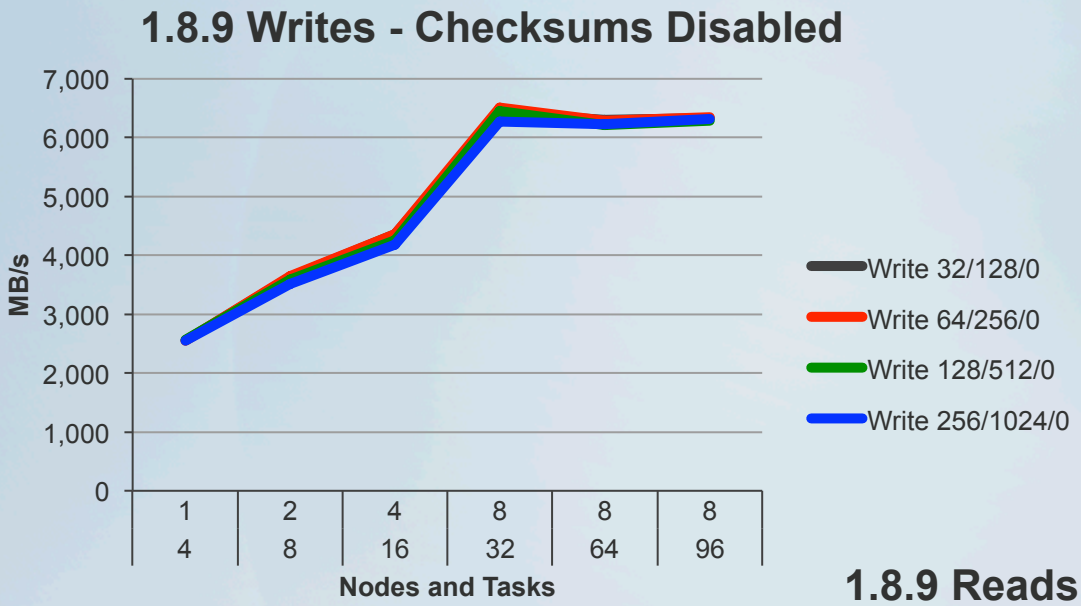
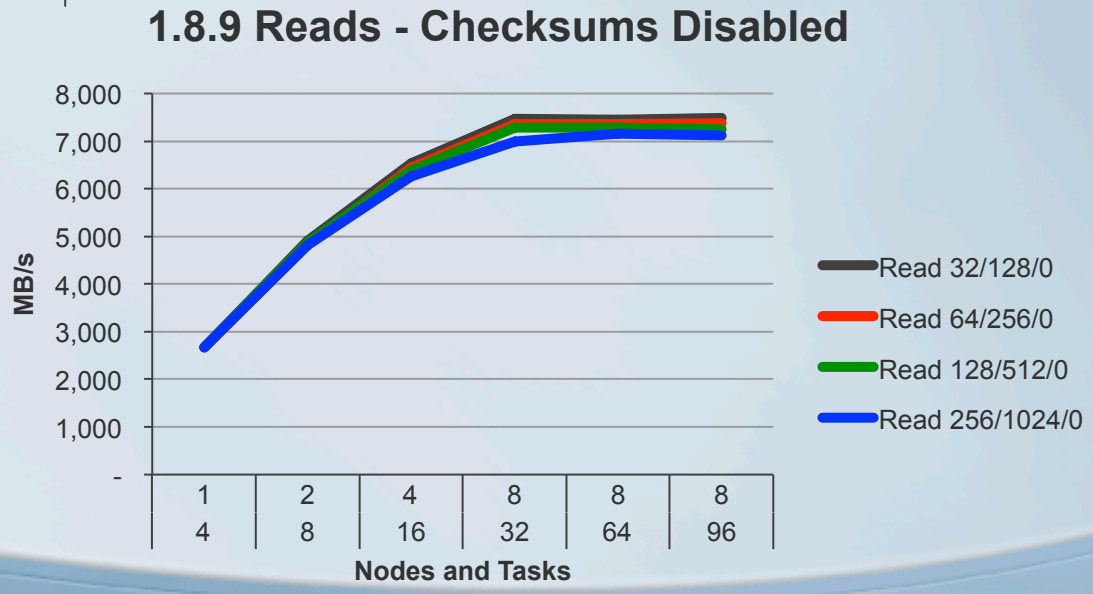
# Impact on Single Thread Performance when Checksums were Enabled

| | Checksums Impact - Single Thread | | |
|---|---|---|---|
| Version | | Reads | Writes |
| 1.8.9 | Performance Impact Difference (MB/s) | 217.80 | 336.84 |
| | Percentage Impact Reduced | 19% | 35% |
| 2.1.6 | Performance Impact Difference (MB/s) | 37.70 | 27.81 |
| | Percentage Impact Reduced | 3% | 6% |
| 2.4.3 | Performance Impact Difference (MB/s) | 45.51 | 9.14 |
| | Percentage Impact Reduced | 6% | 1% |
| 2.5.1 | Performance Impact Difference (MB/s) | 44.91 | 6.50 |
| | Percentage Impact Reduced | 6% | 1% |

# 1.8.9 Client Performance Results




Key:
max_rpcs_in_flight / max_dirty_mb / checksums

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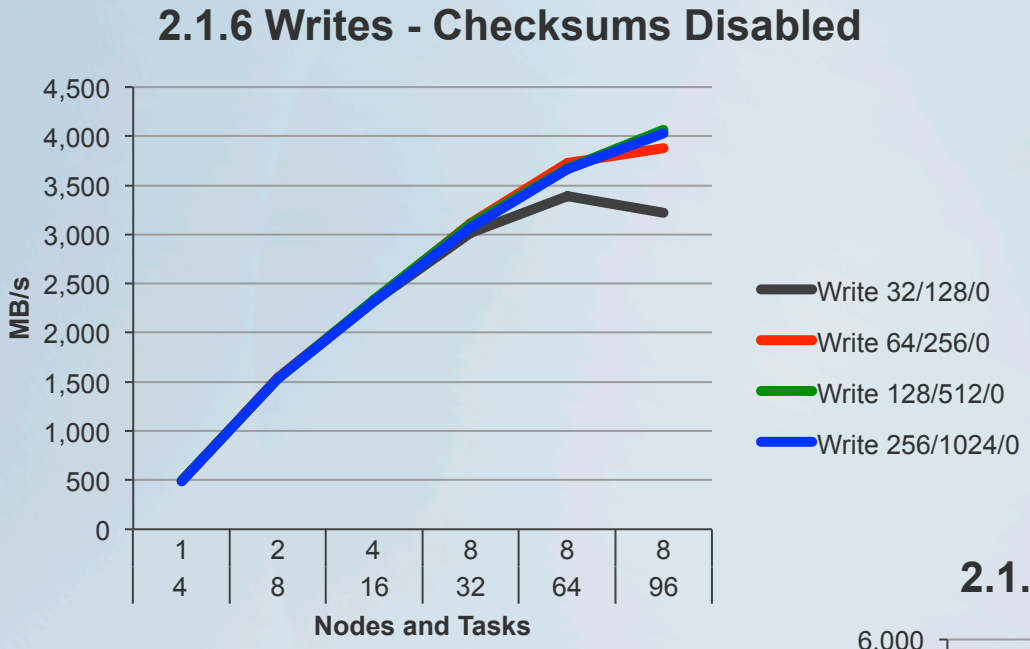
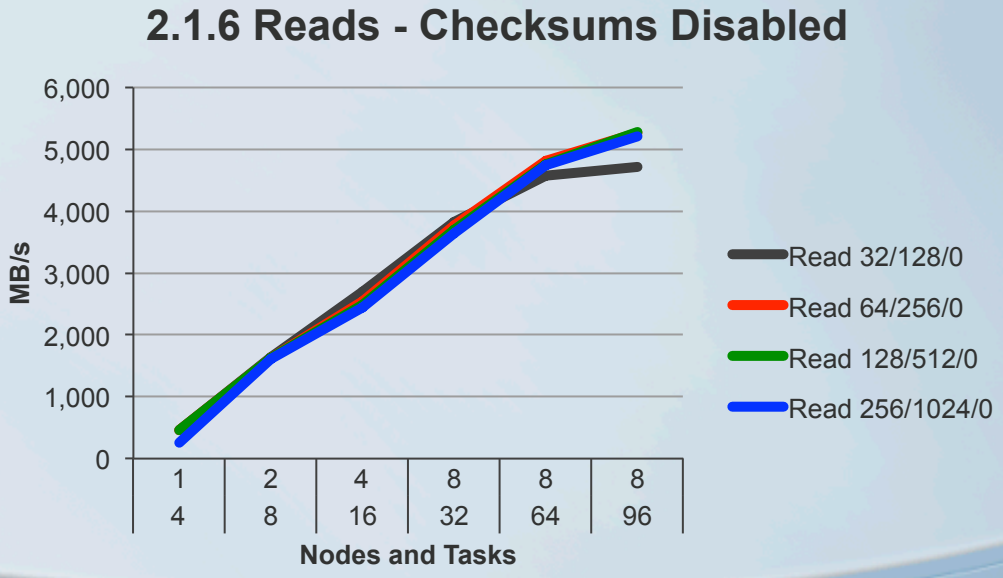
# 2.1.6 Client Performance Results




Key:
max_rpcs_in_flight / max_dirty_mb / checksums

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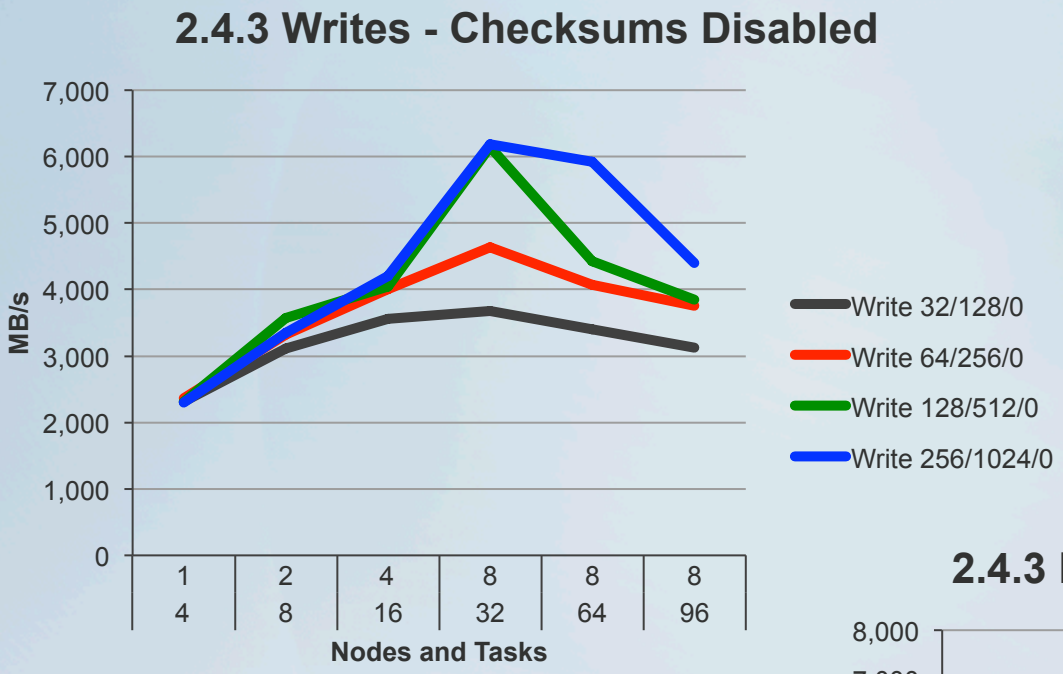
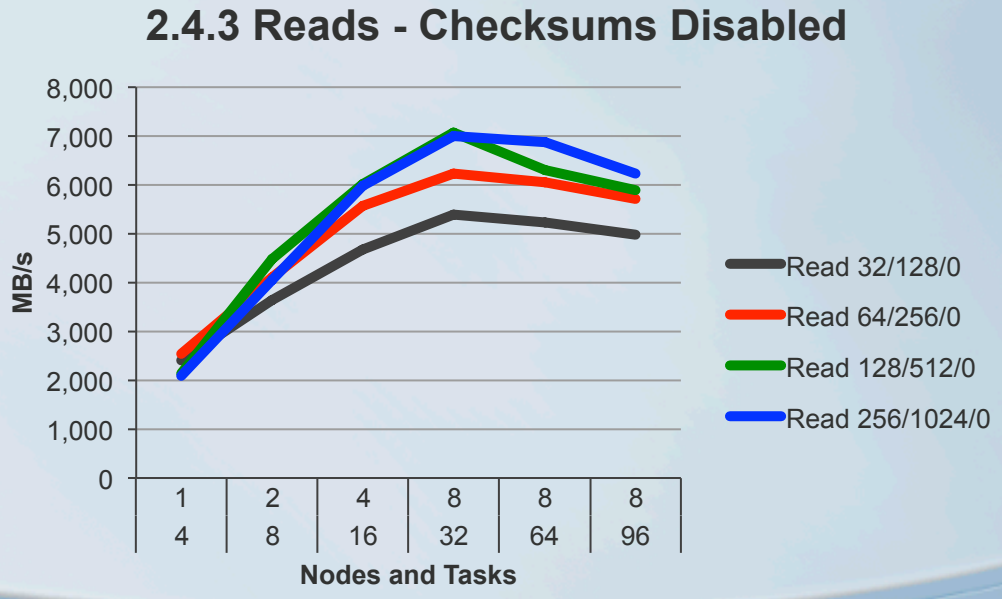
# 2.4.3 Client Performance Results




Key:
max_rpcs_in_flight / max_dirty_mb / checksums

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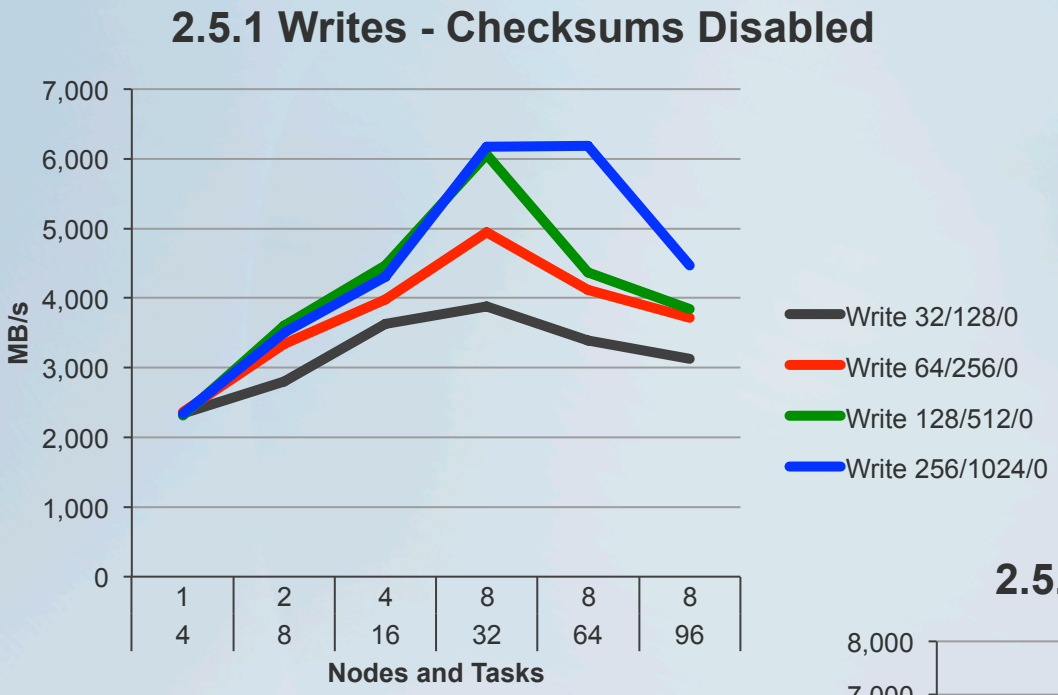
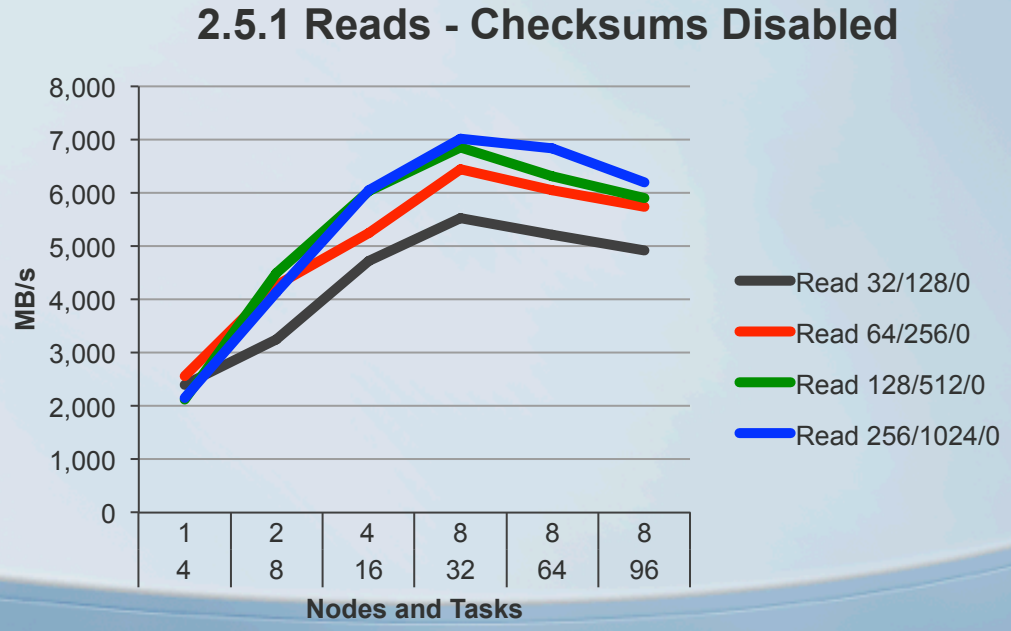
# 2.5.1 Client Performance Results




Key:
max_rpcs_in_flight / max_dirty_mb / checksums

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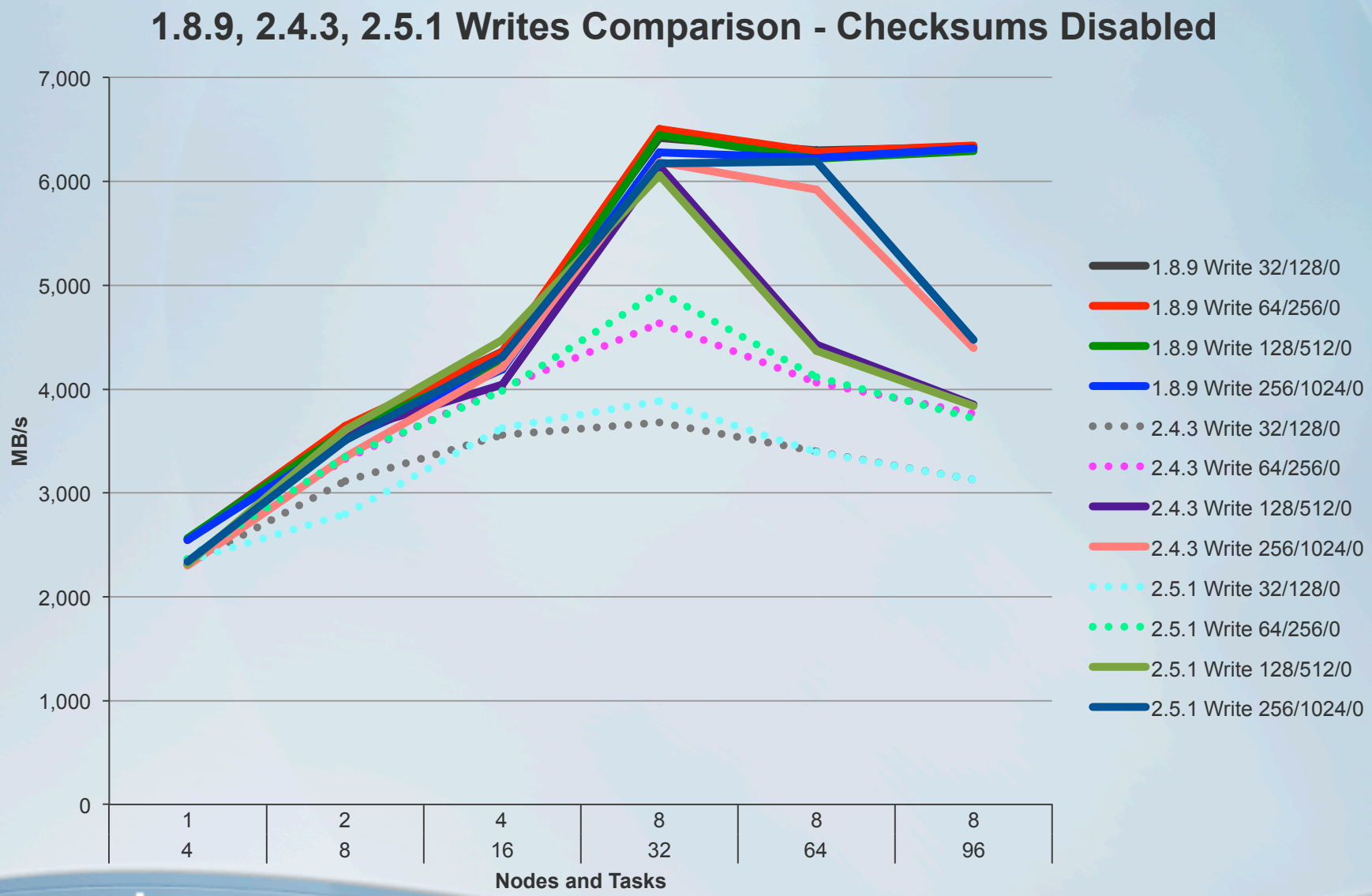
# Average Negative Impact on Performance when Checksums Enabled

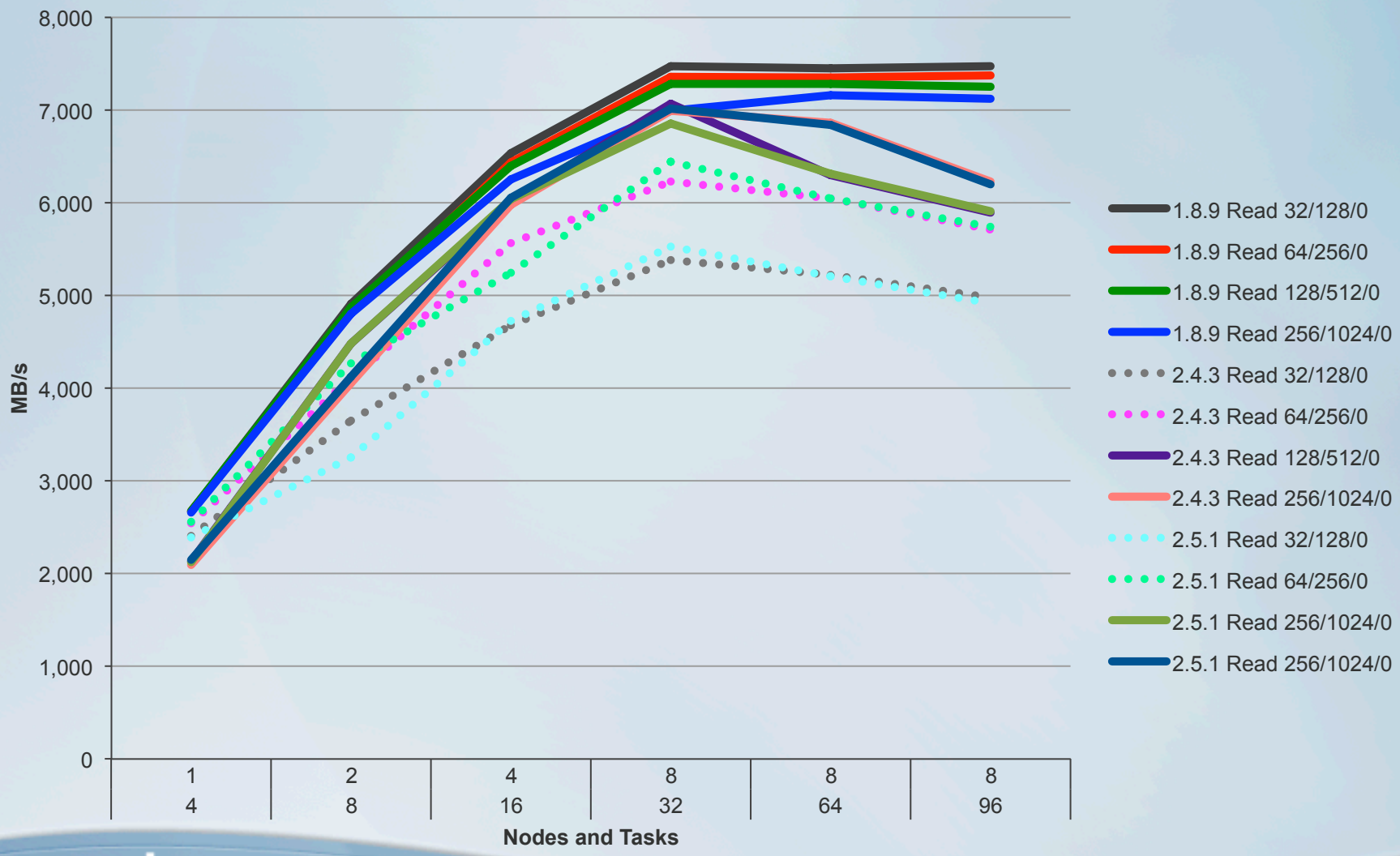
Average results using 4-96 Threads across 1-8 Clients

| | Checksums Impact (max_rpcs_in_flight/max_dirty_mb) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Reads 32/128 | Write 32/128 | Read 64/256 | Write 65/256 | Read 128/512 | Write 128/512 | Read 256/1024 | Write 256/1024 |
| 1.8.9 | Average Impact Difference (MB/s) | 203.40 | 398.09 | 3.12 | 434.41 | 71.03 | 523.17 | 31.19 | 502.31 |
| | Average Impact Percentage | 2% | 10% | -1% | 10% | 0% | 13% | 0% | 12% |
| 2.1.6 | Average Impact Difference (MB/s) | 541.64 | 269.93 | 446.17 | 196.06 | 445.79 | 189.33 | 453.34 | 180.07 |
| | Average Impact Percentage | 22% | 12% | 19% | 9% | 18% | 8% | 9% | 8% |
| 2.4.3 | Average Impact Difference (MB/s) | 333.18 | 94.53 | 277.32 | 77.16 | 380.47 | 194.21 | 326.76 | 315.71 |
| | Average Impact Percentage | 7% | 3% | 5% | 2% | 7% | 4% | 5% | 6% |
| 2.5.1 | Average Impact Difference (MB/s) | 486.11 | 161.09 | 245.24 | 154.50 | 366.05 | 256.85 | 346.78 | 423.12 |
| | Average Impact Percentage | 12% | 5% | 5% | 4% | 6% | 6% | 6% | 9% |

# 1.8.9, 2.4.3, 2.5.1 Overall Write Comparison



# 1.8.9, 2.4.3, 2.5.1 Overall Read Comparison

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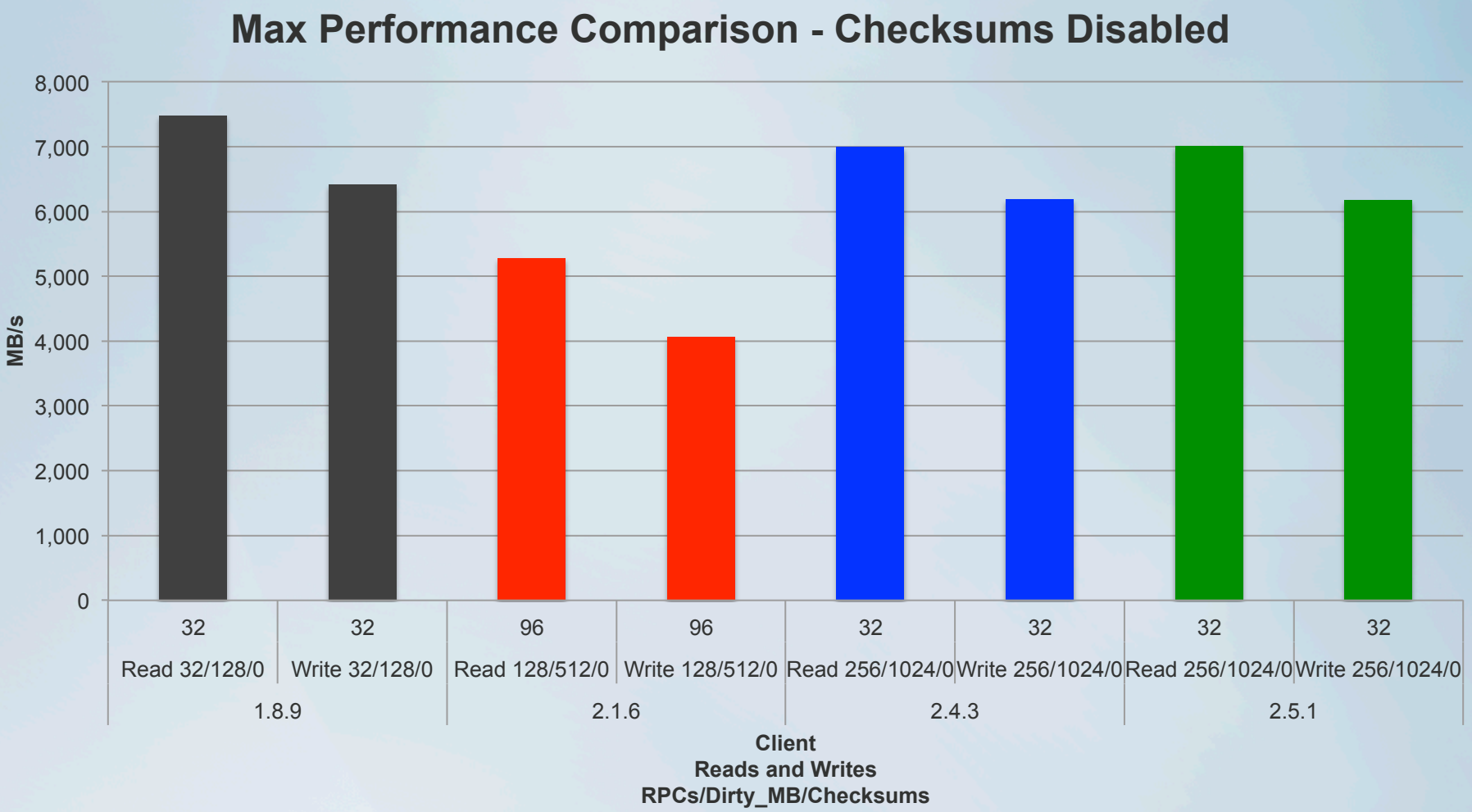
# Maximizing Performance for Each Client

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# Interesting Results Analyzing Raw Data

- In general, 1.8.9 Client performed the same regardless of client settings
- 2.4.3 and 2.5.1 followed the same performance curve
  - Clients settings need to be increased to achieve maximum storage throughput
  - Both max_rpcs_in_flight and max_dirty_mb need to be increased to at lest 256
    - Anything less than 256 will result in less than optimal Storage performance
- The rule of thumb: max_dirty_mb = max_rpcs_in_flight * 4 is not holding true with Client versions 2.4.3 and 2.5.1

# Summary

- 1.8.9 single thread performance results are the highest, but 2.4.3 and 2.5.1 improved over previous 2.x client versions
- With the right client settings, 2.4.3 and 2.5.1 client versions can maximize storage throughput, along with 1.8.9 clients
- 2.1.6 Client underperformed, regardless of client tuning
- Checksums impact varied with the number of threads, but, on average, not a “big” performance impact
  - Biggest impact on performance with Checksums enabled was on the Single Thread tests
- 2.4.3 and 2.5.1 performance results were similar across all threads and client tuning parameters

# Thank You

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