Q500-F21 performance report

Version 0.2

Aug 2014

Table of Contents

1. Test bed

The testing environment includes host servers, HBA cards, HDDs, and switches. All performance cases conducted here are on Windows platform. There are no Linux, Unix, or Mac platform numbers. Details are listed below.

1.1 Hardware

- Host servers

  There are total 2 servers. Both are ASUS RS700-X7/PS4.

Model name	ASUS RS700-X7/PS4
Processor(s)	CPU:Intel® Xeon® E5-2620 2.00GHz
Memory	ASUS 8GB PC3-10600 (REG, ECC) with ELPIDA
On-board LAN	Intel® 82574L Gigabit Network Connection

- 8Gb Fibre Channel HBA cards

Device name	QLogic QLE2564 PCI-e, 8 Gb/s, 4 ports
Driver version	v9.1.11.20 (2013/03/07)

- Hard drives

  Seagate Cheetah 3.5” 15K.7, ST3300657SS, 300GB x48

  (With one J300Q-D424 JBOD)

- 8Gb Fibre Channel switch

  none

1.2 Software

- Operating system used on host servers.

  Windows Server 2008 R2 Datacenter 64bit

- Benchmark tools
  - Iometer 2006,07,27
  - IOmeter settings
    - Cache hit : max disk size = 20480
    - None cache hit : max disk size = 0

- # of outstanding I/Os : 64
- Ramp up time : 5 seconds
- Run time : 25 seconds

1.3 Storage target settings

- RAID controller : Dual controller Q500-F21-D424
- Firmware version : 1.0.0_ 20131025_0800
- Host interfaces :
  - Single controller : up to 4x 8Gb FC ports + 2x 1GbE iSCSI ports
  - Dual controller : up to 8x 8Gb FC ports + 4x 1GbE iSCSI ports
- Stripe height (KBytes): 64KB
- Block size : 512 Bytes
- Write back or write through : Write back
- Best configuration suggestion

  As a general rule of thumb, try to assign dedicated RAID group (RG) to each host interface port. This will yield the best performance. If you assign each RG to several host interface ports, this usually will result in not so good performance.

2. Test matrix

The following is the test configuration used in this report.

	Sequential	Random
RAID 0	O(single/dual)	X
RAID 5	O(single/dual)	O(single/dual)
Degrade	O(single/dual)	X
Rebuild	O(single/dual)	X
RAID 6	O(single/dual)	O(single/dual)
Degrade	O(single/dual)	X
Rebuild	O(single/dual)	X

3. Single controller - Sequential

3.1 RAID 0

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- RAID 0 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	85418.5	76578.3	71254.2	34515.2	20826.8	10970.3	6113.9	3047.4
NCH	83630.8	71225.5	60729.3	19994.6	11947.8	6419.6	3424.4	1647.1

Read Throughput (MBytes/sec)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	41.7	299.1	556.6	2157.2	2603.3	2742.5	3056.9	3047.4
NCH	40.8	278.2	474.4	1249.6	1493.4	1604.9	1712.2	1647.1

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	82794.3	78975.8	74054.5	38881.9	23536.1	12003.8	6030.4	3011.1
NCH	81959.1	70020.7	60133.4	20078.8	11030.9	5473.8	2841.7	1373.3

Write Throughput (Mbytes/sec)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	40.4	308.5	578.5	2430.1	2942.0	3000.9	3015.2	3011.1
NCH	40.0	273.5	469.7	1254.9	1378.8	1368.4	1420.8	1373.3

3.2 RAID 5

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.

- RAID 5 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	87352.0	76725.7	78724.6	35930.1	20661.2	10903.7	5942.5	3043.8
NCH	82335.3	69224.5	59345.9	19121.2	10802.9	5826.4	2974.0	1462.8

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	42.7	299.7	615.0	2245.6	2582.7	2725.9	2971.2	3043.8
NCH	40.2	270.4	463.6	1195.1	1350.4	1456.6	1487.0	1462.8

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	82730.3	78875.9	75039.3	38665.9	23128.4	11875.6	6017.0	2983.2
NCH	78584.9	61143.8	48995.8	11779.2	6072.4	3224.2	1679.5	820.6

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	40.4	308.1	586.2	2416.6	2891.0	2968.9	3008.5	2983.2
NCH	38.4	238.8	382.8	736.2	759.0	806.1	839.7	820.6

3.2.1 RAID 5 degrade

Configurations

- Host servers : One servers
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- Unplug one HDD to make RAID 5 in degraded mode

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	87254.3	76956.5	78164.3	35501.3	20615.0	11024.1	6040.2	3072.7
NCH	81239.4	64343.4	51058.4	14217.2	7722.3	3942.3	2078.3	1028.4

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	42.6	300.6	610.7	2218.8	2576.9	2756.0	3020.1	3072.7
NCH	39.7	251.3	398.9	888.6	965.3	985.6	1039.2	1028.4

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	83187.5	79509.4	75048.9	39007.1	23233.7	11877.1	6024.9	2984.6
NCH	79790.4	62928.5	51260.4	12407.7	6704.3	3555.5	1886.0	912.9

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	40.6	310.6	586.3	2437.9	2904.2	2969.3	3012.4	2984.6
NCH	39.0	245.8	400.5	775.5	838.0	888.9	943.0	912.9

3.2.2 RAID 5 rebuild

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- Plug in one new HDD to rebuild RAID 5 parity

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	29290.3	34266.1	33297.1	15965.6	9465.0	5049.0	3999.8	2246.0
NCH	41195.4	35577.4	33033.8	15047.7	7758.5	4398.7	2447.7	1289.8

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	14.3	133.9	260.1	997.9	1183.1	1262.2	1999.9	2246.0
NCH	20.1	139.0	258.1	940.5	969.8	1099.7	1223.8	1289.8

Write IOPS

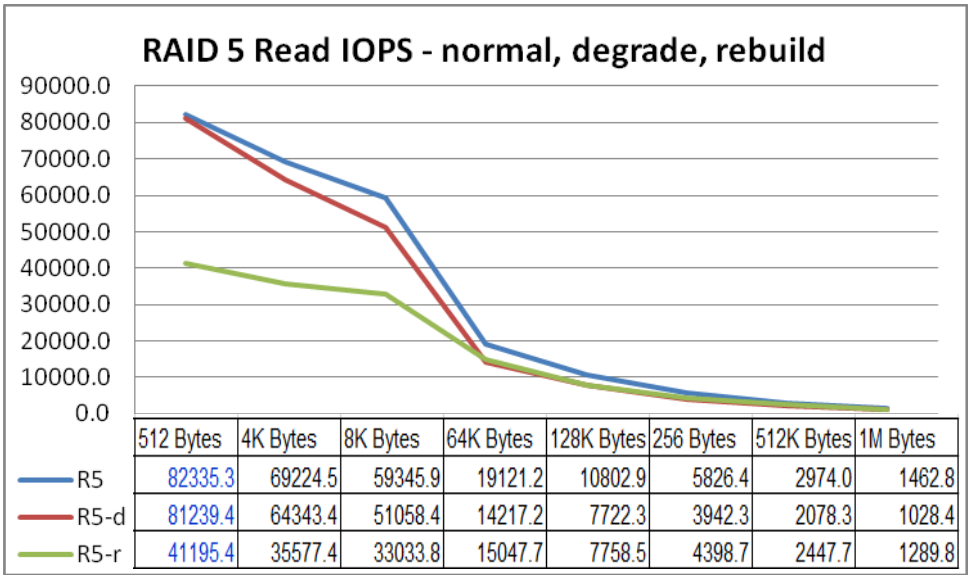
	512B	4K	8K	64K	128K	256K	512K	1M
CH	48148.8	42759.8	41164.1	26531.7	11408.8	6159.9	3146.5	1550.3
NCH	48549.9	38842.2	33629.8	6747.4	3762.5	2168.2	1335.6	767.8

Write Throughput (Mbytes/s)

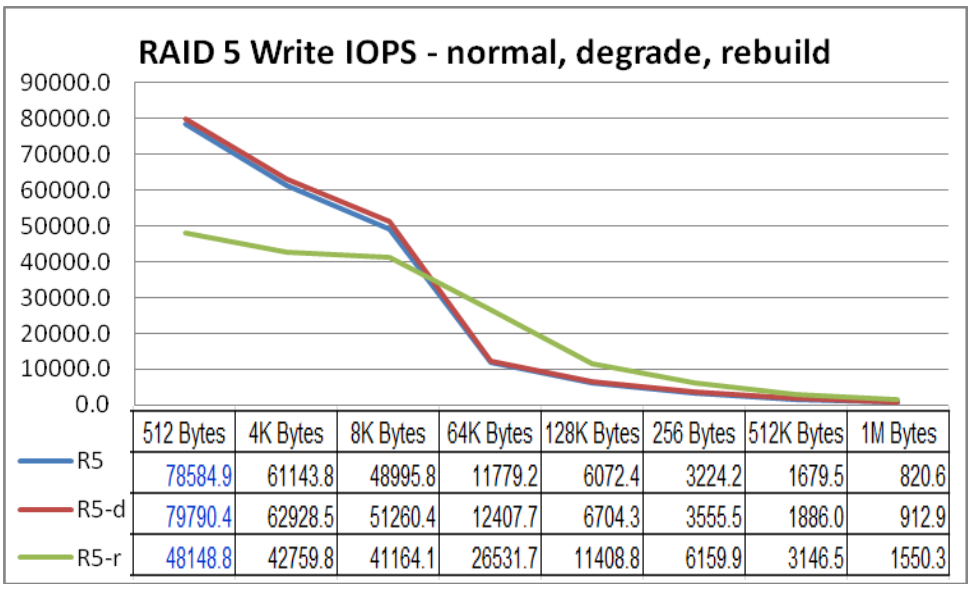
	512B	4K	8K	64K	128K	256K	512K	1M
CH	23.5	167.0	321.6	1658.2	1426.1	1540.0	1573.3	1550.3
NCH	23.7	151.7	262.7	421.7	470.3	542.1	667.8	767.8

3.2.3 RAID 5 comparison

We compare RAID 5 performance under the same configuration to show the degrade and rebuild impact on performance. None cache hit numbers are used here.



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R5	82335.3	69224.5	59345.9	19121.2	10802.9	5826.4	2974.0	1462.8
R5-d	81239.4	64343.4	51058.4	14217.2	7722.3	3942.3	2078.3	1028.4
R5-r	41195.4	35577.4	33033.8	15047.7	7758.5	4398.7	2447.7	1289.8



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R5	78584.9	61143.8	48995.8	11779.2	6072.4	3224.2	1679.5	820.6
R5-d	79790.4	62928.5	51260.4	12407.7	6704.3	3555.5	1886.0	912.9
R5-r	48148.8	42759.8	41164.1	26531.7	11408.8	6159.9	3146.5	1550.3

3.3 RAID 6

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- RAID 6 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	85116.7	74822.8	66898.5	35416.3	21243.0	11843.2	6201.8	2992.1
NCH	82167.9	69543.1	59929.8	20032.4	11329.4	6105.7	3123.1	1507.5

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	41.6	292.3	522.6	2213.5	2655.4	2960.8	3100.9	2992.1
NCH	40.1	271.7	468.2	1252.0	1416.2	1526.4	1561.6	1507.5

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	81907.1	78504.3	74774.8	38827.6	23560.4	11391.8	6031.2	3018.2
NCH	78740.2	59457.5	46065.0	10411.8	5424.7	2663.6	1519.2	746.4

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	40.0	306.7	584.2	2426.7	2945.1	2848.0	3015.6	3018.2
NCH	38.4	232.3	359.9	650.7	678.1	665.9	759.6	746.4

3.3.1 RAID 6 degrade

Configurations

- Host servers : One servers
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- Unplug two HDDs to make RAID 6 in degraded mode

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	86428.5	77359.1	69188.2	36324.0	21642.9	11962.2	6207.3	3013.7
NCH	81053.2	61901.5	48419.6	11728.0	5832.3	3210.7	1618.2	794.0

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	42.2	302.2	540.5	2270.3	2705.4	2990.5	3103.7	3013.7
NCH	39.6	241.8	378.3	733.0	729.0	802.7	809.1	794.0

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	83687.8	79572.2	76013.8	38985.0	23575.8	11329.6	6024.1	3016.9
NCH	79609.4	62347.6	49332.8	11957.8	5998.5	3531.6	1791.2	856.9

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	40.9	310.8	593.9	2436.6	2947.0	2832.4	3012.0	3016.9
NCH	38.9	243.5	385.4	747.4	749.8	882.9	895.6	856.9

3.3.2 RAID 6 rebuild

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- Plug in two HDDs to rebuild RAID 6 parity

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	18381.8	19890.1	19126.4	10439.6	7088.8	4378.7	2227.3	2051.3
NCH	27154.8	32124.3	28716.3	11619.7	6074.2	4021.1	2287.9	1226.3

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	9.0	77.7	149.4	652.5	886.1	1094.7	1113.7	2051.3
NCH	13.3	125.5	224.3	726.2	759.3	1005.3	1143.9	1226.3

Write IOPS

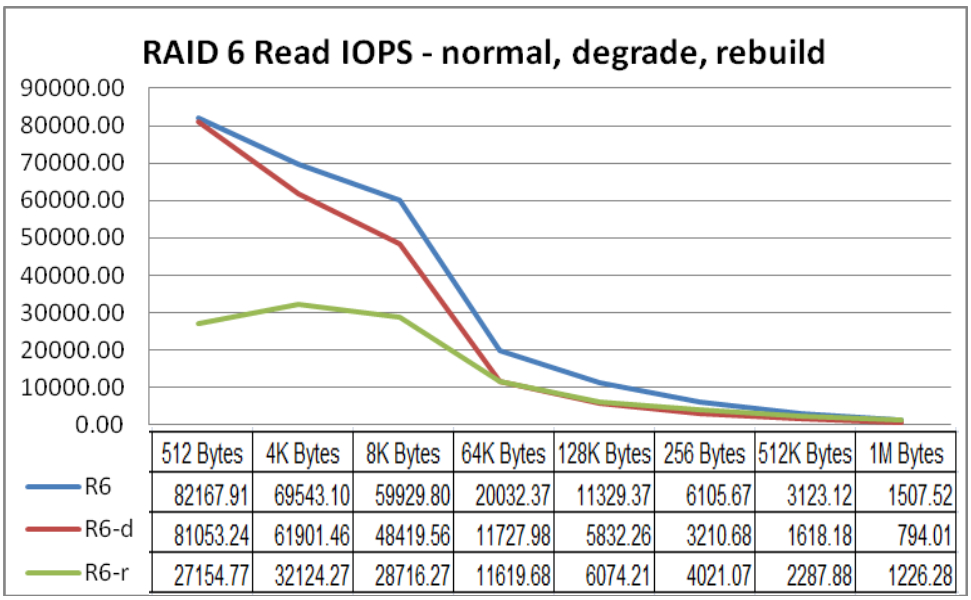
	512B	4K	8K	64K	128K	256K	512K	1M
CH	37904.8	36842.4	37381.3	23888.3	11210.2	5602.1	2776.4	1396.2
NCH	40848.4	34461.1	29645.3	4442.1	2607.5	1579.3	978.2	595.6

Write Throughput (Mbytes/s)

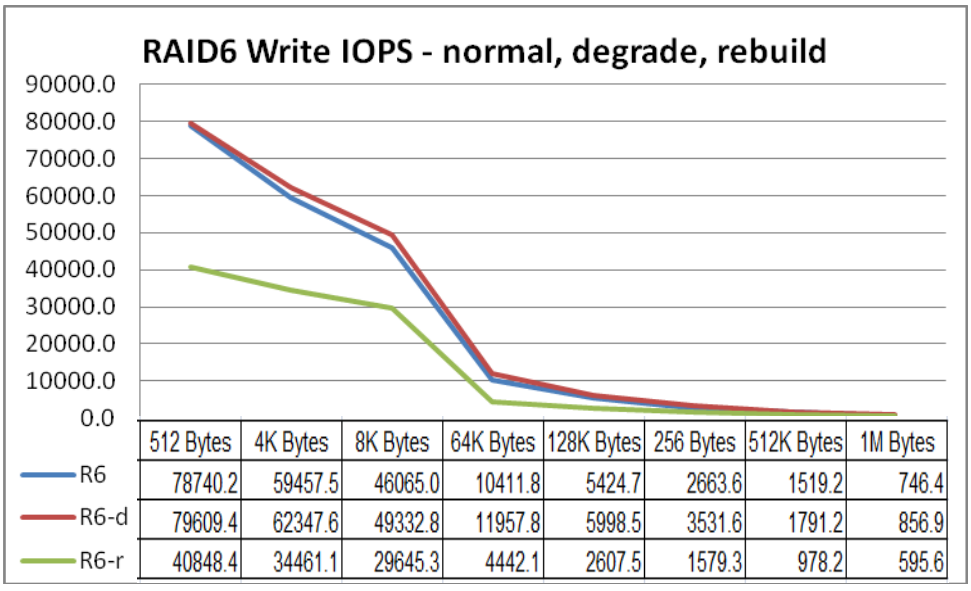
	512B	4K	8K	64K	128K	256K	512K	1M
CH	18.5	143.9	292.0	1493.0	1401.3	1400.5	1388.2	1396.2
NCH	19.9	134.6	231.6	277.6	325.9	394.8	489.1	595.6

3.3.3 RAID 6 comparison

We compare RAID 6 performance under the same configuration to show the degrade and rebuild impact on performance. None cache hit numbers are used here.



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R6	82167.91	69543.10	59929.80	20032.37	11329.37	6105.67	3123.12	1507.52
R6-d	81053.24	61901.46	48419.56	11727.98	5832.26	3210.68	1618.18	794.01
R6-r	27154.77	32124.27	28716.27	11619.68	6074.21	4021.07	2287.88	1226.28



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R6	78740.2	59457.5	46065.0	10411.8	5424.7	2663.6	1519.2	746.4
R6-d	79609.4	62347.6	49332.8	11957.8	5998.5	3531.6	1791.2	856.9
R6-r	40848.4	34461.1	29645.3	4442.1	2607.5	1579.3	978.2	595.6

4. Dual controllers – Sequential

4.1 RAID 0

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- RAID 0 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	171920.6	156564.9	148742.9	70725.3	41943.0	22324.4	12313.1	6083.2
NCH	164422.3	135481.8	118011.9	38407.7	22427.9	11632.9	5927.5	2956.5

Read Throughput (Mbytes/s) Text

	512B	4K	8K	64K	128K	256K	512K	1M
CH	83.9	611.6	1162.1	4420.3	5242.9	5581.1	6156.6	6083.2
NCH	80.3	529.2	922.0	2400.5	2803.5	2908.2	2963.8	2956.5

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	142075.9	117395.3	101500.5	33462.0	17464.6	8918.8	4516.2	2252.8
NCH	138010.5	112343.7	87771.5	23934.3	12676.3	6467.5	3262.3	1633.1

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	69.4	458.6	793.0	2091.4	2183.1	2229.7	2258.1	2252.8
NCH	67.4	438.8	685.7	1495.9	1584.5	1616.9	1631.1	1633.1

4.2 RAID 5

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- RAID 5 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	175902.8	156675.8	156642.6	72058.0	41218.9	21915.7	11959.5	6104.9
NCH	166798.3	139177.9	119821.4	40508.0	22189.8	11612.1	5778.0	2848.2

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	85.9	612.0	1223.8	4503.6	5152.4	5478.9	5979.7	6104.9
NCH	81.4	543.7	936.1	2531.8	2773.7	2903.0	2889.0	2848.2

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	144859.8	119683.9	101519.3	33528.0	17482.9	8951.3	4529.1	2253.8
NCH	138914.0	100799.1	76182.0	18760.8	9500.5	4933.0	2564.2	1308.5

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	70.7	467.5	793.1	2095.5	2185.4	2237.8	2264.5	2253.8
NCH	67.8	393.7	595.2	1172.5	1187.6	1233.3	1282.1	1308.5

4.2.1 RAID 5 degrade

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- Unplug one HDD to make RAID 5 in degraded mode

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	172187.5	156161.2	158614.0	72246.0	41223.0	22079.9	12050.0	6123.3
NCH	163684.4	125796.9	101811.8	28153.8	15416.7	7757.9	4046.6	2029.1

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	84.1	610.0	1239.2	4515.4	5152.9	5520.0	6025.0	6123.3
NCH	79.9	491.4	795.4	1759.6	1927.1	1939.5	2023.3	2029.1

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	143989.5	119785.7	102347.9	33639.3	17489.3	8960.8	4529.7	2246.3
NCH	137931.9	101405.7	76590.2	18414.5	9654.1	4874.8	2459.6	801.0

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	70.3	467.9	799.6	2102.5	2186.2	2240.2	2264.8	2246.3
NCH	67.3	396.1	598.4	1150.9	1206.8	1218.7	1229.8	801.0

4.2.2 RAID 5 rebuild

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- Plug in one new HDD to rebuild RAID 5 parity

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	78478.5	68114.2	63767.5	29293.1	15037.6	8380.6	4717.2	2508.0

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	20.1	139.0	258.1	940.5	969.8	1099.7	1223.8	1289.8

Write IOPS

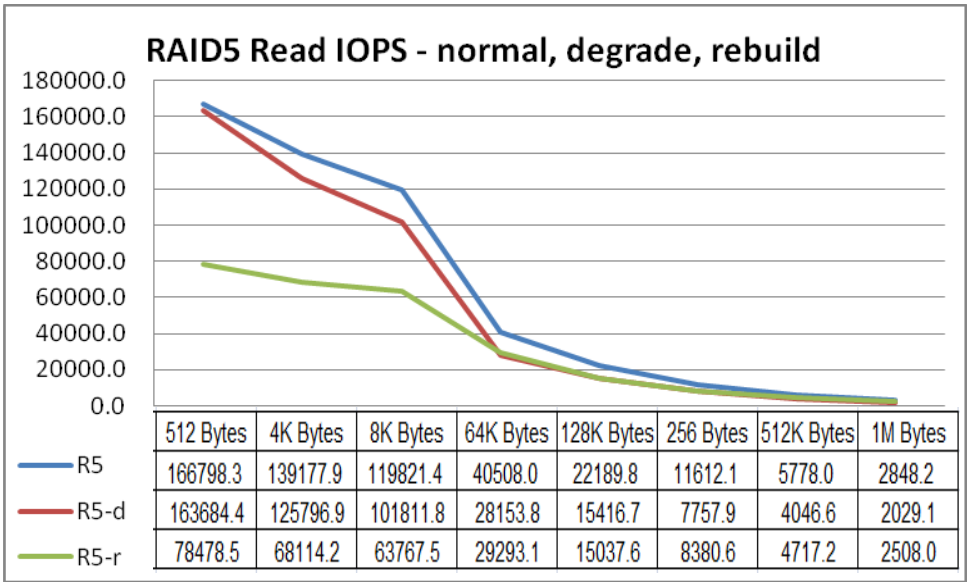
	512B	4K	8K	64K	128K	256K	512K	1M
NCH	48549.9	38842.2	33629.8	6747.4	3762.5	2168.2	1335.6	767.8

Write Throughput (Mbytes/s)

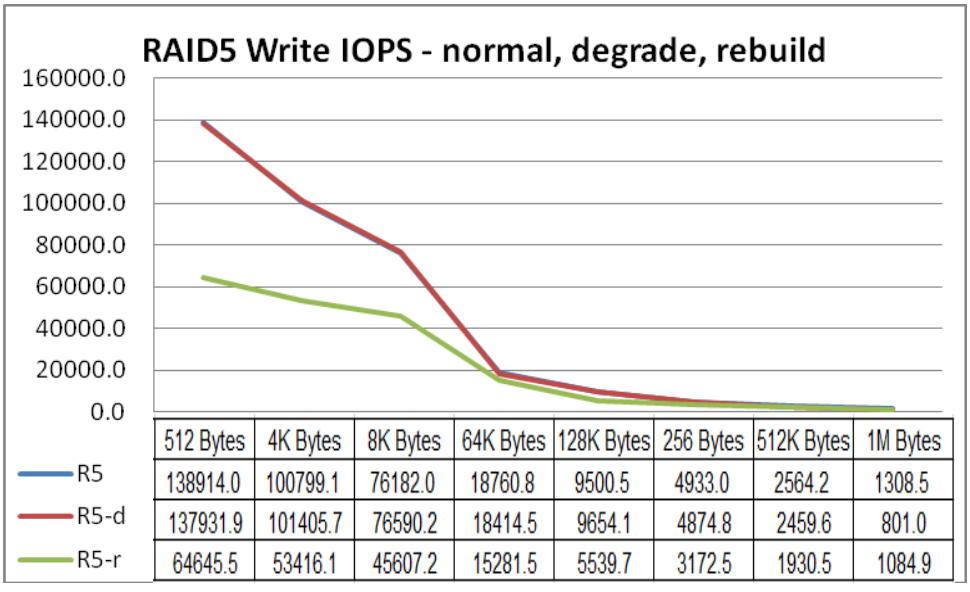
	512B	4K	8K	64K	128K	256K	512K	1M
NCH	23.7	151.7	262.7	421.7	470.3	542.1	667.8	767.8

4.2.3 RAID 5 comparison

We compare RAID 5 performance under the same configuration to show the degrade and rebuild impact on performance. None cache hit numbers are used here.



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R5	166798.3	139177.9	119821.4	40508.0	22189.8	11612.1	5778.0	2848.2
R5-d	163684.4	125796.9	101811.8	28153.8	15416.7	7757.9	4046.6	2029.1
R5-r	78478.5	68114.2	63767.5	29293.1	15037.6	8380.6	4717.2	2508.0



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R5	138914.0	100799.1	76182.0	18760.8	9500.5	4933.0	2564.2	1308.5
R5-d	137931.9	101405.7	76590.2	18414.5	9654.1	4874.8	2459.6	801.0
R5-r	64645.5	53416.1	45607.2	15281.5	5539.7	3172.5	1930.5	1084.9

4.3 RAID 6

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- RAID 6 sequential read/write

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	174834.6	157273.1	139680.0	74041.7	43473.7	24460.8	12443.0	6074.6
NCH	168253.4	139966.6	119714.6	39910.3	21964.9	12057.9	6193.1	3002.0

Read Throughput (MBytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	85.4	614.3	1091.2	4627.6	5434.2	6115.2	6221.5	6074.6
NCH	82.2	546.7	935.3	2494.4	2745.6	3014.5	3096.6	3002.0

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	146721.6	118503.8	102452.2	33697.0	17641.8	9202.9	4598.5	2294.2
NCH	140808.6	97350.7	73572.6	16850.9	8568.5	4436.2	2209.9	1090.3

Write Throughput (MBytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	71.6	462.9	800.4	2106.1	2205.2	2300.7	2299.2	2294.2
NCH	68.8	380.3	574.8	1053.2	1071.1	1109.1	1104.9	1090.3

4.3.1 RAID 6 degrade

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- Unplug two HDDs to make RAID 6 in degraded mode

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	174052.7	156223.1	138974.6	73412.3	43779.2	24557.9	12439.0	6073.1
NCH	166479.8	124891.6	97767.9	23699.5	11981.8	6350.1	3269.0	1604.6

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	85.0	610.2	1085.7	4588.3	5472.4	6139.5	6219.5	6073.1
NCH	81.3	487.9	763.8	1481.2	1497.7	1587.5	1634.5	1604.6

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
CH	146264.4	118035.6	102175.0	33686.3	17647.0	9198.7	4612.9	2291.4
NCH	137813.9	102678.9	76089.0	16951.7	8642.9	4286.7	2125.7	1079.4

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
CH	71.4	461.1	798.2	2105.4	2205.9	2299.7	2306.4	2291.4
NCH	67.3	401.1	594.4	1059.5	1080.4	1071.7	1062.8	1079.4

4.3.2 RAID 6 rebuild

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- Plug in two new HDDs to start RAID 6 rebuilding process

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	59751.6	65409.8	58817.2	23999.0	12001.7	7904.9	4558.7	2442.0

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	29.2	255.5	459.5	1499.9	1500.2	1976.2	2279.4	2442.0

Write IOPS

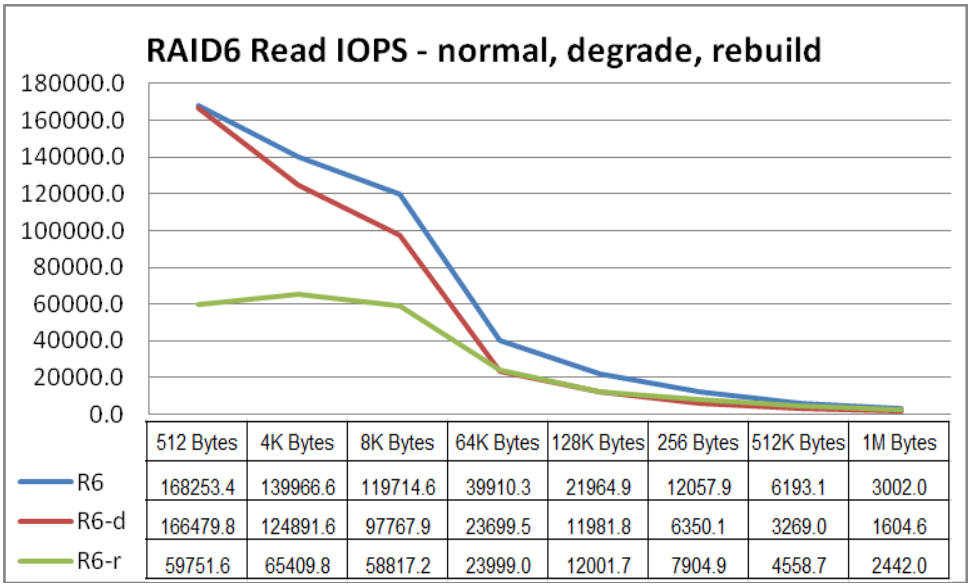
	512B	4K	8K	64K	128K	256K	512K	1M
NCH	54809.8	45208.9	40152.3	10005.2	4187.4	2620.9	1602.5	921.2

Write Throughput (Mbytes/s)

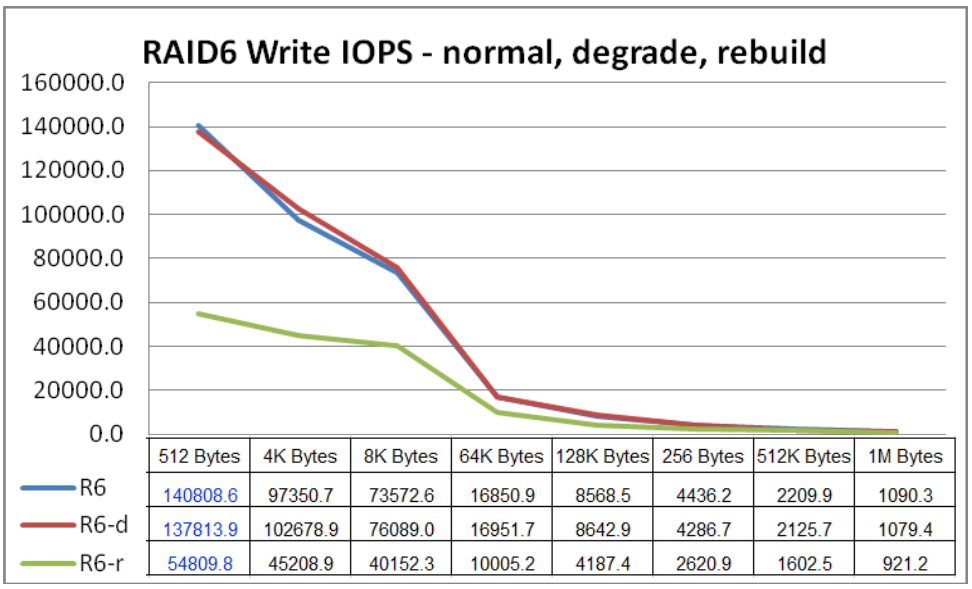
	512B	4K	8K	64K	128K	256K	512K	1M
NCH	26.8	176.6	313.7	625.3	523.4	655.2	801.2	921.2

4.3.3 RAID 6 comparison

We compare RAID 6 performance under the same configuration to show the degrade and rebuild impact on performance. None cache hit numbers are used here.



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R6	168253.4	139966.6	119714.6	39910.3	21964.9	12057.9	6193.1	3002.0
R6-d	166479.8	124891.6	97767.9	23699.5	11981.8	6350.1	3269.0	1604.6
R6-r	59751.6	65409.8	58817.2	23999.0	12001.7	7904.9	4558.7	2442.0



	512 Bytes	4K Bytes	8K Bytes	64K Bytes	128K Bytes	256 Bytes	512K Bytes	1M Bytes
R6	140808.6	97350.7	73572.6	16850.9	8568.5	4436.2	2209.9	1090.3
R6-d	137813.9	102678.9	76089.0	16951.7	8642.9	4286.7	2125.7	1079.4
R6-r	54809.8	45208.9	40152.3	10005.2	4187.4	2620.9	1602.5	921.2

5. Single controller – Random

5.1 RAID 5

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- RAID 5 random read/write. All none cache hit.

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	9487.1	9372.3	9275.6	8149.0	4338.3	2318.7	1402.0	816.7

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	4.6	36.6	72.5	509.3	542.3	579.7	701.0	816.7

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	2433.8	2402.5	2406.5	715.2	1173.9	712.6	410.1	291.7

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	1.2	9.4	18.8	44.7	146.7	178.1	205.1	291.7

5.2 RAID 6

Configurations

- Host servers : One server
- # of host interface : 4x 8Gb FC ports
- 4x RGs. Each RG has one VD. Each RG has 6x HDDs.
- RAID 6 random read/write. All none cache hit.

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	8989.5	8930.8	8836.2	7830.3	4183.7	2244.8	1301.3	954.5

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	4.4	34.9	69.0	489.4	523.0	561.2	650.6	954.5

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	1607.8	1607.7	1605.9	398.2	897.7	1386.8	367.9	339.6

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	0.8	6.3	12.5	24.9	112.2	346.7	184.0	339.6

6. Dual controller - Random

6.1 RAID 5

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports

- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- RAID 5 random read/write. All none cache hit.

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	18975.2	18814.4	18814.4	16367.4	8722.1	4664.5	2832.2	1857.1

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	9.3	73.5	73.5	1023.0	1090.3	1166.1	1416.1	1857.1

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	4848.1	4823.4	4823.4	4835.0	2280.8	1368.1	883.5	592.5

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	2.4	18.8	18.8	37.8	285.1	342.0	441.7	592.5

6.2 RAID 6

Configurations

- Host servers : Two servers
- # of host interface : 8x 8Gb FC ports
- 8x RGs. Each RG has one VD. Each RG has 6x HDDs. (One JBOD is added)
- RAID 6 random read/write. All none cache hit.

Read IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	17,726.3	17,961.6	17,793.7	15,755.7	8,398.5	4,511.0	2,758.9	2,163.5

Read Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	8.7	70.2	139.0	984.7	1,049.8	1,127.7	1,379.5	2,163.5

Write IOPS

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	3,246.5	3,225.2	3,218.5	795.2	1,990.4	2,821.5	758.7	679.9

Write Throughput (Mbytes/s)

	512B	4K	8K	64K	128K	256K	512K	1M
NCH	1.6	12.6	25.1	49.7	248.8	705.4	379.4	679.9