IBM MQ Appliance Performance Report

Model: M2003

Version 1.0 - May 2023

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First Edition, May 2023.

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2 Contents

3 Introduction

This performance report at version 1.0 contains performance data based on the MQ Appliance models M2003A and M2003B. The M2003 model is based on entirely new hardware and is designed for optimal performance; it features increased CPU and RAM capacity, faster NVMe storage and added 100Gb connectivity. This report covers standalone, HA and DR messaging performance and includes the following highlights:

- The M2003A offers up to 70% more throughput than the performance of M2002A in Non-persistent messaging scenarios. See section 4
- Up to 4x increase in performance over M2002A in Persistent messaging scenarios. See section 4
- Up to 3x increase in performance over M2002A in HA Persistent messaging scenarios. See section 4
- Over 485,000 round trips/second peak messaging rate achieved in a Non-persistent messaging scenario (~970,000 messages produced and ~970,000 messages consumed per second). See section 6.1
- Over 160,000 round trips/second peak messaging rate achieved in an HA enabled scenario (~320,000 messages produced and ~320,000 messages consumed per second). See section 8.2

The M2003 hardware components and how they compare to the previous model M2002 are shown below:

Model	M2002A	M2002B	M2003A	M2003B
CPU	2x12 Core HT	1x6 Core HT	2x16 Core HT (2.9GHz)	1x8 Core HT (2.9GHz)
RAM	192GB	192GB	256GB	256GB
Storage	6.4TB SSD	3.2TB SSD	6.4TB NVMe SSD	3.2TB NVMe SSD
IO Subsystem	RAID 10	RAID 10	RAID 10	RAID 10
Workload and replication network connectivity	8x1Gb 6x10Gb 4x40Gb	8x1Gb 6x10Gb 4x40Gb	8x1Gb 4x10Gb 4x40Gb 2x100Gb	8x1Gb 4x10Gb 4x40Gb 2x100Gb
Management	2x1Gb	2x1Gb	2x1Gb	2x1Gb
Chipset	Skylake	Skylake	Icelake	Icelake
RAID	SAS 12Gb/s 2GB cache	SAS 12Gb/s 2GB cache	PCIe 4 x8 16GB/s	PCIe 4 x8 16GB/s

The MQ appliance combines all the core MQ functionality with the convenience, ease of install and simplified maintenance of an appliance.

There are local disks within the appliance to enable efficient persistent messaging by the local Queue Managers. The four 3.2TB NVMe SSD drives are configured in a RAID10 configuration so that data is protected should one of the drives suffer a failure. High Availability (HA) may be achieved by the pairing of two MQ appliances which results in the Queue Manager (QM) log and queue files being distributed synchronously across the pair of appliances. Disaster Recovery (DR) may be achieved by the addition of a remote appliance to which QM data is distributed synchronously or asynchronously. This report will also illustrate the HA and DR capabilities of the new model.

The MQ appliance can be purchased in two variants: M2003A and M2003B. There are two main differences for the M2003B as highlighted in the table above, reduced CPU capacity and reduced filesystem storage space.

As before, you can purchase an upgrade to convert an M2003B appliance to an M2003B+ appliance, which has the same capacity as an M2003A appliance.

The majority of the tests use the M2003A variant of the MQ Appliance and this is the default hardware unless stated otherwise. A number of tests were also conducted using the M2003B variant and provide comparative data points to the main testing to provide appropriate capacity planning information.

The M2003A and M2003B appliances are supplied with 2x100Gb Ethernet network links, 4x40Gb Ethernet network links, 4x10Gb Ethernet network links and 8x1Gb Ethernet network links. If the appliances are configured for redundant HA, 2x1Gb links would be reserved for use by the appliance in addition to another interface to perform the HA replication (this can be configured to use any of the interfaces available or indeed an aggregated interface), leaving a potential total of 186Gb for customer workloads (If a 40Gb port is used for replication). In nonHA mode, all 228Gb connectivity can be utilised for workload traffic. There are a further two separate 1Gb links that are explicitly reserved for appliance administration.

There are two modules that support 40Gb network connectivity with two ports available in each. There is a capacity limit of 40Gb per module. There is one module that supports 100Gb network connectivity with two ports available. There is a capacity limit of 100Gb per module. This report utilises 2 of the 100Gb links for workload traffic; and 1 40Gb port for replication traffic.

All the scenarios featured in this report utilise Request Responder messaging scenarios and the published messaging rate is measured in round trips/sec, which involves 2 message puts and 2 message gets. If you are only utilising one-way messaging (using a message sender, queue and message receiver to perform 1 message put and 1 message get), and you can avoid queue-lock contention, then you may achieve up to double the published rates.

The version of the MQ Appliance as tested in this report is M2003A MQ 9.3.2 and where a comparison is made to the restricted appliance configuration, this uses the MQ Appliance M2003B MQ 9.3.2

4 Comparison of M2003A to M2002A

The new model has provided significant performance and capacity benefits. The majority of scenarios should benefit from either the increased CPU capacity or increased IO performance and capacity.

The M2002 model itself saw significant performance improvements over the M2001, and the M2003 again provides a significant uplift in performance and capacity. The graphs in this section will illustrate that uplift by comparing the M2003A and M2002A models.

The scenarios from sections 6.3, 6.4 and 8.2 are used to compare the performance of M2003A with M2002A.

The following graph shows the improvement provided in Non-persistent messaging:

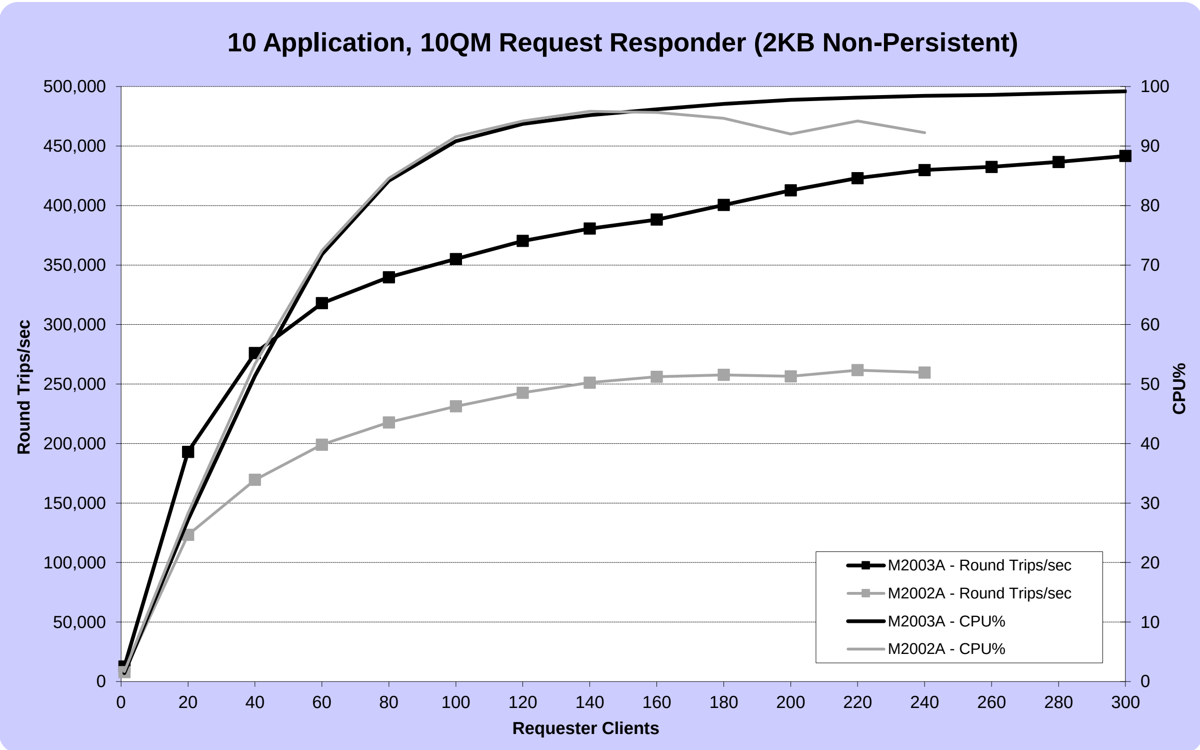

FIGURE 1 - PERFORMANCE RESULTS FOR 2KB, 10QM NON-PERSISTENT MESSAGING, M2003A VS M2002A

Figure 1 (and the tabulated data below) shows that the M2003A appliance is capable of up to 70% increased throughput of Non-persistent messaging when compared with M2002A in CPU limited scenarios.

The 100Gb network connectivity provided in the M2003 appliance offers increased connectivity options and larger overall capacity for messaging bandwidth.

Test	M2003A			M2002A		
	Max Rate*	CPU%	Clients	Max Rate*	CPU%	Clients
10Q 10QM Request Responder (256b Non-persistent)	502,712	98.83	240	305,296	93.41	240
10Q 10QM Request Responder (2KB Non-persistent)	441,704	99.22	300	261,728	94.2	220
10Q 10QM Request Responder (20KB Non-persistent)	190,882	58.19	100	180,970	95.96	200
10Q 10QM Request Responder (200KB Non-persistent)	27,800	25.88	50	22,509	38.9	40

*Round trips/sec

TABLE 1 - PEAK RATES FOR 10QM NON-PERSISTENT MESSAGING, M2003A VS M2002A

The following graph shows the improvement provided in Persistent messaging:

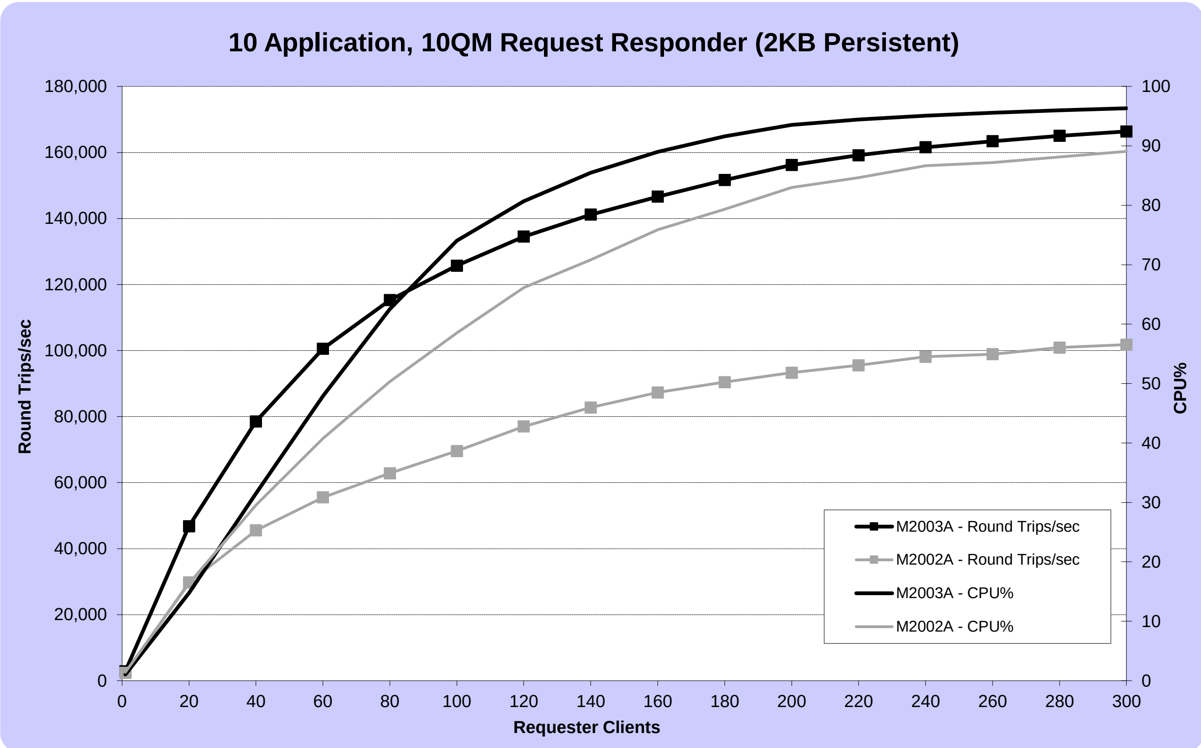

FIGURE 2 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING, M2003A VS M2002A

Figure 2 shows that there is up to 60% performance improvement when using the 2KB message size. For 20KB message sizes, there is an improvement of over 3 times. For 200KB message sizes, the M2003A is nearly 4 times faster.

Test	M2003A			M2002A		
	Max Rate*	CPU%	Clients	Max Rate*	CPU%	Clients
10Q 10QM Request Responder (256b Persistent)	180,207	95.99	300	119,476	94.65	400
10Q 10QM Request Responder (2KB Persistent)	166,391	96.32	300	105,736	92.73	400
10Q 10QM Request Responder (20KB Persistent)	108,926	88.41	300	33,949	33.06	90
10Q 10QM Request Responder (200KB Persistent)	14,009	24.88	100	3,537	7.81	10

*Round trips/sec

TABLE 2 - PEAK RATES FOR 10QM PERSISTENT MESSAGING, M2003A VS M2002A

The following graph shows the improvement provided in Persistent messaging with Queue Managers enabled for HA:

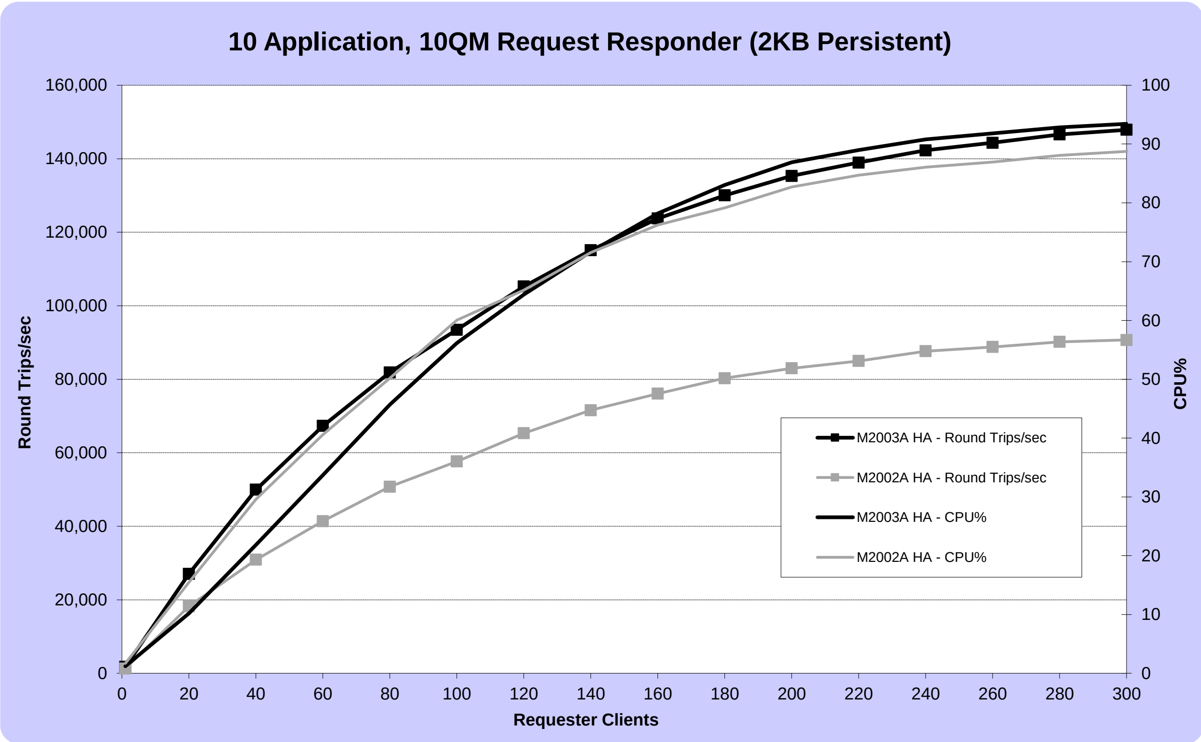

FIGURE 3 - PERFORMANCE RESULTS FOR 2KB, 10QM HA PERSISTENT MESSAGING, M2003A VS M2002A

Figure 3 shows that as with the previous section, there is more than 60% performance improvement when using the 2K message size. For message sizes of 20K and above, there is an improvement of over 3 times.

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	M2002A HA Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	160,801	93.95	300	0.5	100,168	89.36	280	0.6
10Q 10QM Request Responder (2KB Persistent)	147,873	93.44	300	0.6	90,682	88.74	300	0.8
10Q 10QM Request Responder (20KB Persistent)	90,224	76.86	280	0.7	29,353	34.18	160	0.9
10Q 10QM Request Responder (200KB Persistent)	10,679	21.64	120	1.3	3,240	12.31	150	2.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 3 - PEAK RATES FOR 10QM PERSISTENT MESSAGING, M2003A VS M2002A

5 Comparison of M2003A to M2001A

With the end of support date for the M2001A MQ Appliance set at 10th July 2023, it is anticipated that many M2001A users may seek to migrate to the new M2003 MQ Appliance.

The following points indicate the likely improvement in Performance that the M2003A offers in comparison to the M2001A:

- The M2003A offers over 3x more throughput than the performance of M2001A in Non-persistent messaging scenarios. (2KB)
- Up to 9x increase in performance over M2001A in Persistent messaging scenarios. (20KB)
- Up to 8x increase in performance over M2001A in HA Persistent messaging scenarios. (20KB)

This is based on data collected at V9.2.5 for the MQ M2001 Appliance and V9.3.2 for the MQ M2003 Appliance.

6 Request/Responder Scenario

The scenario that will be used in this report reflects the most common, anticipated usage patterns for the MQ appliance and provides guidance for those customers performing capacity planning or migration activities.

Each test was initially conducted and graphs produced using a 2K (2048 byte) message size. Additional tests were also conducted using 256byte, 20K and 200K to provide further data for capacity planning and are found in the accompanying data table.

As customers replace their existing MQ QM infrastructure, they may consolidate their MQ configuration from separate MQ QM servers (possibly running on different hardware and different MQ Versions) onto a single MQ appliance. They may have a mix of applications tightly bound to their existing QM and also a number of applications that connect using the MQ client API. To migrate to the MQ appliance all applications will need to connect via the MQ client API.

The following tests use MQ client connections and present the performance of MQ as deployed on the Appliance.

The test scenario in Figure 4 is a Request Responder scenario that simulates several applications that interact with a single QM. A request queue and a reply queue will be created for each application, so ten pairs of queues are created for this test. One or more requester applications will send messages to one of the application request queues and will wait for a reply on the associated reply queue. Responder applications will listen for messages on the request queues before sending them to the correct reply queue.

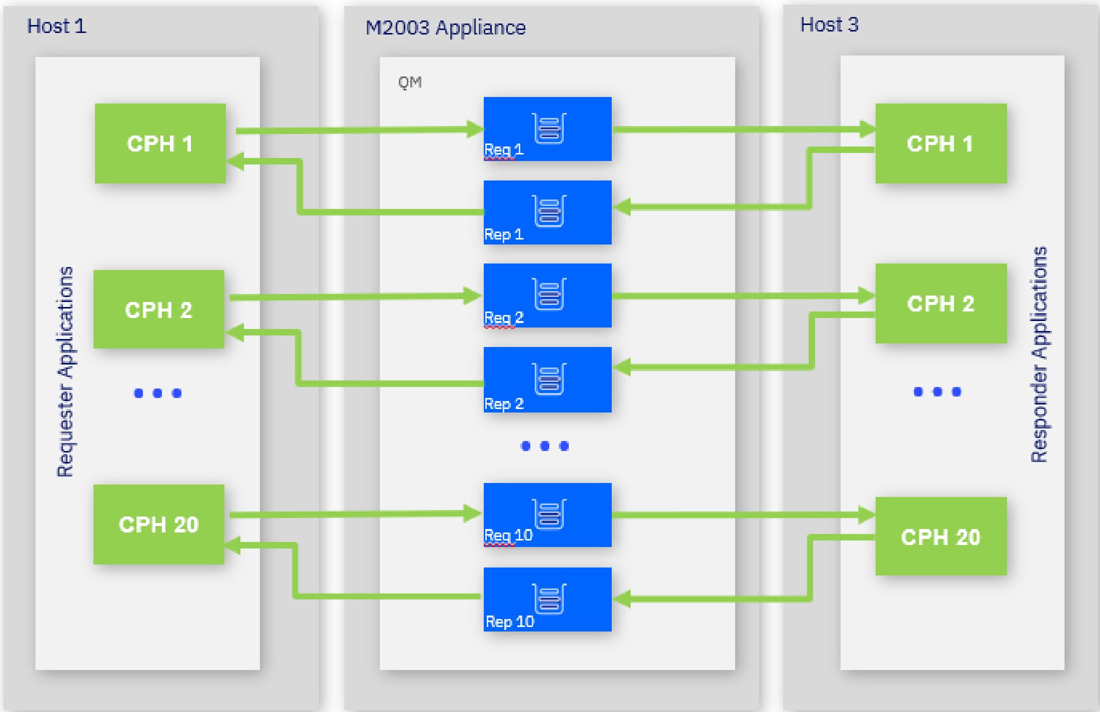

FIGURE 4 - REQUESTER-RESPONDER WITH REMOTE QUEUE MANAGER ON MQ APPLIANCE

Subsequent requester applications will send and receive messages from the set of application queues on a round-robin basis i.e. distributing the messages produced and consumed across the set of application queues.

Results are presented for various numbers of producer threads distributed across the 10 applications (using 10 pairs of queues), 300 fixed responder threads (30 responders per request queue) will send the replies to the appropriate reply queue, and the report will show the message rates achieved (in round trips/second) as the number of producers is increased.

For the 10QM tests, there are 10 QM with 10 applications per QM (again using 10 pairs of queues). There are still 300 overall responder threads, but as we now have 100 pairs of queues, we have 3 responders per request queue.

6.1 Test Scenario C1 – 10 Applications per QM, 1 QM, Non-persistent

The following graph shows how the scenario detailed in section 6 performs with Non-persistent messaging against a single QM.

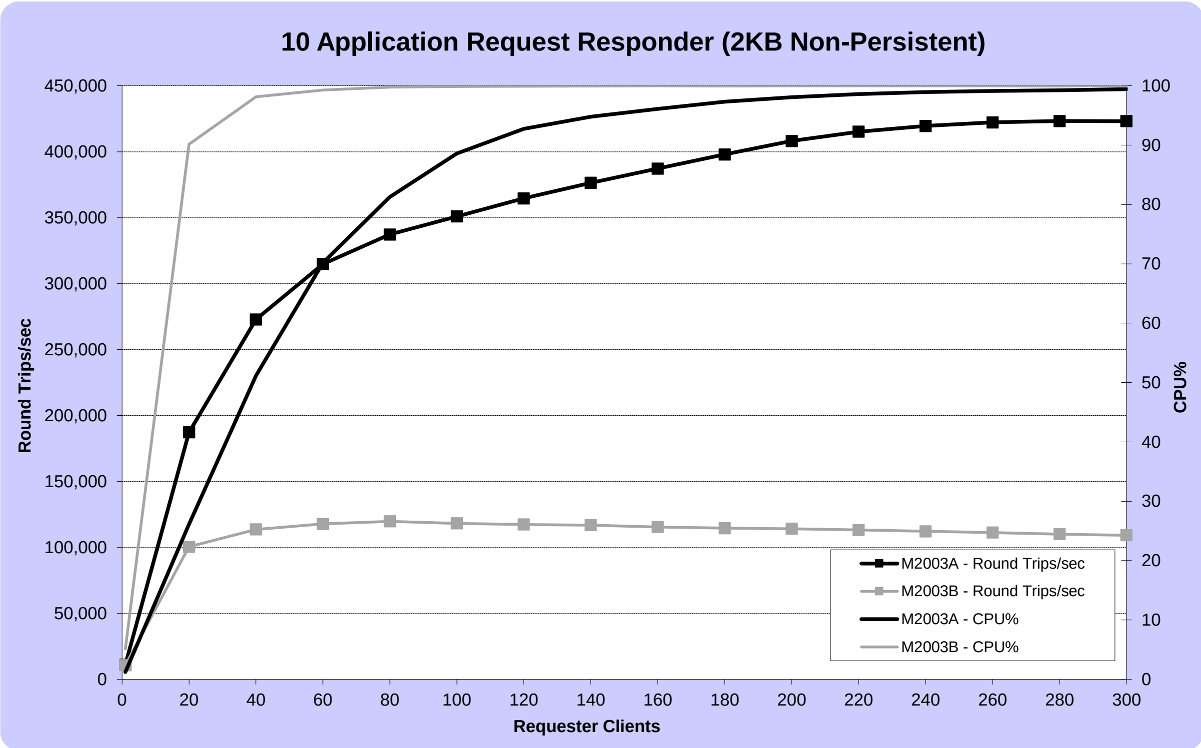

FIGURE 5 – PERFORMANCE RESULTS FOR 2KB NON-PERSISTENT MESSAGING

Figure 5 shows how by increasing the workload on the appliance (by increasing the number of concurrent requester clients), the throughput rate increases until the CPU capacity of the appliance is exhausted.

The M2003A appliance can achieve approximately 3 times the throughput of the M2003B appliance.

Test	M2003A Max Rate*	CPU%	Clients	M2003B Max Rate*	CPU%	Clients
10Q Request Responder (256b Non-persistent)	485,405	98.86	220	149,209	99.72	80
10Q Request Responder (2KB Non-persistent)	423,218	99.26	280	119,795	99.76	80
10Q Request Responder (20KB Non-persistent)	188,662	55.61	100	84,546	99.6	80
10Q Request Responder (200KB Non-persistent)	27,720	26.02	40	20,383	97.12	40

*Round trips/sec

TABLE 4 - PEAK RATES FOR NON-PERSISTENT MESSAGING

6.2 Test Scenario C2 – 10 applications per QM, 1 QM, Persistent

This test repeats the test C1 featured in section 6.1, but utilises persistent messaging on the appliances local RAID10 disk subsystem.

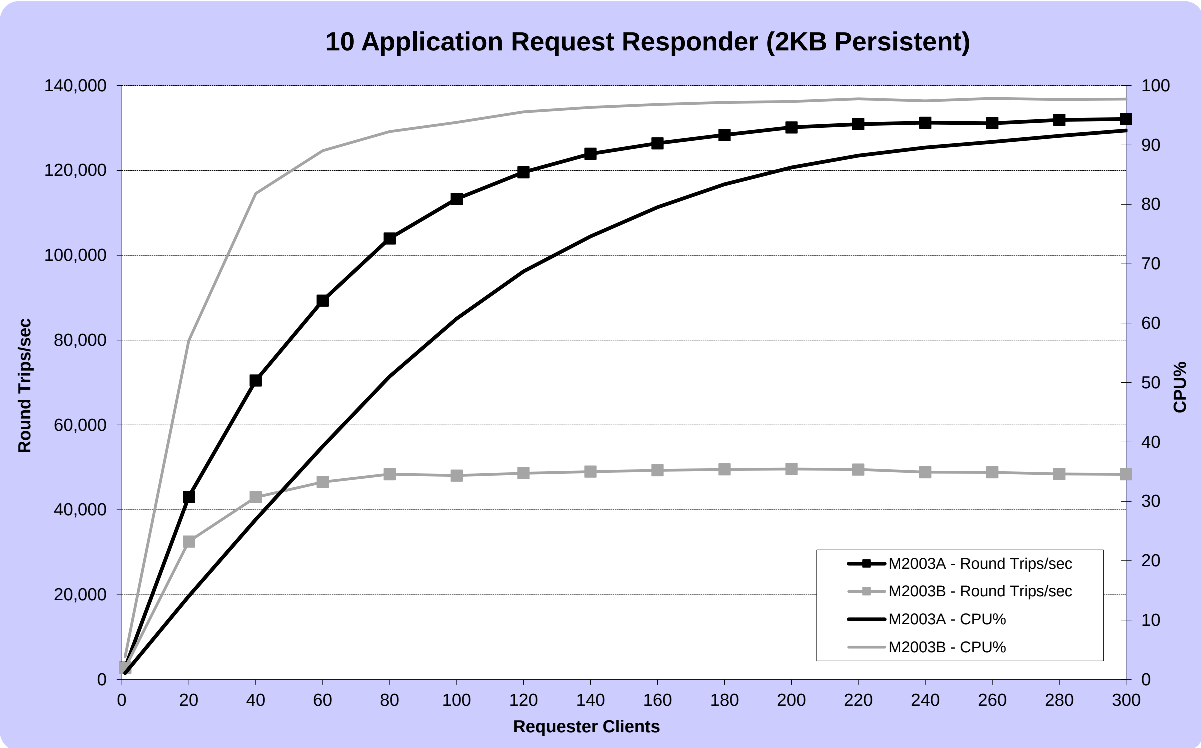

FIGURE 6 - PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 6 shows that as the workload increases, a maximum throughput is achieved (~132,000 Round trips/sec for 2KB message size) and the limits of the local disk subsystem have become the limiting factor for a single QM.

If using a message size of 2KB, the M2003A appliance can achieve approximately 2.5 times the persistent throughput of the M2003B appliance.

Test	M2003A Max Rate*	CPU%	Clients	M2003B Max Rate*	CPU%	Clients
10Q Request Responder (256b Persistent)	140,625	91.71	280	54,379	97.66	200
10Q Request Responder (2KB Persistent)	132,101	92.43	300	49,625	97.32	200
10Q Request Responder (20KB Persistent)	72,628	50.09	140	36,429	91.95	120
10Q Request Responder (200KB Persistent)	8,193	11.3	30	7,371	46.33	25

*Round trips/sec

TABLE 5 – PEAK RATES FOR PERSISTENT MESSAGING

6.3 Test Scenario C3 – 10 applications per QM, 10 QM, Non-persistent

This test is equivalent to test C1 featured in section 6.1 with 10QM instead of 1QM. A total of 100 applications will be distributed across the 10 QM.

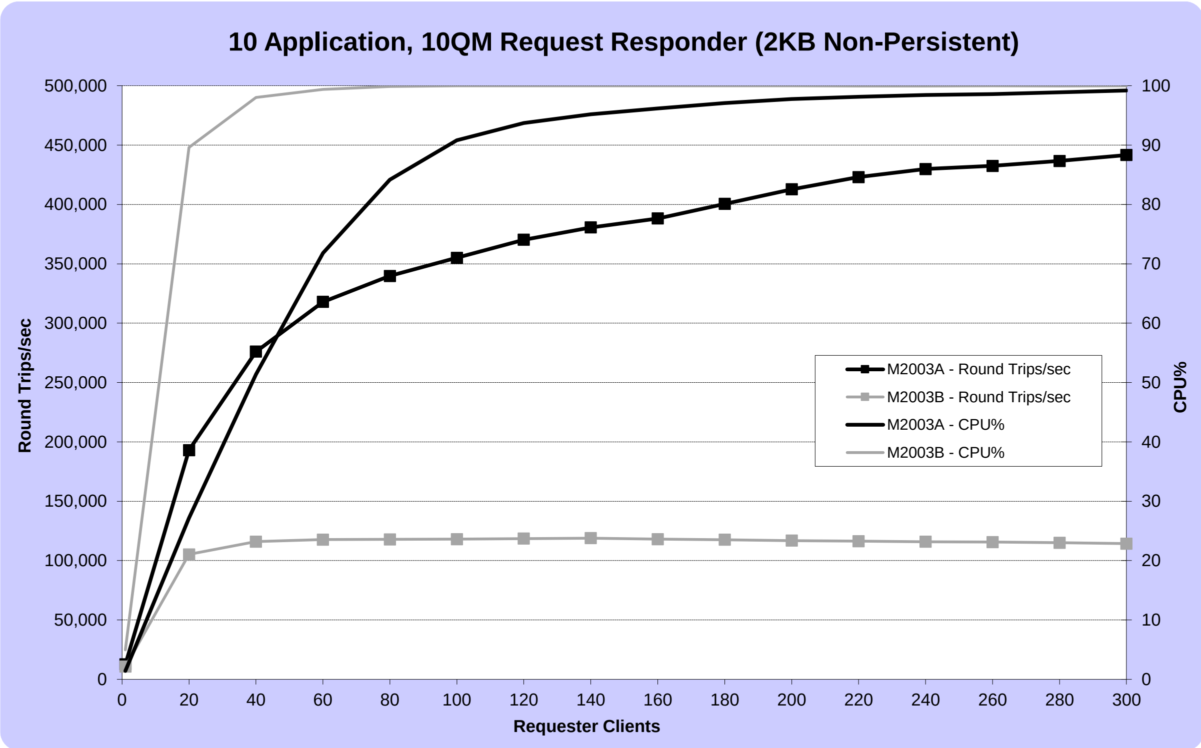

FIGURE 7 - PERFORMANCE RESULTS FOR 2KB, 10QM NON-PERSISTENT MESSAGING

Figure 7 shows that similar or improved performance can be obtained when running Non-persistent messaging through 10QM as compared with the single QM scenario.

The M2003A appliance can achieve approximately 3 times the throughput of the M2003B appliance.

Test	M2003A Max Rate*	CPU%	Clients	M2003B Max Rate*	CPU%	Clients
10Q 10QM Request Responder (256b Non-persistent)	502,712	98.83	240	137,107	99.29	60
10Q 10QM Request Responder (2KB Non-persistent)	441,704	99.22	300	118,938	99.99	140
10Q 10QM Request Responder (20KB Non-persistent)	190,882	58.19	100	85,935	99.36	60
10Q 10QM Request Responder (200KB Non-persistent)	27,800	25.88	50	22,332	97.05	40

*Round trips/sec

TABLE 6 - PEAK RATES FOR 10QM NON-PERSISTENT MESSAGING

6.4 Test Scenario C4 – 10 applications per QM, 10 QM, Persistent

This test repeats the test C3 featured in section 6.3, but utilises persistent messaging on the appliances local RAID10 disk subsystem. The graph and the accompanying data table illustrate that to utilise all of the available IO capacity on the appliance, multiple QM are required.

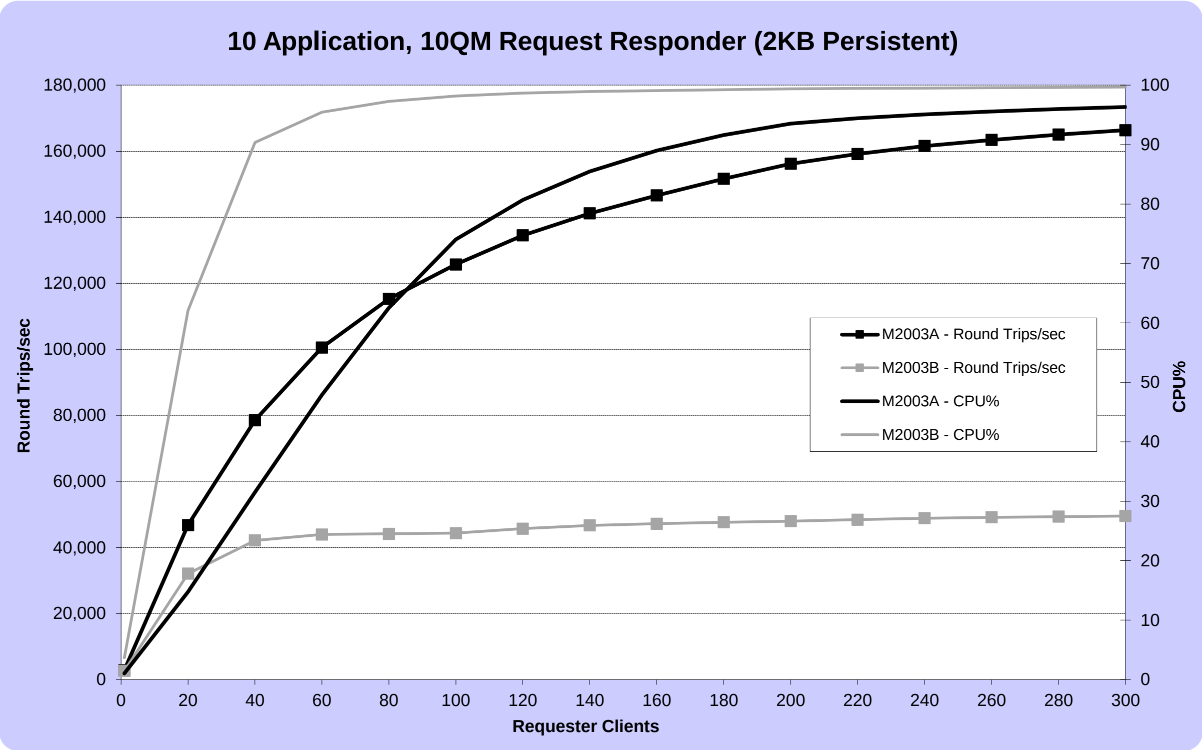

FIGURE 8 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 8 shows that when we have multiple QM performing persistent messaging, the peak messaging rate obtainable on the M2003A is over 160,000 Round trips/sec for 2KB message size.

If using a message size of 2KB, the M2003A appliance can achieve approximately 3 times the persistent throughput of the M2003B appliance.

Test	M2003A			M2003B		
	Max Rate*	CPU%	Clients	Max Rate*	CPU%	Clients
10Q 10QM Request Responder (256b Persistent)	180,207	95.99	300	53,703	99.67	300
10Q 10QM Request Responder (2KB Persistent)	166,391	96.32	300	49,523	99.69	300
10Q 10QM Request Responder (20KB Persistent)	108,926	88.41	300	37,921	99.59	300
10Q 10QM Request Responder (200KB Persistent)	14,009	24.88	100	11,871	95.43	120

*Round trips/sec

TABLE 7- PEAK RATES FOR 10QM PERSISTENT MESSAGING

7 Connection Scaling

The scaling measurement in this section are designed to test a number of scenarios where there are a larger number of clients attached. Whereas the previous tests are optimised for throughout, these tests define an operational environment or scaling challenge to test from a performance perspective.

7.1 Connection Test

This test uses the Requester Responder workload as described in section 6. The requester applications are rated at 1 message every 100 seconds and 60,000 client bound requester applications are connected as fast as possible to determine the overall connection time for those clients to the MQ Appliance.

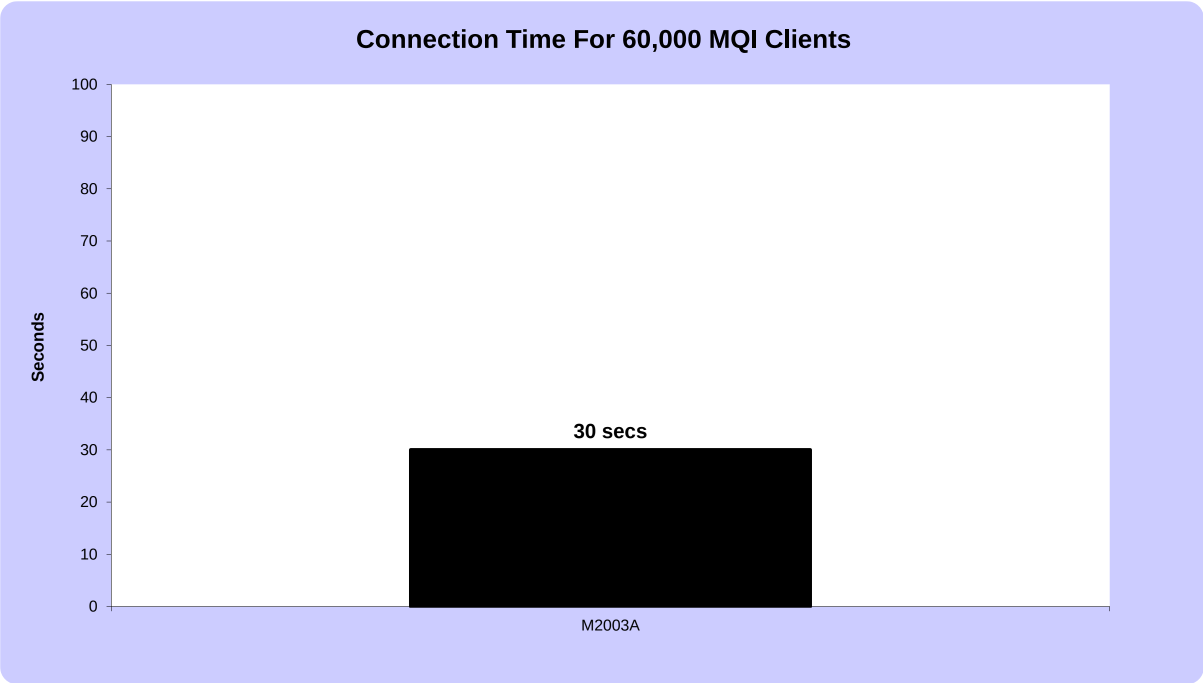

FIGURE 9 – PERFORMANCE RESULTS FOR MQI CLIENT CONNECTION TEST

The M2003 appliance with its range of 10,40 and 100Gb networking supports rapid connections from concurrent client bound applications and the MQ appliance can now support 60,000 clients initiating a connection to a single queue manager in approximately 30 seconds.

8 HA Scenarios

High Availability (HA) can be enabled by pairing two MQ Appliances together to provide continuous availability in the event of one of the appliances suffers a failure. The Queue Manager (QM) log and queue files are synchronously replicated across the pair of appliances.

If separate networks (and switches) are used to connect the pair of appliances, then the pair can also continue to operate in the event of a partial network outage.

To ensure clients reconnect to the QM on either of the pair of appliances, the clients should be made aware of the IP addresses assigned to the workload interfaces of both appliances; or a Virtualised IP address in the case that a suitable load balancer component is employed; or a floating IP if it is configured on the appliance for the QM.

To illustrate the performance profile of enabling the HA infrastructure, tests will be performed on two of the scenarios featured earlier in the report.

1) Request Responder 1QM Persistent (Test C2)
2) Request Responder 10QM Persistent (Test C4)

Each test will be conducted with both a standalone QM and a QM incorporated into an appliance HA group, so that the cost of the synchronous replication can be evaluated.

This section utilises the following connections:

Primary Appliance	Secondary Appliance	Notes
eth13	eth13	Connected directly between appliances with 1Gb copper patch cable
eth17	eth17	Connected directly between appliances with 1Gb copper patch cable
eth31	eth31	Connected directly between appliances with 40Gb DAC cable
eth40		Workload driven via this 100Gb interface
eth41		Workload driven via this 100Gb interface

8.1 Test Scenario HA1 – 10 Applications per QM, 1 QM, Persistent

This test is identical to test C2 in section 6.2 and is presented here with results from running tests against a standalone QM and against a QM that is included in an HA group.

Results are presented for various numbers of requester threads distributed across the 10 applications (using 10 pairs of queues), 300 fixed responder threads (30 responders per request queue) will send the replies to the appropriate reply queue, and the report will show the message rates achieved (in round trips/second) as the number of requesters is increased.

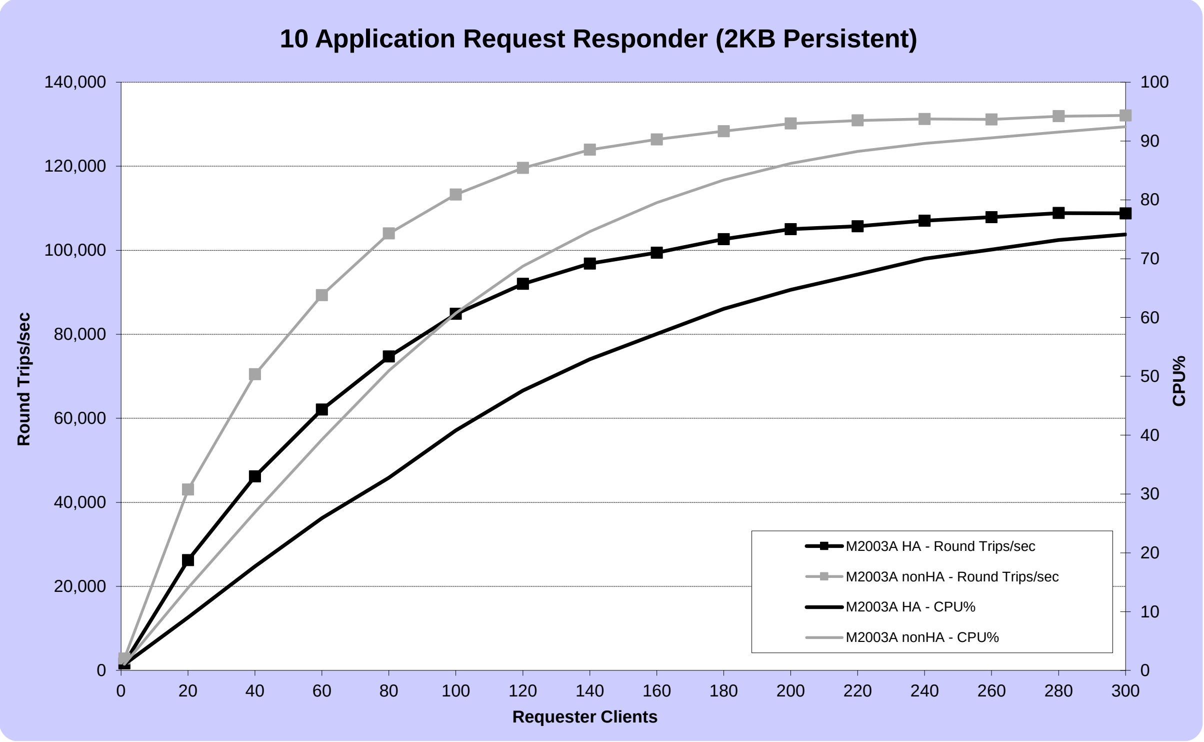

FIGURE 10 – PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 10 shows that by enabling HA capability, the maximum throughput achieved in this single queue manager scenario with a 2K message size is reduced by less than 20%. A small penalty for ensuring your data is synchronously written to both primary and secondary appliances in the HA group.

Test	M2003A HA				M2003A nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	131,351	85.73	280	0.5	140,625	91.71	280	0.3
10Q Request Responder (2KB Persistent)	108,861	73.19	280	0.6	132,101	92.43	300	0.4
10Q Request Responder (20KB Persistent)	31,398	23.59	180	0.7	72,628	50.09	140	0.4
10Q Request Responder (200KB Persistent)	3,422	5.63	30	1.3	8,193	11.3	30	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 8 - PEAK RATES FOR PERSISTENT MESSAGING

8.2 Test Scenario HA2 – 10 applications per QM, 10 QM, Persistent

This test repeats test C4 and is presented here with results from running tests against a standalone set of Queue Managers and against a set of Queue Managers that are included in an HA group.

Results are presented for various numbers of requester threads distributed across the 10 Queue Managers who each host 10 pairs of queues (representing 10 applications per QM), 300 fixed responder threads (3 responders per request queue) will send the replies to the appropriate reply queue which are subsequently received by the originating requester threads, and the report will show the message rates achieved (in round trips/second) as the number of requesters is increased.

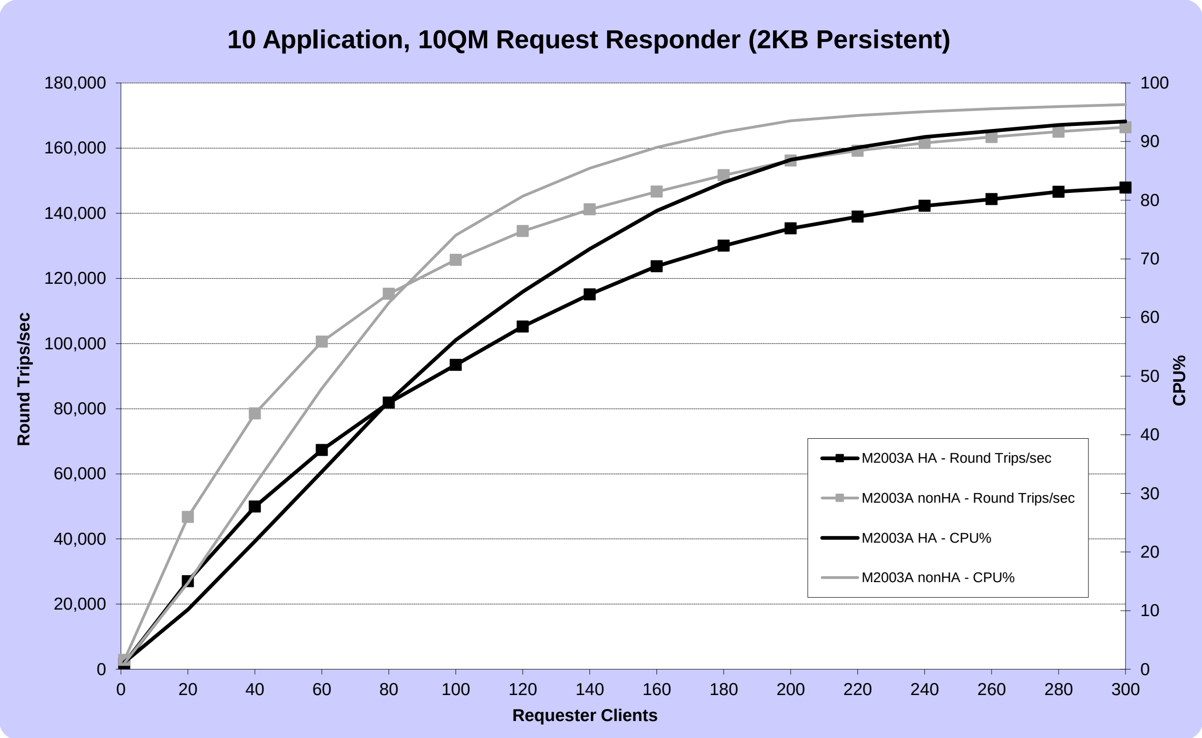

FIGURE 11 – PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 11 shows that when we have multiple QM performing 2KB persistent messaging across a pair of HA appliances, the messaging rate is only 12% less than when distributed across a set of non HA Queue Managers.

Test	M2003A HA				M2003A nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	160,801	93.95	300	0.5	180,207	95.99	300	0.3
10Q 10QM Request Responder (2KB Persistent)	147,873	93.44	300	0.6	166,391	96.32	300	0.3
10Q 10QM Request Responder (20KB Persistent)	90,224	76.86	280	0.7	108,926	88.41	300	0.5
10Q 10QM Request Responder (200KB Persistent)	10,679	21.64	120	1.3	14,009	24.88	100	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 9 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

8.3 How does HA perform over larger distances?

The previous section shows how the MQ appliance HA capability might perform if both appliances were located in the same data centre (i.e. 3m distance between the appliances). How would the HA performance differ if the pair of appliances were located a larger distance apart? Due to testing limitations, we need to simulate the latency that might be experienced as the distances between the appliances grows.

If the appliances are located 100Km apart, you might expect the smallest increase in packet transmission latency for each leg to be calculated as follows:

distance / speed = time

100,000m / 300,000,000m/s [1] = 0.000333s = 333 microseconds

There must also be an allowance for the refraction index of the cable

333 * 1.5 = 500 microseconds

Switching hardware and non-linear cable routing will likely further increase the latency between the pair of HA appliances. It is currently advised to customers to site a pair of HA appliances so that the latency between the two appliances is no greater than 10ms and preferably within the same data centre.

A delay can be inserted into the sending network layer of both appliances to simulate such latency and let us examine how this impacts the HA performance. The following chart repeats test HA2 from section 8.2 and shows the effect of a 1ms round trip latency introduced into the network layer between the two HA appliances.

[1] Assuming speed of light to be $3x10^8$m/s

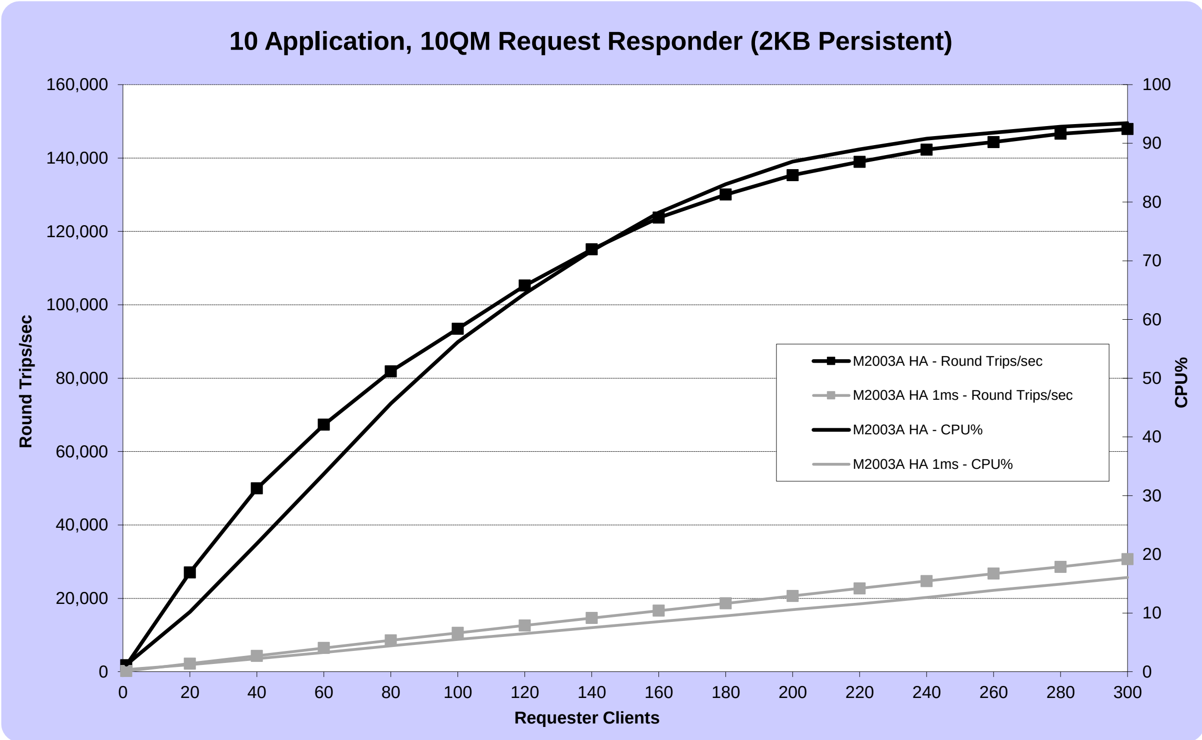

FIGURE 12 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING WITH/WITHOUT 1MS LATENCY

Figure 12 shows that an additional 1ms latency on the round trip time of the HA replication interface results in a ~80% reduction in performance than compared with the direct connection (no additional latency) between the appliances.

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 1ms Latency (256b Persistent)	30,654	14.59	300	4.7	19.1%
10Q 10QM Request Responder 1ms Latency (2KB Persistent)	30,662	16.05	300	5.5	20.7%
10Q 10QM Request Responder 1ms Latency (20KB Persistent)	27,726	19.5	300	5.8	30.7%
10Q 10QM Request Responder 1ms Latency (200KB Persistent)	7,557	15.75	120	6.4	70.8%

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 10 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 1MS SIMULATED LATENCY

The data in the following tables show additional data points with simulated latency delays of 2, 5 and 10ms.

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 2ms Latency (256b Persistent)	15,986	7.89	300	8.7	9.9%
10Q 10QM Request Responder 2ms Latency (2KB Persistent)	16,037	8.64	300	10.5	10.8%
10Q 10QM Request Responder 2ms Latency (20KB Persistent)	15,241	10.89	300	11.0	16.9%
10Q 10QM Request Responder 2ms Latency (200KB Persistent)	4,853	9.96	120	11.5	45.4%

*Round trips/sec
#Single thread round trip latency (ms)

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 5ms Latency (256b Persistent)	6,569	3.57	300	20.9	4.1%
10Q 10QM Request Responder 5ms Latency (2KB Persistent)	6,594	3.91	300	25.0	4.5%
10Q 10QM Request Responder 5ms Latency (20KB Persistent)	6,412	5.17	300	26.4	7.1%
10Q 10QM Request Responder 5ms Latency (200KB Persistent)	2,198	4.6	120	27.0	20.6%

*Round trips/sec
#Single thread round trip latency (ms)

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 10ms Latency (256b Persistent)	3,311	1.92	300	41.2	2.1%
10Q 10QM Request Responder 10ms Latency (2KB Persistent)	3,331	2.24	300	49.4	2.3%
10Q 10QM Request Responder 10ms Latency (20KB Persistent)	3,673	3.29	300	51.9	4.1%
10Q 10QM Request Responder 10ms Latency (200KB Persistent)	1,143	2.61	120	52.7	10.7%

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 11 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 2, 5 AND 10MS SIMULATED LATENCY

9 DR Scenarios

Users can configure a Queue Manager for Disaster Recovery (DR) to ensure that the QM data is distributed to a recovery appliance. This configuration allows the Queue Manager on the recovery appliance to resume work should an outage occur that results in the main appliance becoming unavailable.

Users can also configure a QM for both HA and DR. The performance of this configuration will be examined in section 10, whist in this section we will look at the standalone performance of DR.

The Queue Manager data is replicated asynchronously to the recovery appliance, which can result in messaging data loss (up to a maximum of 4MB per QM is held in the TCP send buffer) should the main appliance become unavailable. The Queue Manager at the recovery appliance must be manually started before it can start accepting connections from clients.

To illustrate the cost of enabling the DR infrastructure, tests will be performed on two of the scenarios featured earlier in this report.

1) Request Responder 1QM Persistent (Test C2)
2) Request Responder 10QM Persistent (Test C4)

Each test will be conducted with both a standalone QM and a QM configured with a remote DR appliance, so that the cost of the asynchronous replication can be evaluated.

This section utilises the following connections:

Appliance A	Appliance B	Appliance C (DR)	Notes
eth13	eth13		Connected directly between appliances with 1Gb copper patch cable. Used in section 10 only
eth17	eth17		Connected directly between appliances with 1Gb copper patch cable. Used in section 10 only
eth30		eth30	Connected via ethernet switch with 40Gb DAC cables for DR
eth31	eth31		Connected directly between appliances with 40Gb DAC cable for HA. Used in section 10 only
eth40			Workload driven via this 100Gb interface
eth41			Workload driven via this 100Gb interface

9.1 Test Scenario DR1 – 10 Applications per QM, 1 QM, Persistent

This test is identical to test C2 in section 6.2 and is presented here with results from running tests against a standalone QM and against a QM that is configured for Disaster Recovery (although the recovery appliance is located 3m from the main appliance).

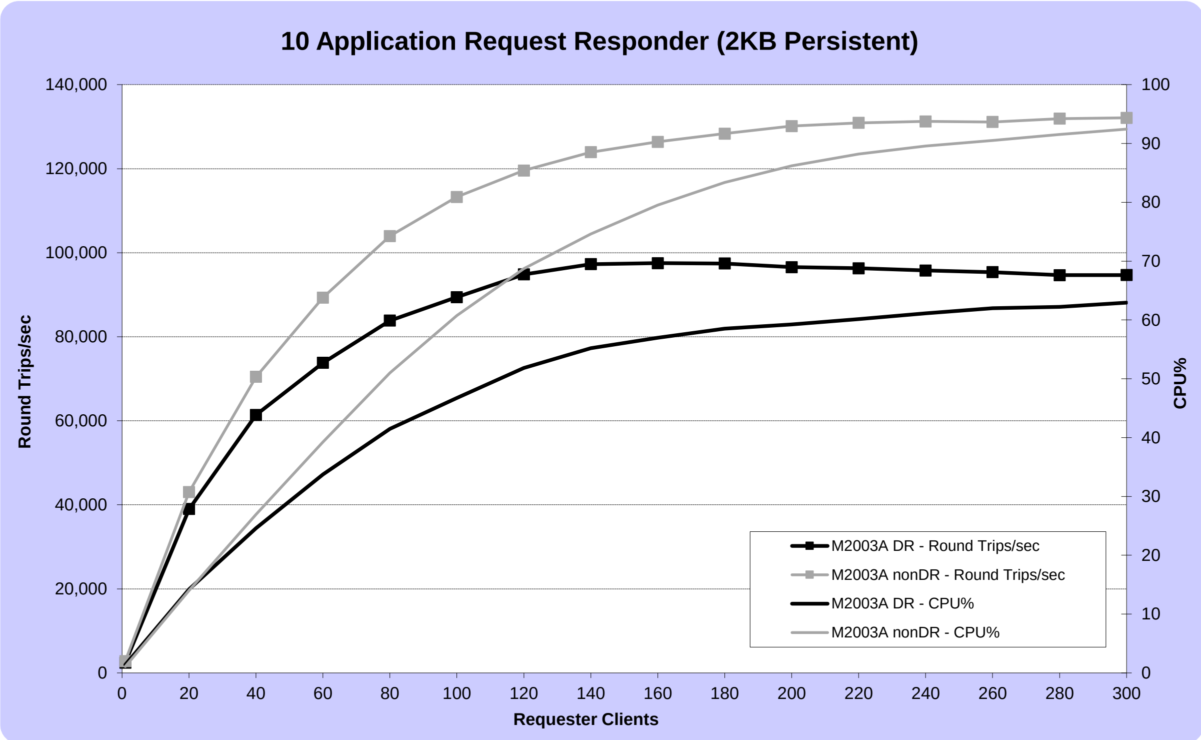

FIGURE 13 – PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 13 shows that by enabling DR capability, the maximum throughput achieved with a 2K message size on a single Queue Manager is reduced by up to 25%. This is similar to the impact of enabling HA replication, but utilises less CPU.

Test	M2003A DR				M2003A nonDR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	126,812	78.17	240	0.4	140,625	91.71	280	0.3
10Q Request Responder (2KB Persistent)	97,509	56.97	160	0.4	132,101	92.43	300	0.4
10Q Request Responder (20KB Persistent)	30,247	23.14	160	0.5	72,628	50.09	140	0.4
10Q Request Responder (200KB Persistent)	3,265	5.69	30	1.2	8,193	11.3	30	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 12 - PEAK RATES FOR PERSISTENT MESSAGING

9.2 Test Scenario DR2 – 10 Applications per QM, 10 QM, Persistent

This test is identical to the test C4 in section 6.4 and is presented here with results from running tests against ten standalone QM and against ten QM that are configured for Disaster Recovery (although the recovery appliance is located 3m from the main appliance).

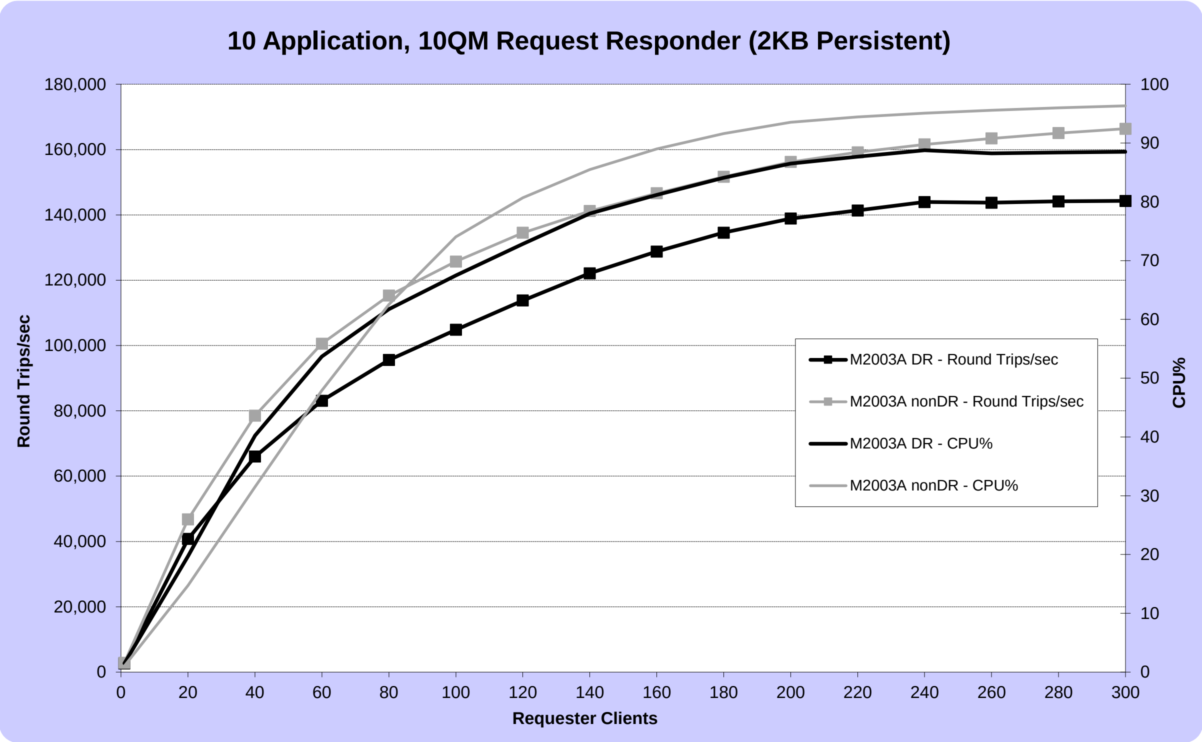

FIGURE 14 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 14 shows that when we have multiple QM configured for Disaster Recovery performing 2KB persistent messaging, the peak messaging rate is within 15% of the rate achieved when distributed across a set of nonDR Queue Managers.

Test	M2003A DR				M2003A nonDR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	158,764	89.68	300	0.4	180,207	95.99	300	0.3
10Q 10QM Request Responder (2KB Persistent)	144,292	88.51	300	0.4	166,391	96.32	300	0.3
10Q 10QM Request Responder (20KB Persistent)	90,944	79.61	240	0.5	108,926	88.41	300	0.5
10Q 10QM Request Responder (200KB Persistent)	11,227	27.74	120	1.1	14,009	24.88	100	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 13 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

9.3 How does DR perform over larger distances?

DR configuration usually requires a remote appliances to be situated a large distance from the primary location so that any particular event that might affect the primary location would be hoped not to affect the remote recovery appliance.

The data in the following tables show the results from the test scenario featured in the previous section but with additional data points using simulated latency delays of 10, 20, 50 and 100ms. A comparison against the DR scenario in which the MQ Appliances are directly connected is also included.

Test	M2003A DR Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 10ms Latency (256b Persistent)	152,075	86.12	300	0.3	95.8%
10Q 10QM Request Responder 10ms Latency (2KB Persistent)	136,400	83	300	0.4	94.5%
10Q 10QM Request Responder 10ms Latency (20KB Persistent)	41,171	29.26	300	0.5	45.3%
10Q 10QM Request Responder 10ms Latency (200KB Persistent)	4,617	9.65	100	1.7	41.1%

***Round trips/sec**
#Single thread round trip latency (ms)

Test	M2003A DR Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 20ms Latency (256b Persistent)	154,425	86.58	300	0.3	97.3%
10Q 10QM Request Responder 20ms Latency (2KB Persistent)	133,902	78.16	280	0.4	92.8%
10Q 10QM Request Responder 20ms Latency (20KB Persistent)	18,581	10.72	240	0.5	20.4%
10Q 10QM Request Responder 20ms Latency (200KB Persistent)	2,514	5.26	110	3.2	22.4%

***Round trips/sec**
#Single thread round trip latency (ms)

Test	M2003A DR Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 50ms Latency (256b Persistent)	114,343	53.44	280	0.4	72.0%
10Q 10QM Request Responder 50ms Latency (2KB Persistent)	39,857	17.41	140	0.6	27.6%
10Q 10QM Request Responder 50ms Latency (20KB Persistent)	7,484	5.09	180	1.4	8.2%
10Q 10QM Request Responder 50ms Latency (200KB Persistent)	651	1.62	120	7.7	5.8%

***Round trips/sec**
#Single thread round trip latency (ms)

Test	M2003A DR Max Rate*	CPU%	Clients	Latency#	vs Direct
10Q 10QM Request Responder 100ms Latency (256b Persistent)	48,179	17.49	220	0.9	30.3%
10Q 10QM Request Responder 100ms Latency (2KB Persistent)	25,095	9.72	260	1.2	17.4%
10Q 10QM Request Responder 100ms Latency (20KB Persistent)	3,459	2.1	140	2.7	3.8%
10Q 10QM Request Responder 100ms Latency (200KB Persistent	385	1.04	100	14.5	3.4%

***Round trips/sec**
#Single thread round trip latency (ms)

TABLE 14 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 10, 20, 50 AND 100MS SIMULATED LATENCY

10 HA and DR Scenarios

Users can configure a Queue Manager for both HA and DR. The data that is asynchronously replicated for disaster recovery is sent from the currently active instance of the HA pair.

This configuration allows the Queue Manager on the DR recovery appliance to resume work should an outage occur that results in both the appliances in the HA group becoming unavailable.

The performance of these scenarios is close to that which has been measured in the HA scenarios featured in sections 8.1 and 8.2; the throughput is slightly reduced due to the additional work performing the asynchronous replication in addition to the synchronous HA replication.

Test	M2003A HA and DR				M2003A nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	125,916	80.07	280	0.5	140,625	91.71	280	0.3
10Q Request Responder (2KB Persistent)	97,141	65.24	260	0.6	132,101	92.43	300	0.4
10Q Request Responder (20KB Persistent)	30,430	23.59	160	0.7	72,628	50.09	140	0.4
10Q Request Responder (200KB Persistent)	3,334	6.2	30	1.4	8,193	11.3	30	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 15 - PEAK RATES FOR PERSISTENT MESSAGING, HA AND DR

Test	M2003A HA and DR				M2003A nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	151,125	93.14	300	0.5	180,207	95.99	300	0.3
10Q 10QM Request Responder (2KB Persistent)	137,960	92.21	300	0.6	166,391	96.32	300	0.3
10Q 10QM Request Responder (20KB Persistent)	88,330	83.67	300	0.7	108,926	88.41	300	0.5
10Q 10QM Request Responder (200KB Persistent)	10,494	28.36	110	1.3	14,009	24.88	100	1.0

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 16 - PEAK RATES FOR 10QM PERSISTENT MESSAGING, HA AND DR

11 Additional M2003A vs M2003B scenarios

In the earlier sections of this report detailing NonHA and NonDR scenarios, graphical and numerical data was also provided for the M2003B model. In the later sections detailing HA and DR scenarios, the comparison points were the equivalent NonHA and NonDR measurements.

This section has been added to illustrate the performance comparison of running HA and DR scenarios on either the M2003A or M2003B appliances.

We will initially look at the results of running test HA1 from section 8.1:

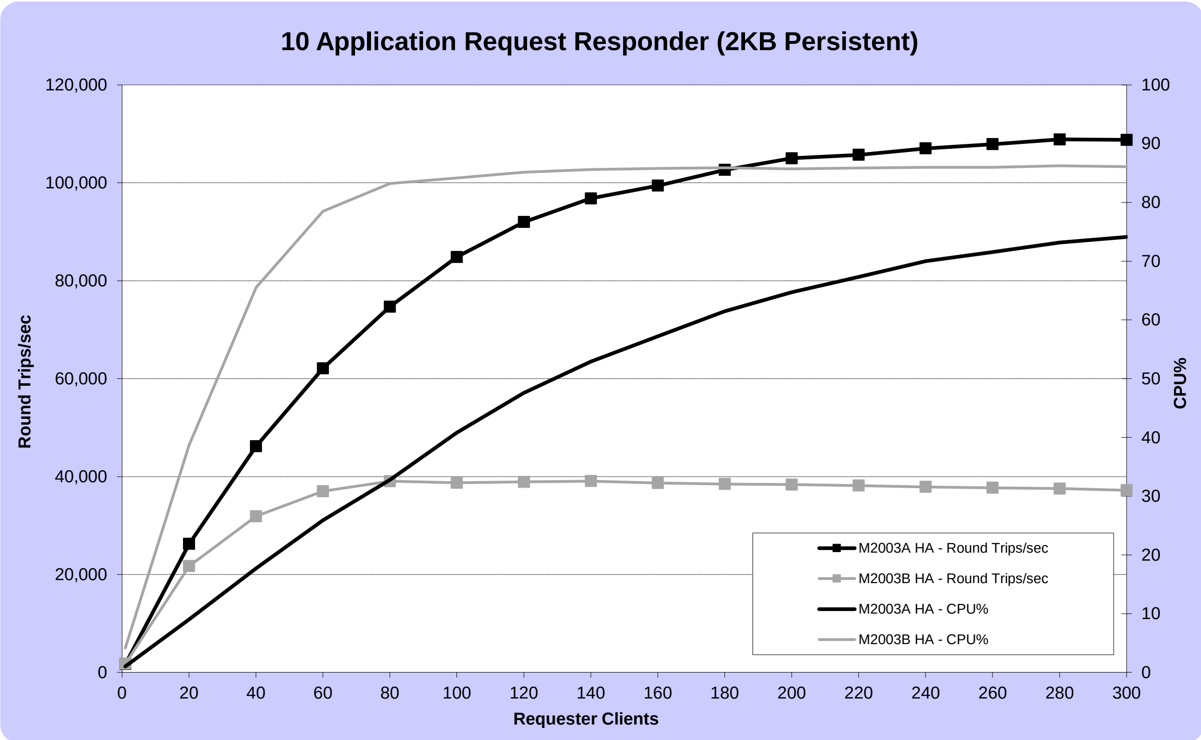

FIGURE 15 - PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 15 shows that the M2003A appliance can achieve nearly three times the throughput of the M2003B appliance in this single HA QM scenario.

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	M2003B HA Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	131,351	85.73	280	0.5	44,312	89.03	120	0.5
10Q Request Responder (2KB Persistent)	108,861	73.19	280	0.6	39,057	85.6	140	0.6
10Q Request Responder (20KB Persistent)	31,398	23.59	180	0.7	20,391	54.97	60	0.7
10Q Request Responder (200KB Persistent)	3,422	5.63	30	1.3	3,140	24.84	30	1.3

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 17 - PEAK RATES FOR PERSISTENT MESSAGING

The following graph shows the results of running test HA2 from section 8.2:

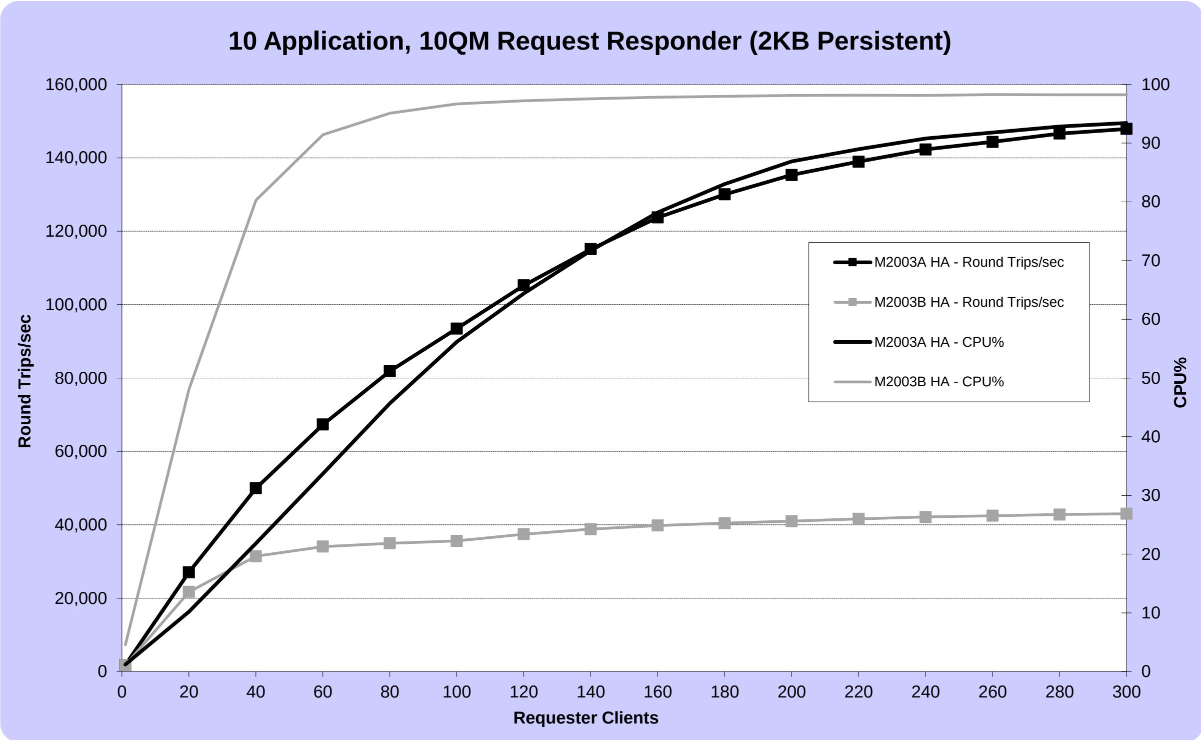

FIGURE 16 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 16 shows that with multiple HA Queue Managers, the M2003A appliance can achieve over 3 times the throughput of the M2003B appliance.

Test	M2003A HA Max Rate*	CPU%	Clients	Latency#	M2003B HA Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	160,801	93.95	300	0.5	47,070	98.61	300	0.5
10Q 10QM Request Responder (2KB Persistent)	147,873	93.44	300	0.6	42,999	98.25	300	0.6
10Q 10QM Request Responder (20KB Persistent)	90,224	76.86	280	0.7	31,881	97.05	300	0.7
10Q 10QM Request Responder (200KB Persistent)	10,679	21.64	120	1.3	9,578	88.56	120	1.3

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 18 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

The following graph shows the results of running test DR1 from section 9.1:

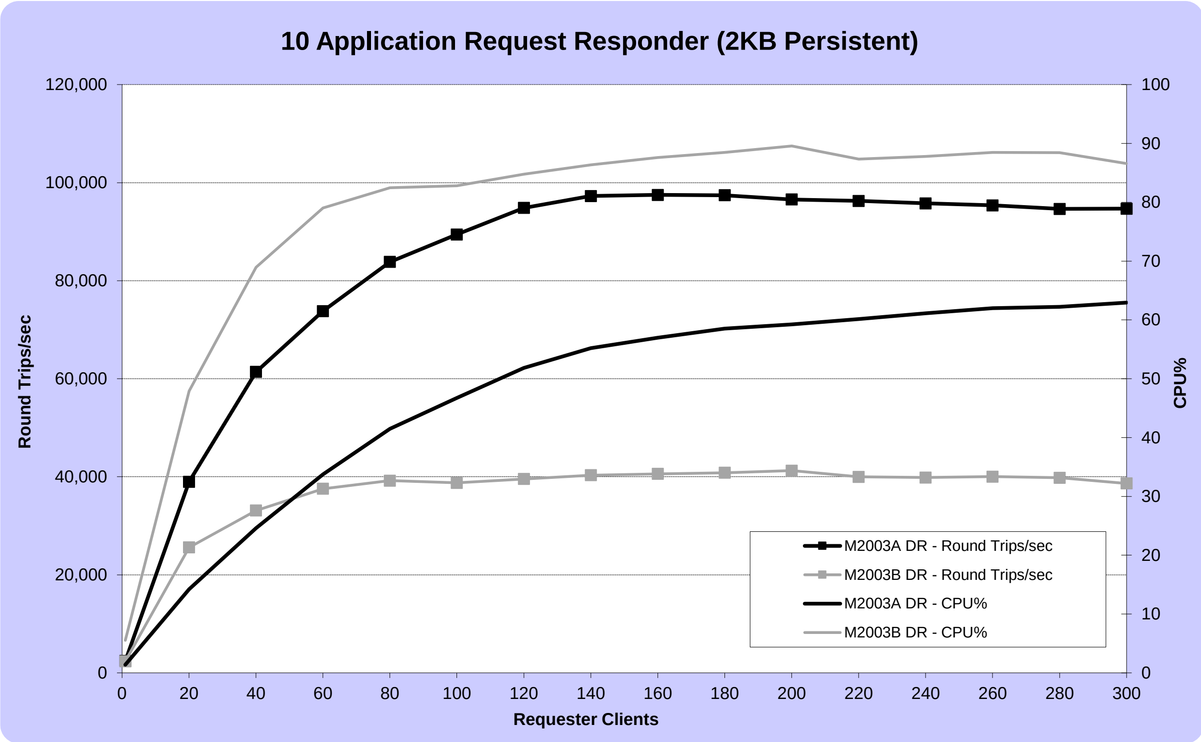

FIGURE 17 - PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 17 shows that the M2003A appliance can achieve more than double the throughput of the M2003B appliance in this single DR QM scenario.

Test	M2003A DR				M2003B DR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	126,812	78.17	240	0.4	45,374	92.63	300	0.4
10Q Request Responder (2KB Persistent)	97,509	56.97	160	0.4	41,257	89.59	200	0.4
10Q Request Responder (20KB Persistent)	30,247	23.14	160	0.5	17,836	52.44	100	0.5
10Q Request Responder (200KB Persistent)	3,265	5.69	30	1.2	3,394	28.28	30	1.2

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 19 - PEAK RATES FOR PERSISTENT MESSAGING

The following graph shows the results of running test DR2 from section 9.2:

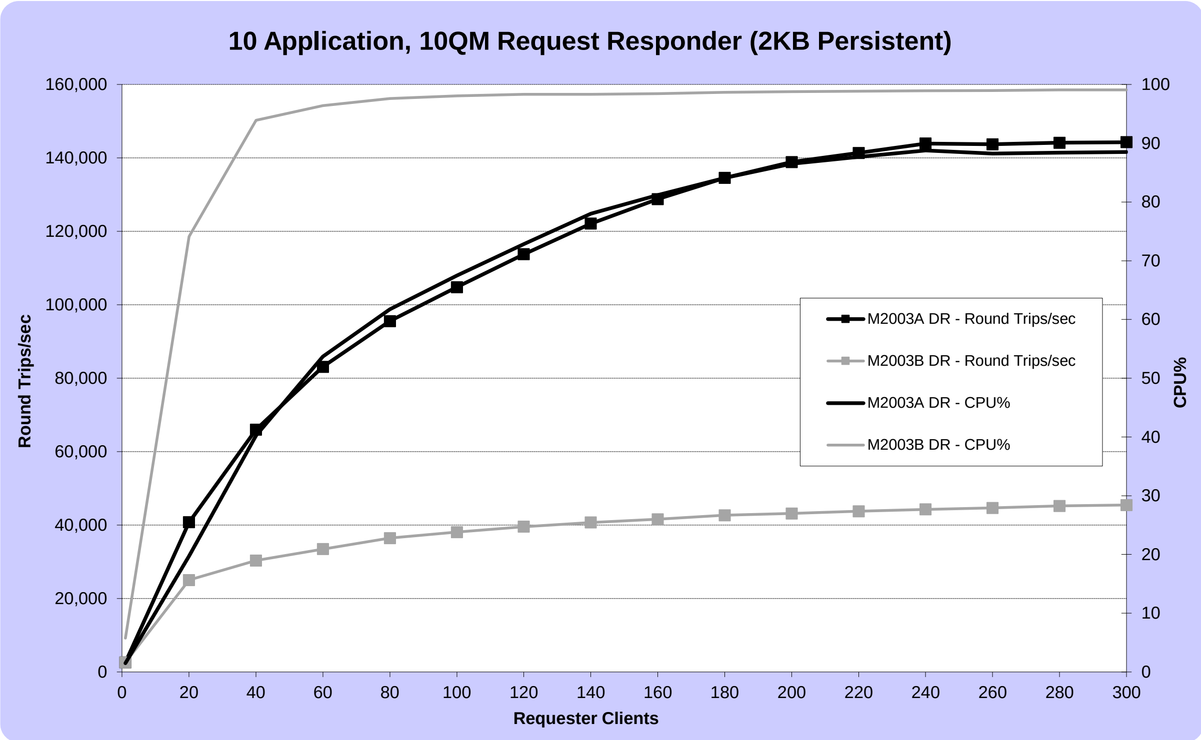

FIGURE 18 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 18 shows that with multiple DR Queue Managers, the M2003A appliance can achieve approximately 3 times the throughput of the M2003B appliance.

Test	M2003A DR Max Rate*	CPU%	Clients	Latency#	M2003B DR Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	158,764	89.68	300	0.4	49,609	99.13	300	0.4
10Q 10QM Request Responder (2KB Persistent)	144,292	88.51	300	0.4	45,452	99.09	300	0.4
10Q 10QM Request Responder (20KB Persistent)	90,944	79.61	240	0.5	31,866	99.24	300	0.5
10Q 10QM Request Responder (200KB Persistent)	11,227	27.74	120	1.1	9,227	96.4	120	1.2

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 20 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

The following graph shows the results of running the combined HA and DR scenario from section 10 for a single Queue Manager:

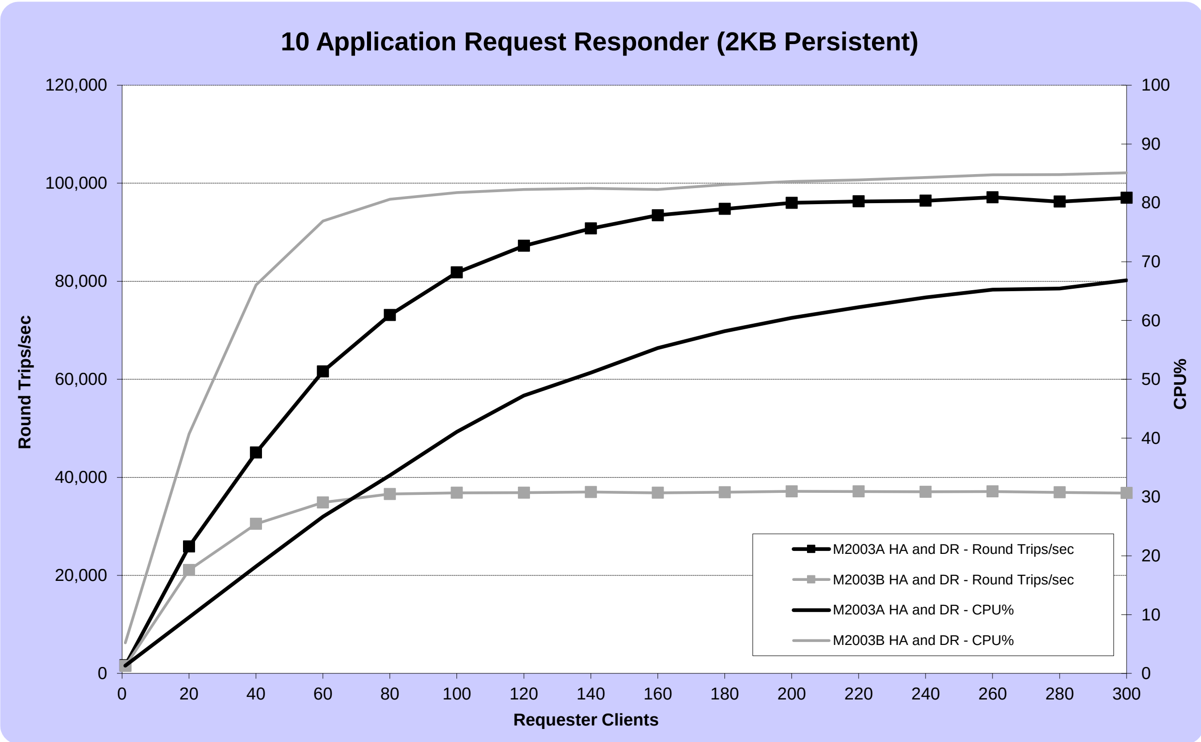

FIGURE 19 - PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 19 shows that the M2003A appliance can achieve more than double the throughput of the M2003B appliance in this single HA and DR QM scenario.

Test	M2003A HA and DR				M2003B HA and DR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	125,916	80.07	280	0.5	42,301	86.84	140	0.5
10Q Request Responder (2KB Persistent)	97,141	65.24	260	0.6	37,134	83.65	200	0.7
10Q Request Responder (20KB Persistent)	30,430	23.59	160	0.7	18,006	55.04	100	0.8
10Q Request Responder (200KB Persistent)	3,334	6.2	30	1.4	2,933	25.8	20	1.3

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 21 - PEAK RATES FOR PERSISTENT MESSAGING

The following graph shows the results of running the combined HA and DR scenario from section 10 against ten Queue Managers:

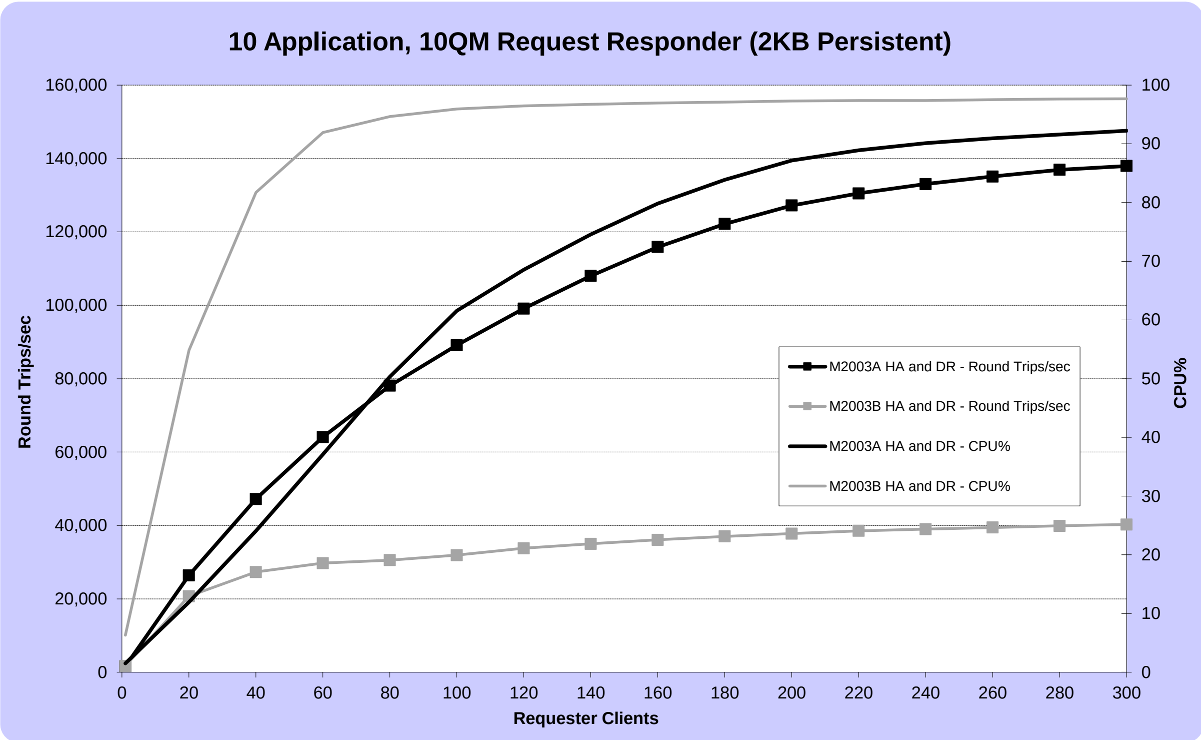

FIGURE 20 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 20 shows that with multiple HA and DR Queue Managers, the M2003A appliance can achieve over 3 times the throughput of the M2003B appliance.

Test	M2003A HA and DR				M2003B HA and DR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	151,125	93.14	300	0.5	44,040	97.81	300	0.5
10Q 10QM Request Responder (2KB Persistent)	137,960	92.21	300	0.6	40,245	97.69	300	0.6
10Q 10QM Request Responder (20KB Persistent)	88,330	83.67	300	0.7	27,630	97.11	280	0.7
10Q 10QM Request Responder (200KB Persistent)	10,494	28.36	110	1.3	7,235	92.47	120	1.3

*Round trips/sec
#Single thread round trip latency (ms)

TABLE 22 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

12 Frequently Asked Questions

Will I be able to use FASTPATH channels to send/receive messages into the MQ Appliance?

Yes - this is now the default MQIBindType as specified in the Channels stanza in the qm.ini configuration file.

How do I view and change QM settings on the MQ Appliance?

You can use the *dspmqini* command to view the QM configuration and *setmqini* to alter any configuration options. There are similar *dspmqvar* and *setmqvar* commands to view/alter environment variables.

What type of logging is used on the MQ Appliance?

Only circular logging is supported on the MQ Appliance, and thus facilities to monitor/prune QM recovery logs (useful for managing linear logs), are not required.

Can I run my existing user exits?

No – for appliance integrity, user exits will not be supported on the MQ Appliance. Many historic reasons for using code exits have now been resolved by product features.

What is throttling my messaging scenario?

If customers experience throttled performance when driving high throughput workloads on M2003A, they should check the following:

- Persistent workloads - Customers might encounter the limits of the RAID10 subsystem as illustrated in this document, although this is less likely with the fast NVMe storage available in the M2003 appliance
- Larger message (10K+) Non-persistent workloads - Customers might encounter network limits depending on which interfaces are selected for workload traffic. Customer can select higher bandwidth connectivity or aggregate multiple interfaces.
- Small message (2K-) Non-persistent workloads – Customers might encounter CPU saturation (Check MQ Console or CLI)
- All - Ensure that they have a sufficient number of concurrent clients to drive workload on the M2003 appliance

I have an M2002A/B, can I upgrade to M2003A/B?

The M2003 appliance has very different hardware to the M2002 appliance, therefore there is no upgrade option.

13 Appendix A – Client machine specification

The two client machines used for the performance tests in this report have the following specification:

Category	Value
Machine	Lenovo ThinkSystem SR630 V2
OS	Red Hat Enterprise Linux Server 8.7
CPU	2x16 (3.1Ghz)
RAM	256GB RAM
Network	10/100Gb Ethernet
Disks	2x 3TB NVMe SSD in RAID-0 array
RAID	Linux mdraid MQ Logs hosted on RAID-0 partition

14 Appendix B – QM Configuration

The following commands and expect scripts were used to create the standalone Queue Managers for this report:

```
crtmqm -lp 64 -lf 16384 -h 5000 -fs 16 PERF0

setmqini -m PERF0 -s TuningParameters -k DefaultPQBufferSize -v 10485760

setmqini -m PERF0 -s TuningParameters -k DefaultQBufferSize -v 10485760


proc configureQM { QMname QMport QMqueues } {

    send "runmqsc $QMname\n"

    send "define listener(L1) trptype(tcp) port($QMport) control(qmgr)\n"

    send "start listener(L1)\n"

    send "alter channel(SYSTEM.DEF.SVRCONN) chltype(SVRCONN) sharecnv(1) maxmsgl(104857600)\n"

    send "alter qmgr maxmsgl(104857600)\n"

    send "alter qlocal(system.default.local.queue) maxmsgl(104857600)\n"

    send "alter qmodel(system.default.model.queue) maxmsgl(104857600)\n"

    send "alter qmodel(system.jms.model.queue) maxmsgl(104857600)\n"

    send "alter qmodel(system.jms.tempq.model) maxmsgl(104857600)\n"

    send "alter qlocal(system.dead.letter.queue) maxmsgl(104857600)\n"

    send "define channel(SYSTEM.ADMIN.SVRCONN) chltype(SVRCONN)\n"

    send "alter qmgr chlauth(disabled)\n"

    send "alter authinfo(SYSTEM.DEFAULT.AUTHINFO.IDPWOS) authtype(IDPWOS) chckclnt(OPTIONAL)\n"

    send "refresh security type(CONNAUTH)\n"

    send "define qlocal(queue) maxdepth(5000) replace\n"

    send "define qlocal(request) maxdepth(5000) replace\n"

    send "define qlocal(reply) maxdepth(5000) replace\n"

    for {set j 0} {$j <= $QMqueues} {incr j 1} {

        send "define qlocal(request$j) maxdepth(5000) replace\n"

        send "define qlocal(reply$j) maxdepth(5000) replace\n"

    }

    send "end\n"

}
```