

IBM MQ Appliance HA and DR Performance Report

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First Edition, December 2015.

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3 Report Highlights

This report contains data points that illustrate the performance of the HA and DR functions of the IBM MQ Appliance. It is worth noting the following highlights:

- Nearly 40,000 round trips/second peak messaging rate in HA enabled scenario (~80,000 messages produced and ~80,000 messages consumed). See section 4.1.
- Peak messaging rate equivalent in large message(20K+) HA and non HA scenarios across multiple queue managers. See section 4.2.
- Performing a manual failover with 500,000 queued messages between a pair of HA appliances took only 13 seconds. See section 4.4.
- Peak messaging rate equivalent in DR and non DR scenarios across multiple queue managers. See section 5.2.
- DR performance degrades by less than 10% across all message sizes when the latency between the paired appliances is under 50ms. See section 5.3.

4 HA Introduction

This report is a follow on document to the previously released MQ Appliance Performance report available at the following location:

<http://www-01.ibm.com/support/docview.wss?uid=swg24040125>

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 (if required) 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.

To illustrate the cost of enabling the HA infrastructure, tests will be performed on two of the scenarios featured in the base MQ Appliance performance report.

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

The results contained in this report should not be directly compared with the base report because as one of the 10Gb Network ports needs to be reserved for HA connectivity, the network configuration is different to that previously used.

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.

The M2000A and M2000B appliances are supplied with 2x10Gb Ethernet Network links and 8x1Gb Ethernet network links. When the appliances are configured for redundant HA, 1x10Gb link and 2x1Gb links are reserved for use by the appliance, leaving a total of 16Gb for customer workloads. In Non-HA mode, all 28Gb connectivity can be utilised for workload traffic. There are a further two separate 1Gb links that are explicitly reserved for appliance administration. This section utilises the following connections:

Appliance A	Appliance B	Notes
eth13	eth13	Connected directly between appliances with 1Gb copper patch cable
eth17	eth17	Connected directly between appliances with 1Gb copper patch cable
eth21	eth21	Connected directly between appliances with 10Gb fibre cable
eth20	eth20	Workload driven via these interfaces

All of 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 section is M2000A 8.0.0.4 (which we will refer to subsequently as M2000A FP4).

The scenarios that will be presented in this report reflect the most common usage patterns that customers are anticipated to use with the MQ appliance and provide guidance for those customers looking to evaluate the performance of the MQ Appliance with HA enabled.

Each test was conducted using a 2K (2048 byte) message size and this data is shown in the graphs included below. Additional tests were conducted using 256byte, 20K and 200K to provide further data points.

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

This test is identical to test C2 in the MQ Appliance performance report and is presented here with results from running tests against a standalone QM and also 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), 200 fixed responder threads (20 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.

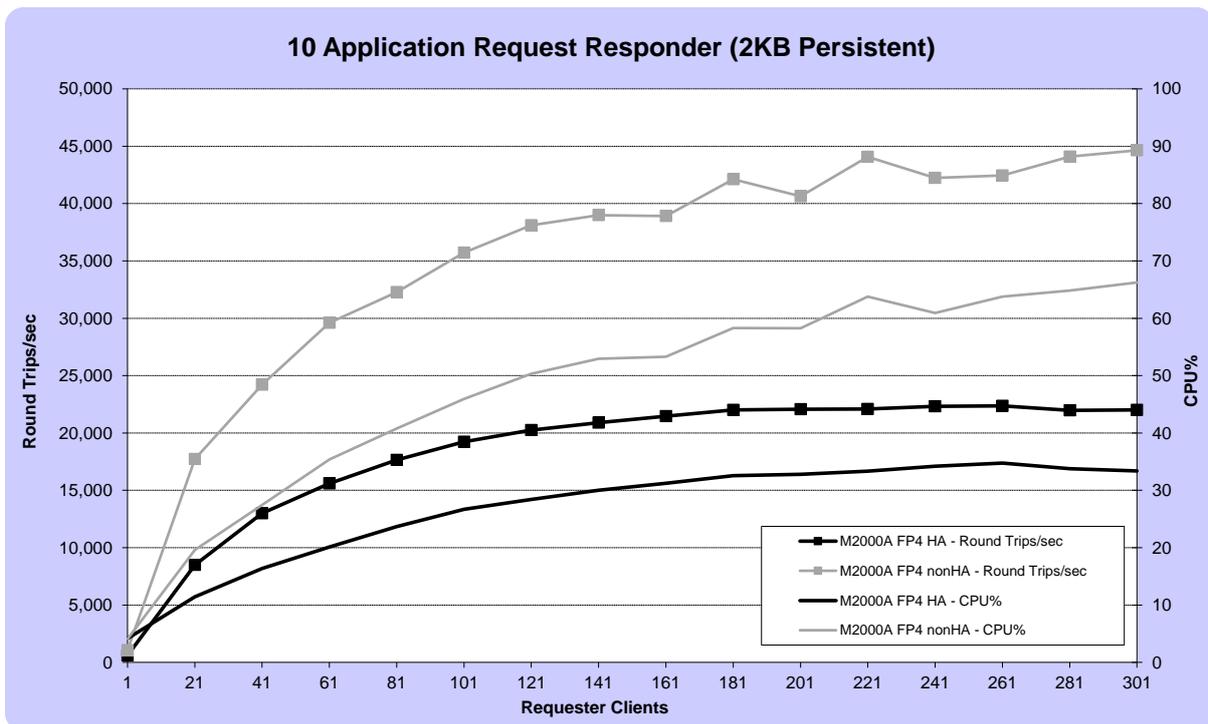


FIGURE 1 – PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 1 shows that by enabling HA capability, the maximum throughput achieved with a 2K message size is approximately halved. There is a similar reduction in CPU utilisation, thus providing capacity to perform additional messaging on the appliance.

Test	M2000A FP4 HA				M2000A FP4 nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	38,951	52.14	301	1.5	53,845	76.87	301	0.9
10Q Request Responder (2KB Persistent)	22,359	34.73	261	1.6	46,505	68.63	301	0.9
10Q Request Responder (20KB Persistent)	5,689	12.82	101	2.2	12,089	23.24	101	1.3
10Q Request Responder (200KB Persistent)	694	8.22	41	4.4	1,480	10.65	31	2.9

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 1 - PEAK RATES FOR PERSISTENT MESSAGING

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

This test repeats the test C4 in the MQ Appliance performance report and is presented here with results from running tests against a standalone set of Queue Managers and also 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), 200 fixed responder threads (2 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.

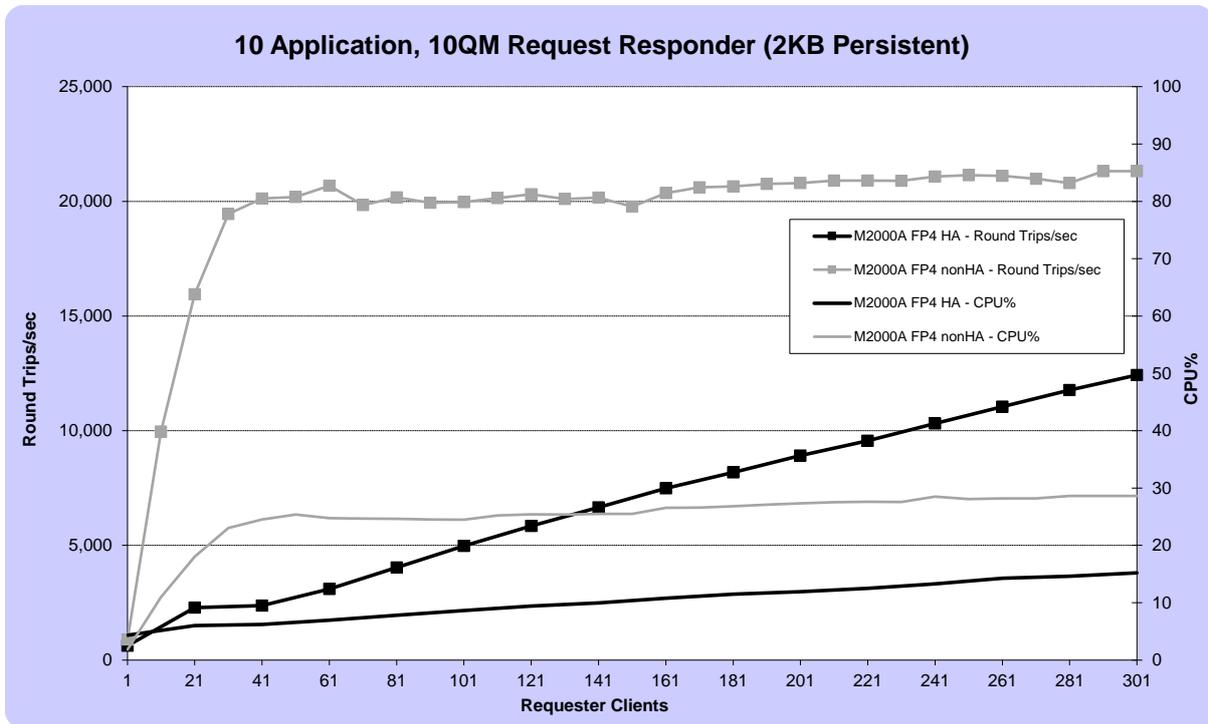


FIGURE 2 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 2 shows that when we have multiple QM performing 2KB persistent messaging across a pair of HA appliances, the messaging rate is approximately 40%-80% less than when distributed across a set of non HA Queue Managers. At larger message sizes, there is less impact on the maximum message rate, although more clients are required to be connected to achieve the maximum rate.

Test	M2000A FP4 HA				M2000A FP4 nonHA			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	12,448	15.33	301	1.6	21,380	29.12	301	1.1
10Q 10QM Request Responder (2KB Persistent)	12,429	15.21	301	1.6	21,315	28.62	301	1.1
10Q 10QM Request Responder (20KB Persistent)	3,306	8.14	141	2.0	3,359	4.78	11	1.4
10Q 10QM Request Responder (200KB Persistent)	356	5.21	11	4.3	357	1.63	6	2.8

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 2 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

4.3 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:

$$\text{distance} / \text{speed} = \text{time}$$

$$100,000\text{m} / 300,000,000\text{m/s}^{\text{a}} = 0.000333\text{s} = 333 \text{ microseconds}$$

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

$$333 * 1.5 = 500 \text{ microseconds}$$

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.

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 the test from Section 4.2 and shows the effect of a 2ms round trip latency introduced into the network layer between the two HA appliances.

^a Assuming speed of light to be $3 \times 10^8 \text{m/s}$

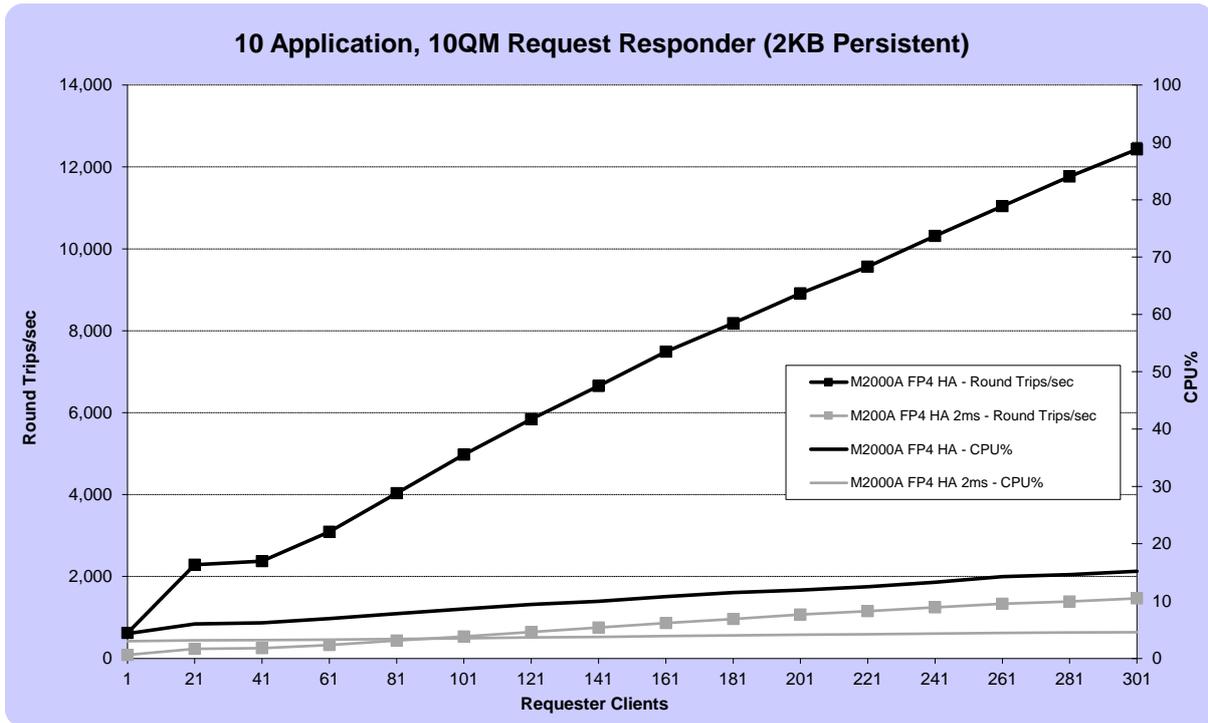


FIGURE 3 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING WITH/WITHOUT 2MS LATENCY

Figure 3 shows that an additional 2ms latency on the round trip time of the HA replication interface results in a ~88% reduction in performance than compared with the direct connection (no additional latency) between the appliances.

Test	M2000A FP4 HA				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 2ms Latency (256b Persistent)	1,470	4.62	301	11.8	11.8%
10Q 10QM Request Responder 2ms Latency (2KB Persistent)	1,466	4.54	301	11.8	11.8%
10Q 10QM Request Responder 2ms Latency (20KB Persistent)	762	4.24	151	12.7	23.0%
10Q 10QM Request Responder 2ms Latency (200KB Persistent)	219	4.45	51	15.0	61.5%

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 3 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 2MS SIMULATED LATENCY

The data in the following tables show additional data points with simulated latency delays of 1, 5 and 10ms.

Test	M2000A FP4 HA				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 1ms Latency (256b Persistent)	2,581	5.81	301	6.9	20.7%
10Q 10QM Request Responder 1ms Latency (2KB Persistent)	2,589	5.89	301	6.6	20.8%
10Q 10QM Request Responder 1ms Latency (20KB Persistent)	1,274	5.13	151	7.5	38.5%
10Q 10QM Request Responder 1ms Latency (200KB Persistent)	319	5.06	51	9.7	89.7%

*Round trips/sec

#Single thread round trip latency (ms)

Test	M2000A FP4 HA				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 5ms Latency (256b Persistent)	657	1.19	301	26.7	5.3%
10Q 10QM Request Responder 5ms Latency (2KB Persistent)	660	1.16	301	26.7	5.3%
10Q 10QM Request Responder 5ms Latency (20KB Persistent)	343	0.93	151	28.1	10.4%
10Q 10QM Request Responder 5ms Latency (200KB Persistent)	110	1.2	51	30.9	30.8%

*Round trips/sec

#Single thread round trip latency (ms)

Test	M2000A FP4 HA				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 10ms Latency (256b Persistent)	417	2.1	301	51.2	3.4%
10Q 10QM Request Responder 10ms Latency (2KB Persistent)	426	1.67	301	51.2	3.4%
10Q 10QM Request Responder 10ms Latency (20KB Persistent)	236	0.43	151	53.8	7.1%
10Q 10QM Request Responder 10ms Latency (200KB Persistent)	78	4.03	51	56.2	22.0%

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 4 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 1, 5 AND 10MS SIMULATED LATENCY

4.4 How long does it take before the QM on the standby appliance becomes available?

There are a number of factors to consider when evaluating the time it takes for a client to failover to the second appliance:

1. Detection by the MQ HA group that the main appliance is no longer responding
2. Making the QM on second appliance available, this involves replaying the transaction log to bring the queue files up to date (this will depend on the current persistent messaging rate and the time since last log checkpoint)
3. Time for client to notice disconnection and reconnect to second appliance

In our testing where a manual failover scenario is triggered, we are only examining the time spent in (2), because triggering a manual failover doesn't use the appliance heartbeating(1) functionality to detect loss of communication between the pair of appliances, and additionally all clients are informed to reconnect so do not have to wait for (3).

Our testing client was configured to attempt to reconnect to the QM on the second appliance when any errors were received whilst communicating with the QM on the main appliance. The location of the active QM was switched to the standby appliance by executing the **sethpreferred** command at the standby appliance. The time taken before a connection to the QM on the second appliance was recorded and can be seen in Table below.

M2000A FP4 HA		
Message size	Queue Depth	Failover time (s)
N/A	0	7
2K	500,000	13
20K	100,000	19
200K	25,000	28

TABLE 5 - FAILOVER TIMES FOR SELECTED MSG SIZES AND QUEUE DEPTHS

5 DR Introduction

From Fixpack 4, the ability to configure a Queue Manager on a recovery appliance to perform a Disaster Recovery (DR) role is provided. 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.

A queue manager can be a part of a disaster recovery configuration, or it can be a member of a high availability group, but it cannot be both.

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 in the base MQ Appliance performance report.

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

The results contained in this report should not be directly compared with the base report, as because one of the 10Gb Network ports needs to be reserved for DR connectivity, the network configuration is different to that previously used.

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.

The M2000A and M2000B appliances are supplied with 2x10Gb Ethernet Network links and 8x1Gb Ethernet network links. When the appliances are configured for Disaster Recovery(DR), 1x10Gb link is reserved for use by the appliance, leaving a total of 18Gb for customer workloads. In Non-DR mode, all 28Gb connectivity can be utilised for workload traffic. There are a further two separate 1Gb links that are explicitly reserved for appliance administration. This section utilises the following connections:

Appliance A	Appliance B	Notes
eth20	eth20	Connected directly between appliances with 10Gb fibre cable
eth21		Workload driven via this interface

All of 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 section is M2000A 8.0.0.4 (FP4).

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

This test is identical to the test in Section 4.1 and is presented here with results from running tests against a standalone QM and also against a QM that is configured for Disaster Recovery (although the recovery appliance is located 3m from the main appliance).

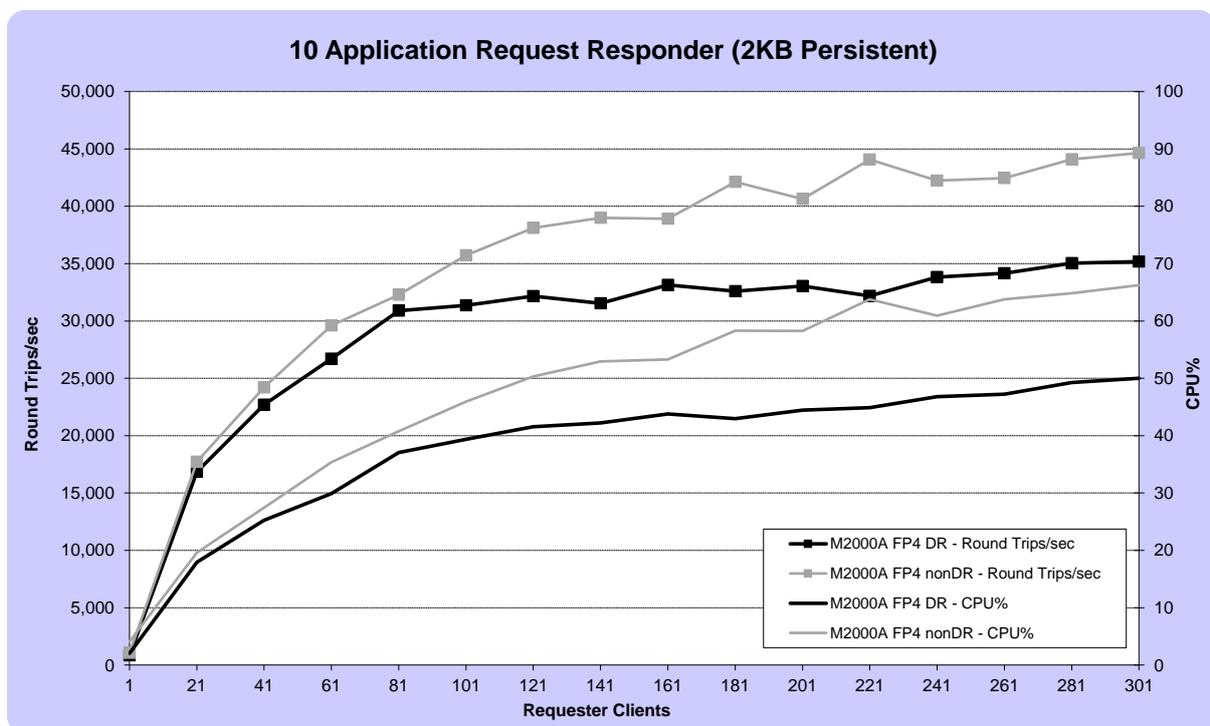


FIGURE 4 – PERFORMANCE RESULTS FOR 2KB PERSISTENT MESSAGING

Figure 4 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%. There is a similar reduction in CPU utilisation, thus providing capacity to perform additional messaging on the appliance.

Test	M2000A FP4 DR				M2000A FP4 nonDR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q Request Responder (256b Persistent)	49,015	63.85	261	1.2	53,845	76.87	301	0.9
10Q Request Responder (2KB Persistent)	35,177	50.02	301	1.2	44,646	68.63	301	0.9
10Q Request Responder (20KB Persistent)	8,000	14.42	81	1.6	12,089	23.24	101	1.3
10Q Request Responder (200KB Persistent)	822	6.48	31	3.2	1,480	10.65	31	2.9

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 6 - PEAK RATES FOR PERSISTENT MESSAGING

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

This test is identical to the test in Section 4.2 and is presented here with results from running tests against a standalone QM and also against a QM that is configured for Disaster Recovery (although the recovery appliance is located 3m from the main appliance).

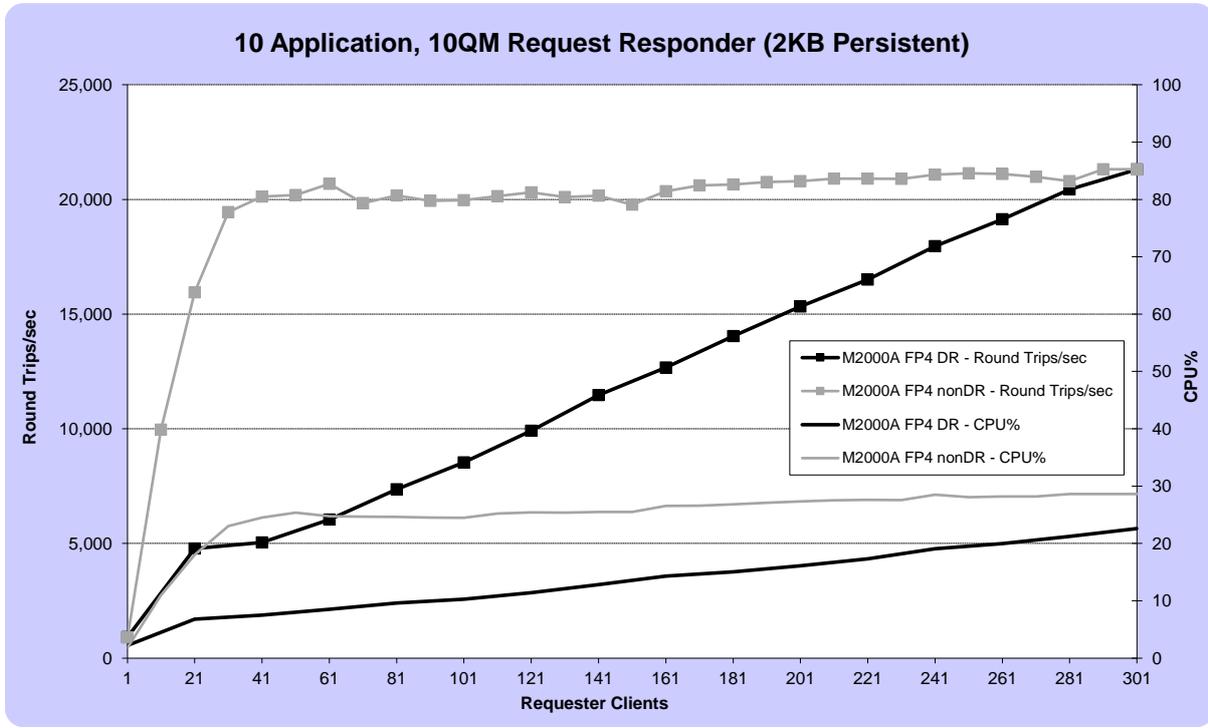


FIGURE 5 - PERFORMANCE RESULTS FOR 2KB, 10QM PERSISTENT MESSAGING

Figure 5 shows that when we have multiple QM performing 2KB persistent messaging across a pair of DR appliances, the peak messaging rate is very similar than when distributed across a set of non DR Queue Managers, although additional clients are required to achieve that level of throughput.

Test	M2000A FP4 DR				M2000A FP4 nonDR			
	Max Rate*	CPU%	Clients	Latency#	Max Rate*	CPU%	Clients	Latency#
10Q 10QM Request Responder (256b Persistent)	21,118	22.9	301	1.1	21,380	29.12	301	1.1
10Q 10QM Request Responder (2KB Persistent)	21,308	22.6	301	1.1	21,315	28.62	301	1.1
10Q 10QM Request Responder (20KB Persistent)	3,305	6.53	61	1.4	3,359	4.78	11	1.4
10Q 10QM Request Responder (200KB Persistent)	363	2.53	11	3.3	357	1.63	6	2.8

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 7 - PEAK RATES FOR 10QM PERSISTENT MESSAGING

5.3 How does DR perform over larger distances?

DR configuration usually requires the pair of appliances to be situated a large distance apart so that any particular event that might affect one appliance would be hoped not to affect the second 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.

Test	M2000A FP4 DR				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 10ms Latency (256b Persistent)	20,868	37.31	301	0.7	98.8%
10Q 10QM Request Responder 10ms Latency (2KB Persistent)	20,955	37.7	261	0.7	98.3%
10Q 10QM Request Responder 10ms Latency (20KB Persistent)	3,319	13.75	31	1.0	100.4%
10Q 10QM Request Responder 10ms Latency (200KB Persistent)	356	10.17	21	3.5	98.1%

*Round trips/sec

#Single thread round trip latency (ms)

Test	M2000A FP4 DR				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 20ms Latency (256b Persistent)	20,218	35.1	281	0.7	95.7%
10Q 10QM Request Responder 20ms Latency (2KB Persistent)	20,121	33.46	281	0.7	94.4%
10Q 10QM Request Responder 20ms Latency (20KB Persistent)	3,011	12.37	51	1.0	91.1%
10Q 10QM Request Responder 20ms Latency (200KB Persistent)	362	9.72	21	3.5	99.9%

*Round trips/sec

#Single thread round trip latency (ms)

Test	M2000A FP4 DR				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 50ms Latency (256b Persistent)	19,090	31.36	261	0.7	90.4%
10Q 10QM Request Responder 50ms Latency (2KB Persistent)	19,304	31.96	281	0.7	90.6%
10Q 10QM Request Responder 50ms Latency (20KB Persistent)	3,082	13.59	61	1.1	93.3%
10Q 10QM Request Responder 50ms Latency (200KB Persistent)	329	9.48	41	7.5	90.7%

*Round trips/sec

#Single thread round trip latency (ms)

Test	M2000A FP4 DR				vs Direct
	Max Rate*	CPU%	Clients	Latency#	
10Q 10QM Request Responder 100ms Latency (256b Persistent)	9,161	18.64	301	0.9	43.4%
10Q 10QM Request Responder 100ms Latency (2KB Persistent)	9,146	18	301	0.9	42.9%
10Q 10QM Request Responder 100ms Latency (20KB Persistent)	2,122	13.05	101	2.1	64.2%
10Q 10QM Request Responder 100ms Latency (200KB Persistent)	290	10.58	31	14.4	79.8%

*Round trips/sec

#Single thread round trip latency (ms)

TABLE 8 - PEAK RATES FOR 10QM PERSISTENT MESSAGING WITH 10, 20, 50 AND 100MS SIMULATED LATENCY

6 Frequently Asked Questions

Can I run any other HA solution in conjunction with the appliance?

No, the HA support by placing a pair of appliances into an MQ Appliance HA group is the only supported method of HA on the MQ Appliance.

What HA cables come with an MQ Appliance?

From FP3, MQ appliances should come supplied with 2x1Gb 10m copper cable and 1x10Gb 5m copper cable.

Can I use a fibre cable for 10Gb HA replication?

Yes, a fibre cable (with correct transceivers) can be used in place of the 10Gb copper cable.

Does the cable medium affect performance?

Copper and fibre cables can be used for the 10Gb HA workload connection. The majority of results in this report were collected using a 3m fibre cable. To compare the performance of using a 3m fibre and a 3m copper cable (with appropriate transceivers), the single QM tests featured in section 4.1 were re-run using a 3m copper cable. There was no discernible change in performance between the two cables over that distance.

Which connections do I need to make to setup the HA group?

Interface eth13 on appliance A needs to be connected to eth13 on appliance B with a 1Gb copper cable. Interface eth17 on appliance A needs to be connected to eth17 on appliance B with a 1Gb copper cable. Interface eth21 on appliance A needs to be connected to eth21 on appliance B with a 10Gb cable.

Which connections do I need to make to setup the DR configuration?

Interface eth20 on appliance A needs to be connected to eth20 on appliance B with a 10Gb cable. The DR configuration doesn't use heartbeating between the appliances, so eth13 and eth17 are not reserved for DR use and can be used for appliance workload.

After starting a QM in an HA group on appliance A, how do I move it to appliance B?

From the mqcli on appliance B, run ***sethappreferred QM*** after which you be able to see it now running on appliance B.

My QM was created on appliance A, an outage caused the QM to be started on appliance B, how do I avoid the QM moving back to appliance A when it becomes available?

When the QM was created, a correlation was made between the QM and the appliance it was created on; where possible the QM will run on that appliance. To prevent the QM from reverting to appliance A, run **clearhappreferred QM** on appliance A or run **sethappreferred QM** on appliance B.

Is there a maximum number of HA QM supported on an appliance?

Yes, up to 16 HA QM are supported. You can however, have many more non HA QM configured and active.

How long does it take to detect an appliance in an HA group is no longer active?

Heartbeats are issued every second between the HA appliances, and after 5 failures it is presumed the other appliance is no longer active.

Can I run HA and DR functionality on my pair of appliances?

At MQ Appliance Fixpack 4, HA **OR** DR capability can be selected. You cannot configure a Queue Manager within an HA group and provide DR capability (to the same secondary appliance or a separate MQ Appliance).

How do I start messaging processing at the DR recovery appliance?

When asynchronous replication is being performed, the secondary Queue Manager at the recovery appliance is in stopped state. You will need to run the **makedrprimary -m QM** and **strmqm QM** commands to start messaging at the recovery appliance.

7 Appendix A – Client machine specification

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

Category	Value
Machine	x3550 M5
OS	Red Hat Enterprise Linux Server 6.6
CPU	2x12 (2.6Ghz)
RAM	128GB RAM
Network	2x10Gb Ethernet
Disks	2x 300GB 15K SAS HDD
RAID	ServeRAID M5210 (4GB Flash RAID cache) MQ Logs hosted on RAID-1 partition