WebSphere MQ IBMi v7.1
Performance Evaluations

Version 1.2

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First Edition, December 2011.

This edition applies to *WebSphere MQ for IBMi v7.1* (and to all subsequent releases and modifications until otherwise indicated in new editions).

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This report is intended for architects, systems programmers, analysts and programmers

wanting to understand the performance characteristics of *WebSphere MQ for IBMi v7.1*. The information is not intended as the specification of any programming interface that is provided by WebSphere. It is assumed that the reader is familiar with the concepts and operation of WebSphere MQ v7.1.

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Preface

Target audience

The SupportPac was designed for people who:

- Will be designing and implementing solutions using WebSphere MQ v7.1
- Want to understand the performance limits of WebSphere MQ v7.1
- Want to understand what actions may be taken to tune WebSphere MQ v7.1

The reader should have a general awareness of the IBMi operating system and of MQSeries in order to make best use of this SupportPac. Readers should read the section '**How this document is arranged**'—**Page VI** to familiarise themselves with where specific information can be found for later reference.

The contents of this SupportPac

This SupportPac includes:

- Release highlights performance charts.
- Performance measurements with figures and tables to present the performance capabilities of WebSphere MQ local queue manager, client channel, and distributed queuing scenarios.
- Interpretation of the results and implications on designing or sizing of the WebSphere MQ local queue manager, client channel, and distributed queuing configurations.

Feedback on this SupportPac

We welcome constructive feedback on this report.

- Does it provide the sort of information you want?
- Do you feel something important is missing?
- Is there too much technical detail, or not enough?
- Could the material be presented in a more useful manner?

Specific queries about performance problems on your WebSphere MQ system should be directed to your local IBM Representative or Support Centre.

Introduction

The three scenarios used in this report to generate the performance data are:

- Local queue manager.
- Client channel
- Distributed queuing

Unless otherwise specified, the standard message sized used for all the measurements in this report is 2KB (2,048 bytes).

Device under test (server)
An IBM i model 550 (4-way CPU 1.9GHz Power 5) with 32GB of RAM was used as the device under test.

Driver
An IBM xSeries 350 (4-way CPU 2.0ghz Intel Xeon) with 8GB of RAM was used as the driver for all tests.

How this document is arranged

Pages: 1-13

The first section contains the performance *headlines* for each of the three scenarios, with MQI applications connected to:

- A local queue manager.
- A remote queue manager over MQI-client channels.
- A local queue manager, driving throughput between the local and remote queue manager over server channel pairs.

The headline tests show:

- The maximum message throughput achieved with an increasing number of MQI applications.
- The maximum number of MQI-clients connected to a queue manager.
- The maximum number of server channel pairs between two queue managers, for a fixed think time between messages until the response time exceeds one second.

Large Messages

Pages: 18-38

The second section contains performance measurements for *large messages*. This includes *MQI response times* of 50 byte to 2MB messages. It also includes *20K, 200K* and *2M* byte messages using the same scenarios as for the 2KB messages".

Application Bindings

Page: 39-44

The third section contains performance measurements for *'trusted, shared, and isolated'* server applications, using the same three scenarios as for the 2KB messages.

Performance and Capacity Limits

Pages: 46

Tuning guidance specific to v7.1 on IBMi

Measurement Environment

Pages: 53 55

A summary of the way in which the workload is used in each test scenario is given in the " headlines" section. This includes a more detailed description of the workload, hardware and software specifications.

IBM i O/S:	IBM i V6.1
MQSeries:	Version 6.0.1.11, Version 7.0, Version 7.0.1.6 Version 7.1
Compiler:	C for IBM i Compiler, Version 6

Glossary

Page: 55

A short glossary of the terms used in the tables throughout this document.

CONTENTS

TABLES

FIGURES

1 Overview

WebSphere MQ v7.1 on IBMi has improved performance especially for smaller messages using a small number of queues. For 2KB messages, almost every test shows improvements over earlier versions of WMQ.

Using area under the graph performance analysis techniques for 2k messages v7.1 compares to previous releases as follows :-

For 2k non-persistent messages v7.1 is 18% faster than v6.0.2.11
For 2k persistent messages v7.1 is 4% faster than v6.0.2.11

For 2k non-persistent messages v7.1 is 43% faster than v7.0
For 2k persistent messages v7.1 is 6% faster than v7.0

For 2k non-persistent messages v7.1 is 18% faster than v7.0.1.6
For 2k persistent messages v7.1 is 4% faster than v7.0.1.6

Please note there are instances where performance is slightly down when comparing v7.1 to 6.0.2.11, 7.0 and 7.0.1.6

2 Performance Headlines

The measurements for the local queue manager scenario are for processing messages with no *think-time*. For the client channel scenario and distributed queuing scenario, there are also measurements for *rated* messaging.

No *'think-time'* is when the driving applications do not wait after getting a reply message before submitting subsequent request messages—this is also referred to as *'tight-loop'*.

The rated messaging tests used one round trip per driving application per second. In the client channel test scenarios, each driving application using a dedicated MQI-client channel, in the distributed queuing test scenarios, one or more applications submit messages over a fixed number of server channels.

All tests stop automatically after the response time exceeds 1 second.

2.1 Local Queue Manager Test Scenario

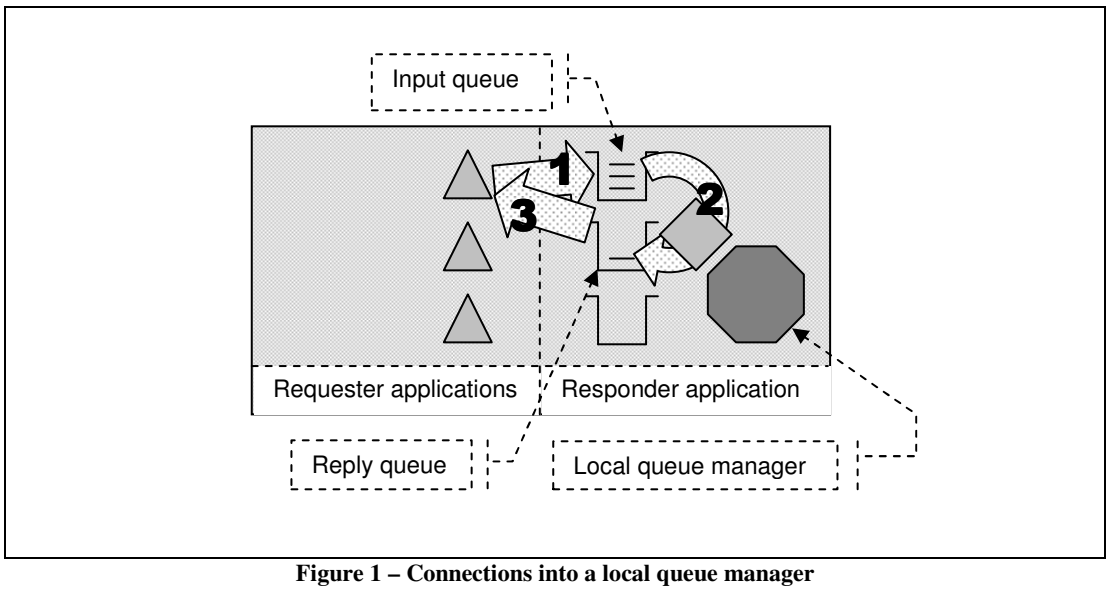

Figure 1 – Connections into a local queue manager

1) The Requester application puts a message to the common input queue on the local queue manager, and holds on to the message identifier returned in the message descriptor. The Requester application then waits indefinitely for a reply to arrive on the common reply queue.

2) The Responder application gets messages from the common input queue and places a reply to the common reply queue. The queue manager copies over the message identifier from the request message to the correlation identifier of the reply message.

3) The Requester application gets a reply from the common reply queue using the message identifier held from when the request message was put to the common input queue, as the correlation identifier in the message descriptor.

Non-persistent and persistent messages were used in the local queue manager tests, with a message size of 2KB. The effect of message throughput with larger messages sizes is investigated in the "***Large Messages***" section.

Application Bindings of the Responder program are 'Shared' and the Requester program is normally 'Trusted' except in the 'non-trusted' scenario where both programs use 'Shared' bindings.

2.1.1 Non-persistent Messages – Local Queue Manager

Figure 2, Figure 3 and Figure 4 shows the non-persistent, non-persistent non-trusted and persistent message throughput achieved using an increasing number of driving applications in the local queue manager scenario (see Figure 1 on the previous page) for different production levels of WebSphere MQ (versions 7.1, 7.0.1.6, 7.0 and 6.0.2.11).

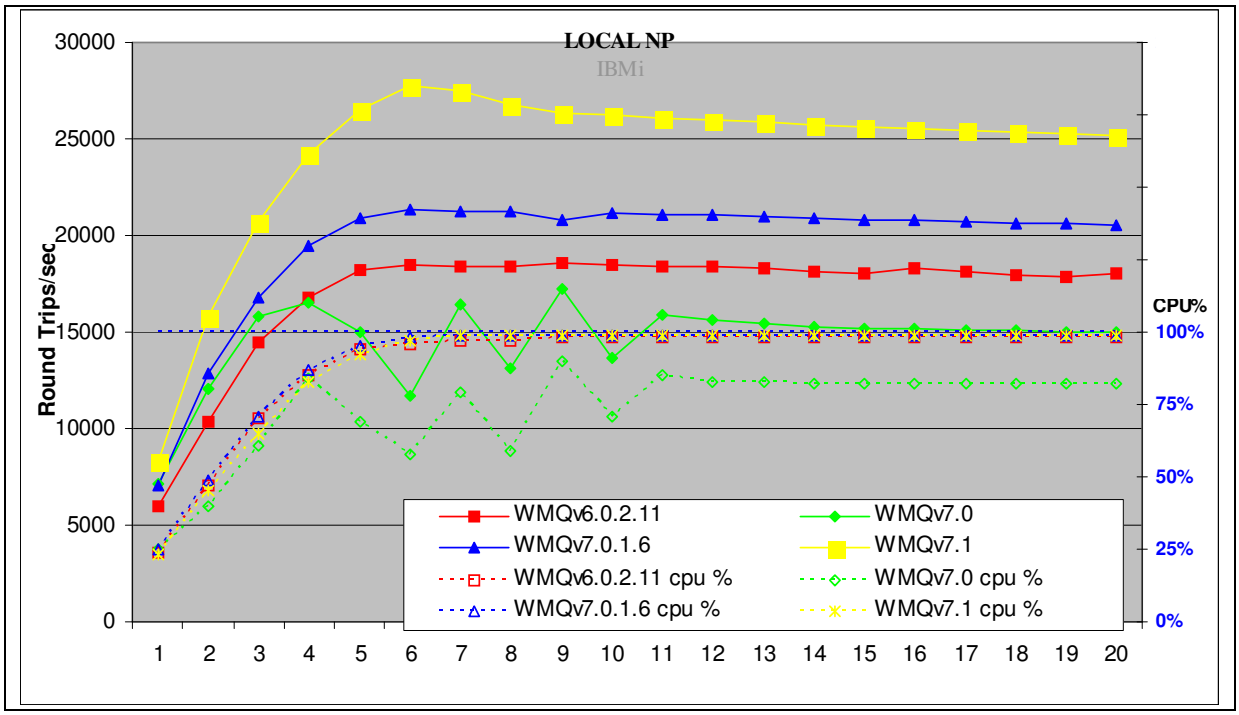

Figure 2 – Performance headline, non-persistent messages and local queue manager.

Figure 2 and Table 1 show that the peak throughput of non-persistent messages has increased by 50% when comparing version 7.1 to V7.0

Test Name: LOCAL NP	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	9	18595	0.00059	98%
WMQv7.0	9	17223	0.00063	90%
WMQv7.0.1.6	6	21342	0.00034	98%
WMQv7.1	6	27762	0.00025	97%

Table 1 – Performance headline, non-persistent messages and local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.1.2 Non-persistent Messages – Non-trusted – Local Queue Manager

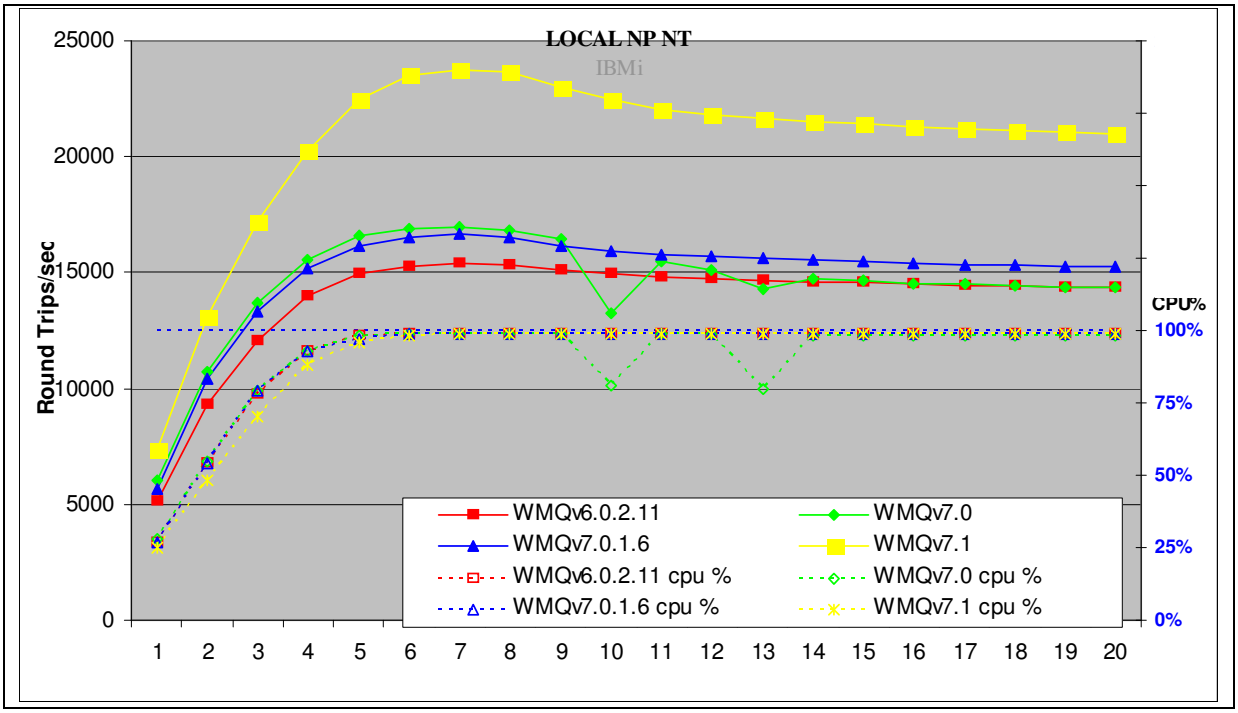

Figure 3 Performance headline, non-persistent, non-trusted messages and local queue manager.

Figure 3 and Table 2 shows that the peak throughput of non-persistent, non-trusted messages (shared bindings - MQIBINDTYPE=NORMAL) has increased by 40% when comparing version 7.1 to v7.0.

Test Name: LOCAL NP NT	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	7	15375	0.00057	99%
WMQv7.0	7	16984	0.00052	99%
WMQv7.0.1.6	7	16665	0.00052	99%
WMQv7.1	7	23768	0.00035	99%

Table 2 – Performance headline, non-persistent, non-trusted messages and local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.1.3 Persistent Messages – Local Queue Manager

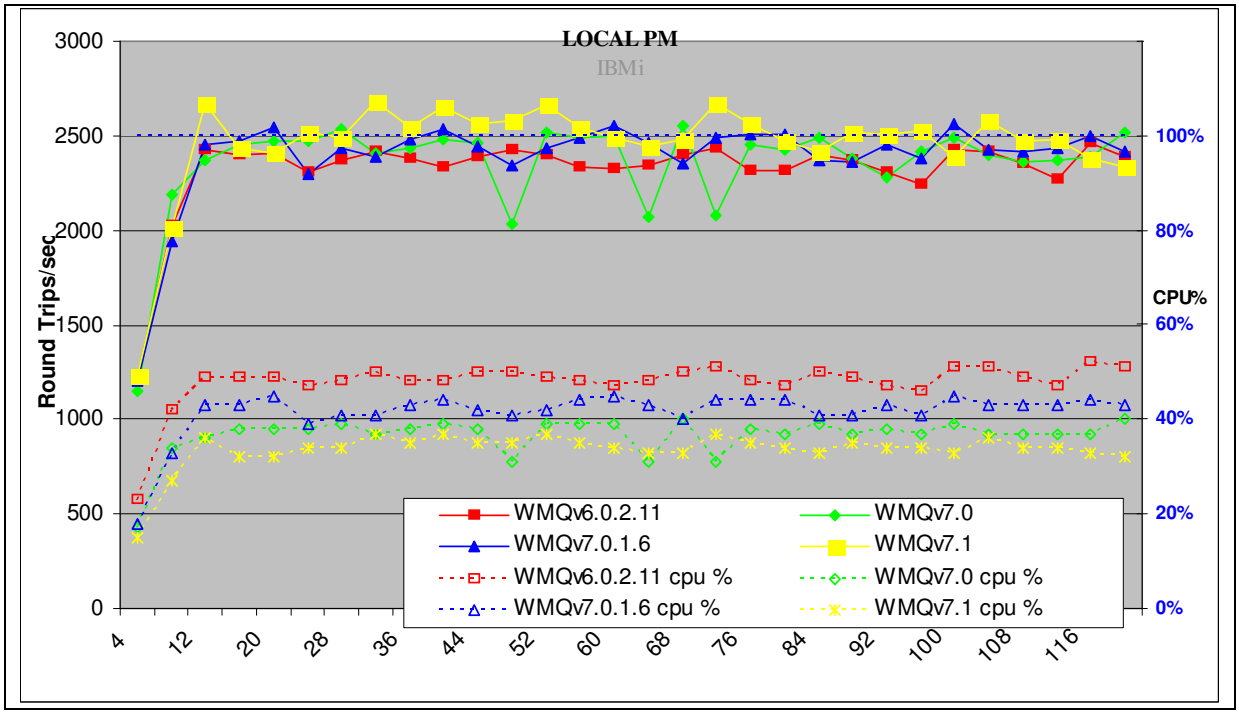

Figure 4 – Performance headline, persistent messages and local queue manager

Figure 4 and Table 3 shows that the peak throughput of persistent messages has increased by 5% when comparing version 7.1 to V7.0.

Test Name: LOCAL PM	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	116	2461	0.057	52%
WMQv7.0	68	2557	0.031	40%
WMQv7.0.1.6	100	2564	0.047	45%
WMQv7.1	32	2679	0.014	37%

Table 3 – Performance headline, persistent messages and local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.2 Client Channels Test Scenario

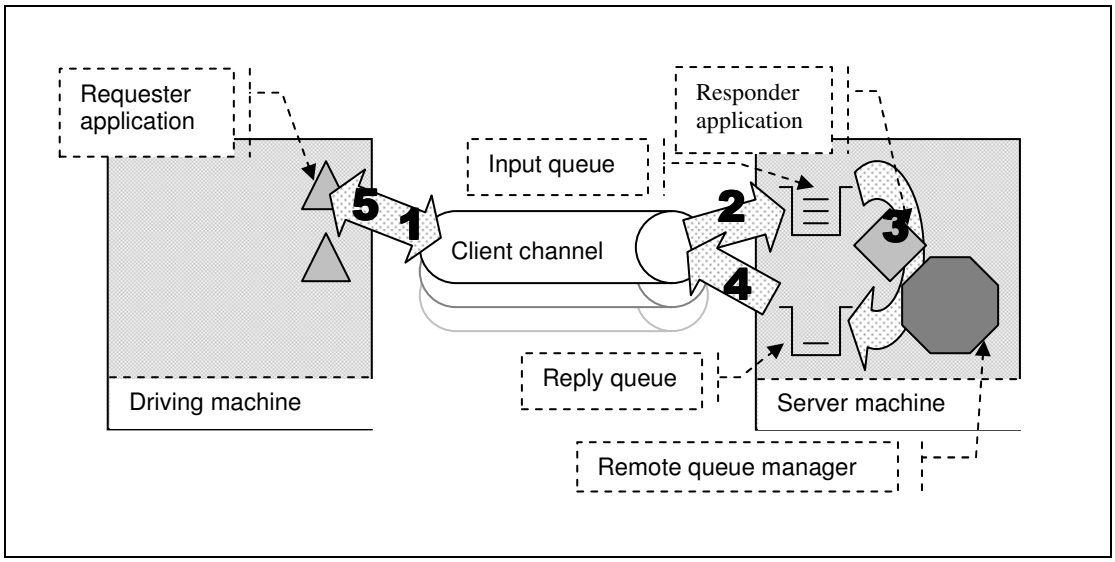

Figure 5 – MQI-client channels into a remote queue manager

1, 2) The Requester application puts a request message (over a client channel), to the common input queue, and holds on to the message identifier returned in the message descriptor. The Requester application then waits indefinitely for a reply to arrive on the common reply queue.

3) The Responder application gets messages from the common input queue and places a reply to the common reply queue. The queue manager copies over the message identifier from the request message to the correlation identifier of the reply message.

4, 5) The Requester application gets the reply message (over the client channel), from the common reply queue. The Requester application uses the message identifier held from when the request message was put to the common input queue, as the correlation identifier in the message descriptor.

Non-persistent and persistent messages were used in the client channel tests, with a message size of 2KB. The effect of message throughput with larger messages sizes is investigated in the "***Large Messages***" section.

Application Bindings of the Responder program are 'Shared' and the Client Channel is set to 'MQIBindType = FASTPATH' except in the 'non-trusted' scenario where 'MQIBindType =STANDARD' is used.

Version 7 onwards will multiplex multiple clients from the same process over one TCP socket. We have standardized all client measurements to use SHARECNV(1) since we have various tests that have between 1 and 100 clients per process and we are interested in results when all the clients come from different computers. Further information in section 7.1.4

2.2.1 Non-persistent Messages – Client Channels

Figure 6, Figure 7 and Figure 8 shows the non-persistent, non-persistent non-trusted and persistent message throughput achieved using an increasing number of driving applications in the client channel scenario (see Figure 5 on the previous page) for different production levels of WebSphere MQ (versions 7.1, 7.0.1.6, 7.0 and 6.0.2.11).

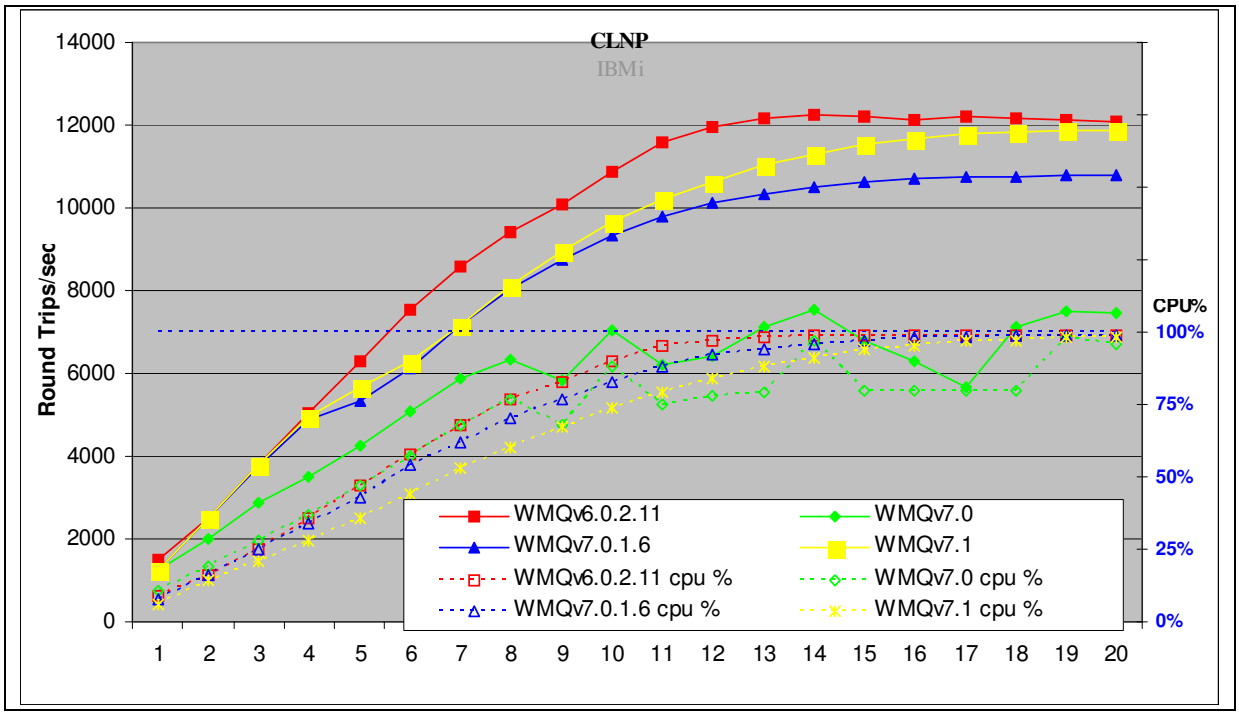

Figure 6 – Performance headline, non-persistent messages and client channels

Figure 6 and Table 4 show that the peak throughput of non-persistent messages has increased by 60% when comparing version 7.1 to 7.0. Peak throughput is similar when comparing 7.1 and 6.0.2.11. There are instances where 7.1 is degraded compared to 6.0.2.11

Test Name: CLNP	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	14	12237	0.0013	99%
WMQv7.0	14	7535	0.0021	97%
WMQv7.0.1.6	20	10789	0.0021	99%
WMQv7.1	20	11883	0.0019	98%

Table 4 – Performance headline, non-persistent messages and client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.2.2 Non-persistent Messages – Non-Trusted Client Channels

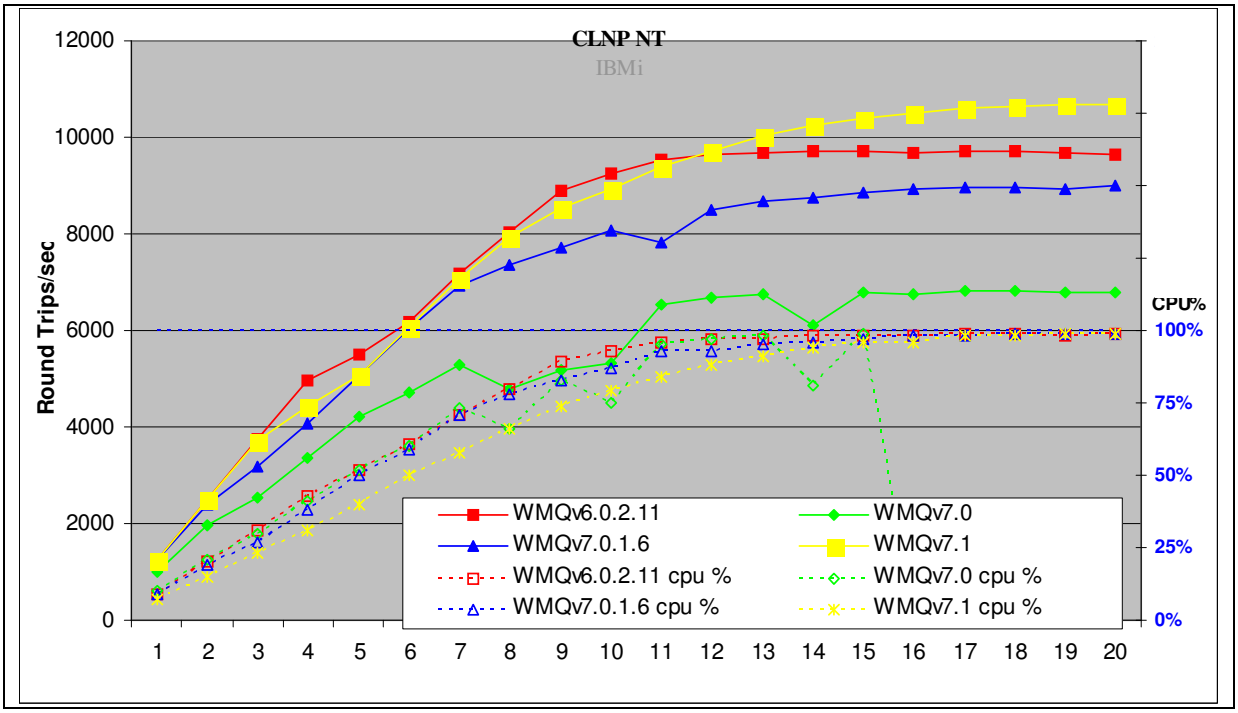

Figure 7 – Performance headline, non-persistent messages with non-trusted client channels

Figure 7 and Table 5 shows that the peak throughput of non-persistent, non-trusted messages (shared bindings - MQIBINDTYPE=NORMAL) has increased by 57% when comparing version 7.1 to V7.0

Test Name: CLNP NT	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	17	9720	0.002	99%
WMQv7.0	17	6817	0.0029	0%
WMQv7.0.1.6	20	8994	0.0026	99%
WMQv7.1	19	10695	0.0021	99%

Table 5 – Performance headline, non-persistent messages and client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.2.3 Persistent Messages – Client Channels

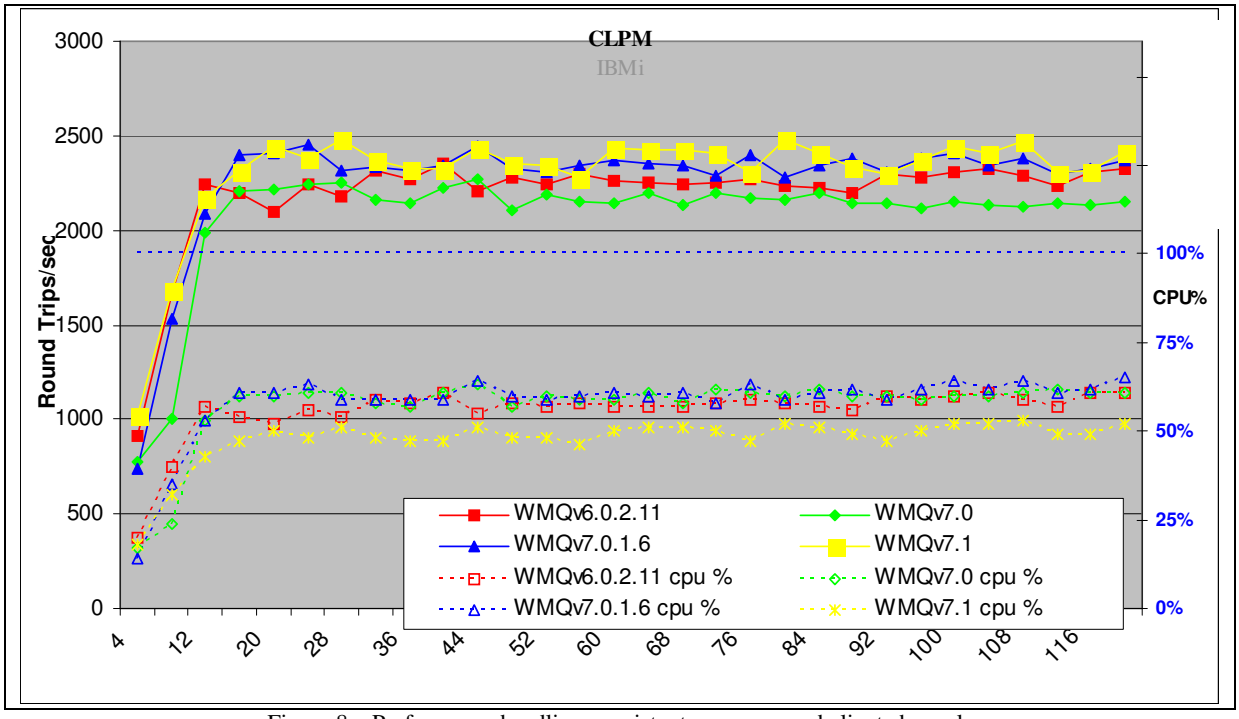

Figure 8 – Performance headline, persistent messages and client channels

Figure 8 and Table 6 shows that the peak throughput of persistent messages is similar when comparing version 7.1 to V7.0

Test Name: CLPM	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	40	2353	0.019	61%
WMQv7.0	44	2267	0.022	63%
WMQv7.0.1.6	24	2454	0.01	63%
WMQv7.1	28	2482	0.013	51%

Table 6 – Performance headline, persistent messages and client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.2.4 Client Channels

For the following client channel measurements, the messaging rate used is 1 round trip per second per MQI-client channel, i.e. a request message outbound over the client channel and a reply message inbound over the channel per second.

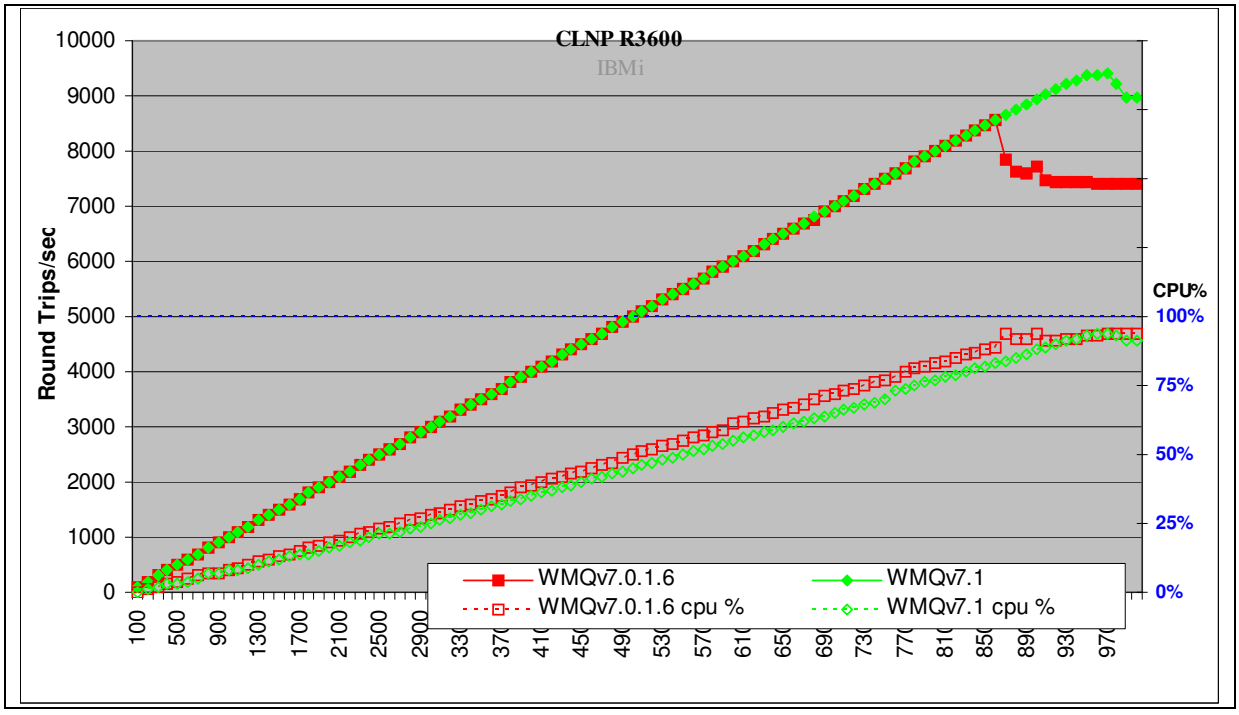

Figure 9 – 1 round trip per driving application per second, client channels and non-persistent messages

Note: Messaging in these tests is 1 round trip per driving application per second.

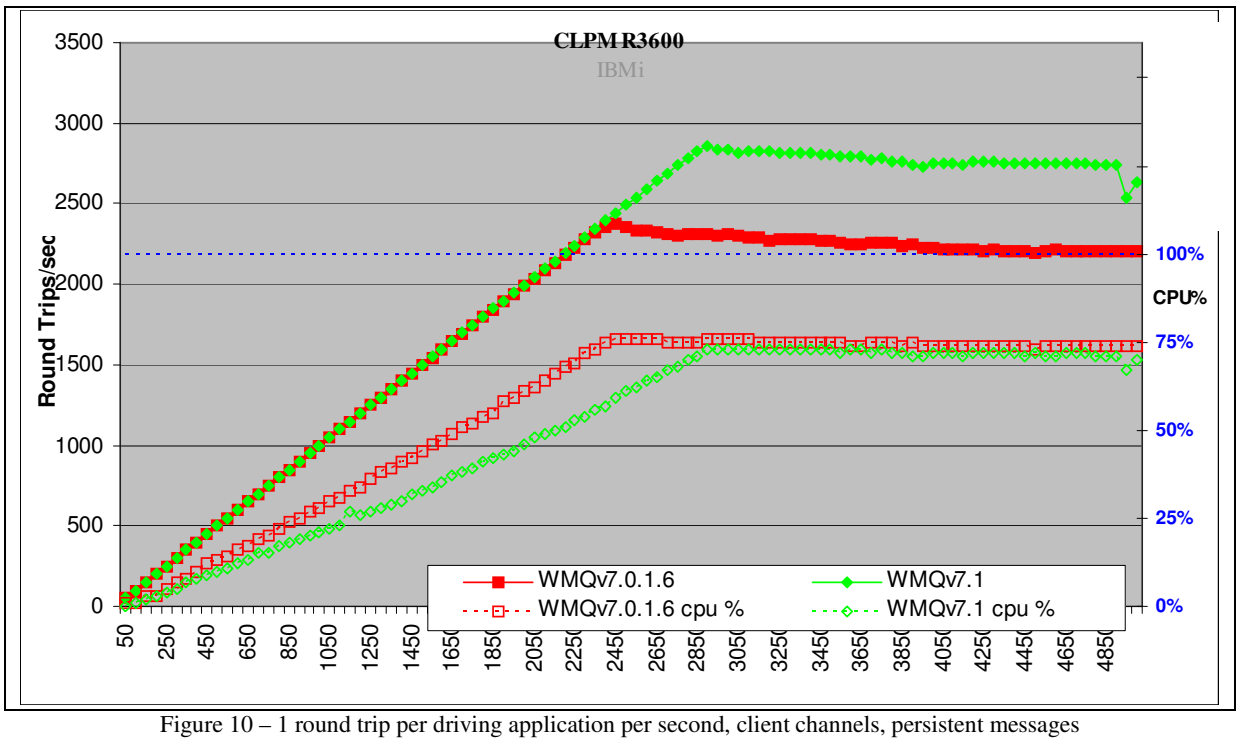

Figure 10 – 1 round trip per driving application per second, client channels, persistent messages

Figure 9, Figure 10 and Table 7 show that the peak throughput of non-persistent messages is the same when comparing version 7.1 to V7.0 but Persistent messages the peak throughput is 31% better when comparing v7.1 to v7.0

Test Name: CLNP R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.0.1.6	8600	8559	0.0079	89%
WMQv7.1	9700	9402	0.012	94%

Test Name: CLPM R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.0.1.6	2450	2377	0.051	76%
WMQv7.1	2900	2860	0.099	73%

Table 7 – 1 round trip per driving application per second, client channels

Note: ***The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time***

2.3 Distributed Queuing Test Scenario

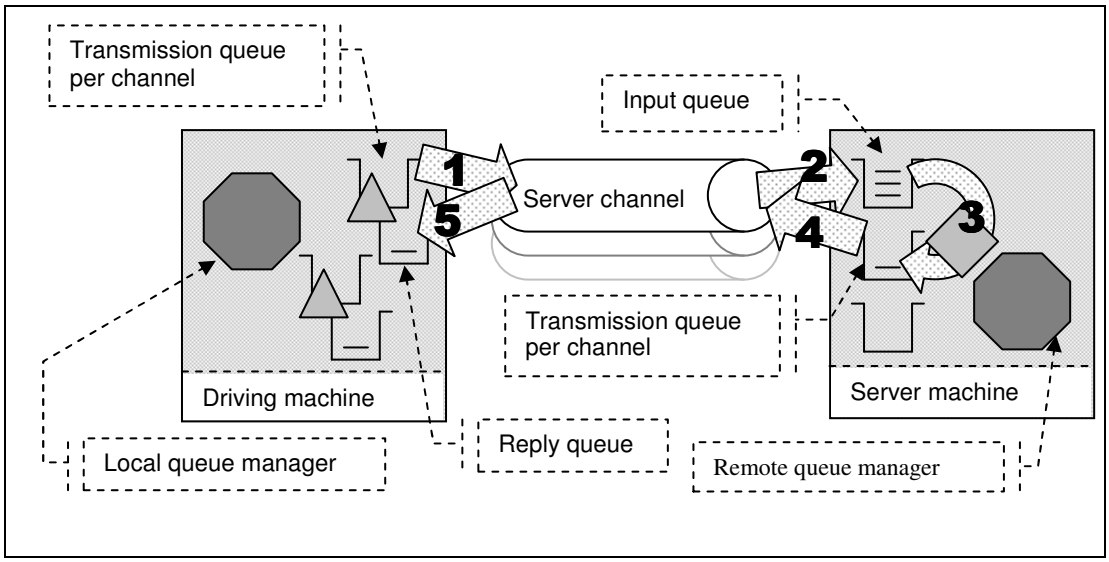

Figure 11 – Server channels between two queue managers

1) The Requester application puts a message to a local definition of a remote queue located on the server machine, and holds on to the message identifier returned in the message descriptor. The Requester application then waits indefinitely for a reply to arrive on a local queue.

2) The message channel agent takes messages off the channel and places them on the common input queue on the server machine.

3) The Responder application gets messages from the common input queue, and places a reply to the queue name extracted from the messages descriptor (the name of a local definition of a remote queue located on the driving machine). The queue manager copies over the message identifier from the request message to the correlation identifier of the reply message.

4) The message channel agent takes messages off the transmission queue and sends them over the channel to the driving machine.

5) The Requester application gets a reply from a local queue. The Requester application uses the message identifier held from when the request message was put to the local definition of the remote queue, as the correlation identifier in the message descriptor

Non-persistent and persistent messages were used in the distributed queuing tests, with a message size of 2KB. The effect of message throughput with larger messages sizes is investigated in the "***Large Messages***" section.

Application Bindings of the Responder program are 'Shared' , the Requester program is normally 'Trusted' , and the channels specified as 'MQIBindType = FASTPATH' except in the 'non-trusted' scenario where both programs use 'shared' bindings and the channels are specified as 'MQIBindType = STANDARD'.

2.3.1 Non-persistent Messages – Server Channels

Figure 121, Figure 12 and Figure 143 show the non-persistent, non-persistent non-trusted and persistent message throughput achieved using an increasing number of driving applications in the distributed queuing scenario (see Figure 11 on the previous page) and WebSphere MQ (versions 7.1, 7.0.1.6, 7.0 and 6.0.2.11).

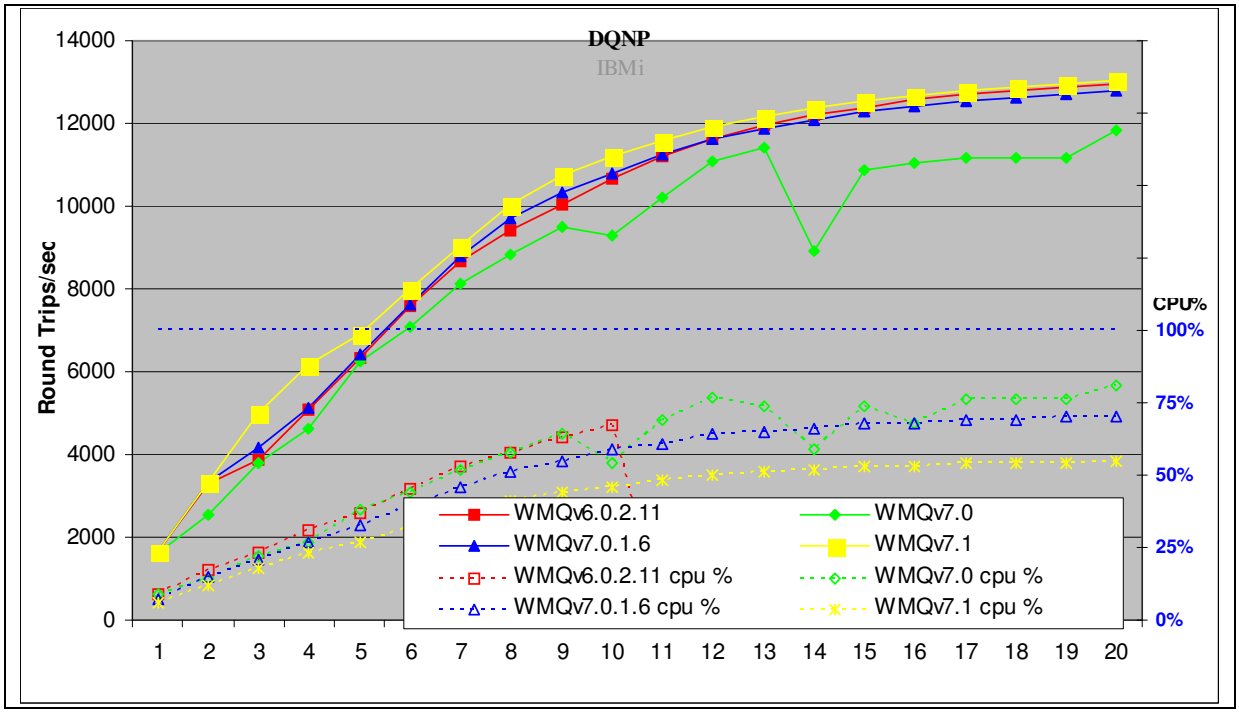

Figure 121 – Performance headline, non-persistent messages and server channels

Figure 121 and Table 8 shows that the peak throughput of non-persistent messages has improved by 10% when comparing version 7.1 to 7.0.

Test Name: DQNP	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	20	12966	0.002	0%
WMQv7.0	20	11851	0.0023	81%
WMQv7.0.1.6	20	12792	0.002	70%
WMQv7.1	20	13031	0.0021	55%

Table 8 – Performance headline, non-persistent messages and server channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.3.2 Non-Persistent non-Trusted – Server Channels

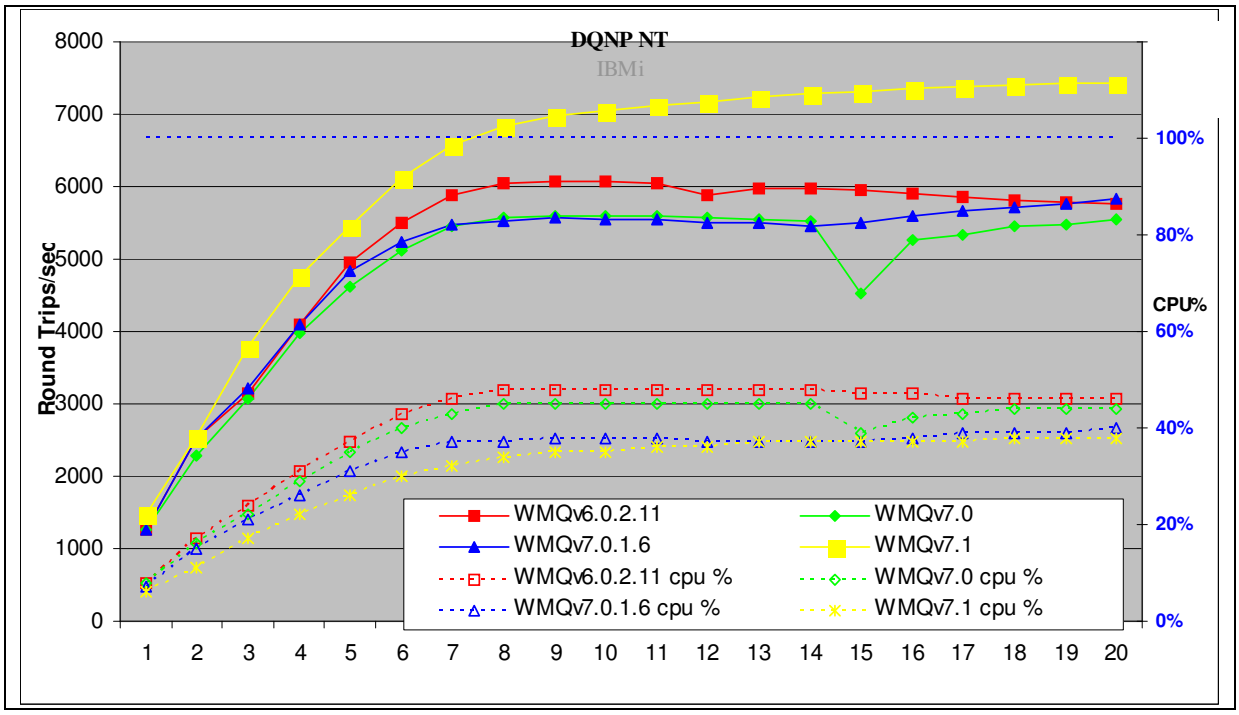

Figure 132 – Performance headline, non-persistent, not trusted messages and server channels

Figure 172 and **Table 9** shows that the peak throughput of non-persistent, non-trusted messages has increased by 33% when comparing version 7.1 to 7.0

Test Name: DQNP NT	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	9	6082	0.0018	48%
WMQv7.0	10	5606	0.0021	45%
WMQv7.0.1.6	20	5828	0.0037	40%
WMQv7.1	20	7437	0.003	38%

Table 9 – Performance headline, non-persistent, non trusted messages and server channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.3.3 Persistent Messages – Server Channels

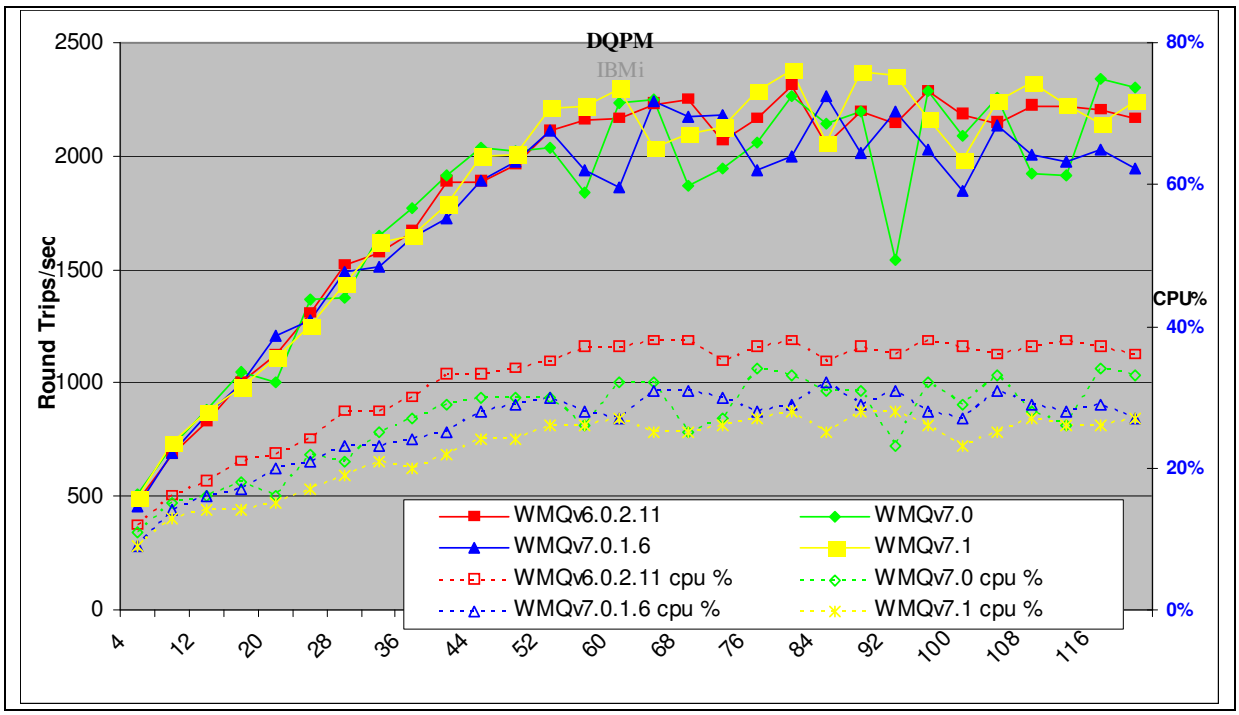

Figure 143 – Performance headline, persistent messages and server channels

Figure 143 and Table 10 shows that the peak throughput of persistent messages using 2 pairs of channels is similar when comparing version 7.1 to V7.0.

Test Name: DQPM	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	80	2312	0.044	38%
WMQv7.0	116	2343	0.059	34%
WMQv7.0.1.6	84	2262	0.045	32%
WMQv7.1	80	2377	0.04	28%

Table 10 – Performance headline, persistent messages and server channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

2.3.4 Server Channels

For the following distributed queuing measurements, the messaging rate used is 1 round trip per driving application per second, i.e. a request message outbound over the sender channel, and a reply message inbound over the receiver channel per second. Note that there are a fixed number of 4 server channel pairs for the non-persistent messaging tests, and 2 pairs for the persistent message tests.

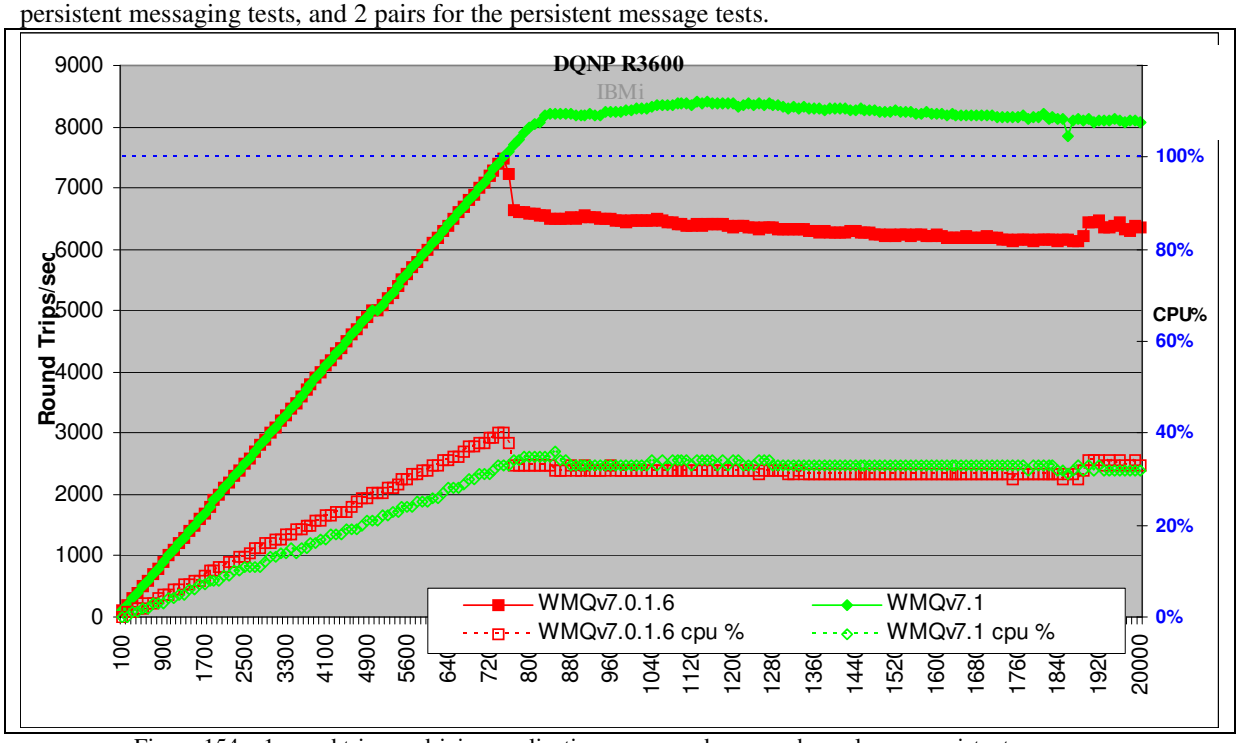

Figure 154 – 1 round trip per driving application per second, server channel, non-persistent messages

Note: Messaging in these tests is 1 round trip per driving application per second.

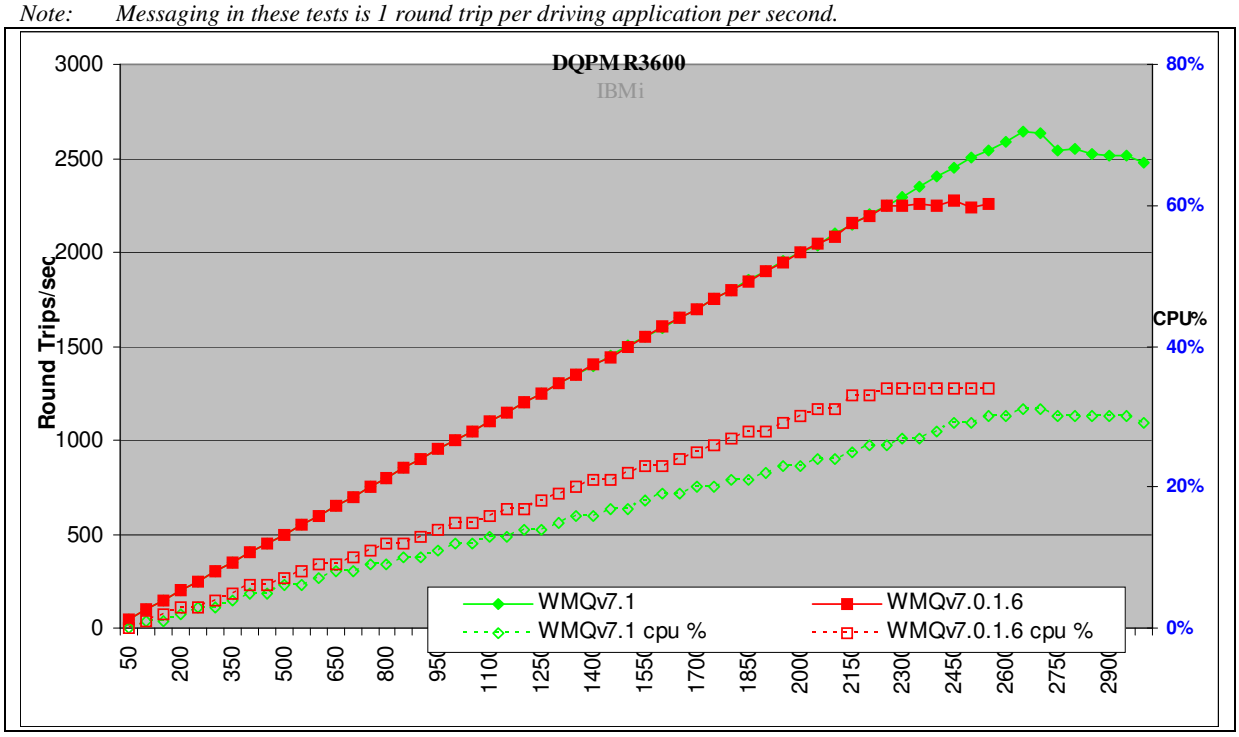

Figure 165 – 1 round trip per driving application per second, server channel, persistent messages

Figure 14, Figure 165 and Table 11 shows that the throughput of non-persistent messages has improved by 50% for non Persistent and 23% for Persistent when comparing version 7.1 to 7.0.

Test Name: DQNP R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.0.1.6	7500	7487	0.0096	40%
WMQv7.1	8400	8403	0.17	34%

Test Name: DQPM R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.0.1.6	2450	2276	1.2	34%
WMQv7.1	2650	2638	0.35	31%

Table 11 – 1 round trip per driving application per second, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3 Large Messages

3.1 MQI Response Times: 50bytes to 100MB – Local Queue Manager

3.1.1 50bytes to 32KB

Figure 16 show the response time for MQPut/MQGet for NP message sizes between 50bytes and 32Kb.

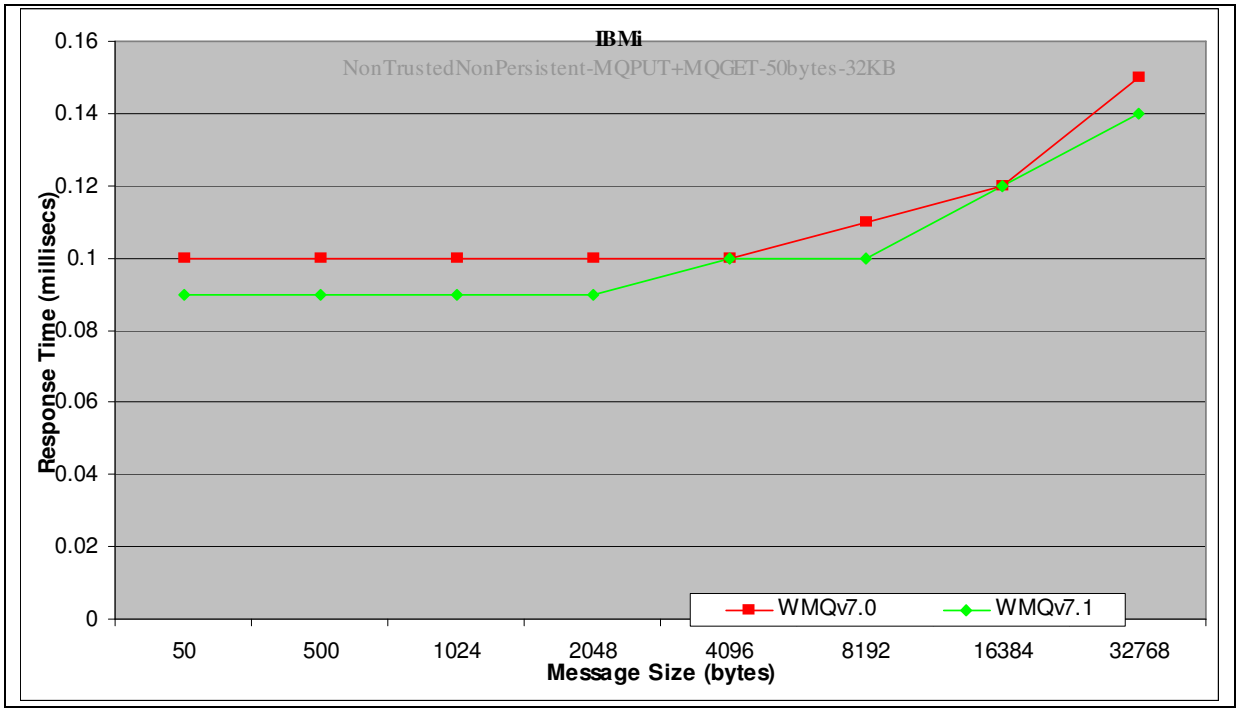

Figure 16 –The effect of non-persistent message size on MQI response time (50byte - 32K)

Figure 17 show that the response for MQPut/MQGet pairs for pers message sizes between 50bytes and 32Kb.

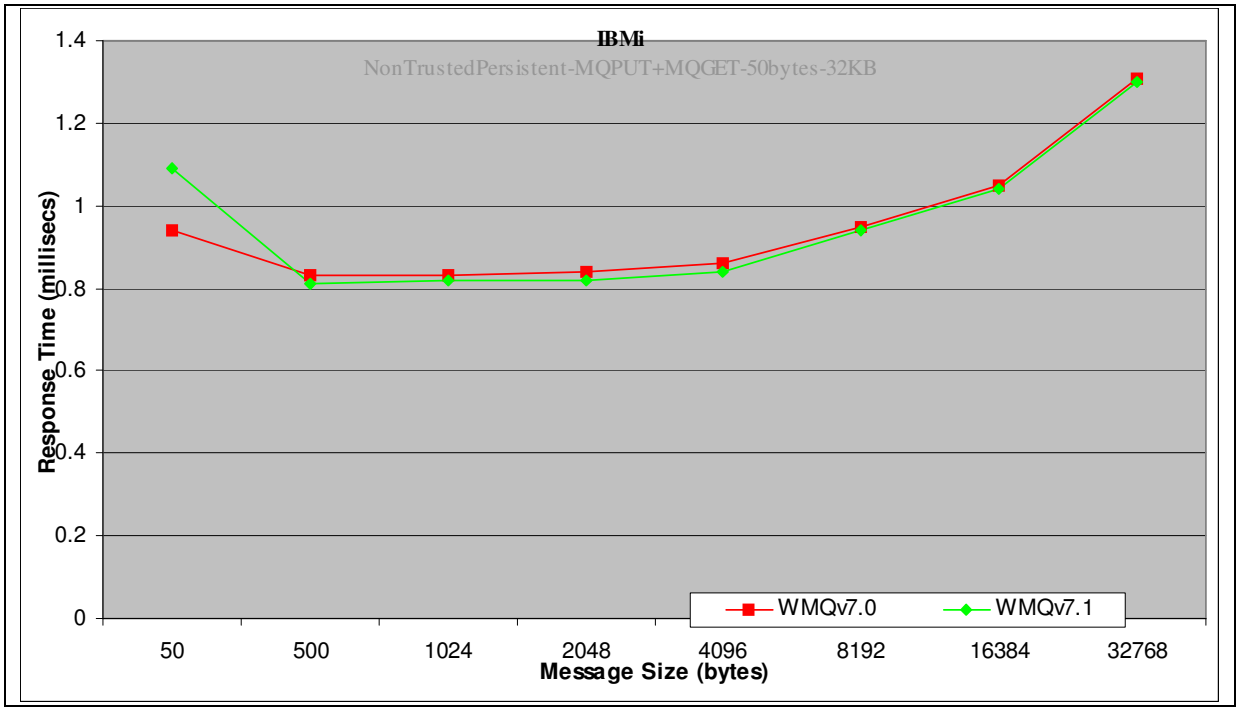

Figure 17 –The effect of persistent message size on MQI response time (50byte - 32K)

3.1.2 32KB to 2MB

Figure 18 show that the response time for MQPut/MQGet pairs for non-persistent message sizes between 32KB and 2MB.

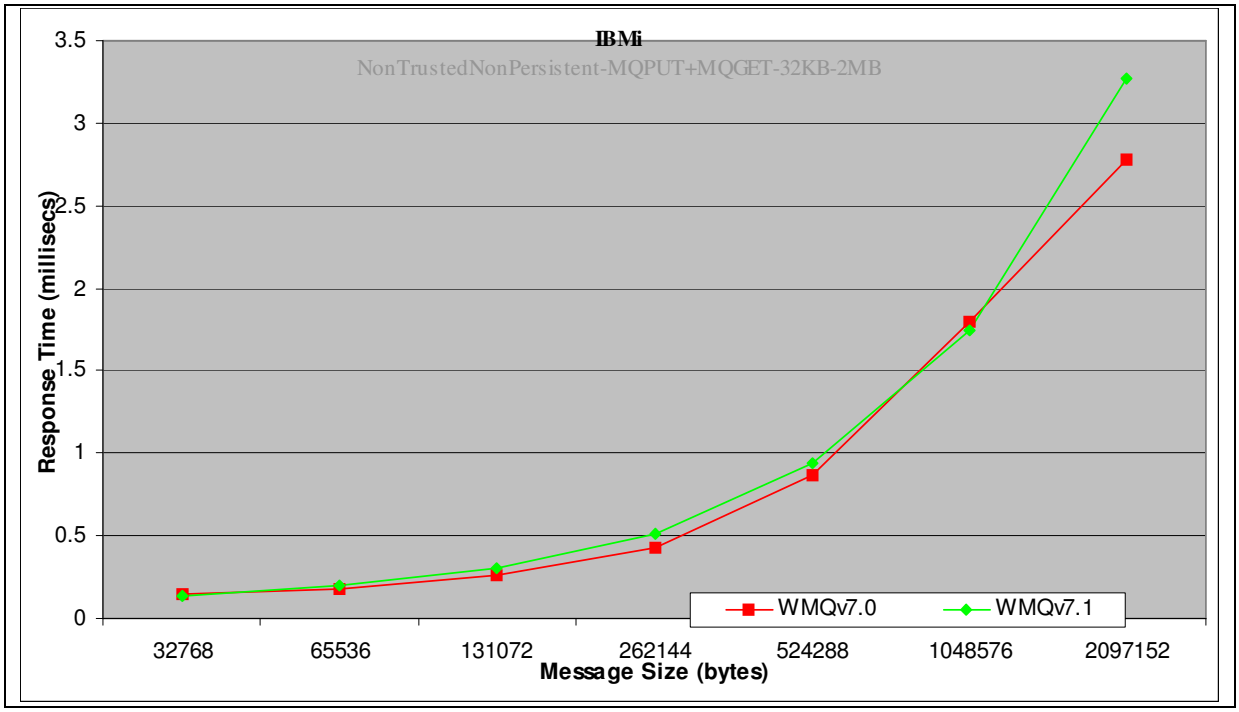

Figure 18 –The effect of non-persistent message size on MQI response time (32KB – 2MB)

Figure 19 show that the response for MQPut/MQGet pairs for persistent message sizes between 32KB and 2MB.

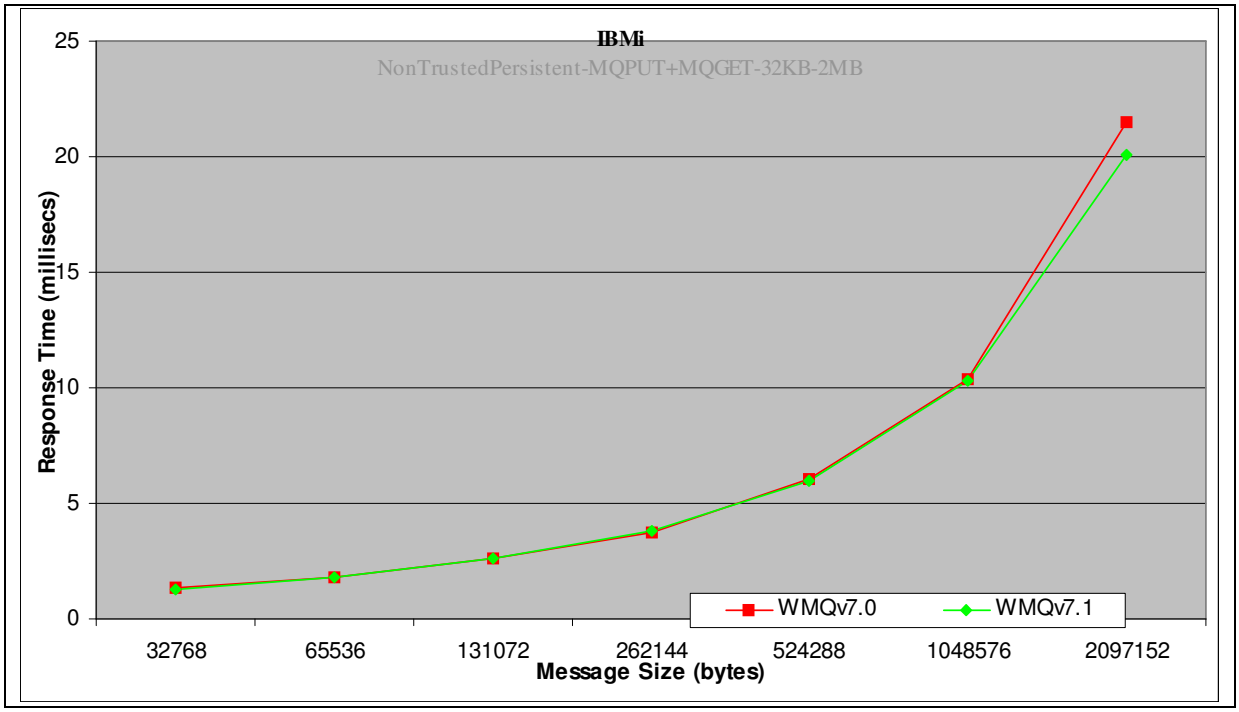

Figure 19 –The effect of persistent message size on MQI response time (32KB – 2MB)

3.1.3 2MB to 100MB

Figure Response time for MQPut/MQGet pairs for NP message between 2MB and 100MB.

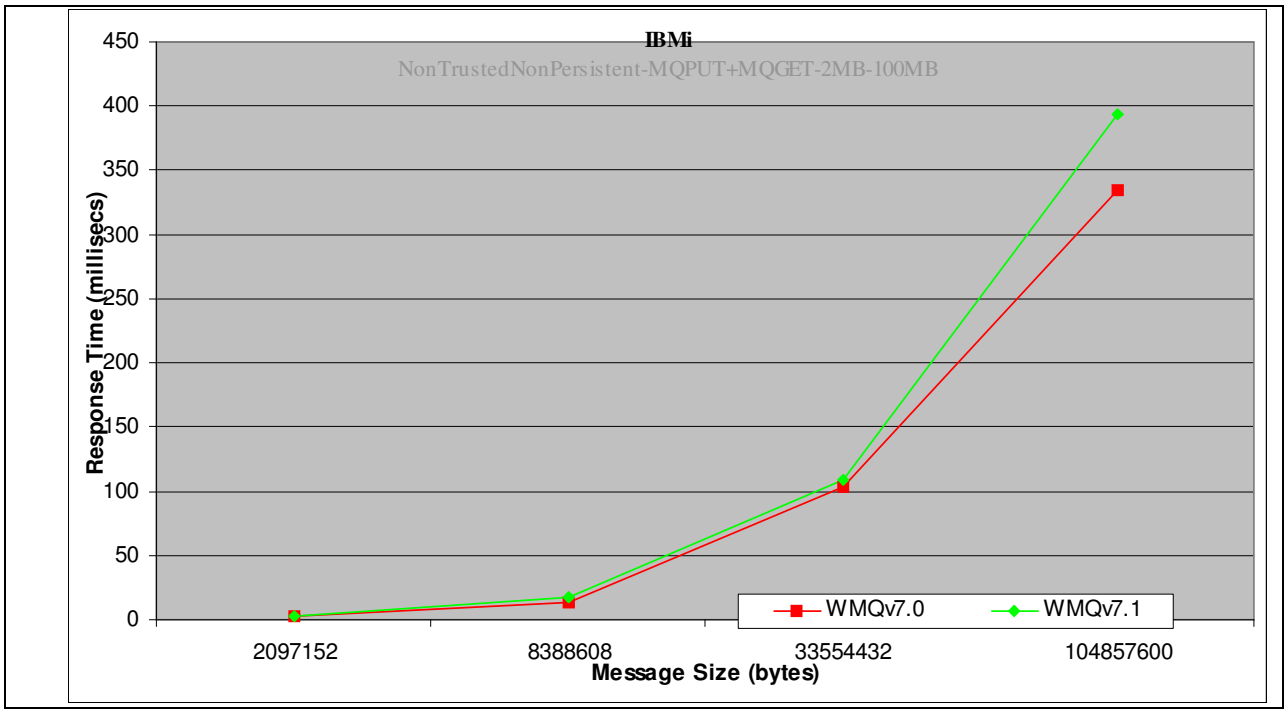

Figure 20 –The effect of non-persistent message size on MQI response time (2MB – 100MB)

Figure 21 The response for MQPut/MQGet pairs for persistent message sizes between 2MB and 33MB.

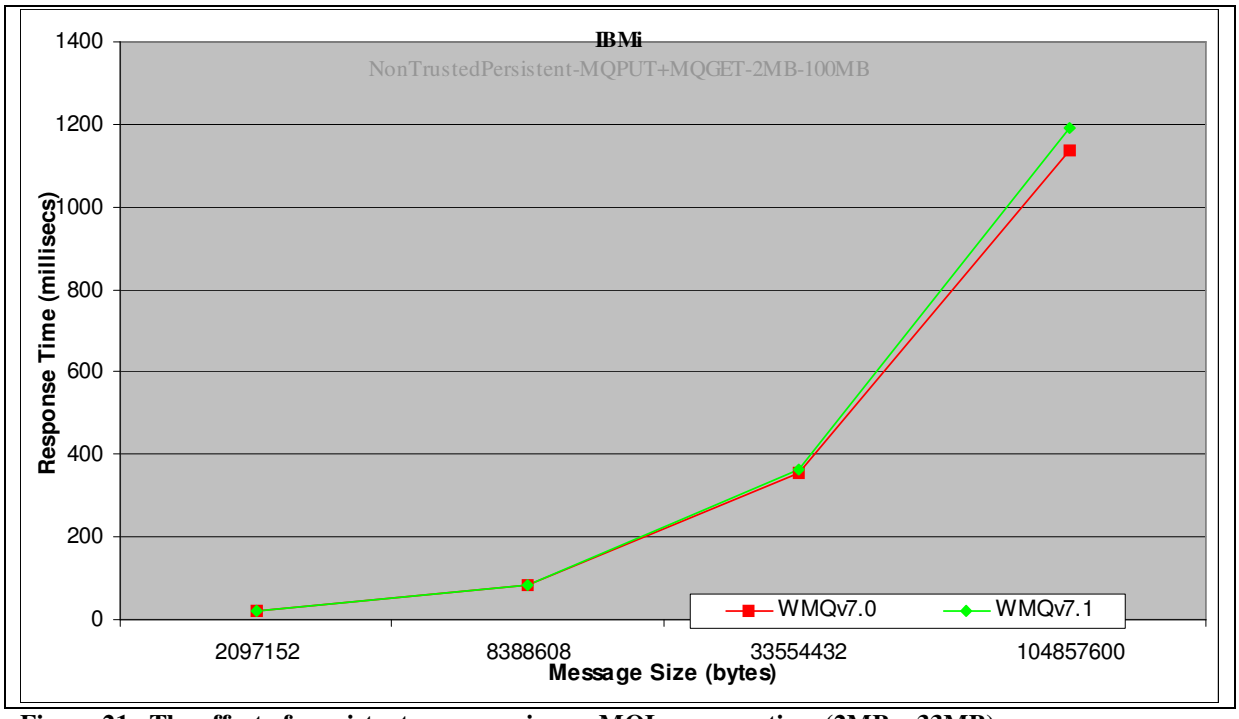

Figure 21 –The effect of persistent message size on MQI response time (2MB – 33MB)

3.2 20KB Messages

3.2.1 Local Queue Manager

Figure 17 and Figure 18 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the local queue manager scenario.

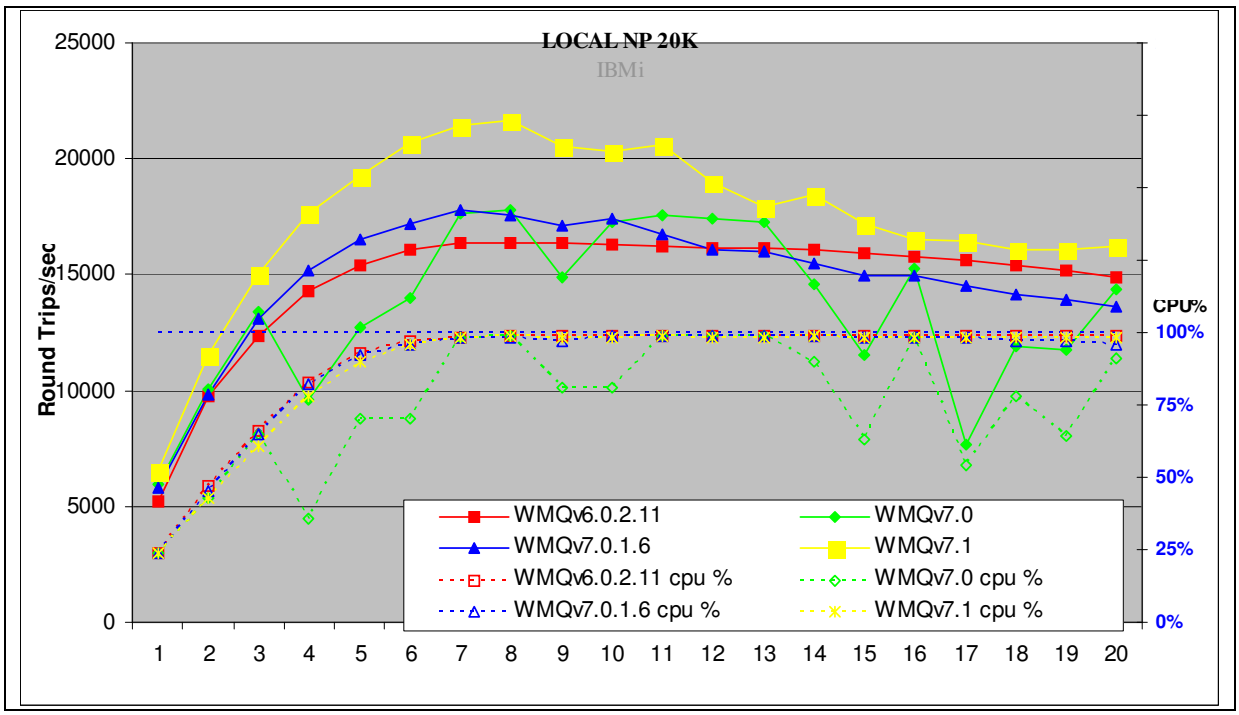

Figure 17 – 20KB non-persistent messages, local queue manager

Figure 17 and Table 12 shows that the peak throughput of non-persistent messages has increased by 22% when comparing version 7.1 to V7.0.

Test Name: LOCAL NP 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	7	16371	0.0005	98%
WMQv7.0	8	17806	0.00054	99%
WMQv7.0.1.6	7	17817	0.00047	98%
WMQv7.1	8	21645	0.00046	99%

Table 12 – 20KB non-persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.2.1.1 Persistent Messages

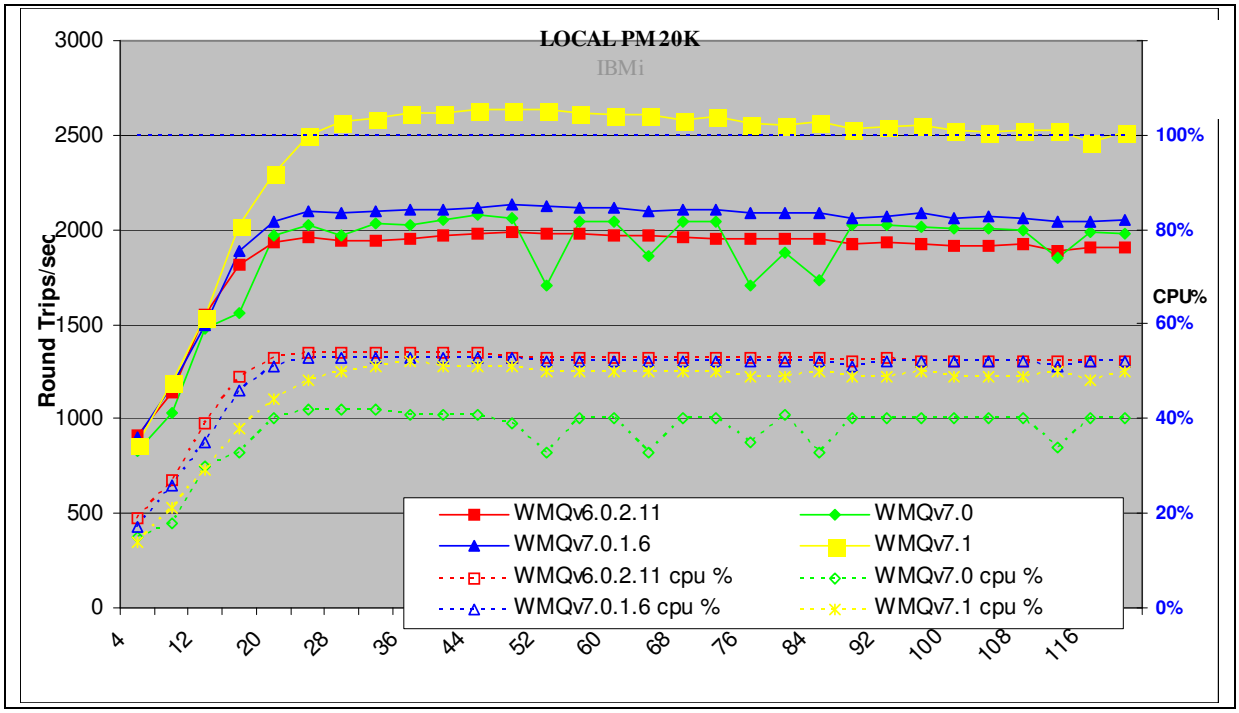

Figure 18 – 20KB persistent messages, local queue manager

Figure 18 and Table 13 shows that the peak throughput of persistent messages has increased by 26% when comparing version 7.1 to V7.0.

Test Name: LOCAL PM 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	48	1984	0.031	53%
WMQv7.0	44	2083	0.025	41%
WMQv7.0.1.6	48	2133	0.026	53%
WMQv7.1	48	2633	0.022	51%

Table 13 – 20KB persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.2.2 Client Channel

Figure 25 and Figure 26 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the client channel scenario.

3.2.2.1 Non-persistent Messages

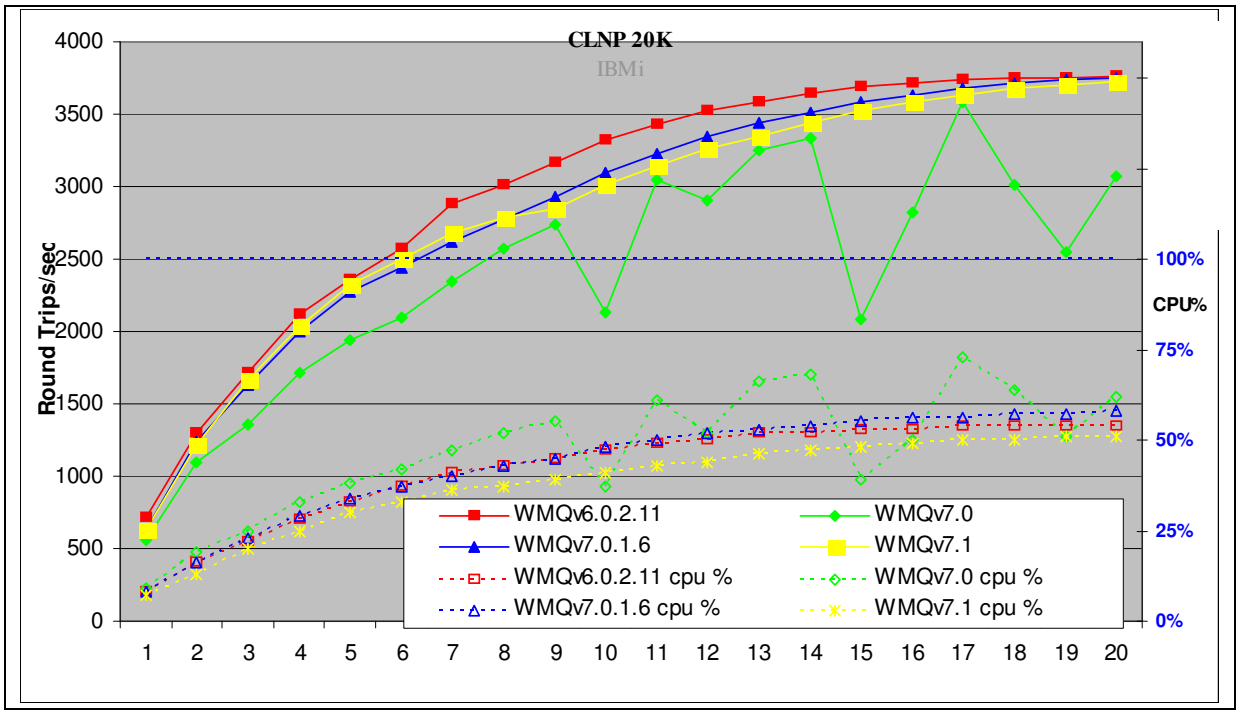

Figure 19 – 20KB non-persistent messages, client channels

Figure 25 and Table 14 shows that the peak throughput of non-persistent messages is 5% improved when comparing version 7.1 to V7.0. However there are instances where 7.1 throughput is degraded against 6.0.2.11 and 7.0.1.6

Test Name: CLNP 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	20	3756	0.0063	54%
WMQv7.0	17	3578	0.0056	73%
WMQv7.0.1.6	20	3746	0.0063	58%
WMQv7.1	20	3723	0.0063	51%

Table 14 – 20KB non-persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.2.2.2 Persistent Messages

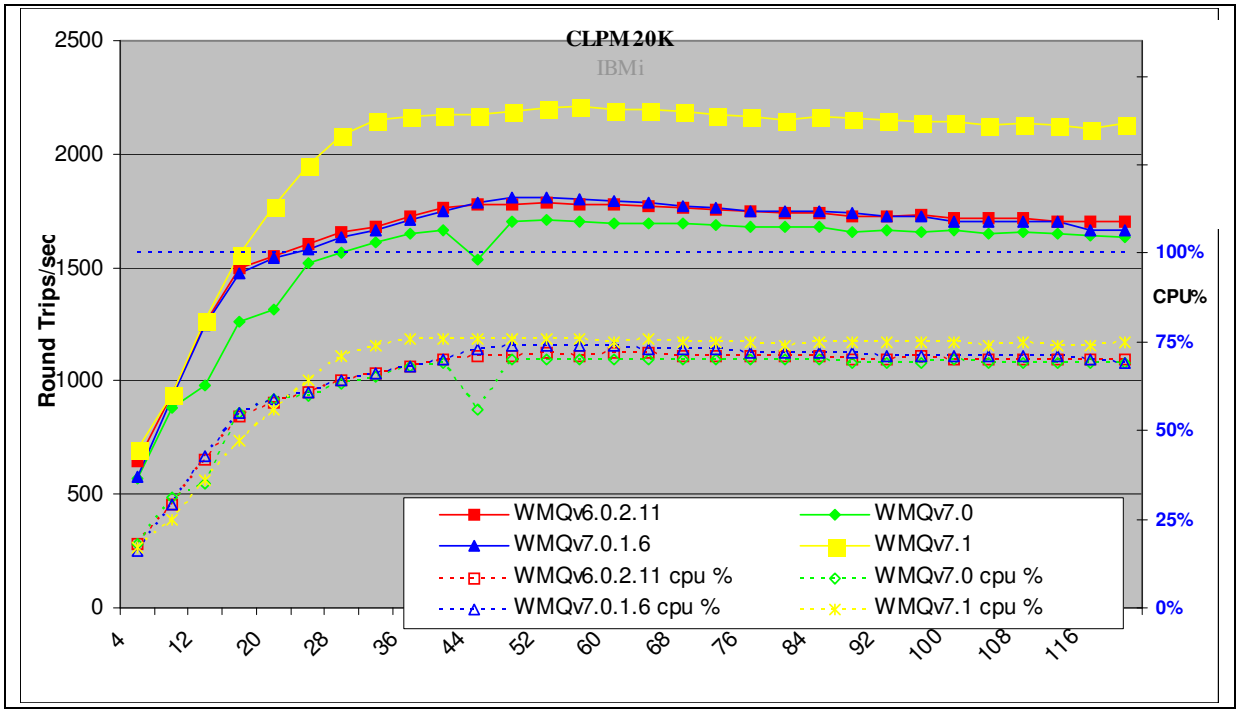

Figure 20 – 20KB persistent messages, client channels

Figure 26 and Table 15 shows that the peak throughput of persistent messages has increased by 30% when comparing version 7.1 to V7.0.

Test Name: CLPM 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	52	1786	0.033	72%
WMQv7.0	52	1707	0.036	70%
WMQv7.0.1.6	48	1812	0.032	74%
WMQv7.1	56	2209	0.03	76%

Table 15 – 20KB persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.2.3 Distributed Queuing

Figure 21 and Figure 28 shows the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the distributed queuing scenario

3.2.3.1 Non-persistent Messages

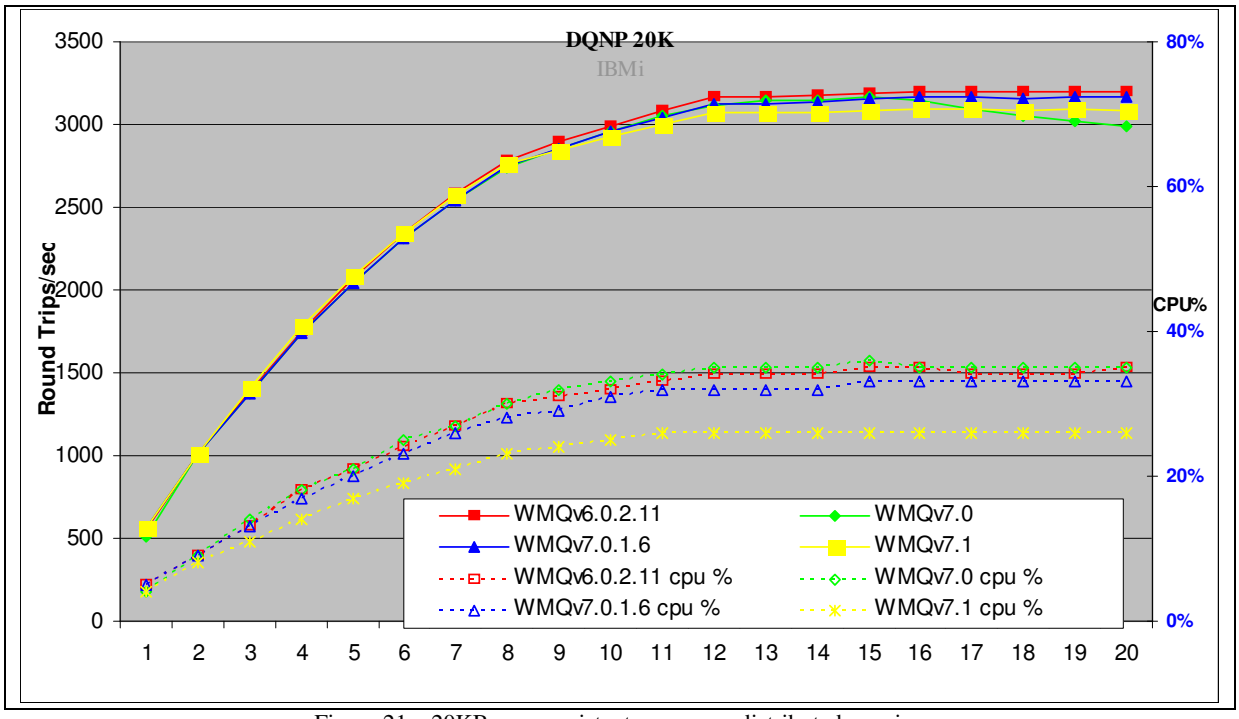

Figure 21 – 20KB non-persistent messages, distributed queuing

Figure 21 and Table 16 shows that the peak throughput of non-persistent messages is similar when comparing version 7.1 to V7.0.

Test Name: DQNP 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	16	3199	0.0059	35%
WMQv7.0	15	3166	0.0056	36%
WMQv7.0.1.6	17	3164	0.0065	33%
WMQv7.1	17	3092	0.0066	26%

Table 16 – 20KB non-persistent messages, client channels

Note: *The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time*

3.2.3.2 Persistent Messages

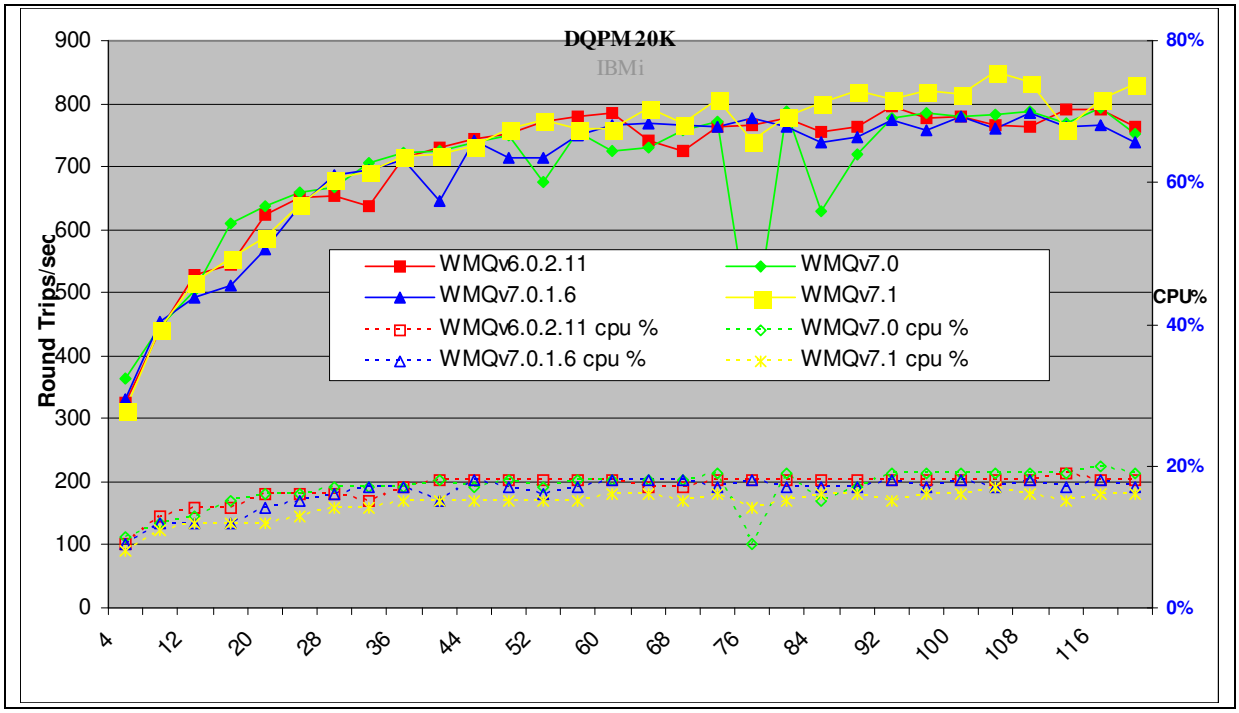

Figure 22 – 20KB persistent messages, distributed queuing

Figure 28 and Table 17 shows that the peak throughput of persistent messages has increased by 7% when comparing version 7.1 to V7.0.

Test Name: DQPM 20K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	92	796	0.16	18%
WMQv7.0	116	794	0.14	20%
WMQv7.0.1.6	108	785	0.16	18%
WMQv7.1	104	851	0.13	17%

Table 17 – 20KB persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3 200K Messages

3.3.1 Local Queue Manager

Figure 29 and Figure 30 shows the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the local queue manager scenario.

3.3.1.1 Non-persistent Messages

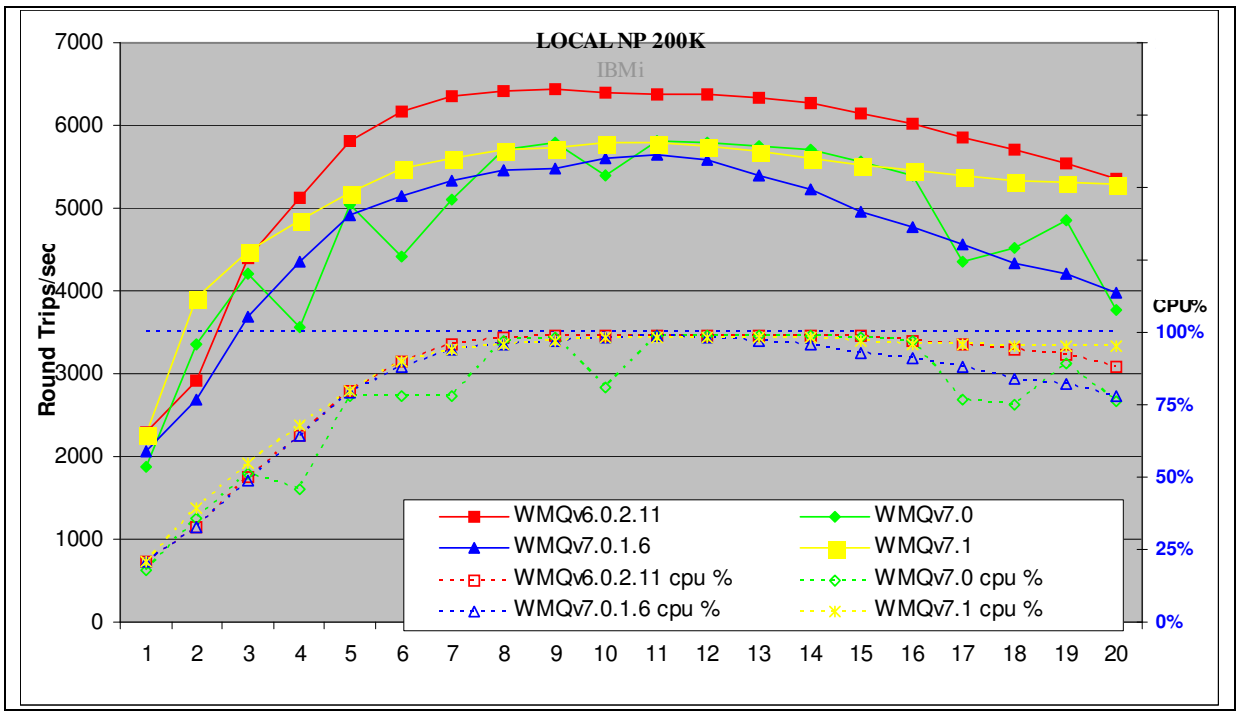

Figure 23 – 200KB non-persistent messages, local queue manager

Figure 29 and Table 18 shows that the peak throughput of non-persistent messages is similar when comparing version 7.1 to V7.0, but is 11% degraded when comparing version 7.1 to 6.0.2.11.

Test Name: LOCAL NP 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	9	6429	0.0016	99%
WMQv7.0	11	5809	0.0022	99%
WMQv7.0.1.6	11	5651	0.0024	99%
WMQv7.1	10	5801	0.002	98%

Table 18 – 200KB non-persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3.1.2 Persistent Messages

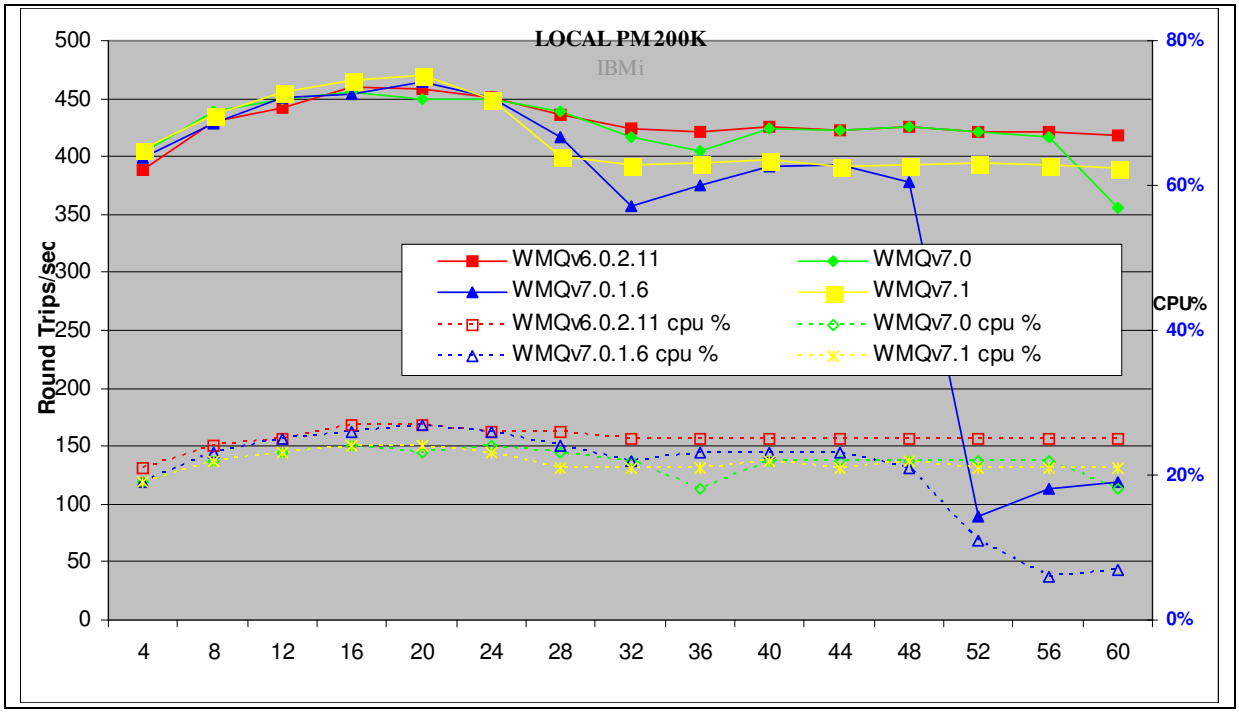

Figure 24 – 200KB persistent messages, local queue manager

Figure 30 and Table 19 shows that the peak throughput of persistent messages is similar when comparing version 7.1 to V7.0.

Test Name: LOCAL PM 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	16	459	0.042	27%
WMQv7.0	16	456	0.039	24%
WMQv7.0.1.6	20	465	0.054	27%
WMQv7.1	20	471	0.058	24%

Table 19 – 200KB persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3.2 Client Channel

Figure 31 and Figure 32 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the client channel scenario.

3.3.2.1 Non-persistent Messages

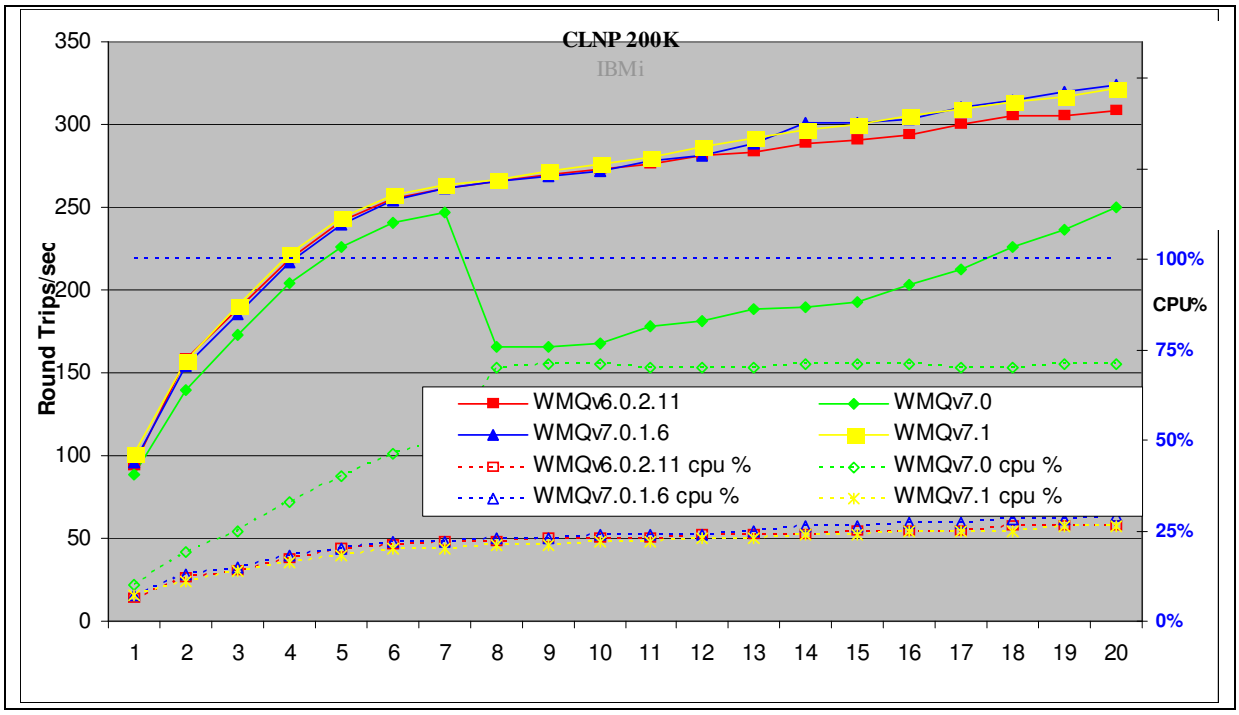

Figure 25 – 200KB non-persistent messages, client channels

Figure 31 and Table 20 shows that the peak throughput of non-persistent messages is 28% improved when comparing version 7.1 to V7.0.

Test Name: CLNP 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	20	308	0.077	26%
WMQv7.0	20	250	0.093	71%
WMQv7.0.1.6	20	324	0.072	29%
WMQv7.1	20	322	0.074	26%

Table 20 – 200KB non-persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3.2.2 Persistent Messages

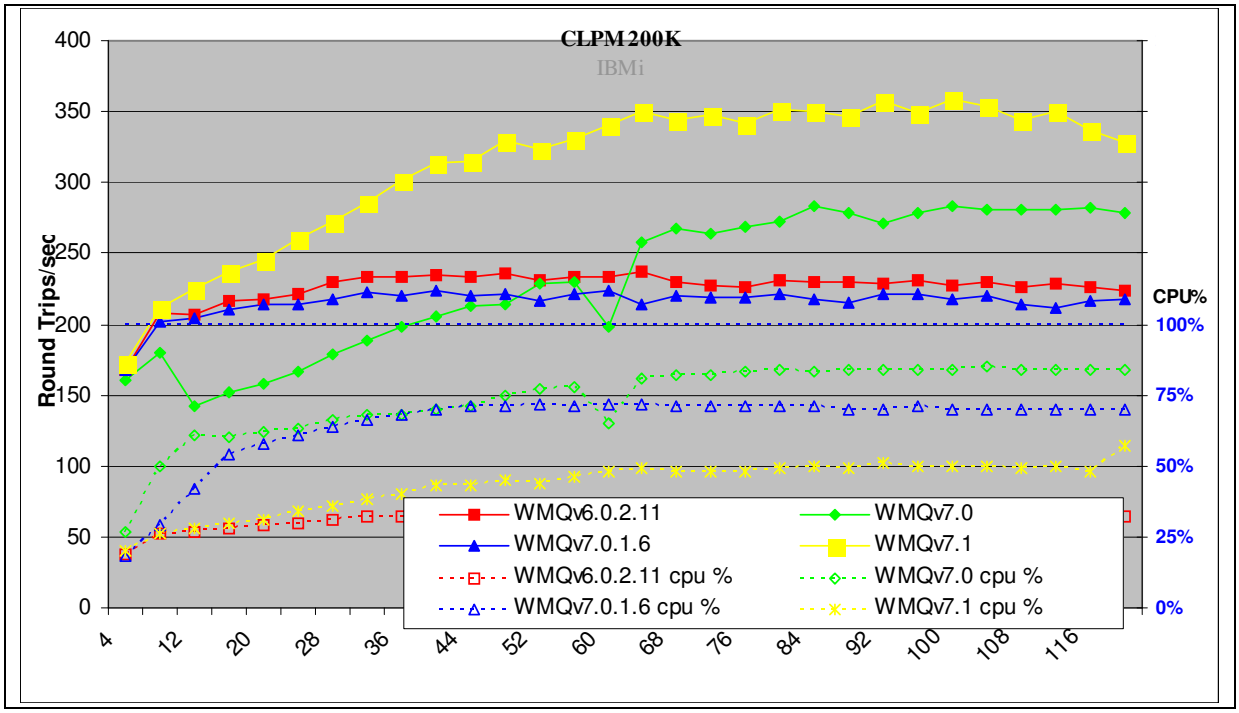

Figure 26 – 200KB persistent messages, client channels

Figure 32 and Table 21 shows that the peak throughput of persistent messages has increased by 27% when comparing version 7.1 to V7.0.

Test Name: CLPM 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	64	237	0.36	33%
WMQv7.0	100	283	0.43	84%
WMQv7.0.1.6	40	224	0.2	70%
WMQv7.1	100	358	0.32	50%

Table 21 – 200KB persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3.3 Distributed Queuing

Figure 33 and Figure 34 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the distributed queuing scenario

3.3.3.1 Non-persistent Messages

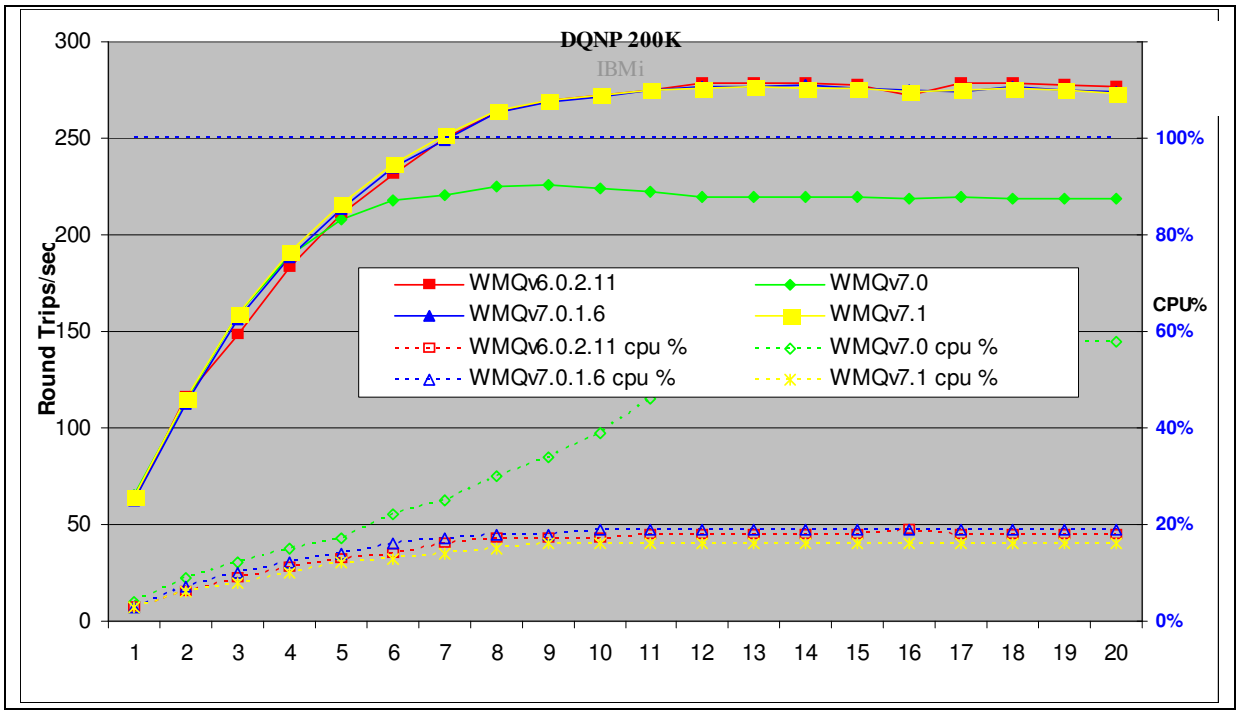

Figure 27 – 200KB non-persistent messages, distributed queuing

Figure 33 and Table 22 shows that the throughput of non-persistent messages is similar when comparing version 7.1 to V7.0.

Test Name: DQNP 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	13	279	0.054	18%
WMQv7.0	9	226	0.046	34%
WMQv7.0.1.6	14	277	0.061	19%
WMQv7.1	13	277	0.055	16%

Table 22 – 200KB non-persistent messages, distributed queuing

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.3.3.2 Persistent Messages

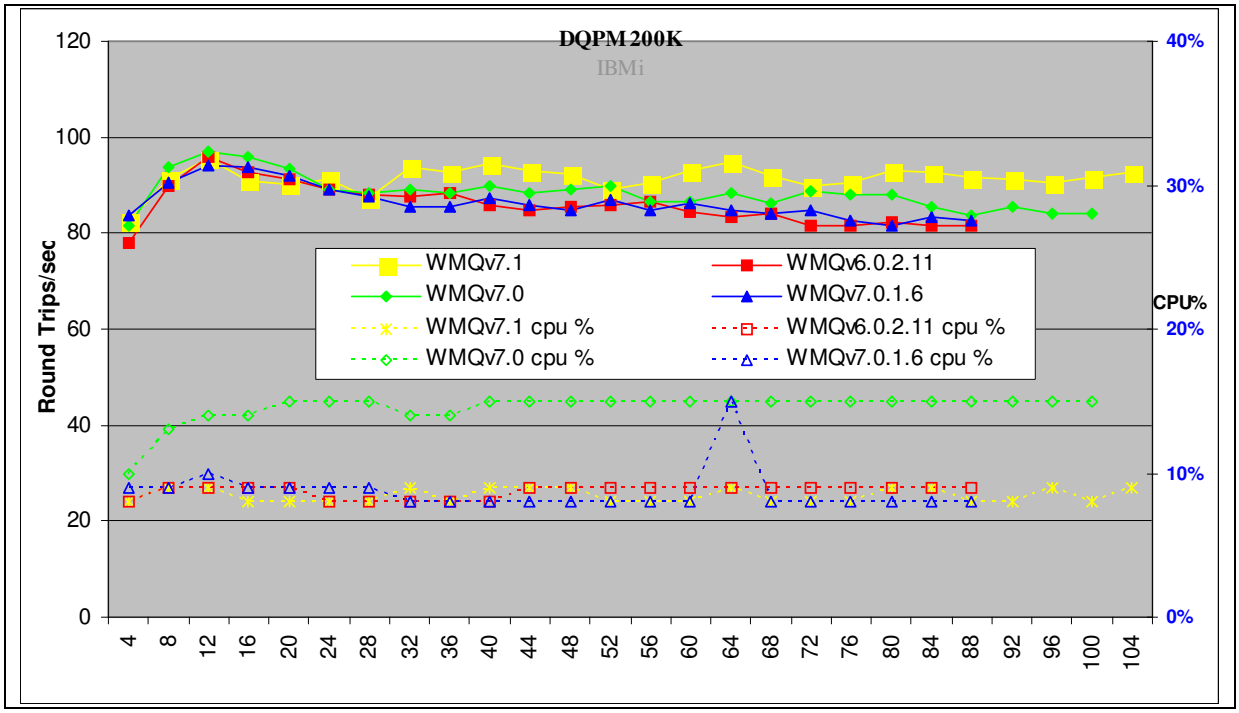

Figure 28 – 200KB persistent messages, distributed queuing

Figure 34 and Table 23 shows that the peak throughput of persistent messages is similar when comparing version 7.1 to V7.0.

Test Name: DQPM 200K	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	12	96	0.13	9%
WMQv7.0	12	97	0.13	14%
WMQv7.0.1.6	12	94	0.14	10%
WMQv7.1	12	95	0.14	9%

Table 23 – 200KB persistent messages, distributed queuing

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4 2MB Messages

3.4.1 Local Queue Manager

Figure 35 and Figure 26 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the local queue manager scenario.

3.4.1.1 Non-persistent Messages

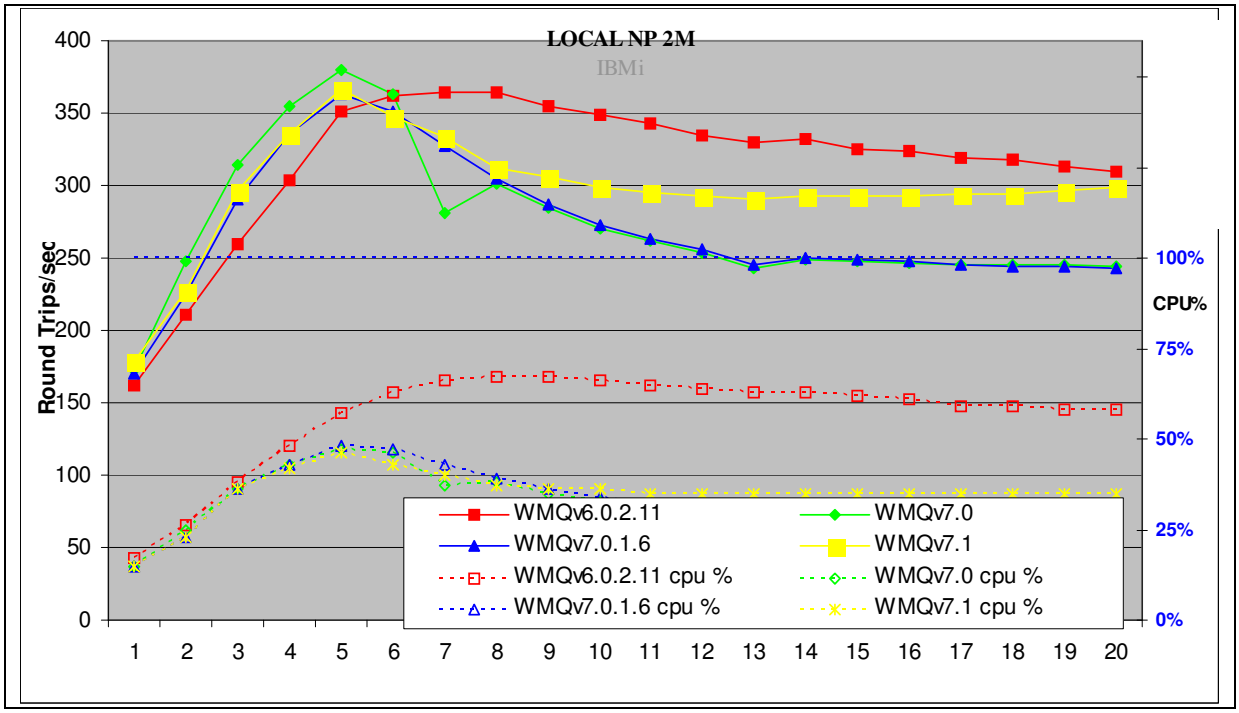

Figure 29 – 2MB non-persistent messages, local queue manager

Figure 35 and Table 24 shows that the peak throughput of non-persistent messages is similar when comparing version 7.1 to V7.0.

Test Name: LOCAL NP 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	8	364	0.025	67%
WMQv7.0	5	379	0.014	47%
WMQv7.0.1.6	5	363	0.015	48%
WMQv7.1	5	367	0.015	46%

Table 24 – 2MB non-persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4.1.2 Persistent Messages

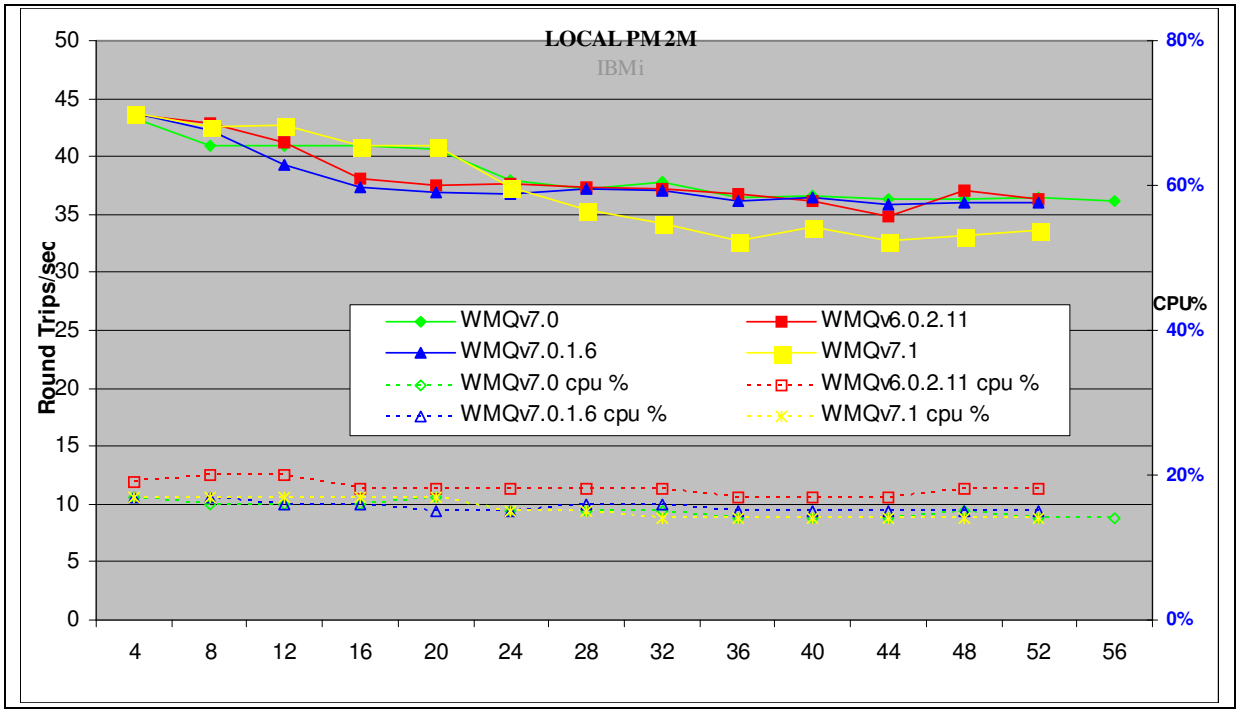

Figure 30 – 2MB persistent messages, local queue manager

Figure 36 and Table 25 shows that the peak throughput of persistent messages is similar when comparing version 7.1 to V7.0. At higher applications v7.1 throughput is slightly degraded against 7.0, 6.0.211 and 7.0.1.6

Test Name: LOCAL PM 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	4	44	0.091	19%
WMQv7.0	4	43	0.09	17%
WMQv7.0.1.6	4	44	0.092	17%
WMQv7.1	4	44	0.091	17%

Table 25 – 2MB persistent messages, local queue manager

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4.2 Client Channel

Figure 31 and Figure 38 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the client channel scenario.

3.4.2.1 Non-persistent Messages

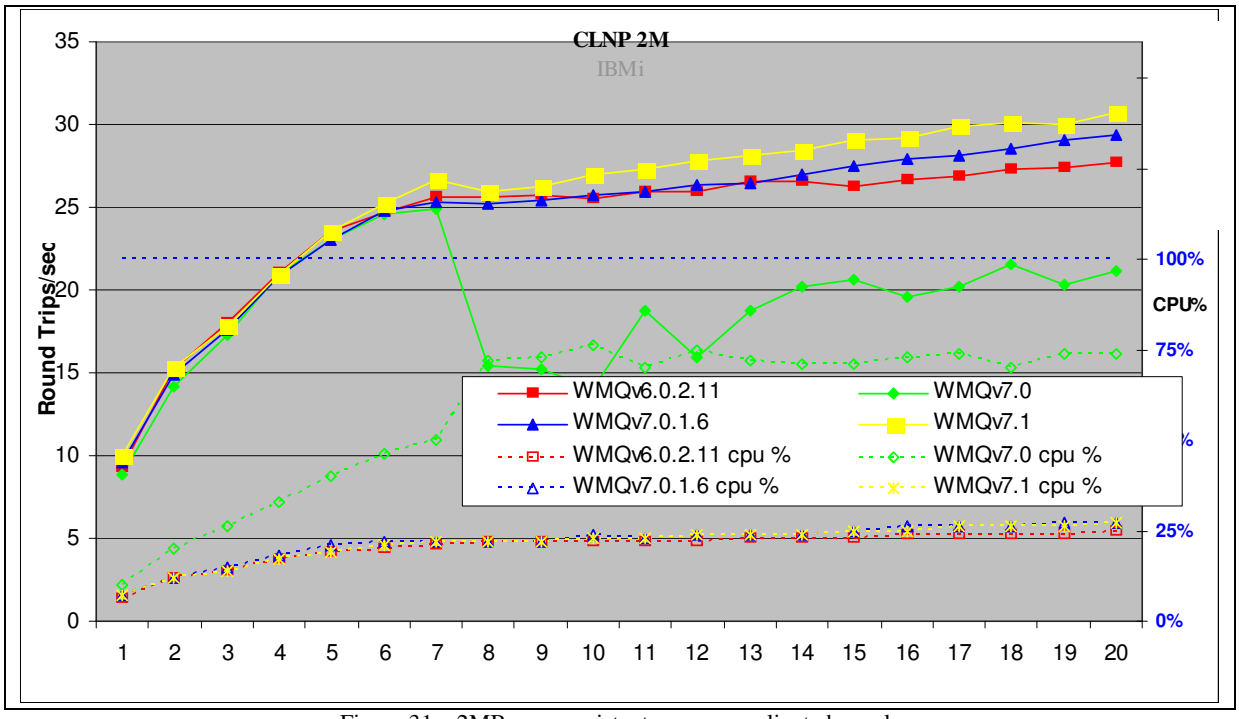

Figure 31 – 2MB non-persistent messages, client channels

Figure 31 and Table 26 shows that the peak throughput of non-persistent messages has increased by 24% when comparing version 7.1 to V7.0.

Test Name: CLNP 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	20	28	0.85	25%
WMQv7.0	7	25	0.32	50%
WMQv7.0.1.6	20	29	0.81	27%
WMQv7.1	20	31	0.77	27%

Table 26 – 2MB non-persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4.2.2 Persistent Messages

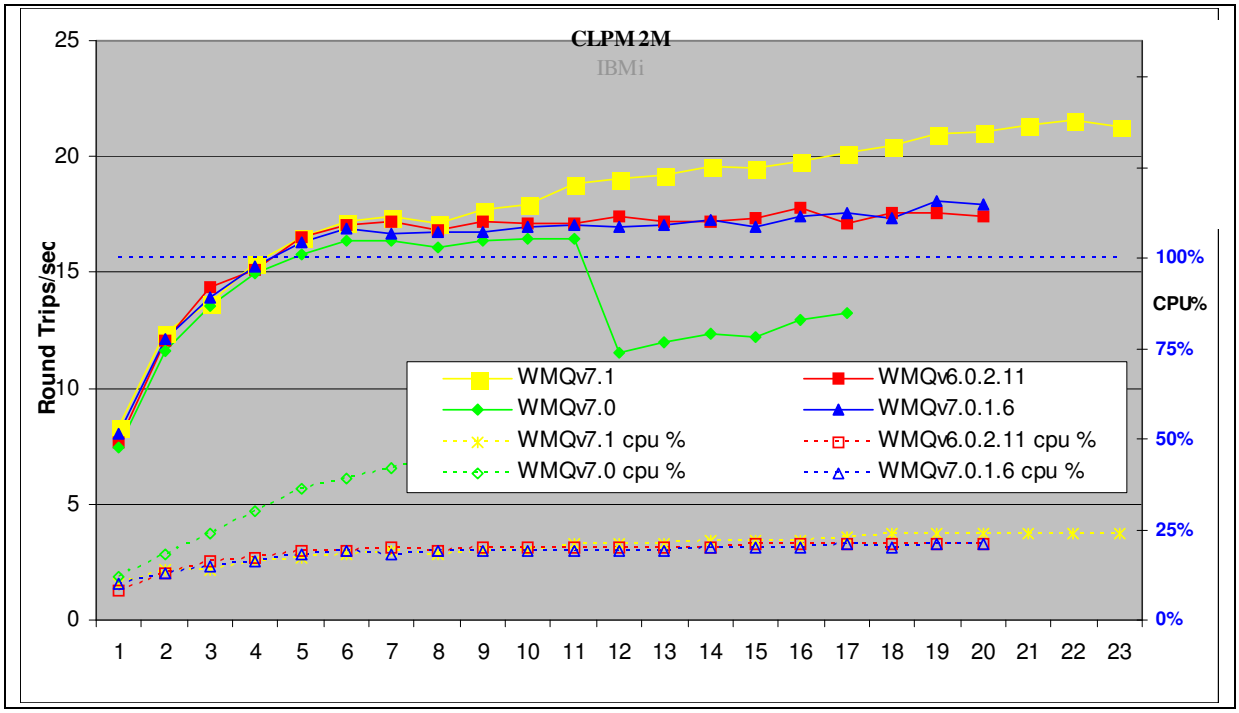

Figure 32 – 2MB persistent messages, client channels

Figure 38 and Table 27 shows that the peak throughput of persistent messages has increased by 38% when comparing version 7.1 to V7.0.

Test Name: CLPM 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	16	18	1	21%
WMQv7.0	10	16	0.72	44%
WMQv7.0.1.6	19	18	1.2	21%
WMQv7.1	22	22	1.2	24%

Table 27 – 2MB persistent messages, client channels

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4.3 Distributed Queuing

Figure 39 and Figure 30 show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the distributed queuing scenario.

3.4.3.1 Non-persistent Messages

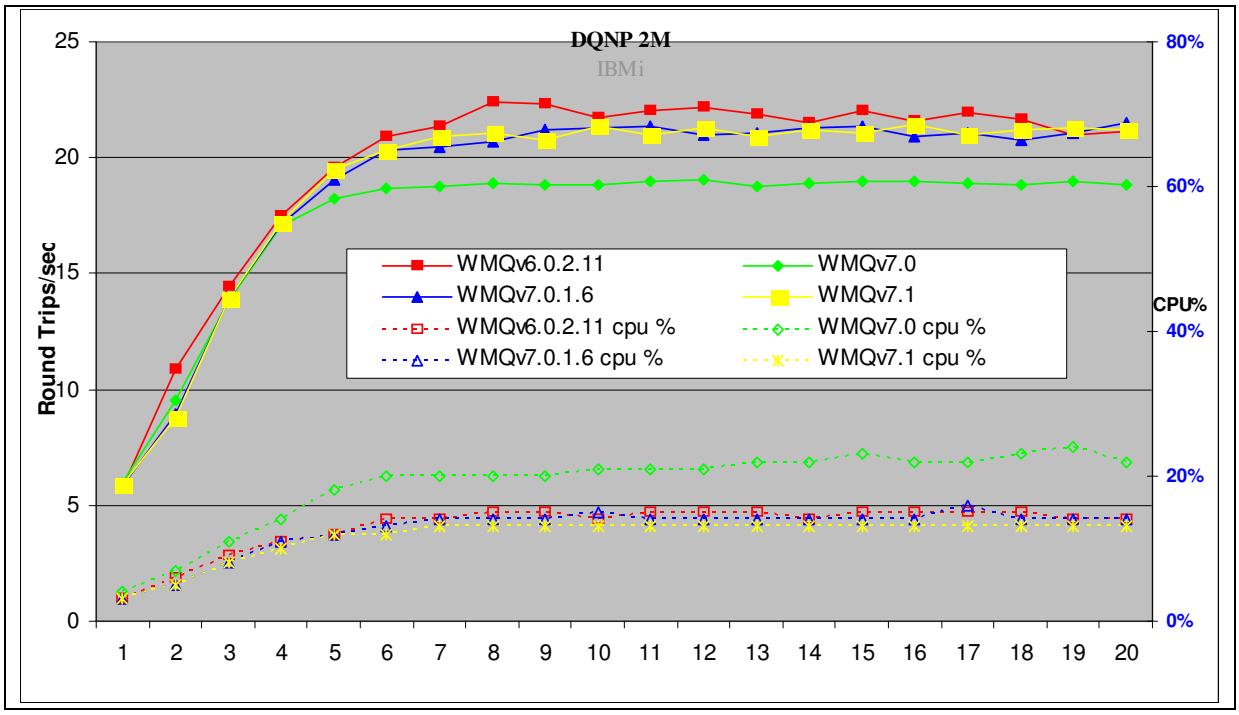

Figure 33 – 2MB non-persistent messages, distributed queuing

Figure 39 and Table 28 shows that the peak throughput of non-persistent messages is similar when comparing version 7.1 to V7.0

Test Name: DQNP 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	8	22	0.42	15%
WMQv7.0	12	19	0.74	21%
WMQv7.0.1.6	20	22	1	14%
WMQv7.1	16	21	0.86	13%

Table 28 – 2MB non-persistent messages, distributed queuing

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

3.4.3.2 Persistent Messages

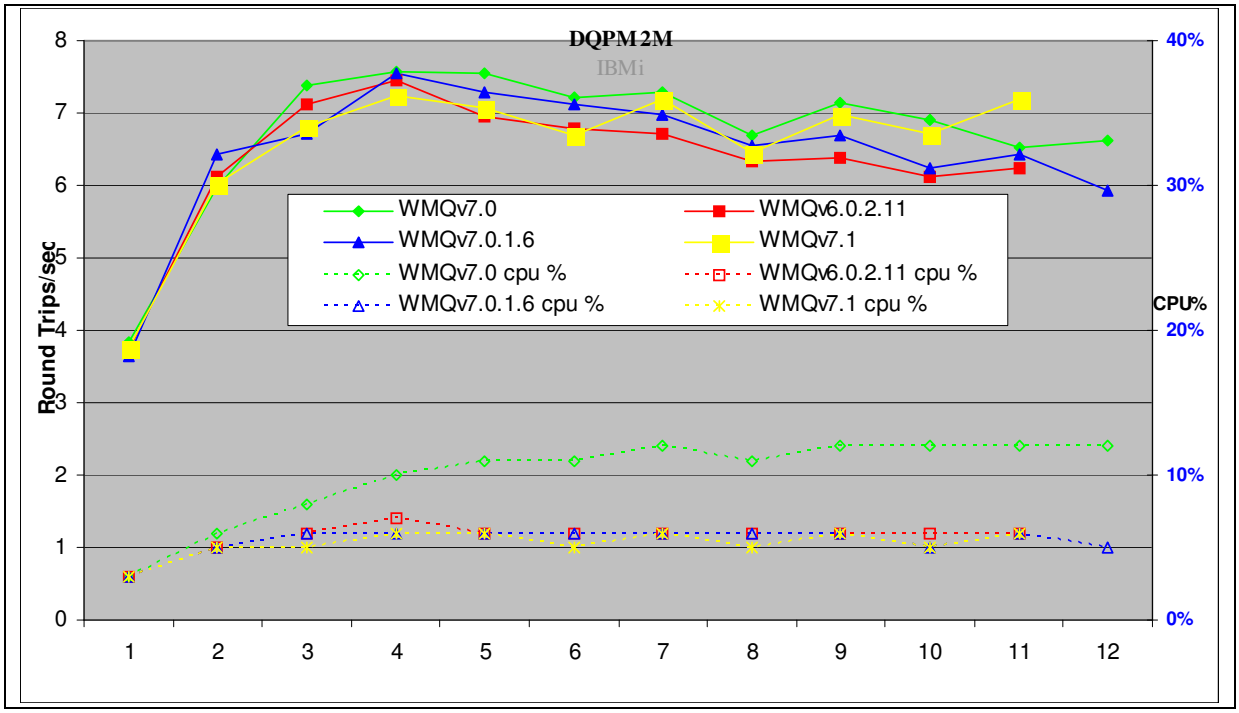

Figure 34 - 2MB persistent messages, distributed queuing

Figure 40 and Table 29 shows that the peak throughput of persistent messages is similar when comparing version 7.1 to 7.0.

Test Name: DQPM 2M	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv6.0.2.11	4	7	0.61	7%
WMQv7.0	4	8	0.61	10%
WMQv7.0.1.6	4	8	0.62	6%
WMQv7.1	4	7	0.63	6%

Table 29 – 2MB persistent messages, distributed queuing

Note: The numbers in the table above show the peak number of round trips per second, the number of driving applications used, the response time and the server CPU at that time

4 Application Bindings

This report analyzes the message rate between a Requester (Driver) application and a Responder (Server) application. This chapter looks at the effect of various combinations of application bindings for Requester and Responder programs.

	Requester	Responder
Normal	Trusted	Non Trusted
Isolated	Isolated	Isolated
Trusted	Trusted	Trusted
Non Trusted	Shared	Shared

4.1 Local Queue Manager

Figure 35 and **Figure 36** show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the local queue manager scenario.

4.1.1 Non-persistent Messages

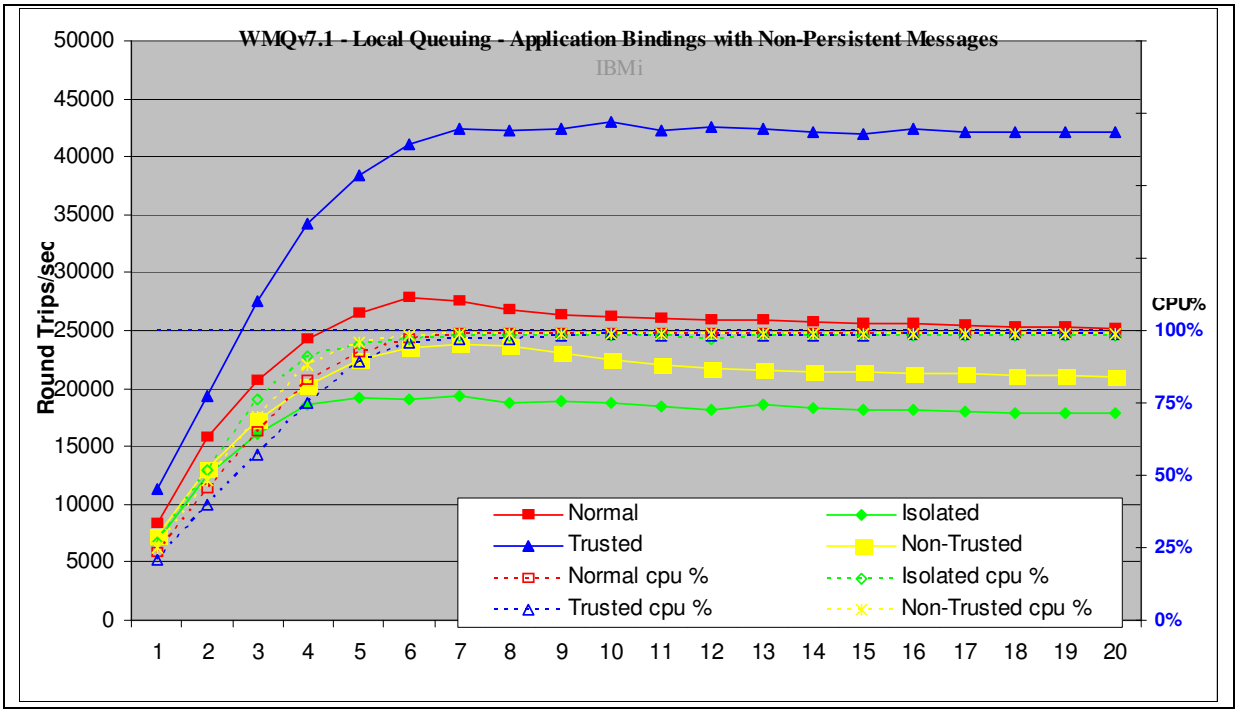

Figure 35 – Application binding, non-persistent messages, local queue manager

Figure 35 and Table 30 shows that the throughput of non-persistent messages when comparing Normal, Isolated, Trusted and Shared bindings.

Test Name: WMQv7.1 - Local Queuing - Application Bindings with Non-Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	6	27762	0.00025	97%
Isolated	7	19419	0.00044	98%
Trusted	10	43001	0.00029	99%
Non-Trusted	7	23768	0.00035	99%

Table 30 – Application binding, non-persistent messages, local queue manager

4.1.2 Persistent Messages

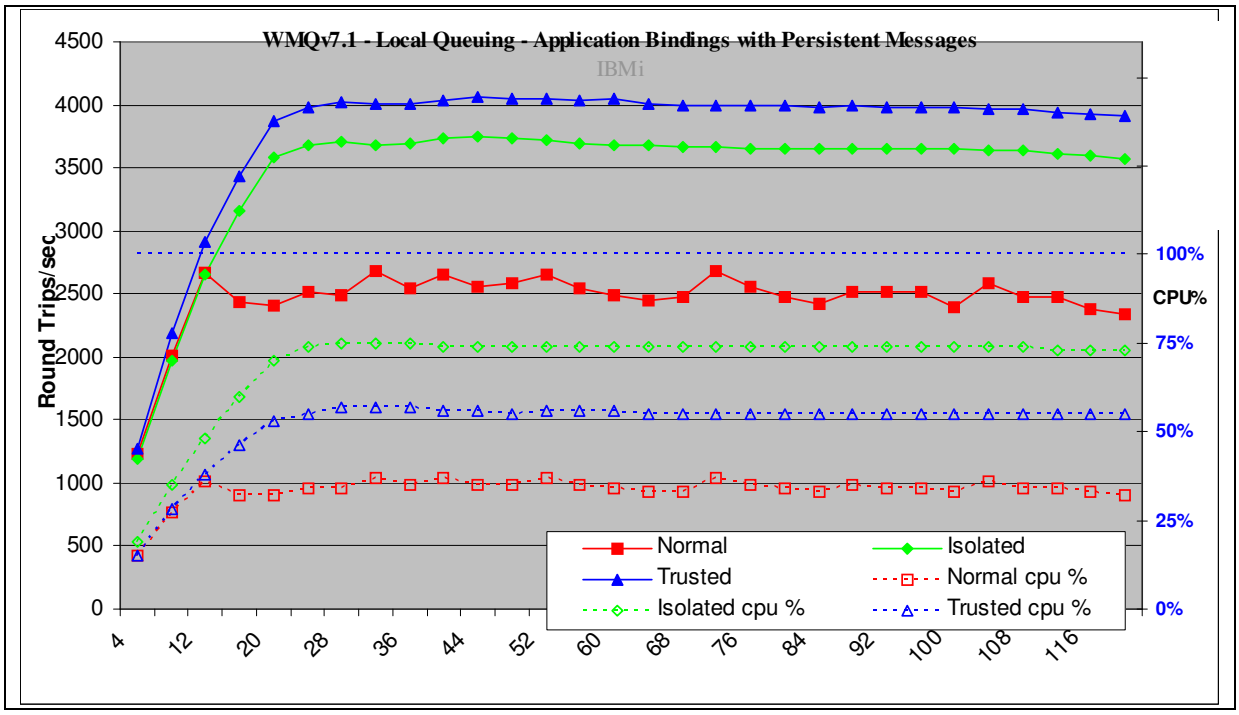

Figure 36 – Application binding, persistent messages, local queue manage

Figure 36 and Table 31 shows the throughput of persistent messages when comparing Normal, Isolated and Trusted bindings

Test Name: WMQv7.1 - Local Queuing - Application Bindings with Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	32	2679	0.014	37%
Isolated	44	3747	0.014	74%
Trusted	44	4064	0.012	56%

Table 31 – Application binding, persistent messages, local queue manager

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4.2 Client Channels

Figure 37 and **Figure 38** show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the client channel scenario.

4.2.1 Non-persistent Messages

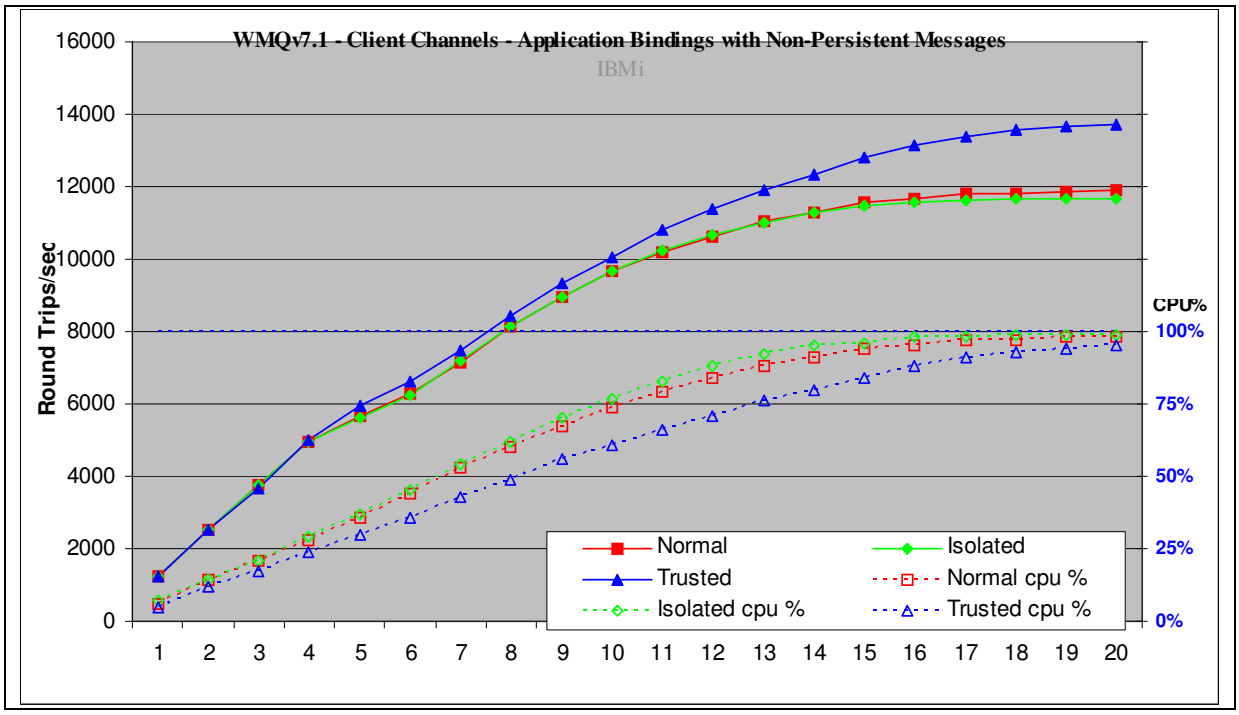

Figure 37 – Application binding, non-persistent messages, client channels

Figure 37 and Table 32 shows that the peak throughput of non-persistent messages when comparing Normal, Isolated and Trusted bindings.

Test Name: WMQv7.1 - Client Channels - Application Bindings with Non-Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	20	11883	0.0019	98%
Isolated	20	11664	0.002	99%
Trusted	20	13709	0.0018	95%

Table 32 – Application binding, non-persistent messages, client channels

4.2.2 Persistent Messages

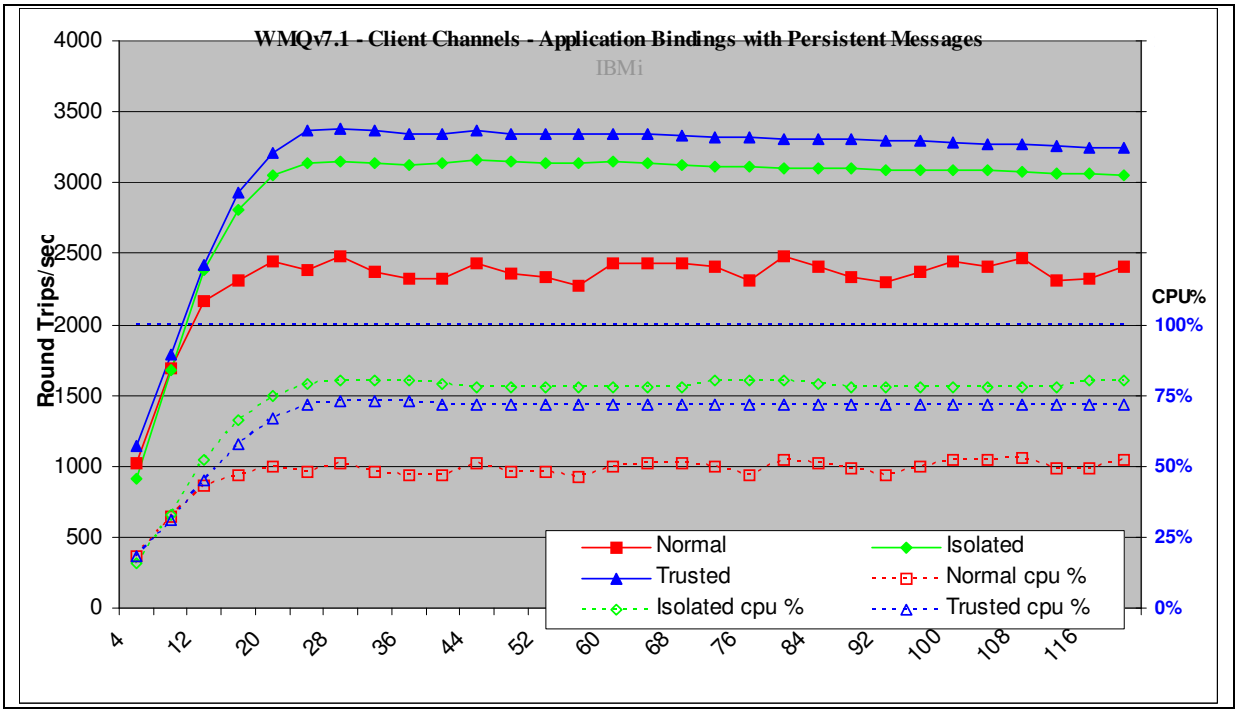

Figure 38 – Application binding, persistent messages, client channels

Figure 38 and Table 33 shows the peak throughput of non-persistent messages when comparing Isolated and Trusted bindings.

Test Name: WMQv7.1 - Client Channels - Application Bindings with Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	28	2482	0.013	51%
Isolated	44	3161	0.016	78%
Trusted	28	3377	0.0097	73%

Table 33 – Application binding, persistent messages, client channels

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4.3 Distributed Queuing

Figure 38 and **Figure 39** show the non-persistent and persistent message throughput achieved using an increasing number of driving applications in the distributed queuing scenario.

4.3.1 Non-persistent Messages

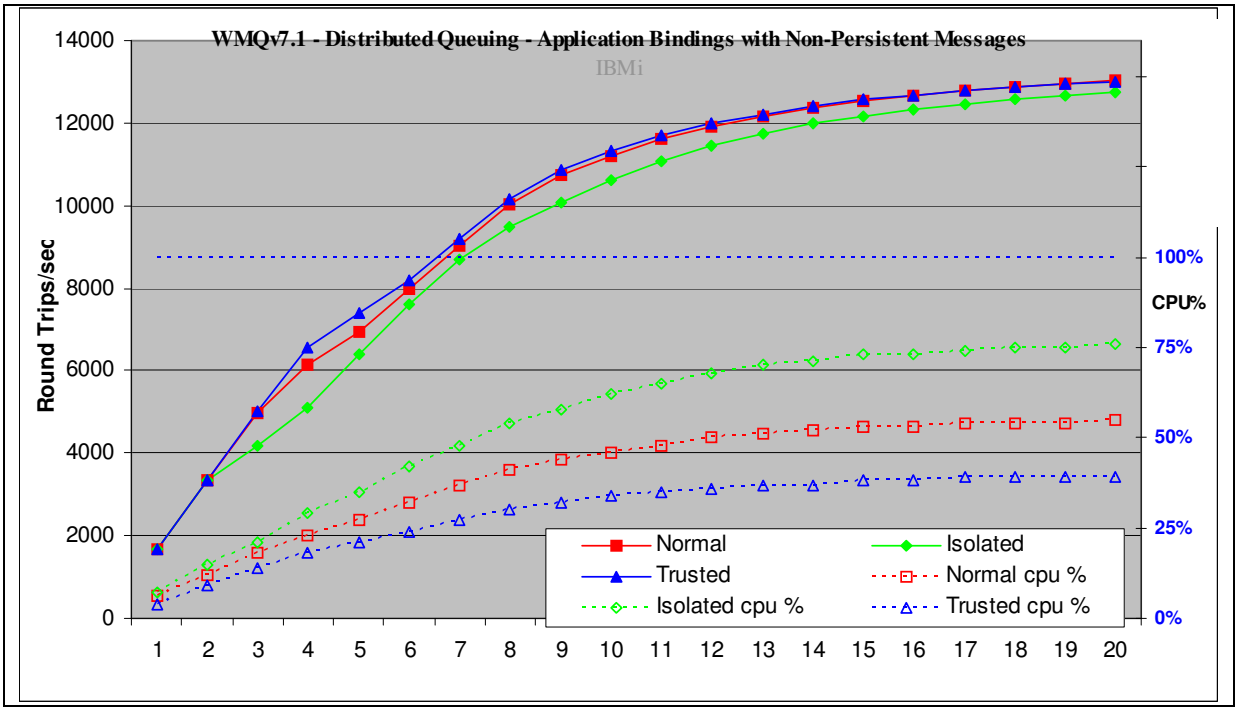


Figure 39 – Application binding, non-persistent messages, distributed queuing

Figure 39 and Table 34show that the peak throughput of non-persistent messages when comparing Normal, Isolated and Trusted bindings.

Test Name: WMQv7.1 - Distributed Queuing - Application Bindings with Non-Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	20	13031	0.0021	55%
Isolated	20	12756	0.002	76%
Trusted	20	13008	0.0021	39%

Table 34 – Application binding, non-persistent messages, distributed queuing

Note: The large bold numbers in the table above show the peak number of round trips per second, and the number of driving applications used to achieve the peak throughput.

4.3.2 Persistent Messages

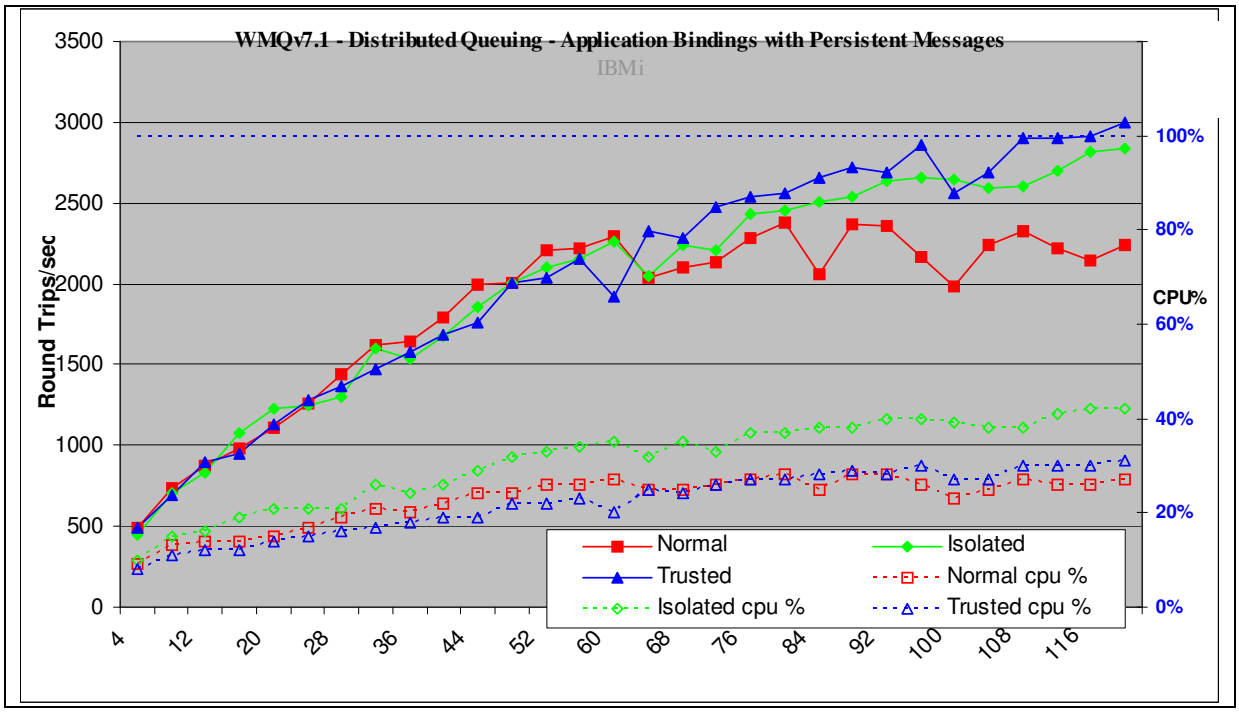


Figure 40 – Application binding, persistent messages, distributed queuing

Figure 40 and Table 35 show that the peak throughput of non-persistent messages when comparing Isolated and Trusted bindings.

Test Name: WMQv7.1 - Distributed Queuing - Application Bindings with Persistent Messages	Apps	Round Trips/Sec	Response time (s)	CPU
Normal	80	2377	0.04	28%
Isolated	120	2844	0.047	42%
Trusted	120	2994	0.046	31%

Table 35 – Application binding, persistent messages, distributed queuing

Note: The large bold numbers in the table above show the peak number of round trips per second, and the number of driving applications used to achieve the peak throughput.

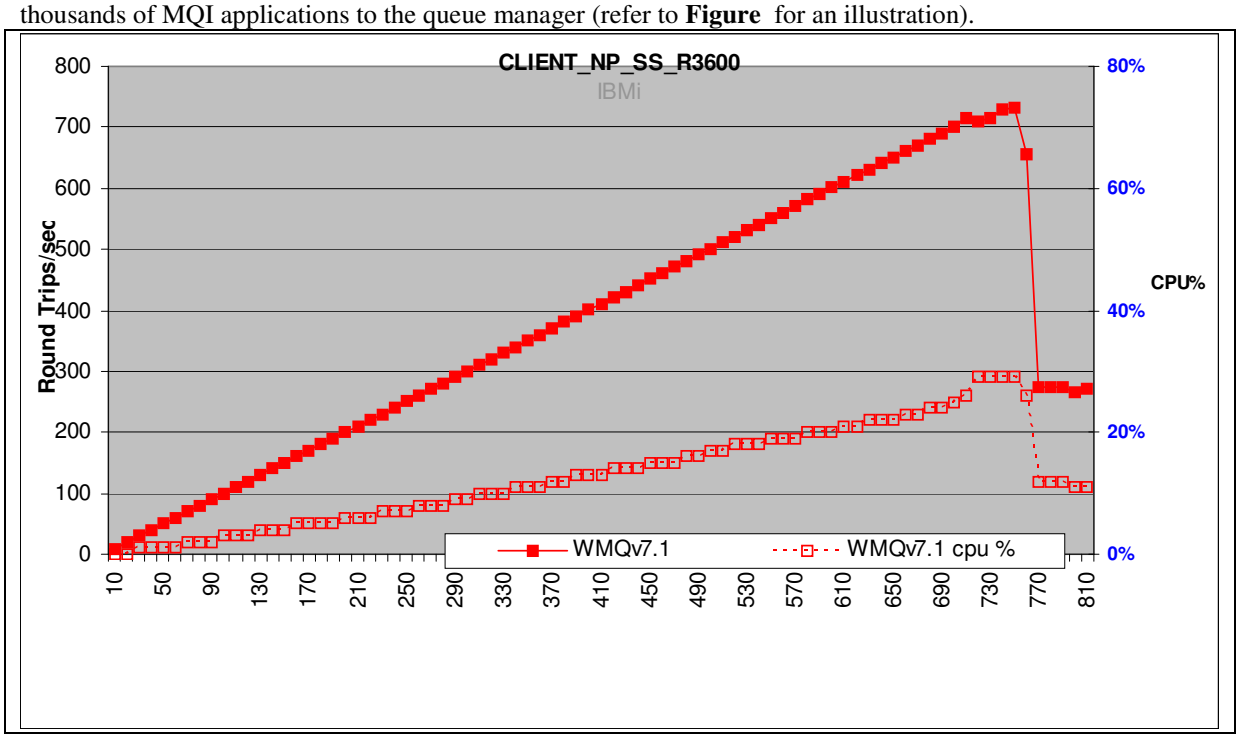
5 Short & Long Sessions

The previous chapters in this report only reported on steady state messaging that does not include any session setup and termination function. This chapter specifically bracket groups of five MQPut/MQGet pairs with MQConn/MQDisc and MQOpen/MQClose calls so a comparison of this overhead can be seen.
A short session is a term used to describe the behaviour of an MQI application as it processes a small number of messages using one or more queues and a queue manager. The measurements in this document use an MQI-client application and the following sequence:

- connects to the queue manager
- opens the common input queue, and common reply queue
- puts a request message to the common input queue
- gets the reply message from the common reply queue
- wait one second
- closes both queues
- disconnects from the queue manager

"Why measure short sessions?"

For each new connecting application or disconnecting application, the queue manager and Operating System must start a new process or thread and set up the new connection. As the number of connecting and disconnecting applications increases, the Operating System and queue manager are subjected to a higher load. While these requests are being serviced, the queue manager has less time available to process messages, so fewer driving applications can be reconnected to the queue manager per second before the response time exceeds one second.
This effect is greater than that of reducing the total messaging throughput of the queue manager by connecting thousands of MQI applications to the queue manager (refer to **Figure** for an illustration).



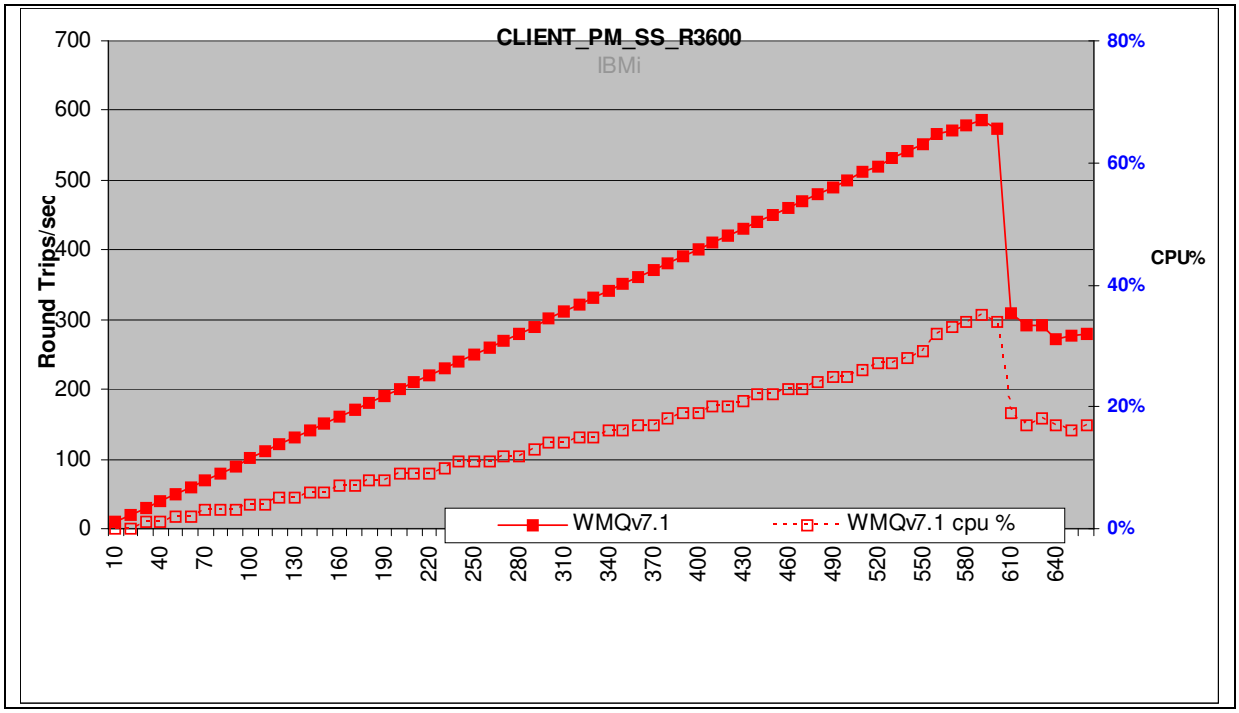


Figure 47 – Short sessions, client channels

Test Name: CLIENT_NP_SS_R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.1	750	734	0.051	29%

Test Name: CLIENT_PM_SS_R3600	Apps	Round Trips/Sec	Response time (s)	CPU
WMQv7.1	590	587	0.1	35%

Table 36 – Short sessions, client channels

*Note: Messaging in these tests is 1 round trip per driving application per second, i.e. 1 short session per driving application every **5** seconds*

Note: The figures for non-persistent short sessions were generated with all message processing within sync-point control. All other non-persistent messages within this report were generated outside sync-point control

Note:- Short session data collected with sharecnv(1).

The 'runmqlsr' has a much smaller overhead of connecting to and disconnecting from the queue manager because it only uses a single thread per connection rather than an entire process.

6 Performance and Capacity Limits

6.1 Client channels – capacity measurements

The measurements in this section are intended to test the maximum number of client channels into a server queue managers with a messaging rate of 1 round trip per client channel per *minute* while additional

connections are made. The maximum number of connected applications is likely to be determined by other criteria such as recovery time or manageability. Measurements are also made with smaller number of Client channels where the message insertion rate is increased until the system gets congested. This information is intended to be useful to the reader sizing a system with similar scenarios. These client measurements of V7.1 allocate a separate socket for each client (sharecnv=1 on svrcon channel).

Queue manager configuration for client channels capacity tests:

MaxChannels=50000 (100,000 for clnp_cmax). MQIBINDTYPE=FASTPATH

Test name:	Apps	Rate/app/hr	Round Trips/sec	Response time (s)	CPU
clnp	20	n/a*	12285	0.002	98%
clnp_r3600	10000	3600	8963	0.035	92%
clnp_c6000	6000	4500	7422	0.795	22%
clnp max	22000 22000 30000	900 1140 870	11412 13956 7251	0.016 0.293 0.336	? ? 95%
cl_persist_c6000	6000 6000	960 1140	1602 1888	0.081 0.798	42% 50%
clnp_cmax_no_correllid	30000	90	665	0.003	27%

Table 37 – Capacity measurements, client channels

* *There was no delay between the response to the previous message and the insertion of the next message with 20 clients.*

The maximum message throughput is achieved when there are a small number of requester applications. The clnp_3600 measurement peaks when the queue of input messages waiting to be processed by the Server application builds up because the server application threads can no longer keep up with the demand. Although this ensures the server threads are always busy, the messages are being spilt from the Queue buffer to the file system and possibly to the disk. Each client uses a thread in the AMQRRMPA processes and the management of lots of threads and lots memory objects results in a larger CPU cost to handle each message.

Measurements normally use a Get by Correlation_Id from a common reply queue for all clients whereas the tests labelled 'no_correlid' have a separate reply queue per client. Each additional Client needs a thread in the AMQRMPPA process. Using a separate queue per client needs additional shared memory per client.

6.2 Distributed queuing – capacity measurements

The measurements in this section are intended to test the maximum number of server channel pairs between two queue managers with a messaging rate of 1 round trip per server channel per *minute* while applications are being attached. For the same number of server channel pairs, a faster message rate gives a higher total message throughput over each channel pair. This information is intended to be useful to the reader sizing a system with similar scenarios.

Queue manager and log configuration for distributed queuing capacity tests:

```
MaxChannels=20000, LogPrimaryFiles=12, LogFilePages=16384, LogBufferPages=512
```

Note: The large log capacity for this test is for writing the object definitions to the log disk (the transmission queue definitions for both sides of the server channel pair, and reply queue per receiver channel on the driving machine).

Test name:	Apps	Rate/app/hr	Round Trips/sec	Response time (s)	CPU
dqnp	20	n/a*	13062	0.002	55%
dqnp_r3600	20000	3600	8067	0.307	32%
dqnp_q1000	1000	25000	6914	0.001	44%
dqnp_qmax	7530	60	125	0.001	1.7%
dq-persist_q1000	1000	6800	512	0.3	15%

Table 38 – Capacity measurements, server channels

* *There was no delay between the response to the previous message and the insertion of the next message with 20 driving applications..*

The dqnp and dqnp_r3600 both used a total of 4 pairs of Sender/Receiver pairs of channels between queue managers while the dqnp_qmax and dq_persist_q1000 used a pair of channels per application. The dqnp_q1000 shows the reduced throughput experienced when 1000 queue mangers are connected into a central hub.

7 Tuning Recommendations

7.1 Tuning the Queue Manager

This section highlights the tuning activities that are known to give performance benefits for WebSphere MQ V7.1; The reader should note that the following tuning recommendations **may not** necessarily **need** to be applied, especially if the message throughput and/or response time of the queue manager system already meets the required level. Some tuning recommendations that follow may degrade the performance of a previously balanced system if applied inappropriately. The reader should carefully monitor the results of tuning the queue manager to be satisfied that there have been no adverse effects.

Customers should test that any changes have not used excessive real resources in their environment and make only essential changes. For example, allocating several megabytes for multiple queues reduces the amount of shared and virtual memory available for other subsystems, as well as over committing real storage.

Note: The 'TuningParameters' stanza is not a documented external interface and maybe changed or be removed in future releases.

7.1.1 Queue Disk, Log Disk, and Message Persistence

Non-persistent messages are held in main memory, spilt to the file system as the queues become deep and lazily written to the Queue file. Persistent messages are synchronously written to the log by an MQCmit that are also periodically flushed to the Queue file.

To avoid potential queue and log I/O contention due to the queue manager simultaneously updating a queue file and log extent on the same disk, it is important that queues and logs are located on *separate* and *dedicated* physical devices. Multiple disks can be redirected to a Storage Area Network (SAN) but multiple high volume Queue managers can require different Logical Volumes to avoid congestion.

With the queue and log disks configured in this manner, careful consideration must still be given to message persistence: persistent messages should only be used if the message needs to survive a queue manager restart (forced by the administrator or as the result of a power failure, communications failure, or hardware failure). In guaranteeing the recoverability of persistent messages, the pathlength through the queue manager is three times longer than for a non-persistent message. This overhead does not include the additional time for the message to be written to the log, although this can be minimised by using cached disks or SAN.

7.1.1.1 Non-persistent and Persistent Queue Buffer

The default non-persistent queue buffer size is 64K per queue and the default persistent is 128K per queue for 32 bit Queue Managers and 128K /256K for 64 bit Queue Managers (AIX, Solaris, HPUX, Linux_64, z_Linux, and Windows64). They can all be increased to 1Mb using the TuningParameters stanza and the *DefaultQBufferSize* and DefaultPQBufferSize parameters. (For more details see SupportPac MP01: MQSeries – Tuning Queue Limits). Increasing the queue buffer provides the capability to absorb peaks in message throughput at the expense of real storage. Once these queue buffers are full, the additional message data is given to the file system that will eventually find its way to the disk. Defining queues using large non-persistent or persistent queue buffers can degrade performance if the system is short of real memory either because a large number of queues have already been defined with large buffers, or for other reasons -- e.g. large number of channels defined.

Note: The queue buffers are allocated in shared storage so consideration must be given to whether the agent process or application process has the memory addressability for all the required shared memory segments.

Queues can be defined with different values of *DefaultQBufferSize* and *DefaultPQBufferSize*. The value is taken from the TuningParameters stanza in use by the queue manager when the queue was defined. When the queue manager is restarted existing queues will keep their earlier definitions and new queues will be created with the current setting. When a queue is opened, resources are allocated according to the definition held on disk from when the queue was created.

7.1.2 Log Buffer Size, Log File Size, and Number of Log Extents

Not applicable for IBMi

7.1.2.1 LogWriteIntegrity: SingleWrite or TripleWrite

Not applicable for IBMi

7.1.3 Channels: Process or Thread, Standard or Fastpath?

Threaded channels are used for all the measurements in this report ('runmqlsr', and for server channels an MCATYPE of 'THREAD') the threaded listener 'runmqlsr' can now be used in all scenarios with client and server channels. Additional resource savings are available using the 'runmqlsr' listener rather than 'inetd', including a reduced requirement on: virtual memory, number of processes, file handles, and System V IPC.

Fastpath channels, and/or fastpath applications—see later paragraph for further discussion, can increase throughput for both non-persistent and persistent messaging. For persistent messages, the improvement is only for the path through the queue manager, and does not affect performance writing to the log disk.

Note: The reader should note that since the greater proportion of time for persistent messages is in the queue manager writing to the log disk, the performance improvement for fastpath channels is less apparent with persistent messages than with non-persistent messages.

7.2 Applications: Design and Configuration

7.2.1 *Standard (Shared or Isolated)* or Fastpath?

The reader should be aware of the issues associated with writing and using fastpath applications—described in the 'MQSeries Application Programming Guide'. Although it is recommended that customers use fastpath channels, it is not recommended to use fastpath applications. If the performance gain offered by running fastpath is not achievable by other means, it is essential that applications are rigorously tested running fastpath, and never forcibly terminated (i.e. the application should always disconnect from the queue manager). Fastpath channels are documented in the 'MQSeries Intercommunication Guide'.

7.2.2 Parallelism, Batching, and Triggering

An application should be designed wherever possible to have the capability to run *multiple instances* or *multiple threads* of execution. Although the capacity of a multi-processor (SMP) system can be fully utilised with a small number of applications using non-persistent messages, more applications are typically required if the workload is mainly using persistent messages. Processing messages inside syncpoint can help reduce the amount of time the queue managers takes to write a group of persistent messages to the log disk. The performance profile of a workload will also be subject to variability through cycles of low and heavy message volumes, therefore a degree of experimentation will be required to determine an optimum configuration.

Queue avoidance is a feature of the queue manager that allows messages to be passed directly from an 'MQPuter' to an 'MQGeter' without the message being placed on a queue. This feature only applies for processing messages outside of syncpoint. In addition to improving the performance of a workload with multiple parallel applications, the design should attempt to ensure that an application or application thread is always available to process messages on a queue (i.e. an 'MQGeter'), then messages outside of syncpoint do not need to ever be physically placed on a queue.

The reader should note that as more applications are processing messages on a single queue there is an increasing likelihood that queue avoidance will not be maintainable. The reasons for this have a cumulative and exponential effect, for example, when messages are being placed on a queue quicker than they can be removed. The first effect is that messages begin to fill the queue buffer—and MQGeters need to retrieve messages from the buffer rather than being received directly from an MQPuter. A secondary effect is that as messages are spilled from the buffer to the queue disk, the MQGeters must wait for the queue manager to retrieve the message from the queue disk rather than being retrieved from the queue buffer. While these problems can be addressed by configuring for more MQGeters (i.e processing threads in the server application), or using a larger queue buffer, it may not be possible to avoid a performance degradation.

Processing persistent messages inside syncpoint (i.e. in batches) can be more efficient than outside of syncpoint. As the number of messages in the batch increases, the average processing cost of each message decreases. For persistent messages the queue manager can write the entire batch of messages to the log disk in one go while outside of syncpoint control, the queue manager must wait for each message to be written to the log before returning control to the application.

Only one log record per queue can be written to the disk per log I/O when processing messages outside of syncpoint. This is not a bottleneck when there are a lot of different queues being processed. When there are a small number of queues being processed by a large number of parallel application threads, it is a bottleneck. By changing all the messages to be processed inside syncpoint, the bottleneck is removed because multiple log records per queue can share the same log I/O for messages processed within syncpoint.

A typical triggered application follows the performance profile of a short session. The 'runmqlsr' has a much smaller overhead compared to inetd of connecting to and disconnecting from the queue manager because it does not have to create a new process. The programmatical implementation of triggering is still worth consideration with regard to programming a disconnect interval as an input parameter to the application program. This can provide the flexibility to make tuning adjustments in a production environment, if for instance, it is more efficient to remain connected to the queue manager between periods of message processing, or disconnect to free queue manager and Operating System resources.

7.3 Tuning the Operating System (IBMi)

Please refer to IBMi specific tuning literature for IBMi tuning techniques

Journal Considerations on IBM i

Persistent messaging on IBM i uses native journaling support to ensure that messages are recoverable. To ensure that maximum rates of throughput are achieved when using persistent messages, you should consider the following:

When the queue manager is created on IBM i, a journal receiver is automatically created and located on the system ASP disk arms. To avoid contention with other IO on these arms, it is recommended that the user manually create and attach a new journal receiver, ensuring that it is located on a user ASP with dedicated disk arms. This will help improve response times for the synchronous disk writes to the journal that are needed for each persistent message.

It will also be helpful to ensure that the disk arms and IOPs used in the user ASP have good overall performance characteristics for write activity, including good write cache performance. Slower disk arms and IOPs will result in less favourable response times and less overall capacity in terms of message throughput.

7.4 Virtual Memory, Real Memory, & Paging

7.4.1 BufferLength

The AMQRMPPA process contains a thread per connected client. The BufferLength parameter of the MQGet is also used to allocate a long term piece of storage of this size in which the message is held before being retrieved by the client. If the size of the arriving messages cannot be predicted then the application should provide a buffer than can deal with 90% of the messages and redrive the MQGet after return code **2080 (X'0820') MQRC_TRUNCATED_MSG_FAILED** by providing a larger BUFFER for retrieving this particular message. There is a mechanism to gradually reduce the size of the storage in AMQRMPPA if the recent BufferLength size is significantly smaller than previous BufferLength.

7.4.2 MQIBINDTYPE

MQIBINDTYPE=FASTPATH will cause the channel to run 'Trusted' mode. Trusted applications do not use a thread in the Agent (AMQZLLA) process. This means there is no IPC between the Channel and Agent because the Agent does not exist in this connection. If the channel is run in STANDARD mode then any messages passed between the channel and agent will use IPCC memory (size = BufferSize with a maximum size of 1Mb) that is dynamically obtained and only held for the lifetime of the MQGet. Standard channels each require an additional 80K bytes of memory. As the message rate increases, there will be more IPCC memory used in parallel.

The power of the machine used to process a workload needs to handle the peaks of troughs. Customers may specify a daily workload but this number cannot be divided by the number of seconds in a day to find the

necessary system configuration. The peak hourly rate cannot be divided by 3600 because the peak rate per second will probably be 2-3 times higher. The system must process these peak loads without building up a backlog of queued work. It is important to prevent the queue depths increasing because they will occupy memory from the 'fre' pool or be spilled out to disk. Over commitment of real memory is handled by the page manager but sudden large jumps (storms) possibly due to queues becoming deep can cause the throughput to break down completely if the page manager chooses too much working set memory to be paged. Gradual over commitment enables the page manager to shuffle out those pages that are not part of the working set.

8 Measurement Environment

8.1 Workload description

8.1.1 MQI response time tool

The MQI tool exercises the local queue manager by measuring elapsed times of the 8 main MQSeries verbs: MQConn(x), MQDisc, MQOpen, MQClose, MQPut, MQGet, MQCmit, and MQBack. The following MQI calls are paired together inside a test application:

- MQConn(X) with MQDisc
- MQOpen with MQClose
- MQPut with MQGet
- MQCmit and MQBack with MQPut and MQGet

Note: MQClose elapsed time is only measured for an empty queue.

Note: Performance of MQCmit and MQBack is measured in conjunction with MQPut and MQGet, putting and getting messages inside a unit of work (i.e. inside syncpoint control). The unit of work is committed at the end of each batch. The number of messages per batch is a parameter of the test.

Note: This tool is not used to measure the performance of verbs: MQSet, MQInq, or MQBegin.

8.1.2 Test scenario workload

The MQI applications use 64 bit libraries for MQ

8.1.2.1 The driving application programs

The test scenario workload simulates many driving applications running on a single driving machine. This is not typical of a customer environment and is only used to facilitate test coordination. Driving applications were multi-threaded with each thread performing a sequence of MQI calls. The driving applications (Requesters) for Local and DQ tests used Trusted bindings. The number of threads in each application was adjusted according to whether the test was measuring a local queue manager, a client channel, or distributed queuing scenario. This was done to reduce storage overheads on the driving system.

Message rate: in all but the *rated* and *capacity limit* tests, message processing was performed in a *tight-loop*. In the *rated* tests a message rate of 1 round trip per driving application per *second* was used, and in the *capacity limit* tests a message rate of 1 round trip per channel per *minute* was used.

Non-persistent and persistent messages were used in all but the *capacity limit* tests.

Note: The driving applications gathered timing information for all MQI calls using a high-resolution timer.

8.1.2.2 The server application program

The server application is written as a multi-threaded program configured to use various threads for processing non-persistent messages and persistent messages. Each server thread performed the sequence of actions as outlined in the test scenario illustrations.

Non-persistent messaging is done outside of syncpoint control. Persistent messaging is done inside of syncpoint control. The average message throughput expressed as a number of round trips per second was calculated and reported by the server program.

8.1.2.3 Analysis techniques

In the overview section, the percentage throughput comparison used the area under the graph as an alternative method of interpreting the performance data. Elsewhere, the percentage throughput comparison used the peak throughputs found in the tables associated with the graphs. The area under the curve is favored in this instance as it gives a much more general performance indicator.

NB: Locking improvements in WMQv7.1 have improved the right hand side of the graphs but came with path length costs that may affect the rate of growth on left hand side of the graph when there is only a small number of parallel applications.

8.2 Hardware

Device under test (Server)

Server system:	IBM iSeries
Model:	550
Processor:	1.9GHz Power 5
Architecture:	4-way SMP
Memory (RAM):	32GB
Disk:	10 70GB disk arms (system ASP, no user ASPs configured)
Network:	1GBit Ethernet Adapter

Driver system:	IBM xSeries
Model:	350
Processor:	2.0GHz Intel Xeon
Architecture:	4 CPU
Memory (RAM):	8GB
Disk:	3 36GB SCSI disk arms
Network:	1GBit Ethernet Adapter

Driver system used in capacity and short sessions

IBM x3850:	Driver system
Model:	x3850 M2 8864 4RG
Processor:	2.93GHz Intel Xeon x7350
Architecture:	2 x quad core CPU
Memory (RAM):	32GB
Disk:	2 SAN disks on DS8700 (5GB each, 1 queue, 1 log)
Network:	10Gbit Ethernet Adapter

8.3 Software

IBM i O/S:	IBM i V6.1
MQSeries:	Version 6.0.1.11, Version 7.0, Version 7.0.1.6 Version 7.1
Compiler:	C for IBM i Compiler, Version 6

9 Glossary

Test name	The name of the test. *Note: The test names in some cases are rather long. This is done to provide a descriptive qualification of the test measurement to relate to the performance discussion in the sections throughout the document:* ***local*** *=> local queue manager test scenario* ***cl*** *=> client channel test scenario* ***dq*** *=> distributed queuing test scenario* ***np*** *=> non-persistent messages* ***pm*** *=> persistent messages* ***r3600*** *=> 1 round trip per driving application per second* ***runmqlsr*** *=> channels using the 'runmqlsr' listener (client channel test scenario, in addition to 'runmqchi' for distributed queuing test scenarios)* ***c6000*** *=> 6,000 client driving applications (i.e. 6,000 MQI-client connections)* ***q1000*** *=> 1,000 server channel pairs* ***max*** *=> maximum number of channels (or channel pairs)* ***no_correl_id*** *=> correlation identifier not used in the response messages (as each response is placed on a unique reply-to queue per driving application)* ***Messages /sec*** *=> Round Trips/sec*
Apps	The number of driving applications connected to the queue manager at the point where the performance measurement is given.
Rate/App/hr	The target message throughput rate of each driving application.
Round T/s	The average achieved message throughput rate of all the driving applications together, measured by the server application.
% (Round T/s)	The percentage increase in the total message throughput rate. *Note: The nature of the comparison is noted under each table where percentage improvements have been given.*
CPU	As reported by VMSTAT
Resp time (s)	The average response time each round trip, as measured and averaged by all the driving applications.
Swap	The total amount of swap area reservation for all processes in Mb, unless otherwise specified as swap/app (i.e. swap area reservation per driving application).
FREE	Free memory as reported by IOSTAT