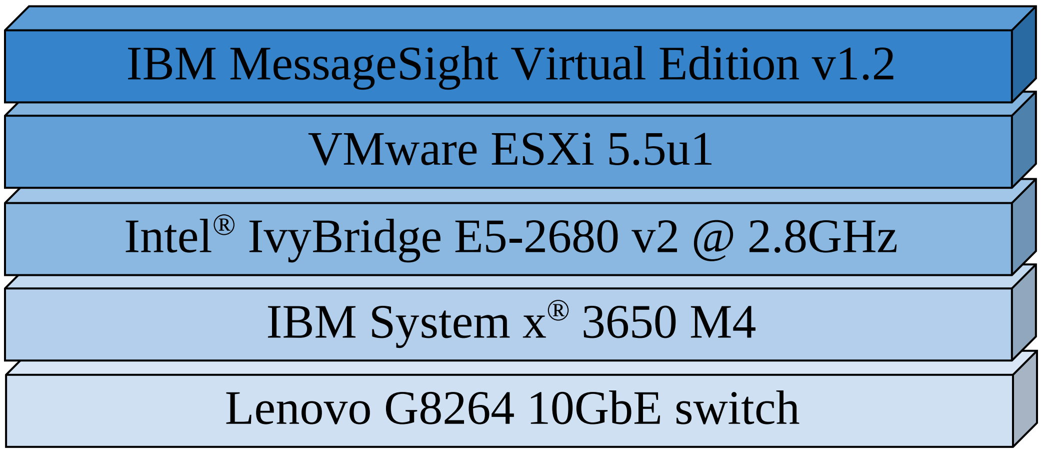
IBM MessageSight Virtual Edition v1.2 Performance Benchmarks

Tested by: IBM

Test date: December 19, 2014


IBM MessageSight Virtual Edition v1.2
VMware ESXi 5.5u1
Intel® IvyBridge E5-2680 v2 @ 2.8GHz
IBM System x® 3650 M4
Lenovo G8264 10GbE switch

Key Results

- IBM MessageSight Virtual Edition can scale up at a ratio of 4K concurrent connections per Gigabyte of memory allocated to the virtual machine.
- On a 16 core virtual machine with 128GB of memory
  - IBM MessageSight Virtual Edition is capable of processing in excess of 500K messages per second in the FANIN.PARTITIONS benchmark.
  - IBM MessageSight Virtual Edition can achieve a peak egress message rate of 100K msgs/sec to 512K MQTT consumer devices in the BROADCAST benchmark.
  - IBM MessageSight Virtual Edition can handle in excess of 30K MQTT non-secure connections per second with a connection latency in the 99th percentile of less than 1 millisecond. The same configuration can also handle 1.8K MQTT/TLSv1.2 connections per second with a connection latency in the 99th percentile of less than 10 milliseconds.

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The evaluations described in this document were conducted under controlled laboratory conditions. Obtaining repeatable, measurable performance results requires a controlled environment with specific hardware, software, network, and configuration in an isolated system. Adjusting any single element may yield different results. Additionally, test results at the component level may not be indicative of system level performance, or vice versa. Each organization has its own unique requirements, and therefore may find this information insufficient for its specific needs.

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Benchmark specifications

Overview

The performance benchmarks in this report test the ability of the IBM MessageSight Virtual Edition to handle high volumes of messaging traffic under a variety of different workloads, configurations, and messaging patterns. The workloads tested in these benchmarks reflect application architectures and messaging patterns which are commonly found in large scale networks of mobile and telemetry devices. The key performance metrics highlighted in this report are non-persistent messaging throughput, connection rate, and concurrent connection scaling.

The hardware required to execute these benchmarks is described in detail in the System under test section of this report. A small number of machines are required to host the test harness programs which generate the messaging workloads which are processed by the IBM MessageSight appliance. The test harness programs (*mqttbench and JMSBenchTest)* used to generate messaging workloads, are described in detail in the Test harness section of this report. These benchmarks do not require any specialized hardware for time synchronization or wire capture; latency and throughput measurements are taken in the test harness programs.

The test harness programs used simulate producer and consumer applications were developed by IBM. Tests were conducted by IBM under controlled laboratory conditions.

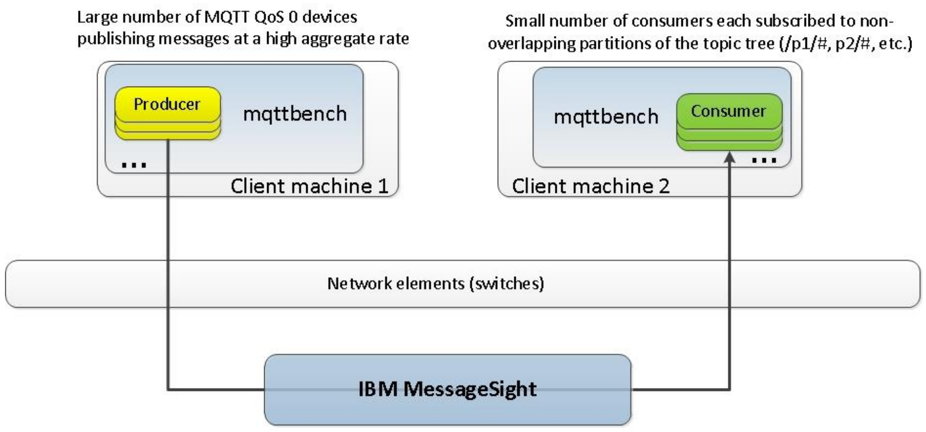
Test case descriptions

This section describes the set of test cases and workloads used to generate the benchmark results included in this report. The results for each test case can be found by test case name in the Score card and Additional test results data sections.

The messages used in the majority of the test cases described below are small messages, less than 512 bytes. The message sizes used in these test cases are intended to be representative of application data, such as GPS coordinates, sensor data, and other compact data that may be sent and received from mobile and telemetry devices.

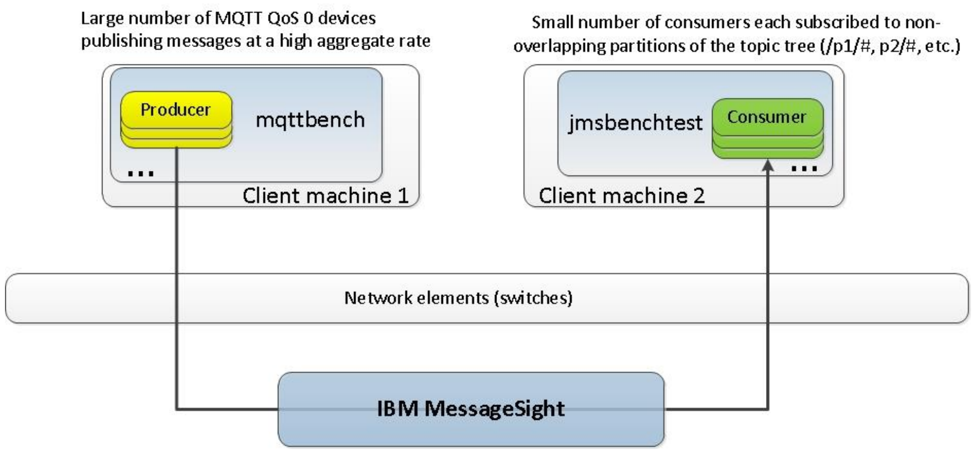
FANIN.PARTITIONS

This test case measures maximum throughput rate. The workload in this test case is generated by a large number of MQTT v3.1.1 producers publishing messages at a high aggregate rate to MessageSight, which then delivers the messages to a small number of MQTT v3.1.1 consumers. Each MQTT (QoS 0) producer publishes messages on its own unique topic. The topic tree is divided into non-overlapping partitions such that each MQTT (QoS 0) consumer will subscribe to, and receive messages from, a single partition, and all partitions are subscribed to by a single consumer. Subscriptions are constructed with a partition name followed by a wildcard. On one client machine a single instance of *mqttbench* is started which creates all consumers in the test, subsequently a second instance of *mqttbench* on a second client machine is started and begins generating the producer load.


Large number of MQTT QoS 0 devices publishing messages at a high aggregate rate
Small number of consumers each subscribed to non-overlapping partitions of the topic tree (/p1/#, p2/#, etc.)
Producer
mqttbench
...
Client machine 1
mqttbench
Consumer
...
Client machine 2
Network elements (switches)
IBM MessageSight

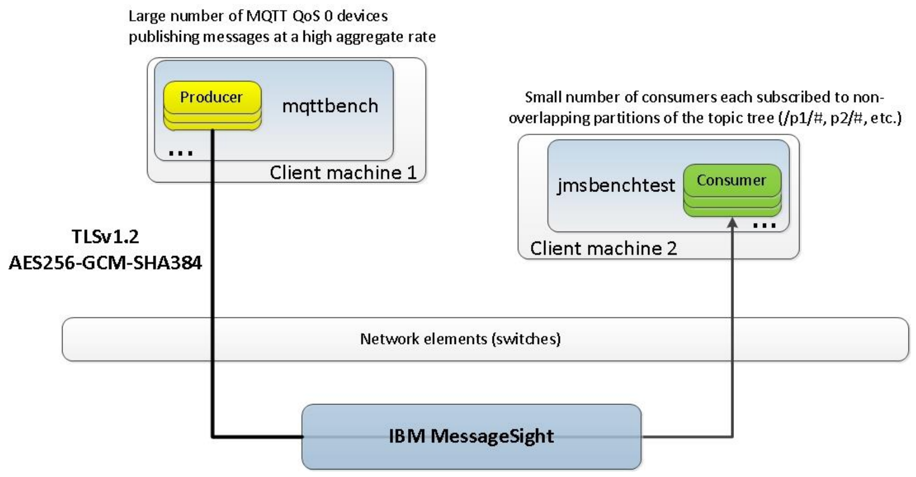
FANIN.JMS.PARTITIONS

This test case measures maximum throughput rate. The workload in this test case is generated by a large number of MQTT v3.1.1 producers publishing messages at a high aggregate rate to MessageSight, which then delivers the messages to a small number of JMS consumers. The *JMSBenchTest* benchmark application creates the JMS consumers using the MessageSight JMS client library. Each MQTT (QoS 0) producer publishes messages on its own unique topic. The topic tree is divided into non-overlapping partitions such that each JMS consumer will subscribe to, and receive messages from, a single partition, and all partitions are subscribed to by a single consumer. Subscriptions are constructed with a partition name followed by a wildcard. In this test case, the lowest quality of service messaging ("fire-and-forget") allowed by the MessageSight JMS client library is used. Fire-and-forget messaging is equivalent to MQTT QoS 0: non-persistent, non-transactional, and ACKing is disabled. This test leverages the MessageSight JMS client library message cache. On one of the client machines a single JVM is started. From this JVM, *JMSBenchTest* is started and creates multiple JMS connections, sessions, and consumers which each subscribe to a different partition. Subsequently, an instance of *mqttbench* on a second client machine is started and begins generating the producer load.

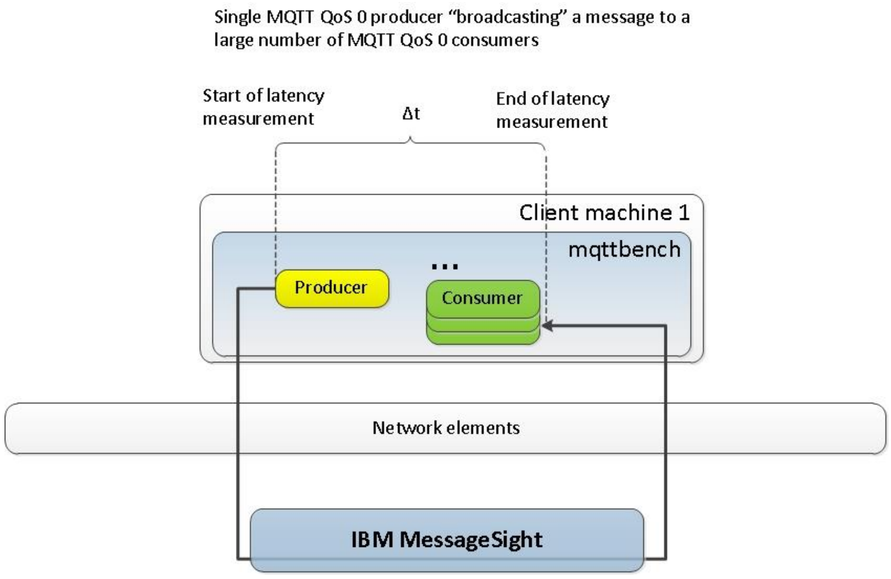

Large number of MQTT QoS 0 devices publishing messages at a high aggregate rate
Small number of consumers each subscribed to non-overlapping partitions of the topic tree (/p1/#, p2/#, etc.)
Producer
mqttbench
...
Client machine 1
jmsbenchtest
Consumer
...
Client machine 2
Network elements (switches)
IBM MessageSight

FANIN.SEC.JMS.PARTITIONS

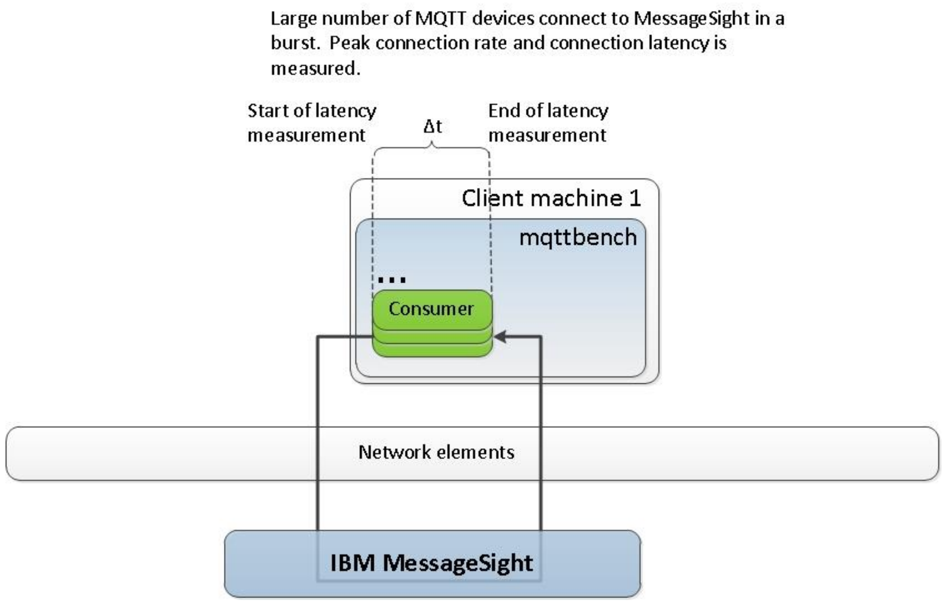
This test case measures maximum throughput rate. The workload in this test case is identical to FANIN.JMS.PARTITIONS, except that, in this test, communications between the MQTT v3.1.1 producers and MessageSight are secured. The MQTT producers in this test case connect to MessageSight over secure endpoints configured. The TLS protocol used in this test case is TLSv1.2, the cipher category configured in the MessageSight security profile is "BEST" and the negotiated cipher is AES256-GCM-SHA384. The server key used in this test case is 2048 bits. For more detailed information on how the secure endpoints are configured on MessageSight see Appendix A: IBM MessageSight configuration.


Large number of MQTT QoS 0 devices publishing messages at a high aggregate rate
Producer
mqttbench
...
Client machine 1
Small number of consumers each subscribed to non-overlapping partitions of the topic tree (/p1/#, p2/#, etc.)
jmsbenchtest
Consumer
...
Client machine 2
TLSv1.2
AES256-GCM-SHA384
Network elements (switches)
IBM MessageSight

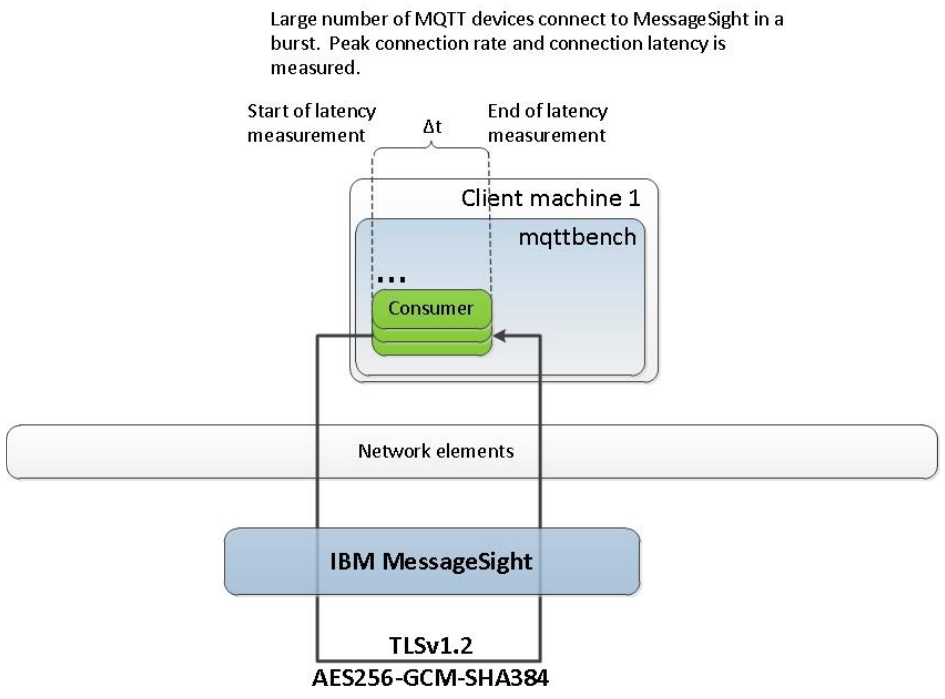
BROADCAST
This test case measures both peak egress message rate and message latency. The workload in this test case is generated by a single MQTT v3.1.1 QoS 0 producer publishing 1 message every 20 seconds to MessageSight, which then delivers the message to a large number of MQTT v3.1.1 QoS 0 consumers all subscribed to the "broadcast" topic. On one client machine a single instance of *mqttbench* is started which creates all consumers in the test and the single producer. Each message published by the producer is timestamped by referencing the local TSC clock. The same TSC is referenced again for each consumer receiving the message. Message latency is then calculated from the receive time and send time. Peak egress message rate is captured from the MessageSight statistics. Message latency includes network latency and client latency


Single MQTT QoS 0 producer "broadcasting" a message to a large number of MQTT QoS 0 consumers
Start of latency measurement
Δt
End of latency measurement
Client machine 1
mqttbench
Producer
...
Consumer
Network elements
IBM MessageSight

CONNBURST
This test case measures the peak connection rate that can be sustained by MessageSight and connection latency. In this workload a large number of MQTT v3.1.1 devices connect to MessageSight using non-secure communications. On client machine 1, a single instance of *mqttbench* starts the MQTT devices which connect to the appliance. The total time to connect all MQTT devices is measured and the average connection rate is calculated from this measurement. Connection latency includes network latency and client latency.

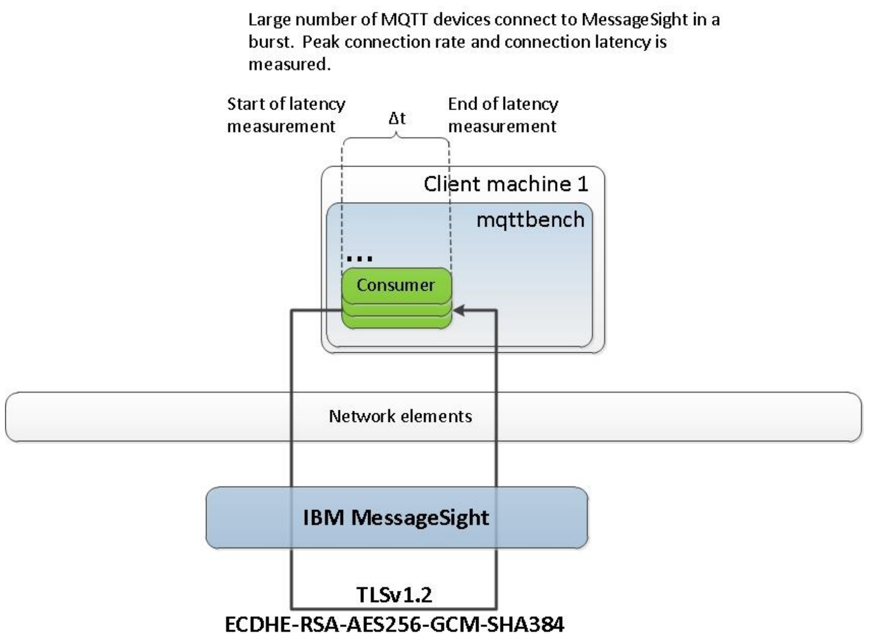

Large number of MQTT devices connect to MessageSight in a burst. Peak connection rate and connection latency is measured.
Start of latency measurement
Δt
End of latency measurement
Client machine 1
mqttbench
...
Consumer
Network elements
IBM MessageSight

CONNBURST.SEC
This test case is identical to CONNBURST, except that communications are secured. In this test case two secure endpoints configured on MessageSight are used for secure communications. The TLS protocol used in this test case is TLSv1.2, the cipher category configured in the MessageSight security profile is "BEST" and the negotiated cipher is AES256-GCM-SHA384. The server key used in this test case is 2048 bits. For more detailed information on how the secure endpoints are configured on MessageSight see Appendix A: IBM MessageSight configuration. On client machine 1, a single instance of *mqttbench* starts the MQTT devices which connect to MessageSight. Connection latency includes network latency and client latency.


Large number of MQTT devices connect to MessageSight in a burst. Peak connection rate and connection latency is measured.
Start of latency measurement
Δt
End of latency measurement
Client machine 1
mqttbench
...
Consumer
Network elements
IBM MessageSight
TLSv1.2
AES256-GCM-SHA384

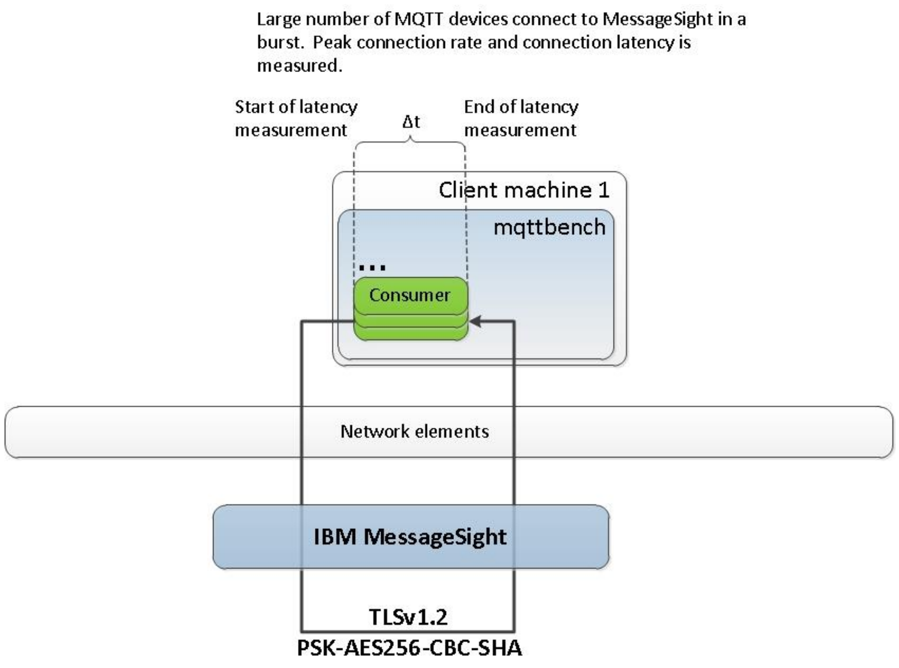
CONNBURST.SEC.ECDHE

This test case is identical to CONNBURST, except that communications are secured. In this test case two secure endpoints configured on MessageSight are used for secure communications. The TLS protocol used in this test case is TLSv1.2, the cipher category configured in the MessageSight security profile is "BEST" and the negotiated cipher is ECDHE-RSA-AES256-GCM-SHA384. ECDHE, or elliptic curve Diffie Hellman key exchange provides forward secrecy to improve protection against MITM attacks, but come at a cost to performance. The server key used in this test case is 2048 bits. For more detailed information on how the secure endpoints are configured on MessageSight see Appendix A: IBM MessageSight configuration. On client machine 1, a single instance of *mqttbench* starts the MQTT devices which connect to MessageSight. Connection latency includes network latency and client latency.


Large number of MQTT devices connect to MessageSight in a burst. Peak connection rate and connection latency is measured.
Start of latency measurement
Δt
End of latency measurement
Client machine 1
mqttbench
...
Consumer
Network elements
IBM MessageSight
TLSv1.2
ECDHE-RSA-AES256-GCM-SHA384

CONNBURST.SEC.PSK

This test case is identical to CONNBURST, except that communications are secured. In this test case two secure endpoints configured on MessageSight are used for secure communications. The TLS protocol used in this test case is TLSv1.2, the cipher category configured in the MessageSight security profile is "BEST" and the negotiated cipher is PSK-AES256-CBC-SHA. PSK, or pre-shared keys based ciphers are frequently used by resource constrained embedded devices. The pre-shared key used in this test case is 16 bytes. For more detailed information on how the secure endpoints are configured on MessageSight see Appendix A: IBM MessageSight configuration. On client machine 1, a single instance of *mqttbench* starts the MQTT devices which connect to MessageSight. Connection latency includes network latency and client latency.


Large number of MQTT devices connect to MessageSight in a burst. Peak connection rate and connection latency is measured.
Start of latency measurement
Δt
End of latency measurement
Client machine 1
mqttbench
...
Consumer
Network elements
IBM MessageSight
TLSv1.2
PSK-AES256-CBC-SHA

Product background

IBM MessageSight Virtual Edition:

MessageSight Virtual Edition allows you to deploy MessageSight to virtual data centers. With VMware ESXi, you can rapidly deploy one or more MessageSight virtual appliances to provide device connectivity.

Designed to be able to sit at the edge of the internet, MessageSight is the ideal extension of an existing infrastructure, reaching new use cases that include mobile or Internet of Things to connect users, devices, or objects. MessageSight can also be used as a stand-alone server for the next generation of application. The ability to scale to an unprecedented level makes MessageSight ideal to deliver large amounts of data to analytics engines and other big data types of application.

The MessageSight form factor and security features such as authentication, authorization, and SSL/TLS protocols provide a secure point of entry into your enterprise.

MessageSight supports emerging, as well as established, messaging and communication standards, including JMS, WebSockets, and MQTT (an open source lightweight protocol). MessageSight can easily extend an existing WebSphere® MQ infrastructure through MQ Connectivity.

Lenovo G8264 10GbE switch:

The Lenovo System Networking RackSwitch G8264 is a 10/40 Gigabit Ethernet (GbE) aggregation switch designed for the data center, providing speed, intelligence and interoperability on a proven platform.

The Lenovo RackSwitch G8264 offers up to 48x10GbE ports and 4×40 GbE ports, which can also be used as a high-density 10 GbE switch, with 1.28 Tbps—in a 1U footprint. The G8264 provides a cost-efficient way to aggregate multiple racks of servers compared to other expensive core switches, while allowing massive scalability for your data center network.

Designed with top performance in mind, the Lenovo RackSwitch G8264 provides line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. Large data center grade buffers keep traffic moving. Hot-swappable, redundant power and fans along with numerous high availability (HA) features enable the G8264 to be available for business-sensitive traffic.

Benchmark participants

The following vendors participated in this benchmark and provided the assets required to complete the benchmark. For the purposes of obtaining the necessary non-disclosure agreements these participants should be contacted:

- IBM

Benchmark assets provided by the participants:

- IBM provided the MessageSight Virtual Edition and MessageSight appliance
- IBM configured and optimized the system under test
- IBM provided the 10/40GbE switch
- IBM provided the software and hardware used to generate workloads handled by the IBM MessageSight appliance.
- IBM provided the PDUs used to measure power efficiency during testing
- IBM sponsored and audited the benchmark

Contacts

For questions or to provide feedback regarding these benchmarks or the test results, contact your IBM sales representative.

Methodology

The benchmark specifications used in these tests were developed by IBM and are described in the Test case descriptions section above.

Throughput tests must remain stable for five minutes in order to be considered as passing. During throughput tests subscription queues are monitored for number of buffered messages and for buffered messages high water marks (HWM). The number of buffered messages can fluctuate, but must not be monotonically increasing. Throughput tests that result in monotonically increasing buffered messages are considered failing tests.

Latency tests run for five minutes over which times several hundreds of thousands of latency measurements are recorded. Latency statistics are calculated from this sample population.

Test harness

The software components used to generate the workloads used in these benchmarks were developed by IBM and are listed below.

MQTT workload generator	*mqttbench v1.0*
JMS workload generator	*JMSBenchTest v1.0* *MessageSight JMS client library v1.2*
Clock source (for latency measurements)	*TSC*

The *mqttbench* test harness program:

- A multi-threaded C program that can simulate up to 1M MQTT v3.1.1 devices
- mqttbench does NOT use the open source Eclipse Paho MQTT client, in particular mqttbench will batch multiple messages per network read/write on high throughput connections. For QoS 1 and higher the inflight message window (unACKed messages) is configurable in mqttbench and defaults to 64K unACKed messages.
- Uses TCP, non-blocking communications
- Supports pub/sub messaging. Does not currently support request/response messaging over the same TCP connection.
- Measures latency using the TSC clock source
- Support for SSL/TLS 1.2

The *JMSBenchTest* harness program:

- A multi-threaded Java® program which uses the MessageSight JMS client API.
- Supports pub/sub messaging. Does not currently support request/response messaging over the same JMS connection.
- Measures latency using the TSC clock source
- Support for SSL/TLS 1.2

Limitations

- These benchmarks were performed in a controlled laboratory environment in which the mobile and telemetry devices were simulated by the test harness software programs listed above. The test harness programs and MessageSight were physically connected on the same high speed network switch. As such, the network RTT in this benchmark environment is much smaller than that of real mobile networks.
- The latency metrics used in these benchmarks are round trip measurements which include the latency of MessageSight, the test harness software programs, and the network switching latency.
- The measurements taken in these benchmarks rely on software instrumentation, which has an impact on performance. This limitation is consistent with all benchmarks.
- The mechanisms used by the test harness programs for controlling the producer message rate can result in an initial message rate spike above the requested message rate before converging on the requested message rate. To compensate for this behavior the test cases are executed by starting the workload at an initial message rate below the maximum achievable message rate and then increasing the message rate until achieving max message rate.

System under test

IBM MessageSight Virtual Edition

MessageSight version	1.2
MessageSight build ID	20141111-2035

VMware ESXi servers

VMware ESXi version	5.5 update 1
Vendor and model	IBM System x 3650 M4 (Model #: 7915AC1)
Processors	2 x Intel Xeon 10-core E5-2680 v2 2.80 GHz
L3 cache	25MB
Memory speed	1600 MHz
Memory size	128GB
RAID	IBM ServeRAID M5110e with 1GB Write Cache
Disks	RAID 10 with 4 x 900GB 10K rpm 2.5" SAS drives
PCIe bus speed	PCIe Gen3 x8 lanes
NIC	Intel x520 dual port 10GbE Intel I350 quad port 1GbE
NIC Driver version	igxbe 3.19.1.iov igb 5.0.5.1
BIOS version	IBM uEFI 1.50 (Build ID: VVE134OUS)

Network elements (switches)

Vendor and model	Lenovo G8264 10GbE RackSwitch (Rear to Front airflow) Layer 2/Layer 3 switch
Software version	Networking OS v7.4.1
Hardware revision	0
Rack units	1U
Power supplies	2 x 450W
Interop guide	ibm.com/networking
Cables	IBM 3m 10GbE DAC SFP+

Client machines

Vendor and model	IBM System x 3650 M3 (Model #: 7945AC1)
Processors	2 x Intel Xeon six-core X5690 3.47GHz
L1/L2/L3 cache	32KB L1 / 256KB L2 / 12MB L3
Memory speed	1333 MHz
Memory size	128GB
PCIe bus speed	PCIe Gen2 x8 lanes
NIC	Mellanox Connect X-3 40GbE NIC
NIC FW/SW	firmware: 2.11.500 software: mlx4_en 1.5.9
BIOS version	IBM uEFI D6E154A (Release date: 09/23/2011)
Rack units	2U
Power supplies	2 x 675W

Client operating system and JVM

OS and version	Red Hat Enterprise Linux® Server 6.4 (x86_64)
JVM	IBM J9 JVM 1.7.0 x86_64

VMware ESXi Servers and MessageSight Virtual Machine (VM) configuration

The VMware ESXi host configuration and the MessageSight VM settings used in these benchmarks are described in this section. For benchmarks which leverage MessageSight HA (not to be confused with VMware based HA) two identical ESXi servers were used. For details on the hardware and software specifications of the ESXi servers used in these benchmarks see the VMware ESXi servers section above. One of the ESXi servers was selected to host the PRIMARY MessageSight VM and the other ESXi server was selected to host the STANDBY MessageSight VM. HA is outside the scope of this report.

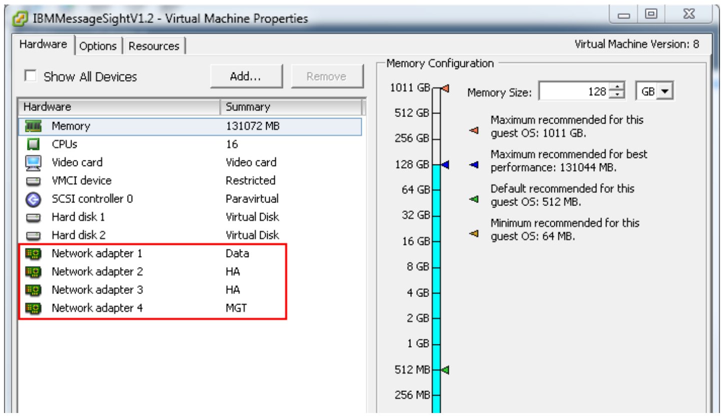
Performance considerations when choosing a VMware data store

When planning a MessageSight Virtual Edition deployment it is important to give consideration to the disk subsystem on which the MessageSight Virtual Edition is deployed. For persistent messaging workloads it is particularly important to deploy *Hard disk 2* (i.e. the persistent messaging store disk) of the MessageSight VM on a fast disk subsystem. Persistent messaging workloads will write to the store disk frequently and disk I/O latency becomes important. For this reason an ESXi server with a fast disk subsystem should be chosen to deploy MessageSight Virtual Edition.

In these benchmarks the ESXi servers have the IBM ServeRAID M5110e RAID controller with a 1GB write cache. The ESXi server local datastore on which the MessageSight VM is deployed is a RAID 10 array consisting of 4 x 900GB 10K rpm 2.5" SAS drives.

Configuring vSwitches and mapping virtual network interfaces

The MessageSight VM is configured with 4 virtual network interfaces. One network interface is dedicated for management traffic, one for messaging traffic (i.e. Data), one for HA data replication, and one of HA discovery (see the screenshot of the MessageSight VM properties below).



Hardware	Summary
Memory	131072 MB
CPUs	16
Video card	Video card
VMCI device	Restricted
SCSI controller 0	Paravirtual
Hard disk 1	Virtual Disk
Hard disk 2	Virtual Disk
Network adapter 1	Data
Network adapter 2	HA
Network adapter 3	HA
Network adapter 4	MGT

Memory Size: 128 GB

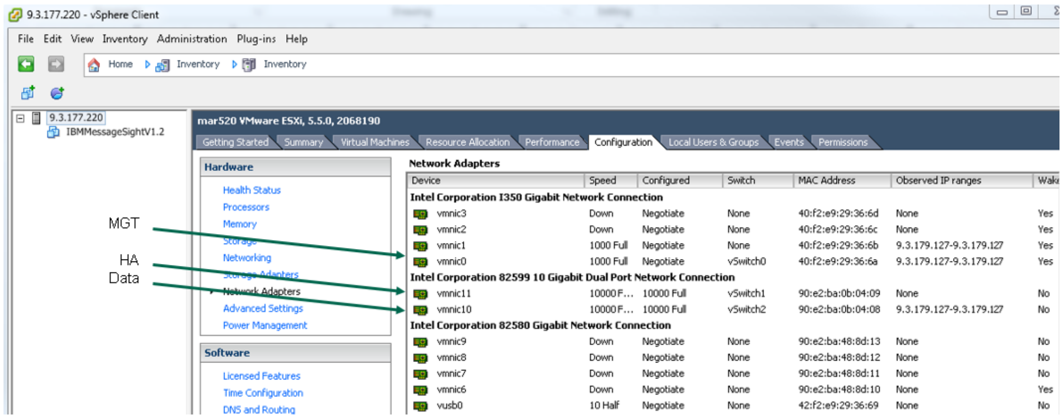
Maximum recommended for this guest OS: 1011 GB.

Maximum recommended for best performance: 131044 MB.

Default recommended for this guest OS: 512 MB.

Minimum recommended for this guest OS: 64 MB.

In these benchmarks the ESXi servers have both Intel 1GbE and 10GbE network interfaces.


9.3.177.220 - vSphere Client
File Edit View Inventory Administration Plug-ins Help
Home Inventory Inventory
9.3.177.220
IBMMessageSightV1.2
mar520 VMware ESXi, 5.5.0, 2068190
Getting Started Summary Virtual Machines Resource Allocation Performance Configuration Local Users & Groups Events Permissions
Hardware
Health Status
Processors
Memory
Storage
Networking
Storage Adapters
Network Adapters
Advanced Settings
Power Management
Software
Licensed Features
Time Configuration
DNS and Routing
MGT
HA
Data

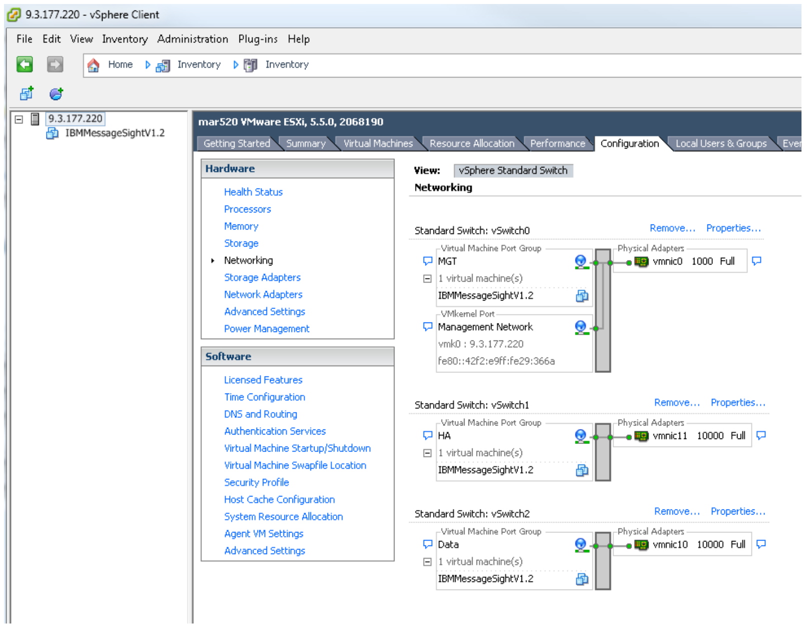
Network Adapters

Device	Speed	Configured	Switch	MAC Address	Observed IP ranges	Wake
Intel Corporation I350 Gigabit Network Connection						
vmnic3	Down	Negotiate	None	40:f2:e9:29:36:6d	None	Yes
vmnic2	Down	Negotiate	None	40:f2:e9:29:36:6c	None	Yes
vmnic1	1000 Full	Negotiate	None	40:f2:e9:29:36:6b	9.3.179.127-9.3.179.127	Yes
vmnic0	1000 Full	Negotiate	vSwitch0	40:f2:e9:29:36:6a	9.3.179.127-9.3.179.127	Yes
Intel Corporation 82599 10 Gigabit Dual Port Network Connection						
vmnic11	10000 F...	10000 Full	vSwitch1	90:e2:ba:0b:04:09	None	No
vmnic10	10000 F...	10000 Full	vSwitch2	90:e2:ba:0b:04:08	9.3.179.127-9.3.179.127	No
Intel Corporation 82580 Gigabit Network Connection						
vmnic9	Down	Negotiate	None	90:e2:ba:48:8d:13	None	No
vmnic8	Down	Negotiate	None	90:e2:ba:48:8d:12	None	No
vmnic7	Down	Negotiate	None	90:e2:ba:48:8d:11	None	No
vmnic6	Down	Negotiate	None	90:e2:ba:48:8d:10	None	Yes
vusb0	10 Half	Negotiate	None	42:f2:e9:29:36:69	None	No

The ESXi servers were configured with three VSphere Standard Switches: vSwitch0, vSwitch1, and vSwitch2. vSwitch0 (alias MGT) maps to the physical host network interface named vmnic0, which is a 1GbE network interface. vSwitch1 (alias HA) maps to the physical host network interface named vmnic11, which is a 10GbE network interface. Finally, vSwitch2 (alias Data) maps to the physical host network interface named vmnic10, which is also a 10GbE network interface.

The virtual network interfaces on the MessageSight VM map to the vSwitches as follows:

VM properties	Guest OS device	VMware vSwitch
Network adapter 1	eth1	vSwitch2 (alias Data)
Network adapter 2	ha0	vSwitch1 (alias HA)
Network adapter 3	ha1	vSwitch1 (alias HA)
Network adapter 4	eth0	vSwitch0 (alias MGT)



Standard Switch: vSwitch0
- Virtual Machine Port Group: MGT — 1 virtual machine(s): IBMMessageSightV1.2
- VMkernel Port: Management Network — vmk0 : 9.3.177.220 — fe80::42f2:e9ff:fe29:366a
- Physical Adapters: vmnic0 1000 Full

Standard Switch: vSwitch1
- Virtual Machine Port Group: HA — 1 virtual machine(s): IBMMessageSightV1.2
- Physical Adapters: vmnic11 10000 Full

Standard Switch: vSwitch2
- Virtual Machine Port Group: Data — 1 virtual machine(s): IBMMessageSightV1.2
- Physical Adapters: vmnic10 10000 Full

It is recommended to separate the MessageSight management traffic from the HA and messaging traffic to prevent delayed response times for administrative commands. A 1GbE interface is adequate for management traffic. It is also recommended to separate messaging (i.e. Data) traffic from MessageSight HA traffic, for this reason messaging and HA traffic are mapped to different physical host network interfaces. In these benchmark tests two 10GbE interfaces were used for messaging and HA traffic, but the workload will determine the speed of the network interface. It is recommended to use 10GbE interfaces for messaging and HA traffic. It is not strictly required to map HA discovery and HA replication traffic on different host network interfaces, but doing so may improve resilience against heartbeat timeouts between members of an HA pair. In these benchmark tests it was determined that mapping both HA discovery and HA replication traffic to the same 10GbE host network interface did not result in any heartbeat timeouts. It is also reasonable to map the management traffic and HA discovery traffic to the same 1GbE host network interface, since these are both low throughput classes of traffic.

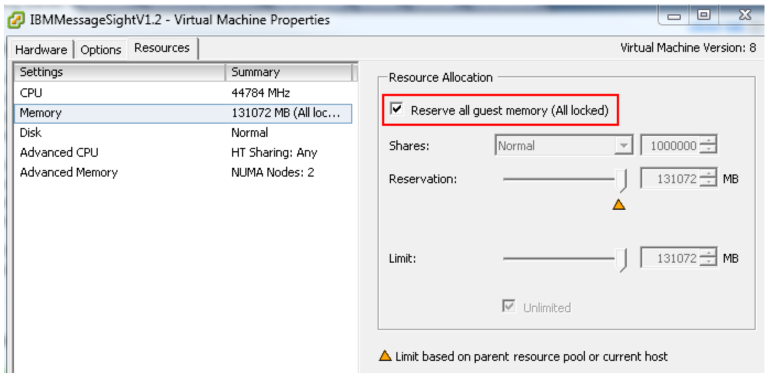
Performance considerations when collocating a MessageSight VM on an ESXi Server with other VMs

When planning a MessageSight Virtual Edition deployment it is important to consider the resources required by MessageSight as well as the resources required by the other VMs collocated on the same ESXi host server.

Memory resource

VMware ESXi servers use a memory management technique known as "ballooning" whereby the ESXi server may harvest "unused" memory from guest VMs when the host is under memory pressure. For more details on this memory management technique refer the following VMware article, http://www.vmware.com/files/pdf/perf-vsphere-memory_management.pdf

It is recommended to reserve (or lock) all guest memory on the MessageSight VM to prevent untimely harvesting of "unused" MessageSight VM memory by the ESXi host. Note, that ESXi server will not allow a VM to lock all of the memory on the ESXi server.



IBMMessageSightV1.2 - Virtual Machine Properties

Hardware | Options | Resources

Virtual Machine Version: 8

Settings	Summary
CPU	44784 MHz
Memory	131072 MB (All loc...
Disk	Normal
Advanced CPU	HT Sharing: Any
Advanced Memory	NUMA Nodes: 2

Resource Allocation

[✓] Reserve all guest memory (All locked)

Shares: Normal 1000000

Reservation: 131072 MB

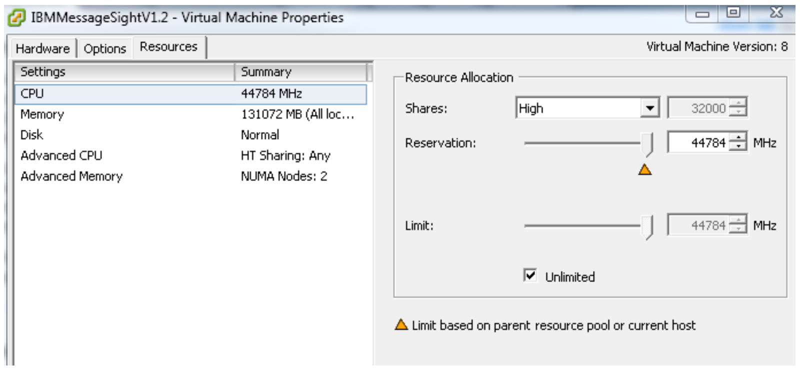
Limit: 131072 MB

[✓] Unlimited

Limit based on parent resource pool or current host

CPU resource

The same recommendation applies to the CPU resource. It is recommended to reserve (or lock) all guest CPU MHz allocated to the VM to prevent untimely CPU starvation of the MessageSight VM by other VMs running on the ESXi server. For example, on an ESXi server with 2.8GHz cores and a VM that is allocated 16 cores, in order to reserve all allocated CPU cycles that would be (2799 * 16) ≈ 44800 MHz.

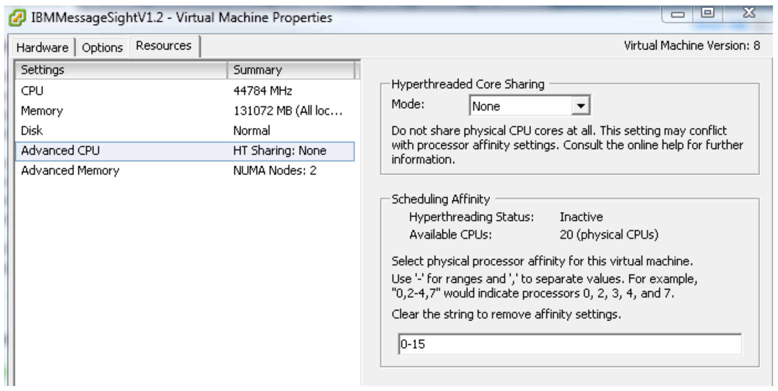

IBMMessageSightV1.2 - Virtual Machine Properties
Hardware
Options
Resources
Virtual Machine Version: 8

Settings	Summary
CPU	44784 MHz
Memory	131072 MB (All loc…
Disk	Normal
Advanced CPU	HT Sharing: Any
Advanced Memory	NUMA Nodes: 2

Resource Allocation
Shares: High 32000
Reservation: 44784 MHz
Limit: 44784 MHz
☑ Unlimited
Limit based on parent resource pool or current host

It is also recommended that when running multiple VMs on an ESXi server to isolate the MessageSight VM on a dedicated set of CPUs, away from other lower priority VMs by setting the CPU affinity of the other VMs on a non-overlapping CPU set. For example, on a dual socket Intel server, deploy the MessageSight VM on the same socket where the high speed network interfaces are installed and deploy all other lower priority VMs on the other CPU socket.

Note, before attempting to affinitize VMs to specific CPUs it is important to know how the logical CPUs in the ESXi host OS map to physical cores (or hyperthreads) on the processors. It is optimal to keep the entire VM on a single CPU socket if the number of CPUs allocated to the VM is less than or equal to the number of cores per CPU socket, in order to leverage the CPU cache as effectively as possible. CPU affinity tuning of VMs is considered an advanced tuning exercise and should not be attempted unless you have the prerequisite knowledge described above.


IBMMessageSightV1.2 - Virtual Machine Properties
Hardware
Options
Resources
Virtual Machine Version: 8

Settings	Summary
CPU	44784 MHz
Memory	131072 MB (All loc…
Disk	Normal
Advanced CPU	HT Sharing: None
Advanced Memory	NUMA Nodes: 2

Hyperthreaded Core Sharing
Mode: None
Do not share physical CPU cores at all. This setting may conflict with processor affinity settings. Consult the online help for further information.

Scheduling Affinity
Hyperthreading Status: Inactive
Available CPUs: 20 (physical CPUs)
Select physical processor affinity for this virtual machine.
Use '-' for ranges and ',' to separate values. For example, "0,2-4,7" would indicate processors 0, 2, 3, 4, and 7.
Clear the string to remove affinity settings.
0-15

Datastore resource
As previously mentioned *Hard disk 2* (i.e. store disk) is used for persistent messaging. The store disk must be at least 4X the size of the memory allocated to the MessageSight VM.

For more detailed information on MessageSight configuration see Appendix A: IBM MessageSight configuration.

Disabling Power Management features

To prevent untimely CPU throttling it is recommended to disable power capping on VMware ESXi host CPUs and CPU frequency scaling features within the system BIOS/uEFI and VMware ESXi configuration, which can result in reduced performance in order to reduce power consumption.

MessageSight VM sizing

There are four critical resources to consider when planning a MessageSight Virtual Edition deployment: memory, CPU, disk I/O, and network I/O. Each resource impacts a different aspect of MessageSight performance. This section, along with the Score card section below, provide the guidance and data that will be needed in sizing exercises before planning a deployment of MessageSight Virtual Edition.

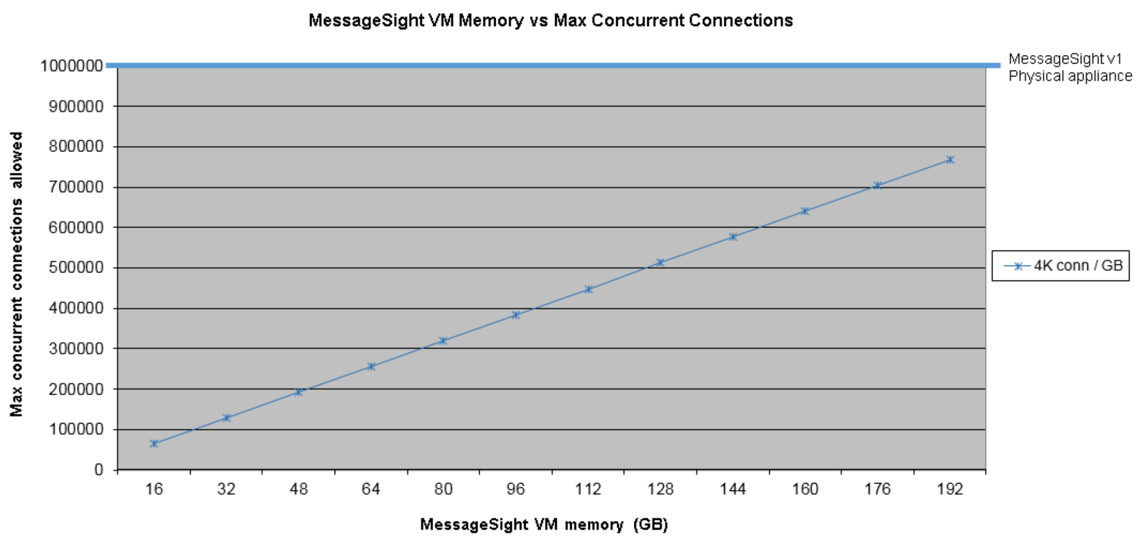
Memory

The memory allocated to the MessageSight VM affects several aspects of MessageSight scalability. The list below enumerates some of the key MessageSight resources affected by the amount of memory allocated to the MessageSight VM.

- concurrent device connections
- buffered messages
- retained messages
- subscriptions
- inflight transactions

As more memory is allocated to the MessageSight VM the number of the MessageSight resources above also increases. The minimum amount of memory that can be allocated to a MessageSight VM for production usage is 16GB.

The maximum number of concurrent connections allowed by MessageSight Virtual Edition is a function of the amount of memory allocated the MessageSight VM. MessageSight allows 4K concurrent device connections for each Gigabyte of memory allocated to the MessageSight VM. Below is a graphical representation of how the maximum number of concurrent device connections scales with the memory allocated to the MessageSight VM.



CPU

The number of CPUs allocated to the MessageSight VM affects several aspects of MessageSight performance. The list below enumerates some of the key MessageSight metrics affected by the number of CPUs allocated to the MessageSight VM.

- connection rate
- non-persistent, non-transactional messaging rate

As more CPUs are allocated to the MessageSight VM the performance of these metrics increases. See the Score card section below for test results of different CPU configurations allocated to the MessageSight VM. The minimum number of CPUs that can be allocated to a MessageSight VM for production usage is 4.

Disk I/O

Disk I/O latency, most notably disk write latency, of the disk subsystem used by the MessageSight store disk affects several aspects of MessageSight performance. The list below enumerates some of the key MessageSight metrics affected by the disk write latency of the MessageSight VM store disk.

- persistent messaging rate
- transactional messaging rate
- MessageSight HA replication rate

Network I/O

Network I/O is also important host resource which affects several aspects of MessageSight performance. Given that the nature of Internet of Things messaging and traffic patterns tends towards small packets at high rates, the underlying networking infrastructure must be able to handle several hundreds of thousands of packets per second. For this reason using high speed network interfaces such as 10GbE or 40GbE interfaces, which are SR-IOV capable, is critical to achieve high packet rates. The list below enumerates some of the key MessageSight metrics affected by the number of CPUs allocated to the MessageSight VM.

- connection rate
- non-persistent, non-transactional messaging rate
- MessageSight HA replication rate

MessageSight VM sizes used in these benchmarks

The table below provides detailed specifications of the three MessageSight VM sizes used in this benchmark testing.

Resource	Small	Medium	Large
CPU cores	8	12	16
Memory (GB)	32	64	128
Store Disk (GB)	128	256	512
Max device connections	128K	256K	512K

Although the largest memory configuration tested in these benchmarks is 128GB, MessageSight will scale the max number of concurrent connections beyond 128GB. Keep in mind, however, that a balance between the key resources listed above is important. For example, provisioning a VM with more memory may allow more concurrent connections, but if there is not sufficient CPU or Disk I/O resources to service those connections then they can experience delays.

The ratio of memory per core in these MessageSight VM configuration ranges from 4GB to 8GB per core, which is a reasonable ratio for most workloads. The ratio will vary based on the specific workload. For large connection/low throughput workloads a slightly higher ratio is recommended. For small connection/high throughput workloads a lower ratio is recommended.

Score card

The score card summarizes the results from each benchmark test case performed in this audit. Not all test cases are performed during every audit. The score card lists the test case name alongside the test results. Detailed descriptions of each test case are provided in the Test case descriptions section above.

For each test case, results below are divided into 4 rows shown in order of the number of cores allocated to the MessageSight VM: 8, 12, and 16. The last row of each test case shows the test result for the MessageSight physical appliance. The *VM size* column denotes the size of the VM next to each test result.

In addition to providing a summary of the benchmark the *Description* column also denotes the units in which the test results are reported. The *VALUE* column indicates the test result. For benchmarks in which message latency or connection latency are measured, the columns: AVG (average), 50P (50th percentile), 95P (95th percentile), 99P (99th percentile), and STDV (standard deviation) contain the latency statistics.

Type	Name	Description	VM Size	VALUE	AVG	50P	95P	99P	STDV
Type	Test case name	Additional test case description details	S	Results for 8 core VM					
			M	Results for 12 core VM					
			L	Results for 16 core VM					
			P	Results for physical appliance					

Note that for ***all*** benchmarks, the number of device connections used in each test is based on the size of the MessageSight VM. For example, the FANIN.PARTITIONS benchmark on the 12 core VM with 64GB of memory involves 256K device connections sending messages, whereas the same benchmark on the 8 core VM with 32GB of memory involves only 128K device connections sending messages. The Additional test results data section below provides additional test result details and charts for those test cases which require additional test results data.

Type	Name	Description	VM Size	VALUE	AVG	50P	95P	99P	STDV
Throughput	FANIN.PARTITIONS	Maximum throughput rate. A large number of MQTT QoS 0 producers sending messages to a small number of MQTT QoS 0 consumers. Message size, 32 bytes. (msgs/sec)	S	420K					
			M	540K					
			L	530K					
			P	310K					
	FANIN.JMS.PARTITIONS	Maximum throughput rate. A large number of MQTT QoS 0 producers sending messages to a small number of JMS "QoS 0 equivalent" consumers. Message size, 32 bytes. (msgs/sec)	S	310K					
			M	390K					
			L	540K					
			P	320K					
	FANIN.SEC.JMS.PARTITIONS	Maximum throughput rate. Identical to FANIN.JMS.PARTITIONS, but with producers connected to MessageSight using TLSv1.2 and AES256-GCM-SHA384 cipher. Message size, 32 bytes. (msgs/sec)	S	220K					
			M	290K					
			L	380K					
			P	300K					
	BROADCAST[1]	Peak egress message rate (msgs/sec) and message latency (milliseconds). Message size, 32 bytes.	S	25K	185	188	344	382	104
			M	50K	435	435	847	911	253
			L	100K	705	718	1331	1448	407
			P	200K	928	883	1953	2467	580
Connection rate	CONNBURST[2]	Peak connection rate that can be sustained by IBM MessageSight (conn/sec) and connection latency (milliseconds). Connections are non-secure.	S	26.9K	1.0	0.5	0.7	0.8	22
			M	34.5K	1.1	0.4	0.6	5.5	20
			L	33.9K	0.8	0.4	0.6	0.7	15
			P	33.9K	34	0.20	200	965	152
	CONNBURST.SEC	Peak connection rate that can be sustained by IBM MessageSight (conn/sec) and connection latency (milliseconds). Connections use protocol TLSv1.2, cipher AES256-GCM-SHA384, and a 2Kb server key.	S	1.8K	12	9.7	28	44	8.4
			M	1.8K	3.9	3.3	6.9	11	2.0
			L	1.8K	3.4	3.0	4.8	8.1	3.1
			P	1.8K	8	2.8	5.6	185	31
	CONNBURST.SEC.ECDHE	Peak connection rate that can be sustained by IBM MessageSight (conn/sec) and connection latency (milliseconds). Connections use protocol TLSv1.2, cipher ECDHE-RSA-AES256-GCM-SHA384, and a 2Kb server key.	S	1.4K	13	11	27	40	11
			M	1.4K	7	6	11	15	3.5
			L	1.4K	6	5	7	13	6.3
			P	1.5K	25	5.9	14	396	157
	CONNBURST.SEC.PSK	Peak connection rate that can be sustained by IBM MessageSight (conn/sec) and connection latency (milliseconds). Connections use protocol TLSv1.2, cipher PSK-AES256-CBC-SHA, and a 16 byte pre-shared key.	S	5.4K	1.5	1.4	1.9	2.6	2.1
			M	5.4K	1.8	1.4	1.9	8.2	4.0
			L	5.4K	2.0	1.3	1.8	22.3	6.8
			P	5.4K	3.3	0.7	0.9	106	20

[1] The peak egress message rate and message latency are heavily affected by the number of consumer connections in the test. For this reason additional tests were performed for the BROADCAST benchmark using 512K devices on the physical appliance in order to provide a more accurate basis for comparison between the MessageSight Virtual Edition and the physical appliance. See the Additional test results data for the BROADCAST benchmark.

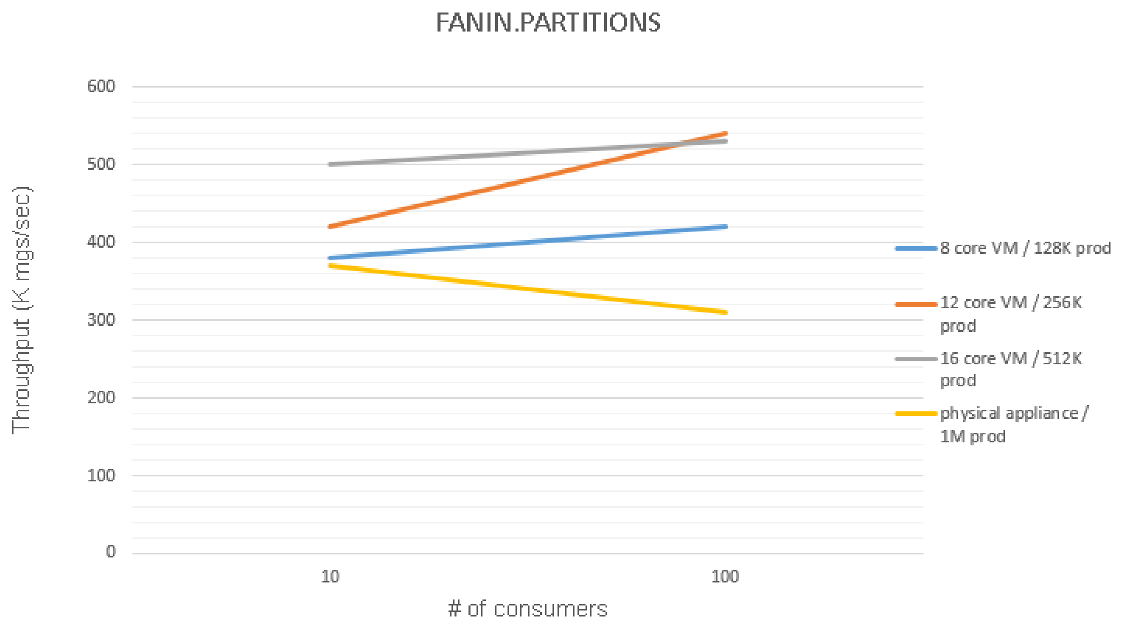
[2] The connection latency results for all CONNBURST tests are heavily affected by the number of consumer connections in the test. For this reason additional tests were performed for the CONNBURST benchmarks using 512K devices on the physical appliance in order to provide a more accurate basis for comparison between the MessageSight Virtual Edition and the physical appliance. See the Additional test results data for the CONNBURST benchmarks.

Additional test results data

Additional test results data and charts supporting the claims made in the score card are provided here.

FANIN.PARTITIONS

The chart below compares the throughput results from the FANIN.PARTITIONS test when dividing the topic tree into 10 partitions, each partition subscribed to by a single consumer, versus dividing the topic tree into 100 partitions. In all three Virtual Edition configurations (8 core with 128K producers, 12 core with 256K producers, and 16 core with 512K producers) there was an improvement in throughput when distributing the load across 100 consumers instead of only 10. The physical appliance, however, performed better with only 10 partitions and 10 consumers.

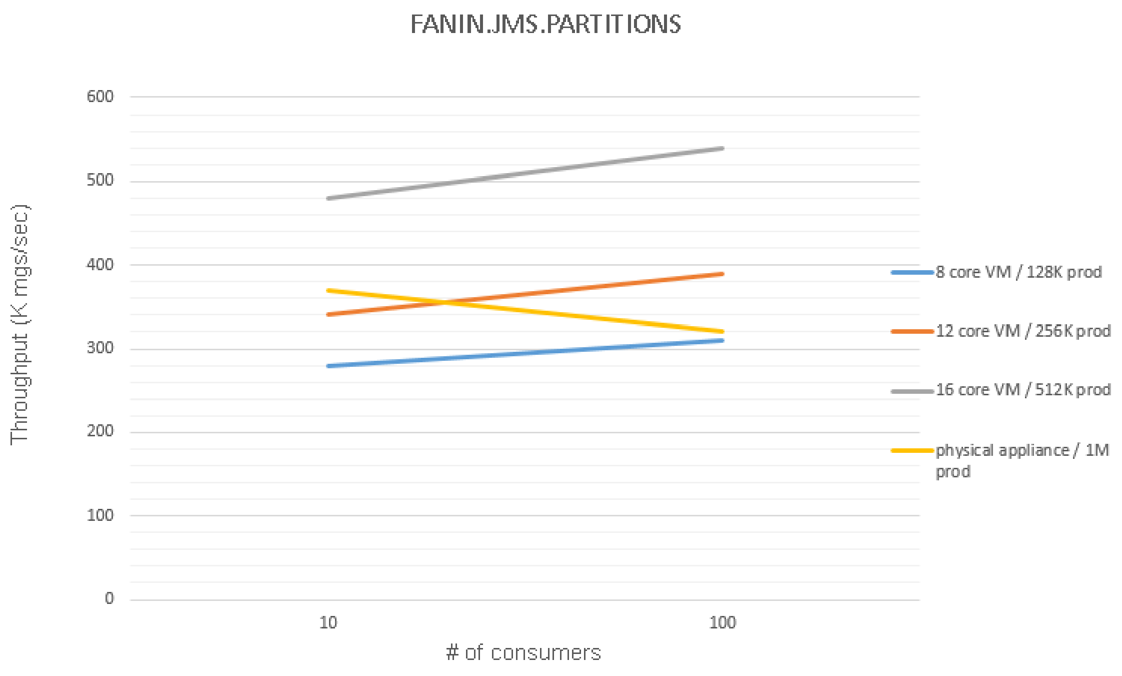


The table below lists the high water mark (HWM) stats from the FANIN.PARTITIONS test. These results show that when dividing the workload across a smaller number of subscriptions (e.g. 10 subscriptions) the subscription queues must be configured with larger limits, that is, in the messaging policies governing these subscriptions queues, the MaxMessages configuration parameter should be larger than a similar workload with 100 subscriptions.

# of consumers	8 core VM HWM (msgs)	12 core VM HWM (msgs)	16 core VM HWM (msgs)	Physical Appliance HWM (msgs)
10	1300	4300	2200	500
100	290	300	260	100

FANIN.JMS.PARTITIONS

The chart below compares the throughput results from the FANIN.JMS.PARTITIONS test when dividing the topic tree into 10 partitions, each partition subscribed to by a single consumer, versus dividing the topic tree into 100 partitions. These results are consistent with the FANIN.PARTITIONS results, in that, for all three Virtual Edition configurations (8 core with 128K producers, 12 core with 256K producers, and 16 core with 512K producers) there was an improvement in throughput when distributing the load across 100 consumers instead of only 10. The physical appliance, however, performed better with only 10 partitions and 10 consumers.

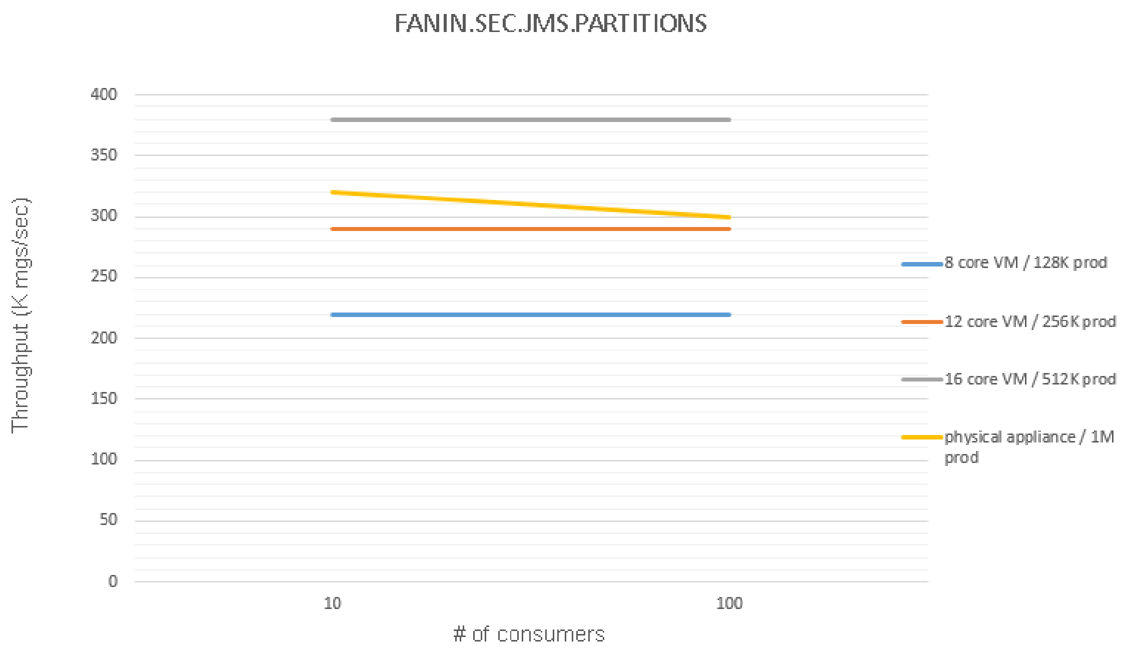


The table below lists the high water mark (HWM) stats from the FANIN.JMS.PARTITIONS test.

# of consumers	8 core VM HWM (msgs)	12 core VM HWM (msgs)	16 core VM HWM (msgs)	Physical Appliance HWM (msgs)
10	22500	24000	43000	6400
100	200	150	9400	800

FANIN.SEC.JMS.PARTITIONS

The chart below compares the throughput results from the FANIN.SEC.JMS.PARTITIONS test when dividing the topic tree into 10 partitions, each partition subscribed to by a single consumer, versus dividing the topic tree into 100 partitions. These results clearly show that when the producer connections are secured with TLS communications there is little or no performance benefit that can be observed by increasing the number of partitions/consumers in the workload. These results also show that physical appliance performance remains fairly constant between the FANIN.JMS.PARTITIONS and FANIN.SEC.JMS.PARTITIONS workloads.

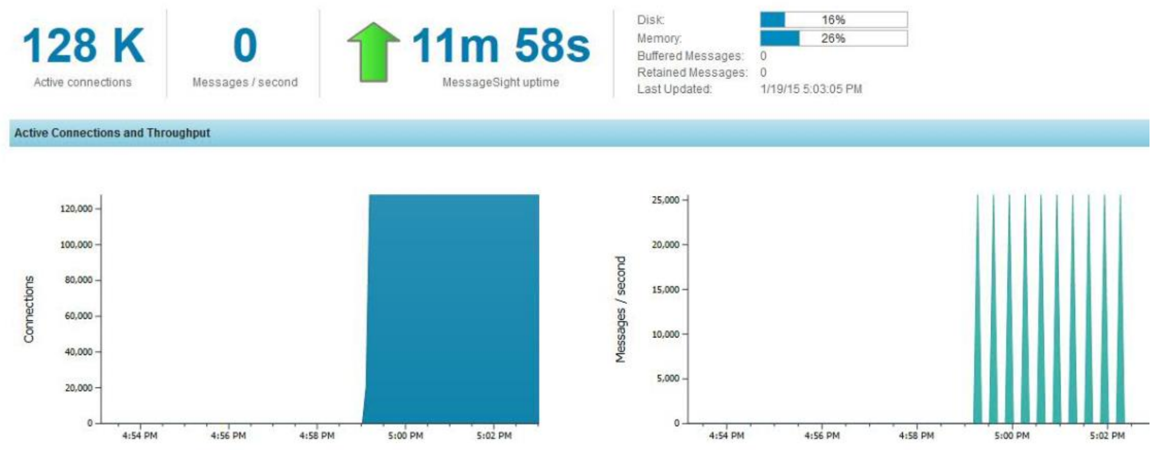


The table below lists the high water mark (HWM) stats from the FANIN.SEC.JMS.PARTITIONS test.

# of consumers	8 core VM HWM (msgs)	12 core VM HWM (msgs)	16 core VM HWM (msgs)	Physical Appliance HWM (msgs)
10	660	3800	19000	3000
100	70	240	3900	450

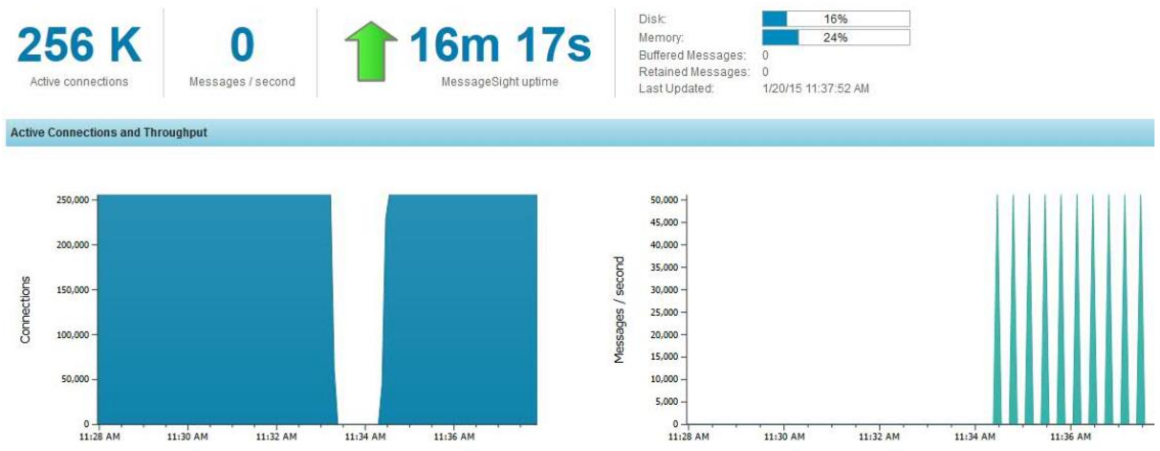
BROADCAST
The series of screenshots below are from the Appliance Dashboard on the MessageSight WebUI. The throughput graph on the right displays the outgoing (egress) message rate during the BROADCAST benchmarks. Each spike is a single message, published from the lone producer, and being delivered to all subscribers of the *broadcast* topic.

The figure below shows an 8 core VM with 128K consumers.
The peak egress message rate = 25K msgs/sec


128 K Active connections
0 Messages / second
11m 58s MessageSight uptime

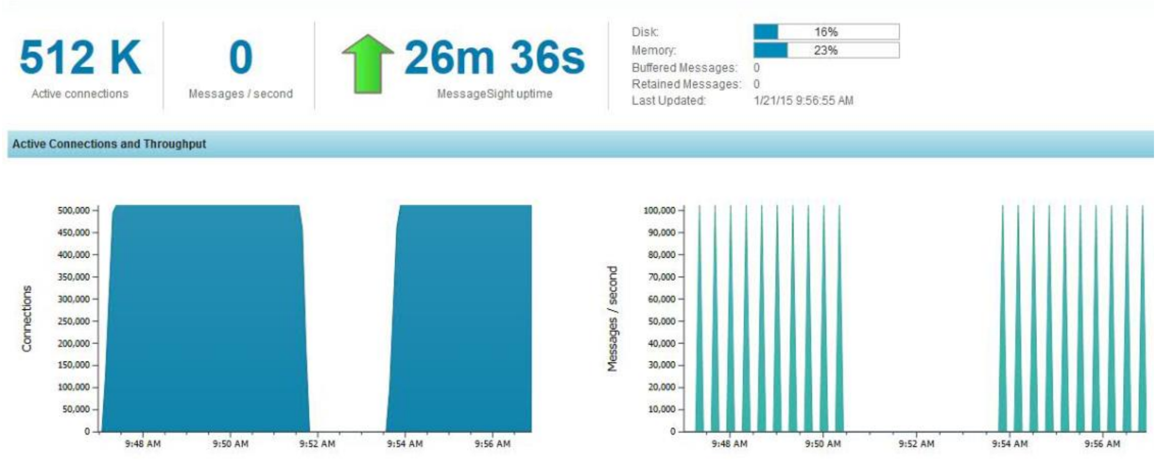
Disk: 16%
Memory: 26%
Buffered Messages: 0
Retained Messages: 0
Last Updated: 1/19/15 5:03:05 PM

The figure below shows a 12 core VM with 256K consumers.
The peak egress message rate = 50K msgs/sec


256 K Active connections
0 Messages / second
16m 17s MessageSight uptime

Disk: 16%
Memory: 24%
Buffered Messages: 0
Retained Messages: 0
Last Updated: 1/20/15 11:37:52 AM

The figure below shows a 16 core VM with 512K consumers.
The peak egress message rate = 100K msgs/sec

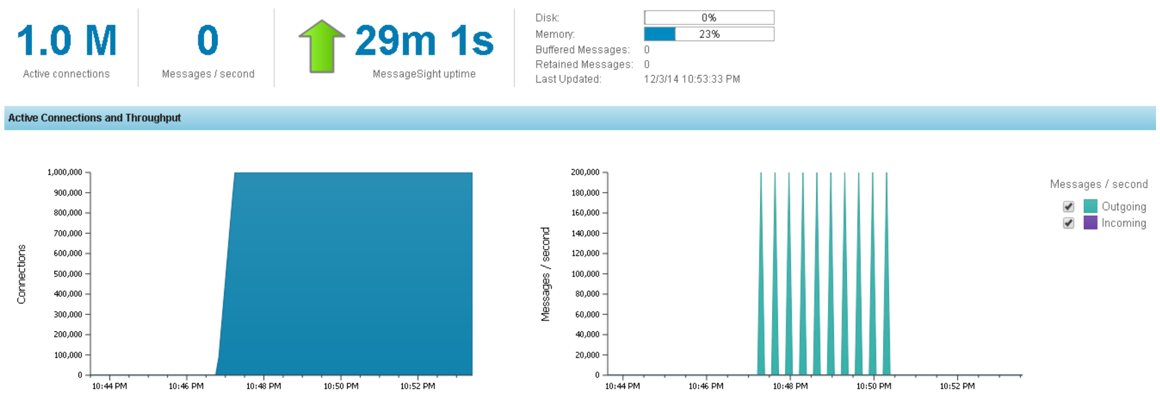


512 K Active connections | 0 Messages / second | 26m 36s MessageSight uptime

Disk: 16%
Memory: 23%
Buffered Messages: 0
Retained Messages: 0
Last Updated: 1/21/15 9:56:55 AM

Active Connections and Throughput

The figure below shows the physical appliance with 1M consumers.
The peak egress message rate = 200K msgs/sec

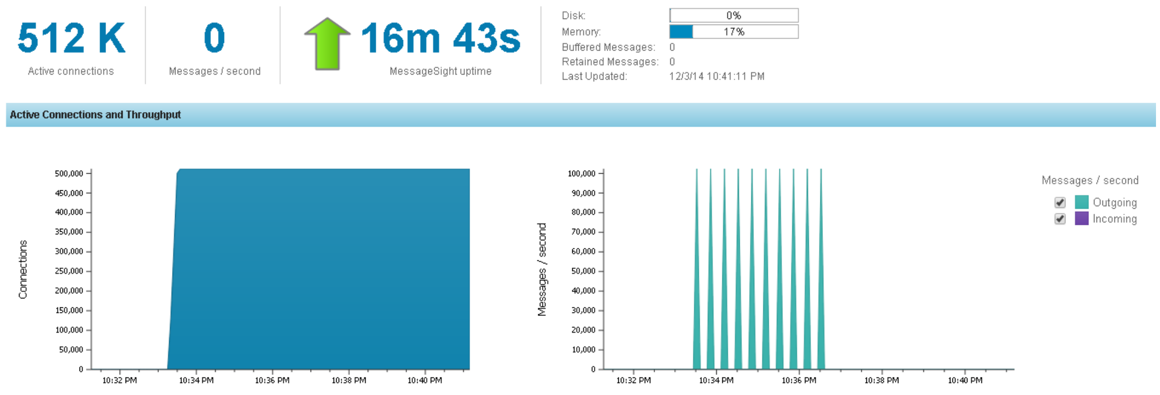


1.0 M Active connections | 0 Messages / second | 29m 1s MessageSight uptime

Disk: 0%
Memory: 23%
Buffered Messages: 0
Retained Messages: 0
Last Updated: 12/3/14 10:53:33 PM

Active Connections and Throughput

The figure below shows the physical appliance with 512K consumers.
The peak egress message rate = 100K msgs/sec

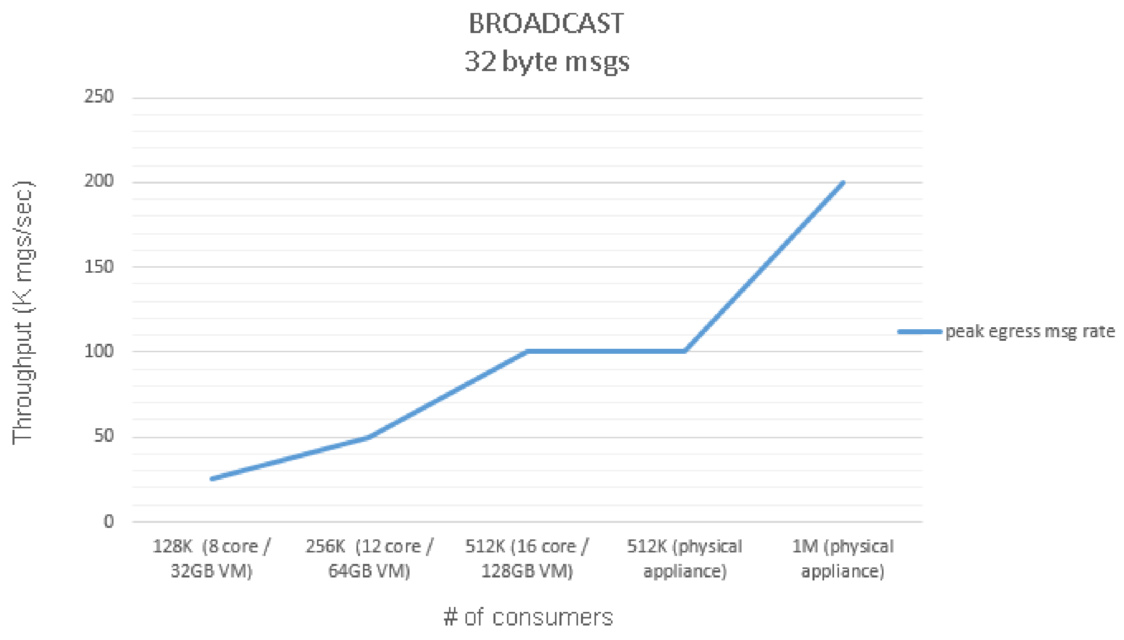


512 K Active connections | 0 Messages / second | 16m 43s MessageSight uptime

Disk: 0%
Memory: 17%
Buffered Messages: 0
Retained Messages: 0
Last Updated: 12/3/14 10:41:11 PM

Active Connections and Throughput

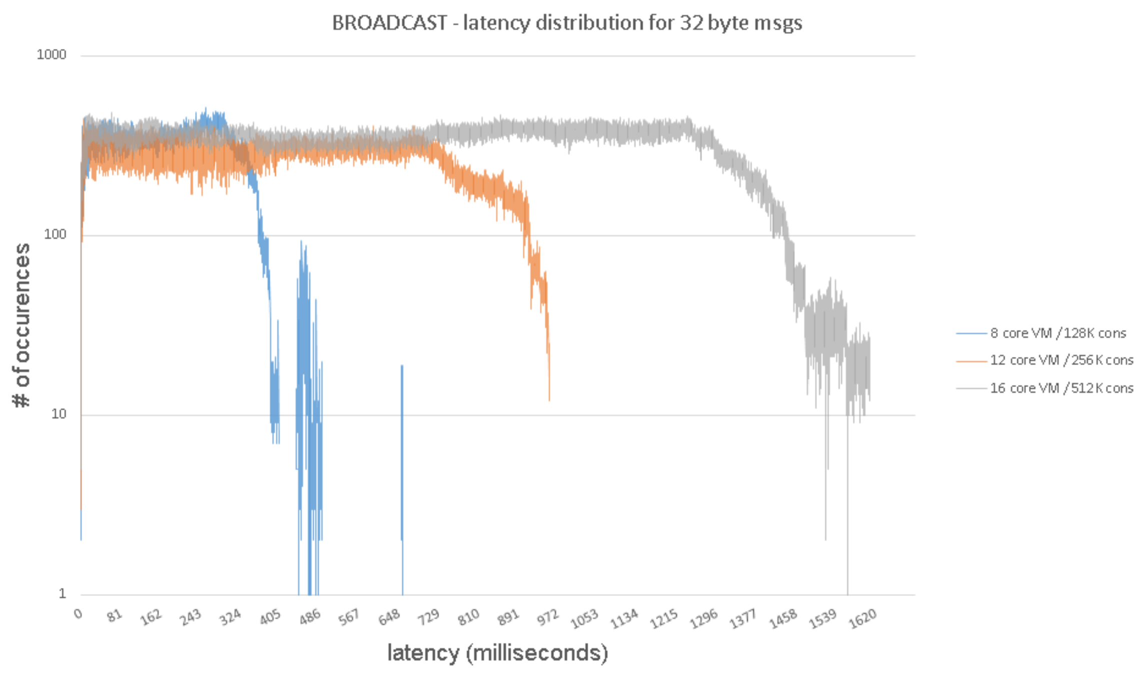
The chart below summarizes the peak egress message rate results of the broadcast benchmark for 32 byte messages.



The table below summarizes the BROADCAST benchmark peak egress message rate results across three different message sizes (32 bytes, 128 bytes, and 512 bytes). The results below show that there is no difference in peak egress message rate across the message sizes tested.

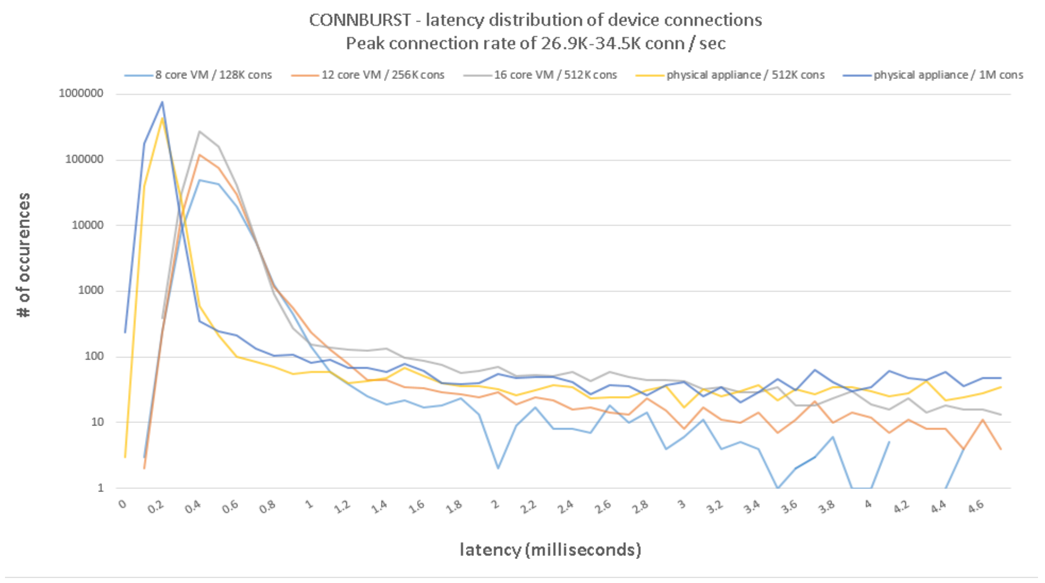
Msg Size (bytes)	8 core VM / 128K consumers (msgs/sec)	12 core VM / 256K consumers (msgs/sec)	16 core VM / 512K consumers (msgs/sec)
32	25K	50K	100K
128	25K	50K	100K
512	25K	50K	100K

The chart below compares the latency distribution of the message latency in the BROADCAST benchmark across the three MessageSight VM sizes. Message latency is defined as the time when the consumer received the "broadcast" message minus the time when the message was sent by the lone producer.

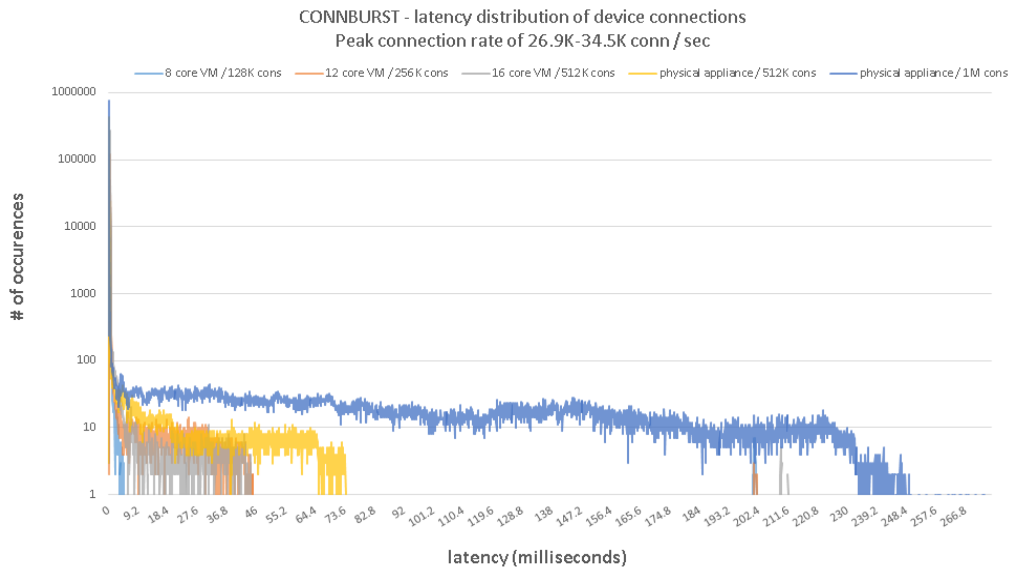


CONNBURST

The chart below compares the distribution of connection latency in the CONNBURST benchmark across the three MessageSight VM sizes and the physical appliance. Connection latency is defined as the time when the consumer sends the TCP SYN request to the time when it receives an MQTT CONNACK from the MessageSight appliance.



The chart below shows the tail of the latency distribution for the CONNBURST test. From the chart above it is clearly shown that the physical appliance has a better 50th% connection latency. The chart below also shows that when comparing the 512K connection tests between the MessageSight physical appliance and a 16 core MessageSight VM, the 16 core VM has a tighter latency distribution with the exception of a few outliers at 211 milliseconds.

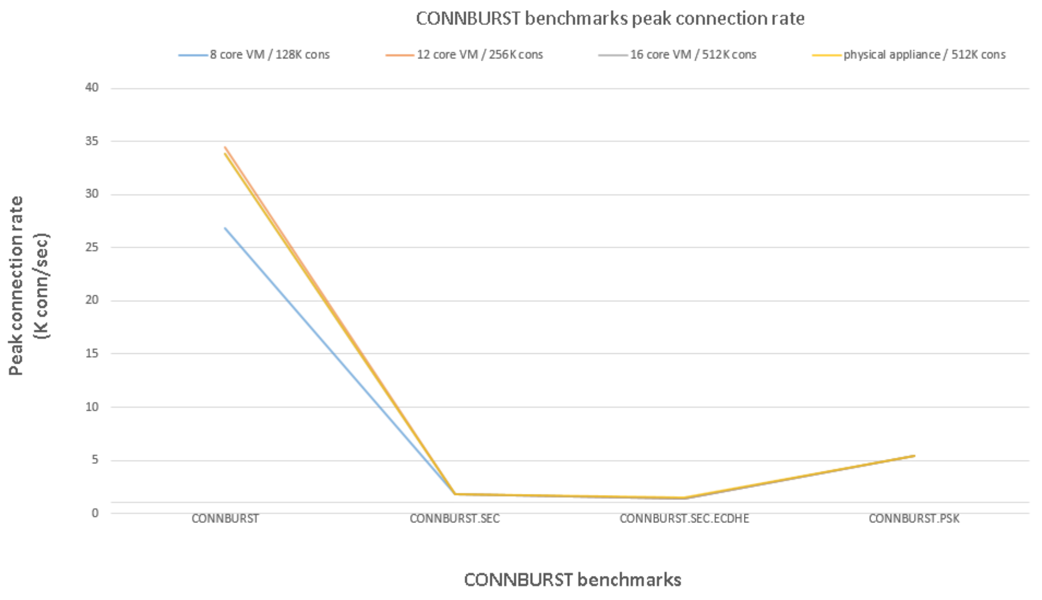


CONNBURST.SEC, CONNBURST.SEC.ECDHE, CONNBURST.SEC.PSK

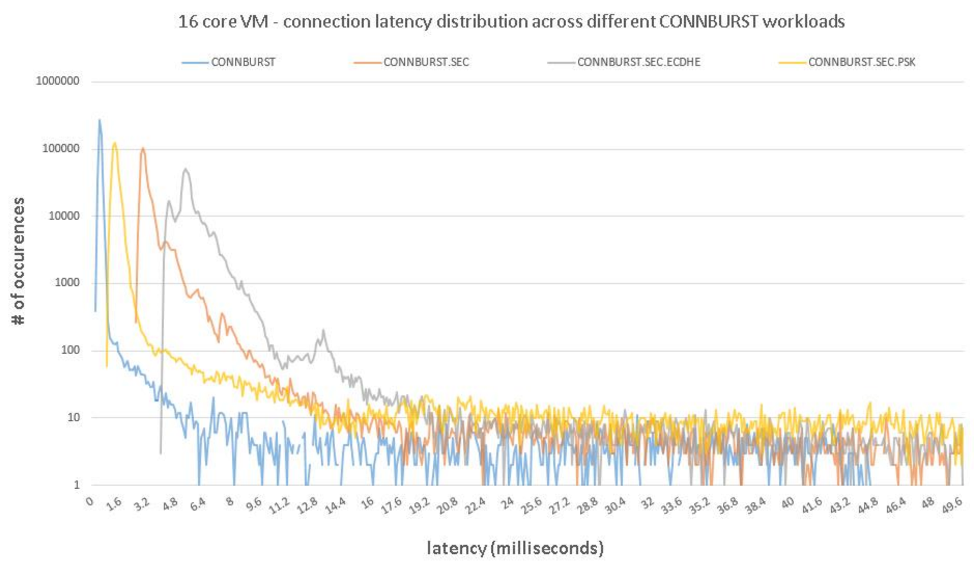
These three benchmarks measure the peak connection rate sustained by IBM MessageSight when the device connections are secured using TLS which terminate on the MessageSight server. All three benchmarks use the TLSv1.2 protocol. For the Ciphers and key sizes used in each test, see the table below.

Benchmark	Cipher	Key size (bits)
CONNBURST.SEC	AES256-GCM-SHA384	2K
CONNBURST.SEC.ECDHE	ECDHE-RSA-AES256-GCM-SHA384	2K
CONNBURST.SEC.PSK	PSK-AES256-CBC-SHA	128

The chart below compares the peak connection rate of all CONNBURST benchmarks.



The chart below compares the latency distribution of the different CONNBURST benchmarks on a 16 core MessageSight VM.



Appendix A: IBM MessageSight configuration

Unless called out explicitly in the sections below all appliance settings were left as the default appliance settings.

Network interface configuration (Physical Appliance)

The Configuring vSwitches and mapping virtual network interfaces section above describes the network interface configuration used for the MessageSight Virtual Edition benchmarks. On the physical appliance, both 40GbE network interfaces were used for in these benchmarks. Each network interface was configured with 9 IPv4 addresses for a total of 18 IPv4 addresses. Each IPv4 address was configured with a 23 bit subnet mask and each IPv4 address is in a different IP subnet.

eth6 - subnets (10.10.0.0/23, 10.10.2.0/23, 10.10.4.0/23, etc.)
eth7 - subnets (10.12.0.0/23, 10.12.2.0/23, 10.12.4.0/23, etc.)

The network interfaces on the client machines were configured in the same fashion.

Multiple IP addresses were assigned to the eth1 (i.e. data) interface of the MessageSight VM.

eth1 - subnets (10.10.0.0/23, 10.10.2.0/23, 10.10.4.0/23, etc.)

Messaging Hub configuration

One connection policy with the default connection policy settings was created. One messaging policy for topics and another messaging policy for queues were created. Both messaging policies specified the wildcard destination '*'. Both messaging policies set a limit of 1M messages to accumulate per subscription. Four endpoints were created, two secure (16903 and 16904) and two non-secure (16901 and 16902). SSL and SECURITY test cases used the secure endpoints. For all other test cases the two non-secure endpoints were used.

Deeper subscription queues are required for the MessageSight Virtual Edition in order to compensate for intermittent scheduling delays in the hypervisor. Subscription queue sizes are configured on the messaging policy object associated with the subscription by setting the MaxMessages configuration parameter.

Security profile configuration

A single security profile was created. TLSv1.2 is specified as the minimal protocol method and the cipher category used is BEST (in NSA Suite B ciphers list).

Certificate profile configuration

A single certificate profile was created. The server certificate and key used in all TLS *SEC* test cases, except CONNBURST.SEC.PSK is 2048 bits. In the CONNBURST.SEC.PSK the key size used was 128 bit.

Appendix B: Client machine tuning

Kernel tuning parameters

The following kernel parameters were set on the client machines for these benchmarks.

Name	**Value**
fs.nr_open	2000000
net.core.wmem_max	65536
net.core.rmem_max	8388608
net.core.wmem_default	16384
net.core.rmem_default	16384
net.core.netdev_max_backlog	2097152
net.ipv4.ip_local_port_range	5000 65000
net.ipv4.tcp_wmem	2048 16384 65536
net.ipv4.tcp_rmem	4096 16384 8388608
net.ipv4.tcp_mem	65536 8388608 16777216
net.ipv4.tcp_tw_reuse	1
net.ipv4.tcp_timestamps	1
net.ipv4.tcp_window_scaling	1
net.ipv4.tcp_sack	1
net.ipv4.tcp_synack_retries	10
net.ipv4.tcp_keepalive_intvl	15
net.ipv4.tcp_keepalive_probes	5
net.ipv4.tcp_fin_timeout	15
kernel.threads-max	2000000
kernel.pid_max	2000000
vm.nr_hugepages	500
vm.max_map_count	4000000

NIC tuning parameters

The following NIC tuning parameters were set on the client machines for these benchmarks.

Name		**Value**
RX ring buffers		8192
TX ring buffers		8192
txqueuelen		1000
MTU		1500
Device Active MTU		1024
Interrupt coalescence	adaptive-rx	off
	rx-usecs	10
	rx-frames	0
	tx-usecs	0
	tx-frames	0

User and process limits

The following user and process limits were set on the client machines for these benchmarks.

Name		Value
nofile		2000000
stack	soft	4096
	hard	32768
nproc		unlimited
core		unlimited
memlock		unlimited
rtprio		100

OS services stopped

The following operating system services were stopped on the client machines before executing these benchmarks. The client operating system was configured to run at runlevel 3. All firewall related services were disabled for these benchmarks, due to the large impact on packet throughput in the Linux TCP stack.

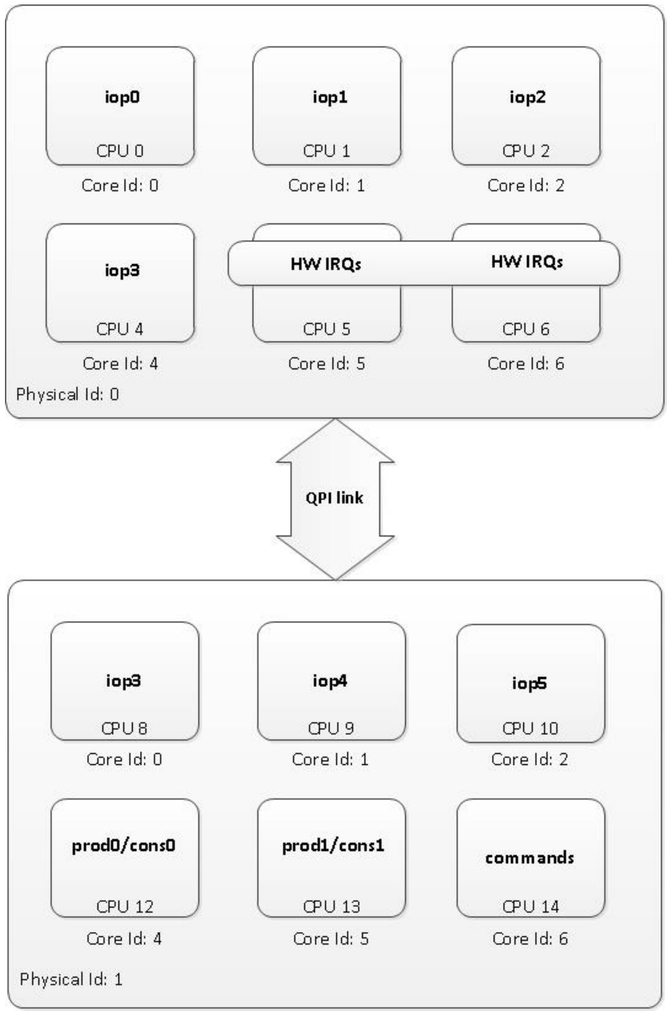
Services stopped: iptables, ip6tables, cpuspeed, cups, crond, atd, auditd, autofs, rhnsd, rhsmcertd, postfix, mdmonitor, jexec, netfs, and more

Interrupt and application CPU affinity tuning parameters

The irqbalance operating system service was configured to pin all non-local interrupts (including network interrupts) to CPUs 4 and 5.

mqttbench CPU affinity

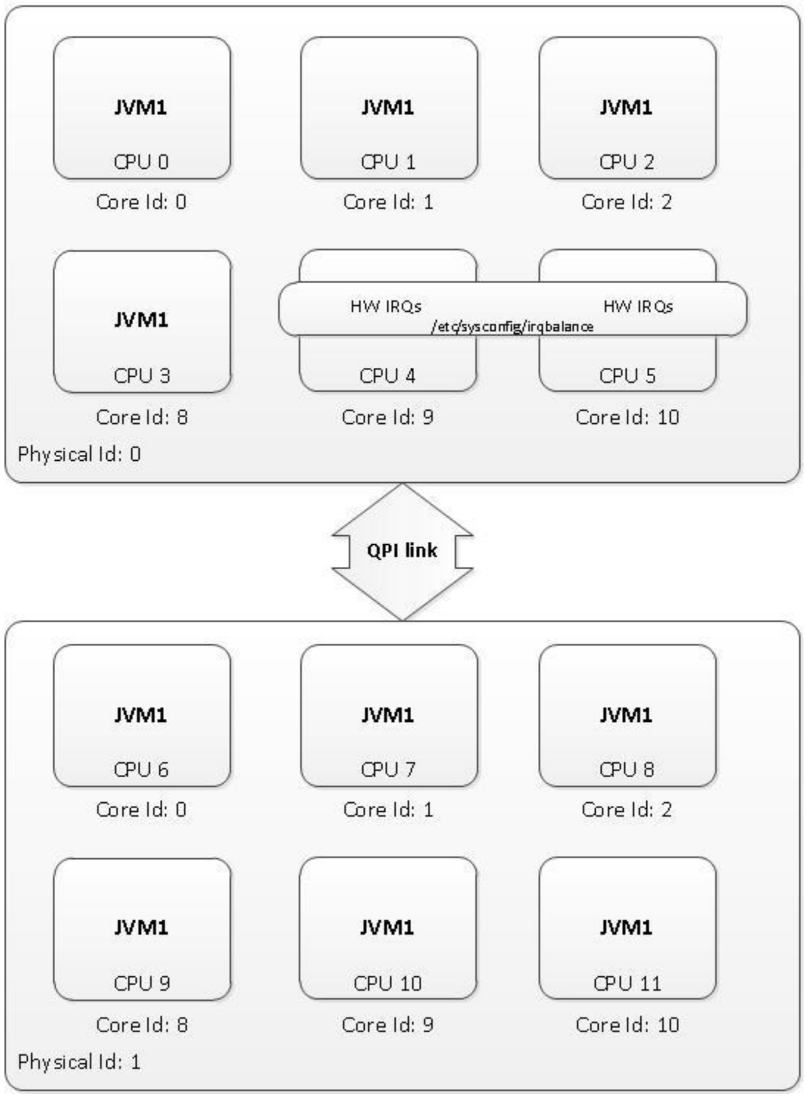
The following diagram shows how the *mqttbench* test harness threads were pinned to the CPUs of the client machine. The diagram below represents the CPU to core mapping on the client machines used in the benchmark tests. mqttbench was configured with 6 IOP threads and 1 IOL thread in these benchmarks.



JMSBenchTest affinity

The following diagram shows how the *JMSBenchTest* test harness threads were pinned to the CPUs of the client machine.

JMSBenchTest test harness CPU affinity map. Single JVM pinned to all CPUs except CPUs 4 and 5.



JVM tuning parameters

The following JVM tuning parameters were set for the JMS benchmark tests.

Name	**Value**
Initial Java heap size	-Xms20G
Max Java heap size	-Xmx20G
Max stack size for Java threads	-Xss256K
GC policy	-Xgcpolicy:metronome
Number of GC threads	-Xgcthreads5
GC tuning	-XX:+UseParallelGC
JIT tuning	-Xjit:optLevel=hot,count=1000

Appendix C: Test harness execution details

The details of how the test harness programs were executed for each test case, including command line parameters and environment details are shown below.

FANIN.PARTITIONS

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1
export BatchingDelay=1
export UseSecureConn=0
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -tx 0:0:/p/t:1:X:2 -np 10 -r Y -s 32-32 -wr -rrs

Where X is the 500000 for the physical appliance and for the Virtual
Edition X is derived from the amount of memory allocated to the
MessageSight VM.

X * 2 = total number of producer connections created in this test.

Y is the aggregate message rate sent by the producers and is expressed
in units of msgs/sec
```

Machine 2

```
export IMAClient=MQTT
export LargeConn=0
export BatchingDelay=1
export IMAPort="16901 16902"
export IMAServer="10.10.0.222 10.10.2.222"

./imaclnt.sh -d 0 -rx 0:1:/p/#:1:X:2 -np Y

Where X is 5 or 50 and Y is 10 or 100.  This benchmark was run with 10
and 100 consumer connections/topic tree partitions.
```

FANIN.JMS.PARTITIONS

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1
export BatchingDelay=1
export UseSecureConn=0
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -tx 0:0:/p/t:1:X:2 -np 10 -r Y -s 32-32 –wr -rrs
```

Where X is the 500000 for the physical appliance and for the Virtual Edition X is derived from the amount of memory allocated to the MessageSight VM.

X * 2 = total number of producer connections created in this test.

Y is the aggregate message rate sent by the producers and is expressed in units of msgs/sec

Machine 2

```
export IMAClient=JMS
export LargeConn=0
export BatchingDelay=1
export DisableACK=1 (IBM MessageSight JMS client connection factory
parameter: DisableACK)
export ClientMessageCache=100000 (IBM MessageSight JMS client
connection factory parameter: ClientMessageCache)
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222
10.12.8.222"

taskset -c 0-3,6-11 ./imaclnt.sh -d 0 -rx -1:0:3:2:0:/p/#:1:1:X:10 –mt
t -np Y
```

Where X is 1 or 10 and Y is 10 or 100. This benchmark was run with 10 and 100 consumer connections/topic tree partitions.

FANIN.SEC.JMS.PARTITIONS

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=900
export BatchingDelay=1
export UseSecureConn=1
export SSLCipher=AES256-GCM-SHA384
export SSLClientMeth=TLSv12
export CERTSIZE=2048
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -tx 0:0:/p/t:1:X:2 -np 10 -r Y -s 32-32 -wr -rrs

Where X is the 500000 for the physical appliance and for the Virtual
Edition X is derived from the amount of memory allocated to the
MessageSight VM.

X * 2 = total number of producer connections created in this test.

Y is the aggregate message rate sent by the producers and is expressed
in units of msgs/sec
```

Machine 2

```
export IMAClient=JMS
export LargeConn=0
export BatchingDelay=1
export DisableACK=1 (IBM MessageSight JMS client connection factory
parameter: DisableACK)
export ClientMessageCache=100000 (IBM MessageSight JMS client
connection factory parameter: ClientMessageCache)
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222
10.12.8.222"

taskset -c 0-3,6-11 ./imaclnt.sh -d 0 -rx -1:0:3:2:0:/p/#:1:1:X:10 -mt
t -np Y

Where X is 1 or 10 and Y is 10 or 100. This benchmark was run with 10
and 100 consumer connections/topic tree partitions.
```

BROADCAST

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1
export BatchingDelay=1
export UseSecureConn=0
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -tx 0:0:t:1:1 -rx 0:1:t:1:X:2 -wr -rrs -s 32-32 -c 10
-r 0.05 -T 0x81 -u 1e-3 -lcsv broadcast_32_qos0.csv

Where X is the 500000 for the physical appliance and for the Virtual
Edition X is derived from the amount of memory allocated to the
MessageSight VM.

X * 2 = total number of consumer connections created in this test.

-u 1e-3 = latency measurements are stored in units of milliseconds
```

CONNBURST

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=5
export BatchingDelay=1
export UseSecureConn=0
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -rx 0:1:t:1:X:2 -T 0xA0 -u 1.0e-4 -lcsv connburst.csv

Where X is the 500000 for the physical appliance and for the Virtual
Edition X is derived from the amount of memory allocated to the
MessageSight VM.

-u 1e-4 = latency measurements are stored in units of tens of
milliseconds
```

CONNBURST.SEC

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1000
export BatchingDelay=1
export UseSecureConn=1
export SSLCipher=AES256-GCM-SHA384
export SSLClientMeth=TLSv12
export CERTSIZE=2048
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -rx 0:1:t:1:X:2 -T 0xA0 -u 1.0e-4 -lcsv
connburst.sec.csv
```

Where X is the 500000 for the physical appliance and for the Virtual Edition X is derived from the amount of memory allocated to the MessageSight VM.

-u 1e-4 = latency measurements are stored in units of tens of milliseconds

CONNBURST.SEC.ECDHE

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1300
export BatchingDelay=1
export UseSecureConn=1
export SSLCipher=ECDHE-RSA-AES256-GCM-SHA384
export SSLClientMeth=TLSv12
export CERTSIZE=2048
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -rx 0:1:t:1:X:2 -T 0xA0 -u 1.0e-4 -lcsv
connburst.sec.ecdhe.csv

Where X is the 500000 for the physical appliance and for the Virtual
Edition X is derived from the amount of memory allocated to the
MessageSight VM.

-u 1e-4 = latency measurements are stored in units of tens of
milliseconds
```

CONNBURST.SEC.PSK

Machine 1

```
export IMAClient=MQTT
export LargeConn=1
export DelayCount=1
export DelayTime=1300
export BatchingDelay=1
export UseSecureConn=1
export SSLCipher=PSK-AES256-CBC-SHA
export SSLClientMeth=TLSv12
export IMAPort="16901 16902 16901 16902 16901 16902 16901 16902 16901
16902 16901 16902 16901 16902 16901 16902 16901"
export IMAServer="10.10.0.222 10.12.0.222 10.10.2.222 10.12.2.222
10.10.4.222 10.12.4.222 10.10.6.222 10.12.6.222 10.10.8.222 10.12.8.222
10.10.10.222 10.12.10.222 10.10.12.222 10.12.12.222 10.10.14.222
10.12.14.222 10.12.16.222"

./imaclnt.sh -d 0 -rx 0:1:t:1:X:2 -T 0xA0 -u 1.0e-4 -lcsv
connburst.sec.psk.csv –psk psk.csv
```

Where X is the 500000 for the physical appliance and for the Virtual Edition X is derived from the amount of memory allocated to the MessageSight VM.

-u 1e-4 = latency measurements are stored in units of tens of milliseconds

The PreSharedKey file was uploaded to MessageSight and applied with the following command: imaserver apply PreSharedKey "PSKFile=psk.csv"