Performance Test Report

Workspace ONE UEM 1907

vmware®

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Introduction

The objective of the test is to gauge the overall performance of the Workspace ONE UEM system by executing variety of tests and create a reference architecture for Workspace ONE UEM 1907 deployment.

The report has been generated after testing WS1 UEM application with the following configuration:

- 500K Devices – 50K Android, 100K iOS, 25K MacOS and 325K Windows
- Devices fairly distributed across 25 Container OG's
- Major scenarios include Certificate Profile publish to 500K devices along with Internal App and Passcode Profile publish

Note: Details of the tests are provided in the below Test Definitions section

Audience

This document is intended for IT architects and administrators who want to understand the performance and scale attributes of Workspace ONE UEM.
Pre-requisites to follow this document, is to have enough understanding of Workspace ONE UEM servers and their configuration, familiarity with MS SQL Server configuration, in addition to an understanding of sizing and performance concepts.

Environment Setup Notes

- Workspace ONE UEM 1907 was used for this testing and all our recommendations in this document apply to this version of Workspace ONE UEM.
- MemCached version 1.4.36 on CentOS Linux release 7.5.1804 (core).
- AWCM version 6.3.4
- All the virtual servers we used for this testing use flash storage.
- Implemented recommended changes, which are documented later in this document on the MS SQL server, at the ESX host level and on Workspace ONE UEM application side to improve performance of the overall system.

Tools used for load simulation

- Falcon - A VMWare proprietary tool used to simulate 500,000 virtual devices
- HP LoadRunner to generate a background load of 50 virtual users as Workspace ONE UEM Console Admins.
- Apache Jmeter tool used to simulate API Load

Risks

1. As the testing was done on Windows Server 2016, any change on the host OS version will remain an unknown and could show different results from the scale test done. We are unaware of the performance impact if the Application Server version is not updated to Windows Server 2016.
2. These tests were run using VMware's proprietary load simulation tool which creates simulated devices. One can expect some differences in server performance between real and simulated devices.

Executive Summary

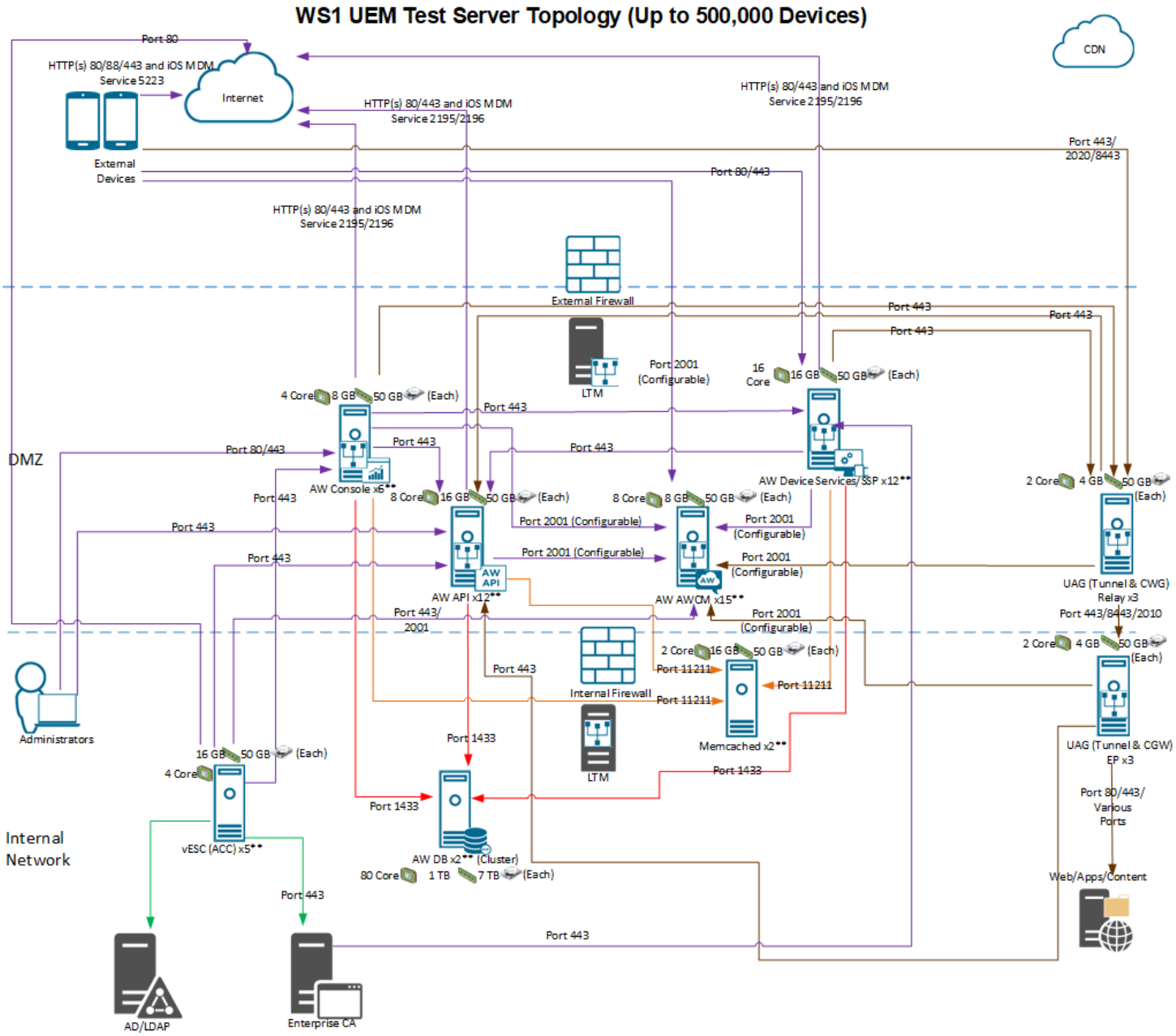
The goal of this report is,

1. To examine performance of WS1 UEM 1907 under load
2. To provide server sizing and performance improvement recommendation based on the analysis

Load included, Profile publish, Certificate publish, Application publish to all devices along with Device check-in and sample simulation.

Workspace ONE UEM 1907 with this environment sizing is scalable and provides stable performance with respect to load described in this document. This console version includes performance improvements for Web Console pages, VPN Profile Publish to Android devices and Profile Publish to iOS devices.

Test Architecture



Test Environment

Recommended Application Server Configuration of WS1 UEM key components based on the performance tests carried out.

Application Server Configurations (VMs)

Recommended configuration		
Database Server	OS	Windows Server 2016
	SQL Server	Microsoft SQL Server Developer 2016 (64-bit)
	SQL Server version	13.0.5026.0
	vCPU	40 cores x 2 sockets (80 CPU)
	vRAM	1 TB
	Total DB storage	2 TB
	Transaction Log storage	1 TB
	Temp DB storage	1 TB
***6 X Admin Console**	OS	Windows Server 2016
	vCPU	2 cores x 2 sockets (4 CPU)
	vRAM	8 GB
	Storage	50 GB
12 X Device Services	OS	Windows Server 2016
	vCPU	8 cores x 2 sockets (16 CPU)
	vRAM	16 GB
	Storage	95 GB
12 X API Server	OS	Windows Server 2016
	vCPU	4 cores x 2 sockets (8 CPU)
	vRAM	16 GB
	Storage	50 GB
2X MemCached Server	OS	CentOS Linux release 7.4.1708
	MemCached Version	1.4.36
	vCPU	1 cores x 2 socket (2 CPU)
	vRAM	16 GB
	Storage	50 GB
15 X AWCM Server	OS	Windows Server 2016
	vCPU	4 cores x 2 sockets (8 CPU)
	vRAM	16 GB
	Storage	50 GB
6 X UAG Server	OS	Windows Server 2016
	vCPU	2 cores x 1 sockets (8 CPU)
	vRAM	4 GB
	Storage	50 GB

Note: Load balancer is configured to offload DS requests on the application server

*If the utilization is high on Console server boxes, we need to have dedicated PE and CDS machines.

VM Host Configuration

Recommended configuration		
Database Server	Host Model	Dell Inc. PowerEdge R640
	Processor Type	Intel(R) Xeon(R) Platinum 8176M CPU @ 2.10GHz
	vCPU	4 sockets x 28 cores
	Logical Processors	112
	Hyper threading	Active
	vRAM	4 TB
	Storage hardware	PURE Fiber Channel Disk (Flash Drive)
AirWatch Servers	Host Model	Dell Inc. PowerEdge R640
	Processor Type	Intel(R) Xeon(R) Platinum 8176M CPU @ 2.10GHz
	vCPU	2 sockets x 22 cores
	Logical Processors	112
	Hyper threading	Active
	vRAM	382 GB
	Storage hardware	PURE Fiber Channel Disk (Flash Drive)

CA Server Configuration

Recommended configuration		
CA Server	OS	Windows Server 2016
	CA service	Microsoft Active Directory Certificate Services [AD CS]
	vCPU	8 cores x 2 sockets (16 CPU)
	RAM	16 GB
	Storage	75 GB

SCEP Server

- AirWatch Certificate Authority was configured and used for all the certificate publish tests having SCEP payload.

Reference Data

Reference Data used during testing		
Devices	Android	50K
	iOS	100K
	Mac OS	25k
	Windows Desktop	325k
Organization Groups	Customer OGs	1
	Container OG	25
	Device Distribution	Fairly Even
	Largest OG	150K
	Smallest OG	10,000
Administrators	Total Accounts	2000
	Logged In	150
Users	Total Accounts	250K
Smart Groups	All Sizes	250
Applications (For BYO devices)	Internal	500
	Public	250
	Unmanaged	10
Profiles	All Types	250

Recommendations

The following settings and recommendations are provided after Performance/Scale tests were successfully completed for 500K devices:

SQL Server Recommendations

1. Add 1 tempdb file per core (80 tempdb files for 80 core)
2. Add below Trace flags in Startup Parameters for "mssqlserver" service as per Microsoft recommendations

Trace Flag	Knowledge Base
T174	https://support.microsoft.com/en-us/help/3026083/fix-sos-cachestore-spinlock-contention-on-ad-hoc-sql-server-plan-cache
T834	https://support.microsoft.com/en-us/help/920093/tuning-options-for-sql-server-when-running-in-high-performance-workloads
T3427	https://support.microsoft.com/en-us/help/3216543/workloads-that-utilize-many-frequent-short-transactions-in-sql-server

3. Set “Lock Pages in Memory” privilege for the service account
4. Disable "Named Pipes" and Enable "TCP/IP" network protocol
5. Increase Maximum Worker threads in server properties to "7500"
6. Set “Max Degree Of Parallelism” to 4 and “Cost threshold for Parallelism” to 50
7. Enable “Received Side scaling” setting for Network Adapter on SQL server
8. Set “Delayed Durability” under database properties = “Forced” to reduce WriteLog waits
9. Update “Minimum and Maximum Server Memory” allocation in Server Properties
    a. Minimum Server Memory (in MB): 500000
    b. Maximum Server Memory (in MB): 1500000

Hardware Recommendations

1. Enable Network Interface Card “Received Side Scaling” for efficient distributions of network receive processing across multiple CPUs on all servers, including SQL server.
2. Change ESX Host power management to “High Performance” (updated windows power policies)
3. If F5 NLB is being used, then enable “OneConnect Profile” for VIP used for DS server to improve Load Balancer performance and equal distribution (Note: DS pool should have Round Robin LB method)

CA Server Recommendation

1. Do not use the default certificate template to issue the certificate. The default certificate template publishes the certificate to Active Directory causing high CPU utilization on CA server and slow issuing rate.
2. To mitigate this problem, create or clone a certificate template with below changes:
    a. Change the issuing template Subject Name property to "*Supply in the request*"
    b. Uncheck "*Publish certificate in Active Directory*" under General property window
    c. Enable this new certificate template on Certificate Authority

Workspace ONE UEM Application Servers Settings and Recommendations

3. Update Workspace ONE UEM application server to 19.7.0 revision 7
4. Set Certificate Profile Publish Frequency: 1000*
5. Set Apple Profile Installation Batch Size: 300
6. Set iOS Device Invites Per Second:30
7. Set FastLaneMessageRateMultiple:1.5
8. Set Batch Size for internal Application Deployment:500
9. Set Wns Throttling :34/sec
10. Set Product Provisioning AWCM Throttle Rate: 20
11. Set Product Provisioning Command Release Batch Size: 2000 per 2 mins
12. Enable File Storage Caching Enabled setting
13. Set Use Recursive OID At Enrollment as disabled for Directory Services

*Change this setting only if using CA that follows the recommendations given in this document.

Note:

Steps to implement or enable recommendations related to SQL server, Hardware and Workspace ONE UEM Application Server settings, along with comprehensive explanations, are given in this appendix.

Test Definitions

Tests were run to simulate device load using Falcon and administrator activity using Load Runner in the Workspace ONE UEM system. These tests were executed through several different scenarios to determine the optimum architecture that can sustain realistic activity from 500,000 devices. The test composed of scenarios with workloads defined below.

The tests below were created to define a typical workflow for large customers using all types of devices on the same instance. The tests encompass areas like certificate profile push, passcode profile push, API load, Internal Application publish with app config and multi-admin usage of the application.

Scenarios

Below scenarios define full load generated for the test.

Scenario 1

Single Profile Publish with Device background load, Console UI load and API load.

- Push a Passcode profile to all Android, iOS, MacOS and Windows devices
- Background load, API Load and Console UI load mentioned below is running throughout the test

Scenario 2

Certificate Profile Push using ADCS along with Device background load, Console UI load and API load.

- Push a Certificate profile (Credential Payload) to all Android, iOS and MacOS devices
- Background load, API Load and Console UI load mentioned below is running throughout the test

Scenario 3

Certificate Profile Push using SCEP along with Device background load, Console UI load and API load.

- Push a Certificate profile (SCEP Payload) to all iOS and MacOS devices
- Background load, API Load and Console UI load mentioned below is running throughout the test

Scenario 4

Internal Application Publish along with Device background load, Console UI load and API load.

- Publish an internal app to all iOS and Android devices
- Background load, API Load and Console UI load mentioned below is running throughout the test

Scenario 5

Combined Load Test

- Publish an internal app to all iOS devices
- Push a Passcode profile to all Android devices
- Push a Certificate profile (SCEP Payload) to all MacOS devices
- Push a Certificate profile (Credential Payload) to all iOS devices
- Background load, API Load and Console UI load mentioned below is running throughout the test

Workload Summary

Workload A – Device Samples

- Samples will be sent and processed as per the below frequency
    - Android – every 8 hours
    - iOS – every 4 hours
    - macOS – every 4 hours
    - Windows – every 4 hours
- Beacons will be sent and processed as per the below frequency
    - Android – every hour
    - iOS – every hour
    - macOS – every 5 minutes
- Above values are directly proportional to number of devices we will have in the test environment valuable
- Run custom Index Job every 24 hours

Workload B – Console UI Test

Overview: Test simulates 50 administrators navigating around the console UI.

Details:

- Number of users – 50
- Administrator will navigate to different OGs
- Administrator will navigate to different list views in an OG
    - Application (Public and Internal), Profiles, Smart Group, Device and Product list view
- Administrators will navigate to Device Details page for different devices at different OG and navigate to the below tabs.
    - Products/Network/Troubleshooting/Certificates tabs
- Load Runner Config:
    - Ramp up – 1 user every 10 seconds
    - Steady state duration – This will run as long as the scenario runs
    - Ramp down – 5 users every 30 seconds

Workload C – API Usage Test

Considerations:

Below table defines API that were executed as part of this workload, with the expected rate

API	Transactions per hour
Search and retrieve details for both internal and external applications based on LocationGroup Id	18/min
Searches for devices based on LocationGroup Id	18/min
Searches devices and its custom attributes based on LocationGroup Id	18/min
Retrieves application details of the device identified by device ID	18/min
Retrieves the user details of the device identified by device ID.	18/min
Returns network information of single device specified by id parameter	18/min
Tunnel API to get config	18/min

Workload C – Internal Application Publish

Considerations:

- Single app will be published automatically to set of devices across few Smart Groups
    - App size: Around 65 MB
    - Publish rate: 500 Batch release every minute
    - CDN: Enabled

Out of Scope

- WS1 app/Hub +vIDM scenarios were not considered
- SEG Load and Tunnel Server (UAG) load i.e. Devices hitting SEG/Tunnel Server
- API's called by SEG and Tunnel Servers
- Persistent client connections on AWCM servers
- Public and VPP application publish

Test Observations – Load Test

- Workspace ONE UEM Application Servers handled the load generated through Profile publish, Certificate publish, Internal application publish, Devices Check in, Console Users and API.
- Average CPU utilization on Device Services servers was around 18% during the test and spikes around 60% each time there is high inflow of device samples.
- SQL server was stable and average CPU utilization was 45% with few spikes up to 70% during full load which includes Profile/Samples and console load
- 8 GB of memory was used on DS and 5 GB on Console server during this full load.
- Average 12 MBps of network bandwidth was used on each DS severs during the test duration
- During full load we observed an average of 95 HTTPS requests being processed per sec across all 12 DS servers and were able handle the load efficiently.
- During Certificate publish with ADCS payload, CA server issued 10 certificates per sec at a constant rate with 5% CPU utilization.
- There were no commands found in the message queues across application servers at the test. This signifies WS1 processed all the commands queued during the test.

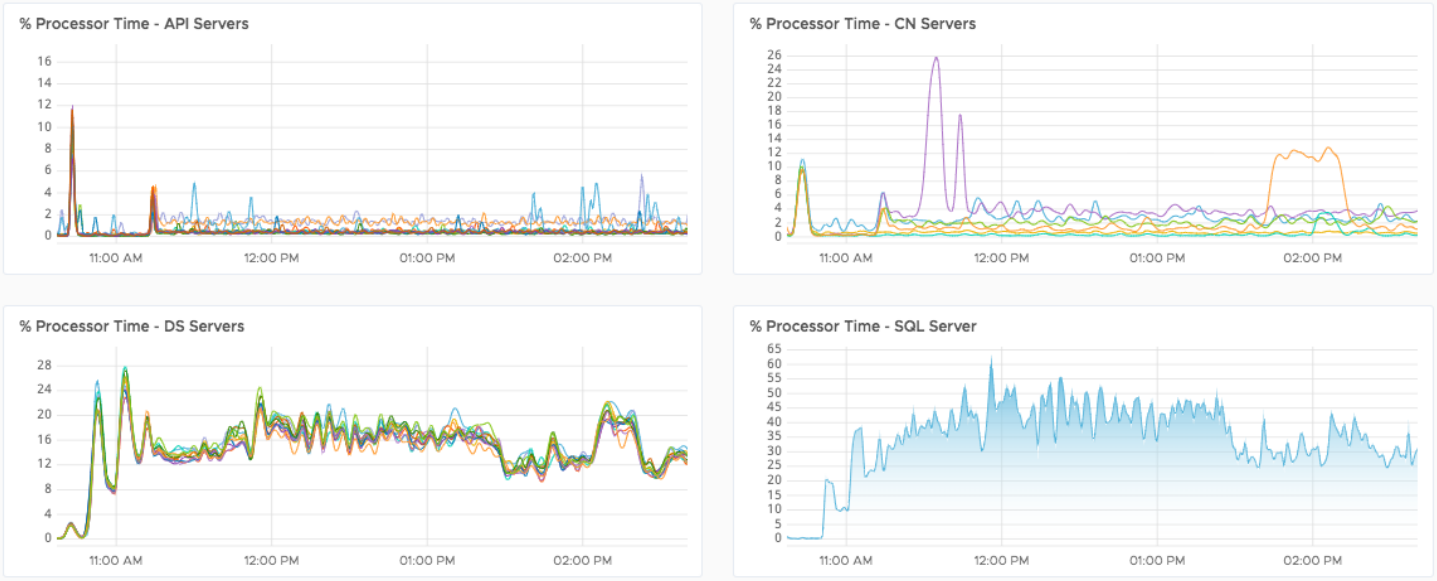
Note:
Under unexpected constant load, the DS servers may utilize 100% CPU and struggle to recover unless traffic is terminated during standard health checks implemented at the Load Balancer. If the server continues to receive requests past capacity, it may be required to perform IIS reset to clear queued requests and return to normal operation.

Server Performance Graphs

Result Set based on Scenario 5:

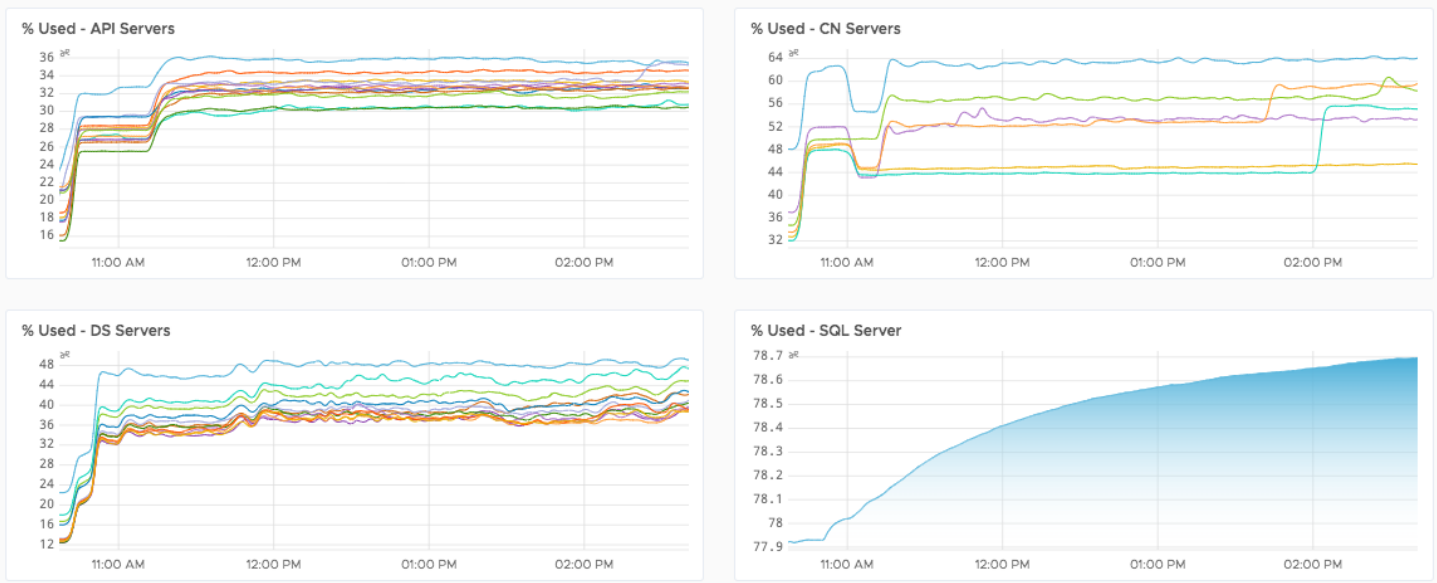
Publishing Internal application along with certificate and profile publish at regular intervals. Graph shows the system health during 1 internal application publish to 100K iOS devices, Android profile publish to 50K devices, Certificate profile with SCEP payload to 25k MacOS devices and Certificate profile with ADCS payload 100K iOS devices.

CPU Utilization



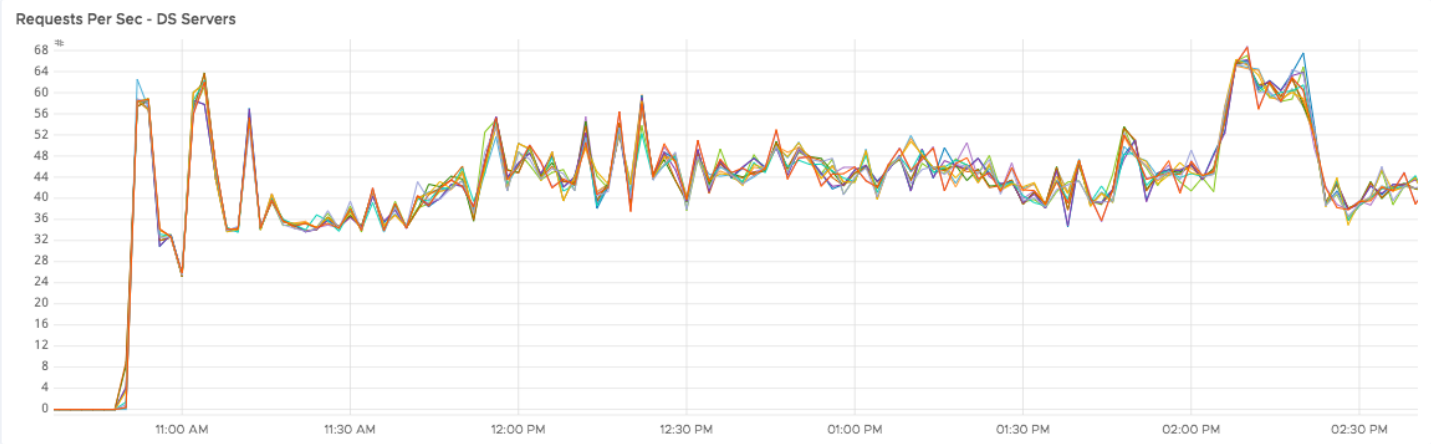
Observation: Average CPU utilization across all servers was below 50% through the test.

Available Memory



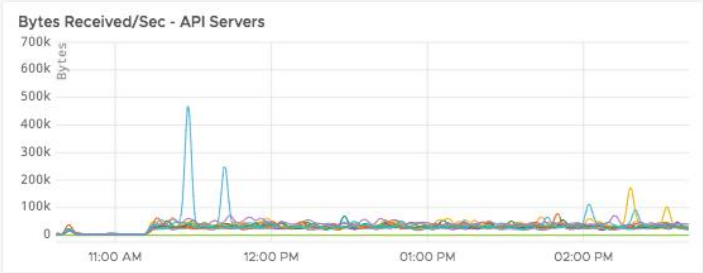
Observation: Average CPU utilization across all servers was below 50% through the test, except for once console, where Scheduler service was running.

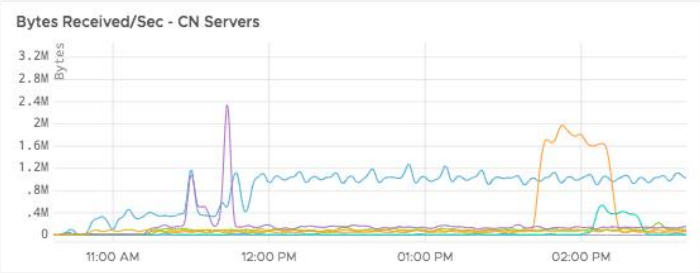
Requests/Sec

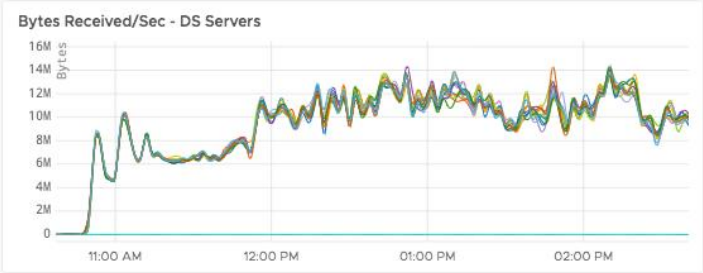


Observation: Each DS server could process 42 requests/sec on average. These requests are http requests with SSL offloading on F5 load balancer.

Network – Bytes Received/sec

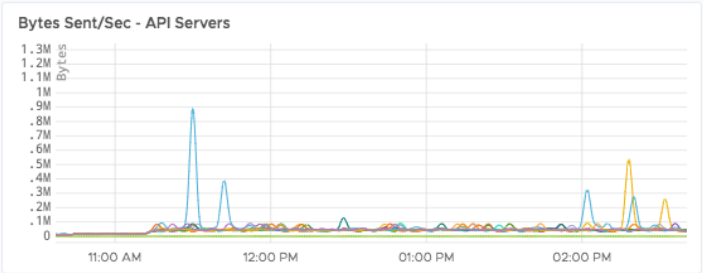


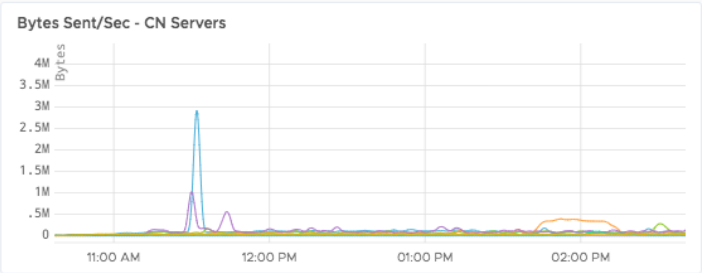


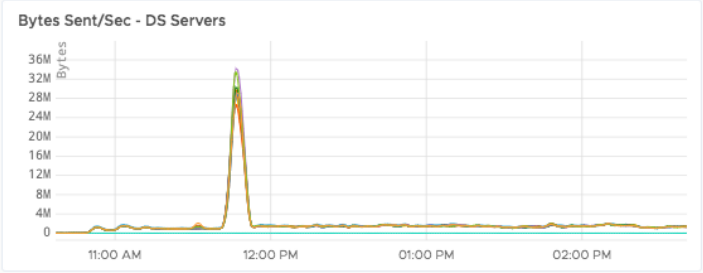


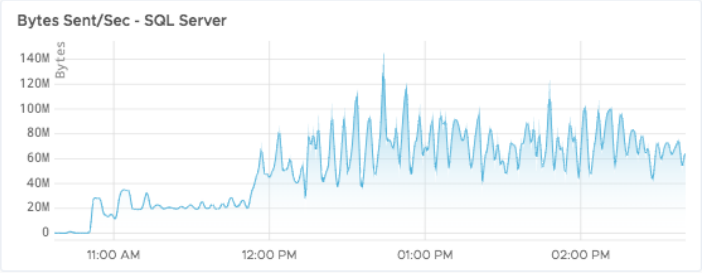
Observation: DS was receiving up to 12 MB of data during the active Certificate/profile/application publish. Average Bytes Received/Sec for DS and SQL server was around 9 MB/s

Network – Bytes Sent/sec



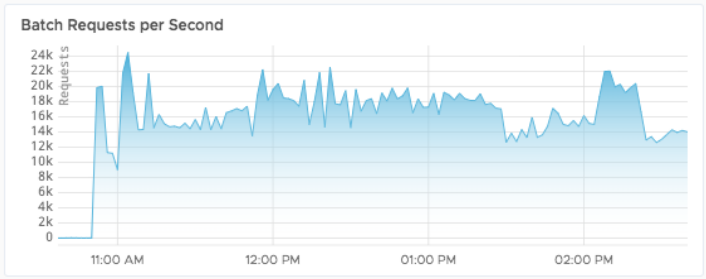


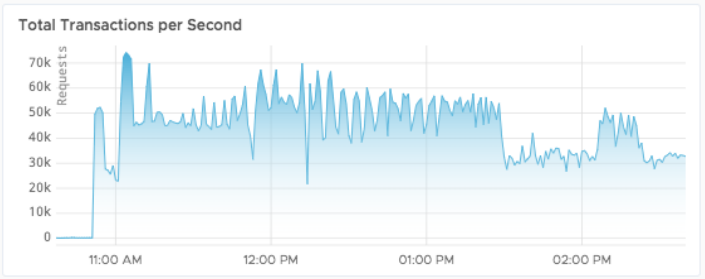




Observation: During a CDN failover test for internal app publish, DS was observed sending bytes around 38 MB/s.
Average Bytes Sent/Sec for DS was 1.6 MB/s and for SQL server it was 53 MB/s

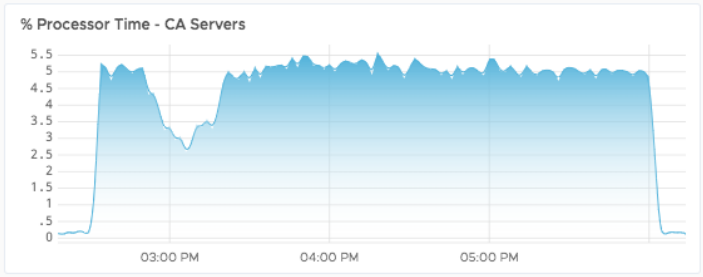
SQL Server Activity

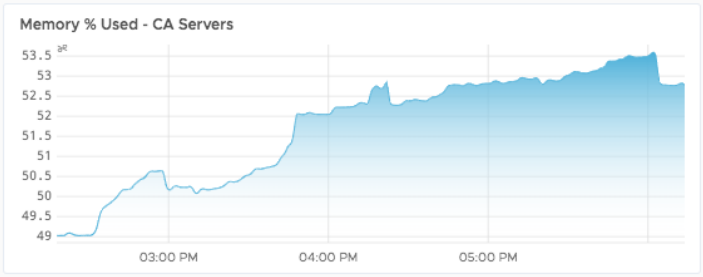


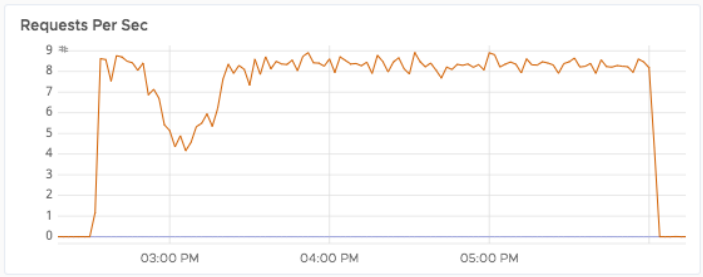


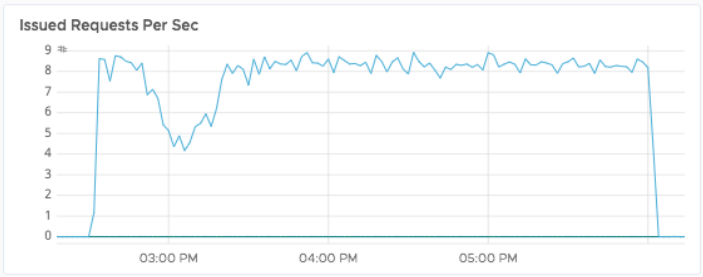
Observation: Avg of 15864 Batch Request/sec and average of 45803 transactions/sec was observed on the database server.

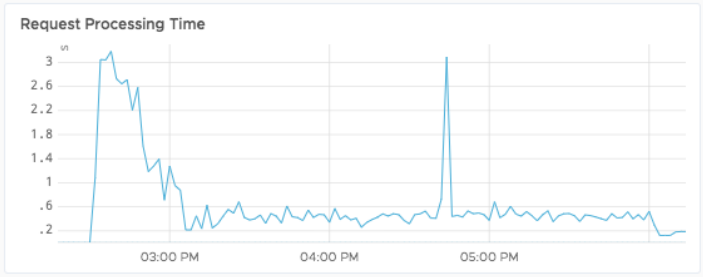
CA Server Activity (During ADCS Certificate publish)

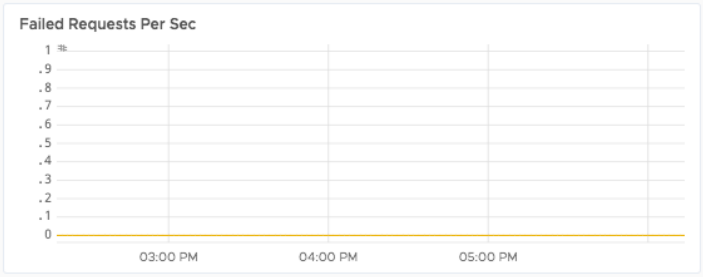












Observation: There were no Failed Requests on CA server during an active ADCS certificate publish. The CA issued certificates at almost 10/sec with an average CPU of less than 5%

Appendix

SQL Server Recommendations

A. Add 1 tempdb file per core (80 tempdb files for 80 core)

i) Each tempdb data file was added with below parameters:

(1) Initial Size: 5000 MB

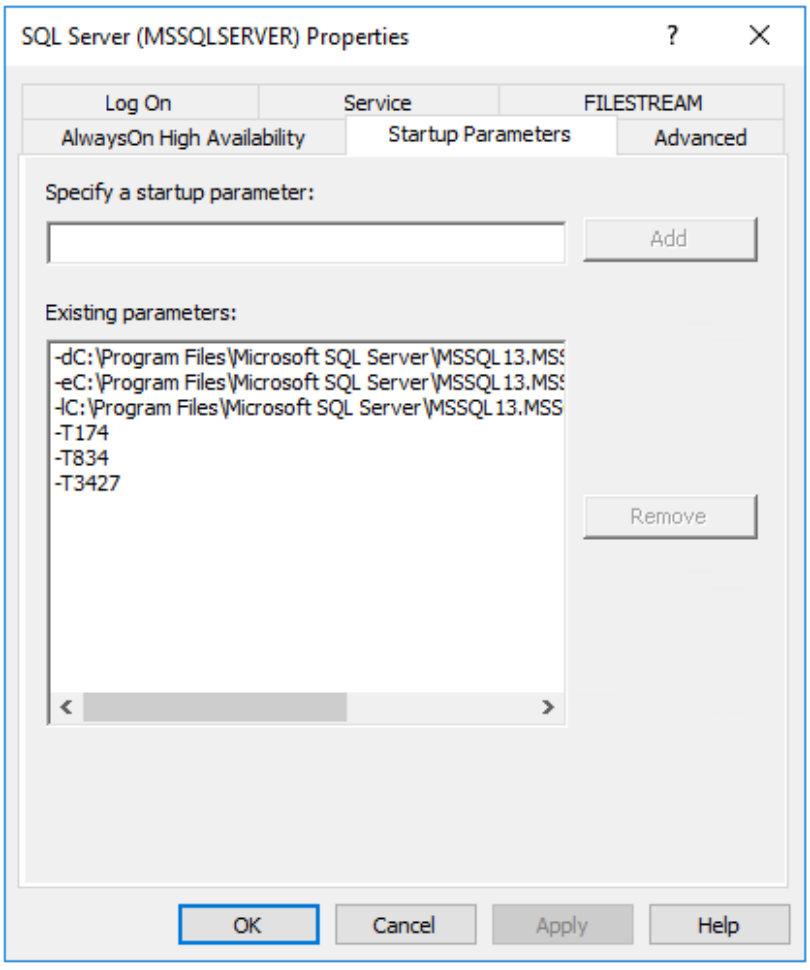
(2) Autogrowth: 512 MB

(3) Sample script for adding new tempdb files

```
/* Adding three additional tempdb files */

USE [master];
GO
ALTER DATABASE [tempdb] ADD FILE (NAME = N'Temp1', FILENAME = N'G:\TempDBFiles\Temp1.ndf' , SIZE = 8GB , FILEGROWTH = 512);
ALTER DATABASE [tempdb] ADD FILE (NAME = N'Temp2', FILENAME = N'G:\TempDBFiles\Temp1.ndf' , SIZE = 8GB , FILEGROWTH = 512);
ALTER DATABASE [tempdb] ADD FILE (NAME = N'Temp3', FILENAME = N'G:\TempDBFiles\Temp1.ndf' , SIZE = 8GB , FILEGROWTH = 512);
GO
```

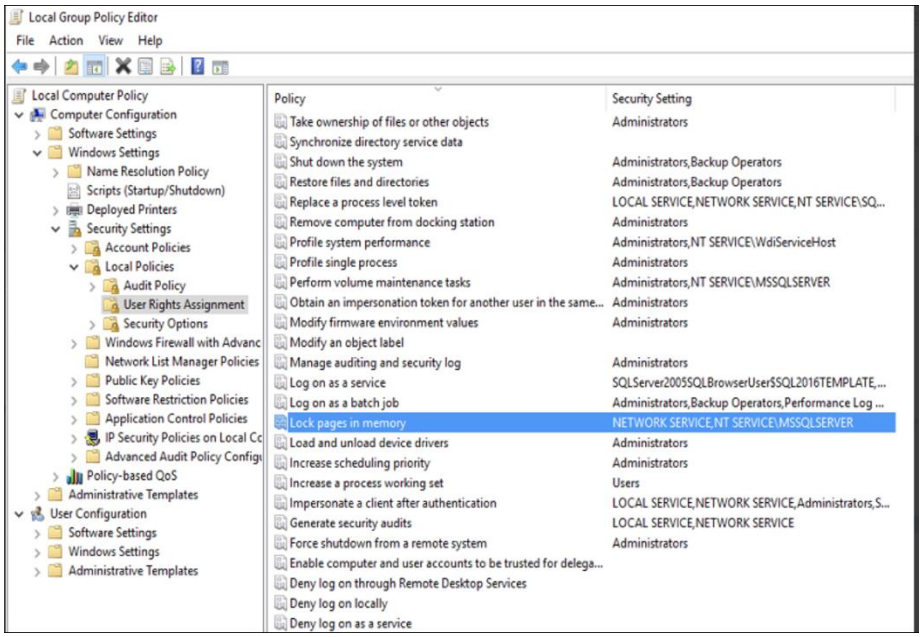
B. Add Trace flags T174, T834 and T3427 in Startup Parameters for "MSSQLSERVER" service as per Microsoft recommendations



C. Set “Lock Pages in Memory” privilege for the service account

i) Open Local Group Policy Editor

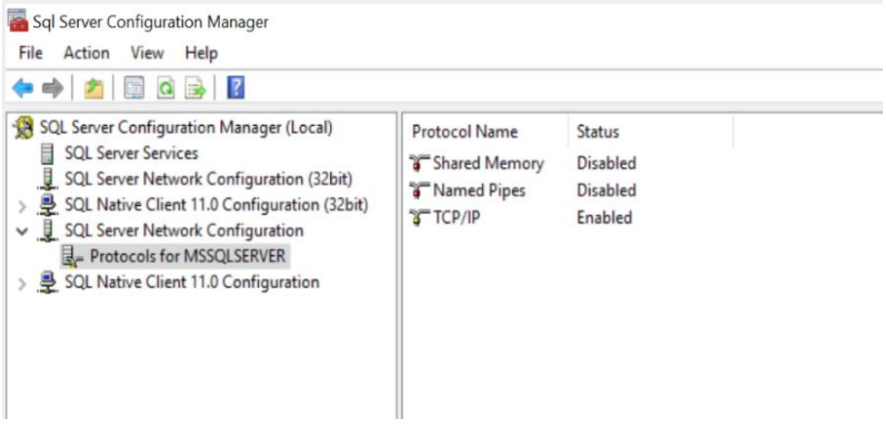
ii) Navigate to Computer Configuration > Windows Settings > Local Policies > User Rights Assignment



D. Disable "Named Pipes" and Enable "TCP/IP" network protocol

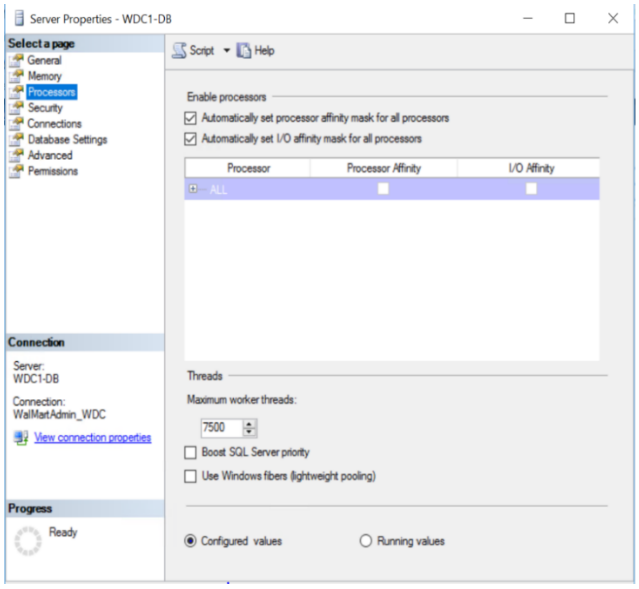
i) Open SQL Server Configuration Manager

ii) Navigate to SQL Server Network Configuration > Protocols for MSSQLSERVER



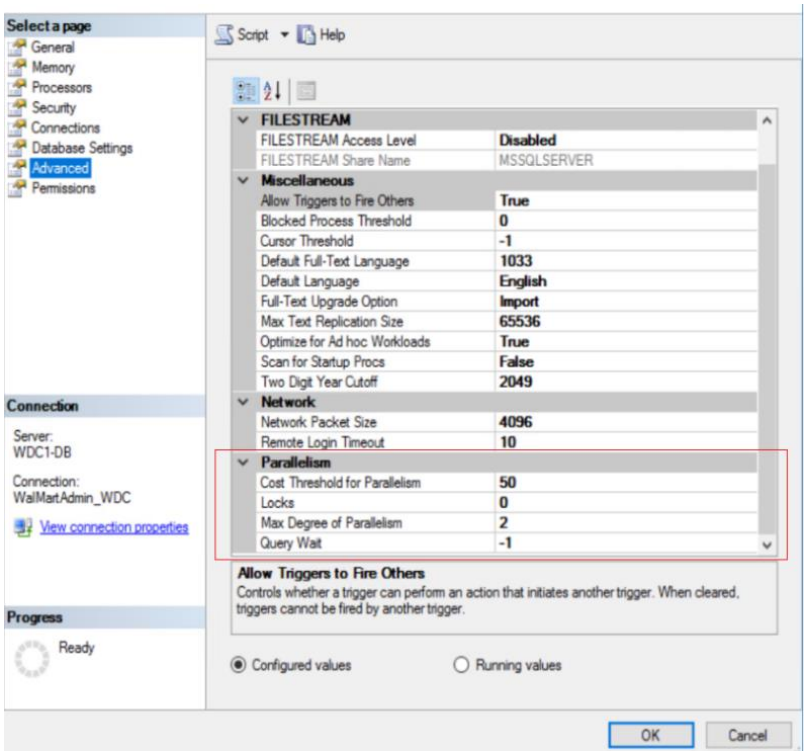
E. Increase Maximum Worker threads in server properties to "**7500**"

i) Open Server Properties from SSMS and go to Processors tab



F. Set “Max Degree of Parallelism” to **4** on database instance level and “Cost threshold for Parallelism” to **50** on database server level

i) Open Server Properties from SSMS and go to Advanced tab

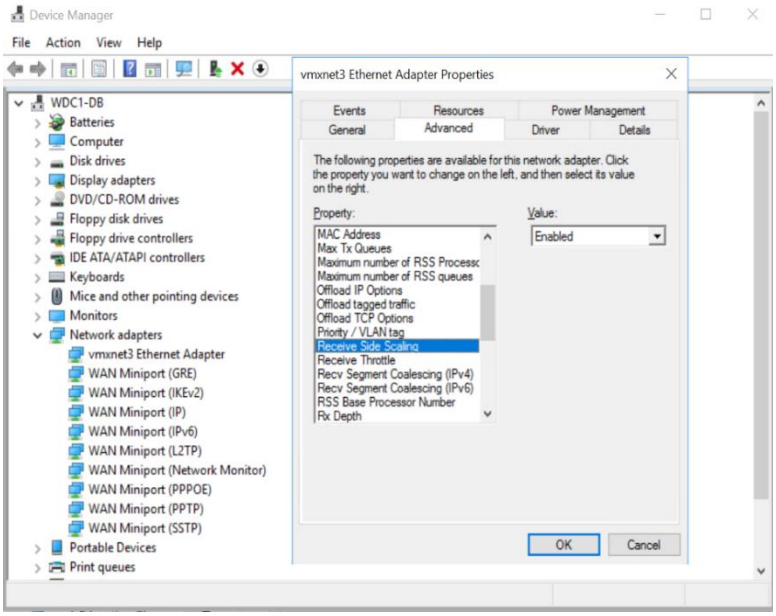


G. Enable “Received Side scaling” setting for Network Adapter on SQL server

i) Open *Device Manager* in SQL server and run DEVMGMT.msc from Command Prompt

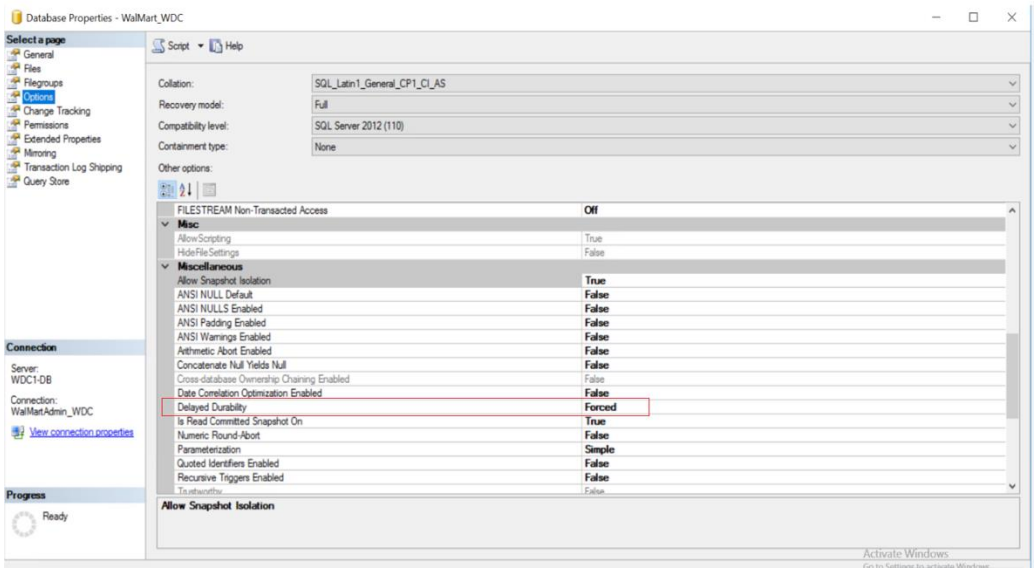
ii) Expand **Network adapters**, right click on your adapter and select **Properties**

iii) Select the **Advanced** tab and find **Receive Side Scaling.** Set this to **Enabled** if it isn’t already.



H. Set “Delayed Durability” under database properties = “Forced” to reduce WriteLog waits

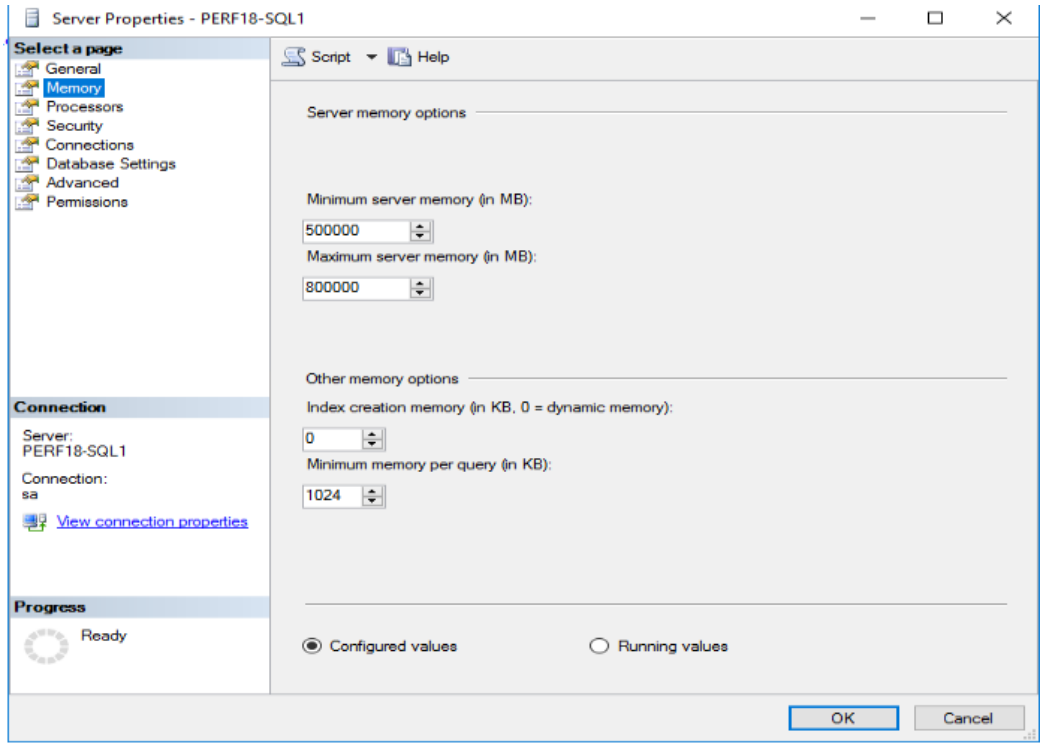
i) Open *Database Properties* from SSMS and go to *Options*



I. Update “Minimum and Maximum Server Memory” allocation in Server Properties

i) Minimum Server Memory (in MB): 500000

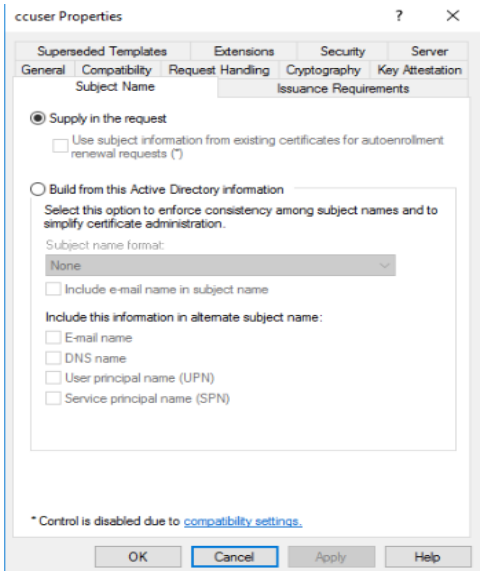
ii) Maximum Server Memory (in MB): 1500000



CA Server Recommendations

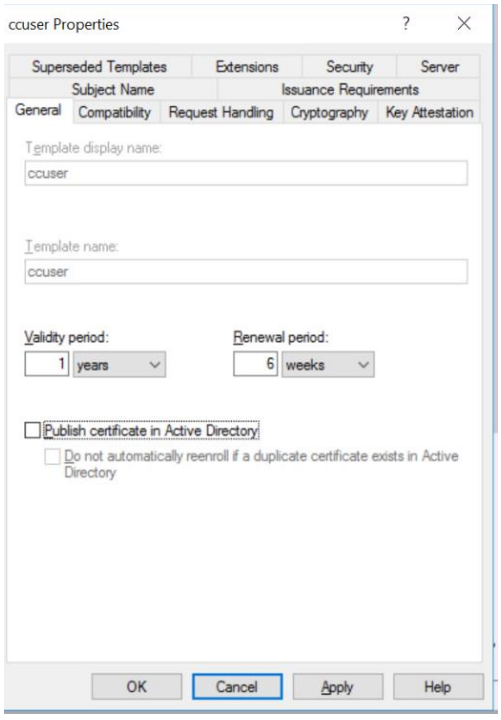
A. Change the issuing template properties to select “Supply in the request” for Subject Name

i. In the CA server, *navigate to the Certificate Template > Manage > “your issuing template” > Properties*



B. Uncheck Publish certificate in Active Directory in issuing template General properties of the CA Server

i. In the CA server, *navigate to the Certificate Template > Manage > “your issuing template” > Properties*



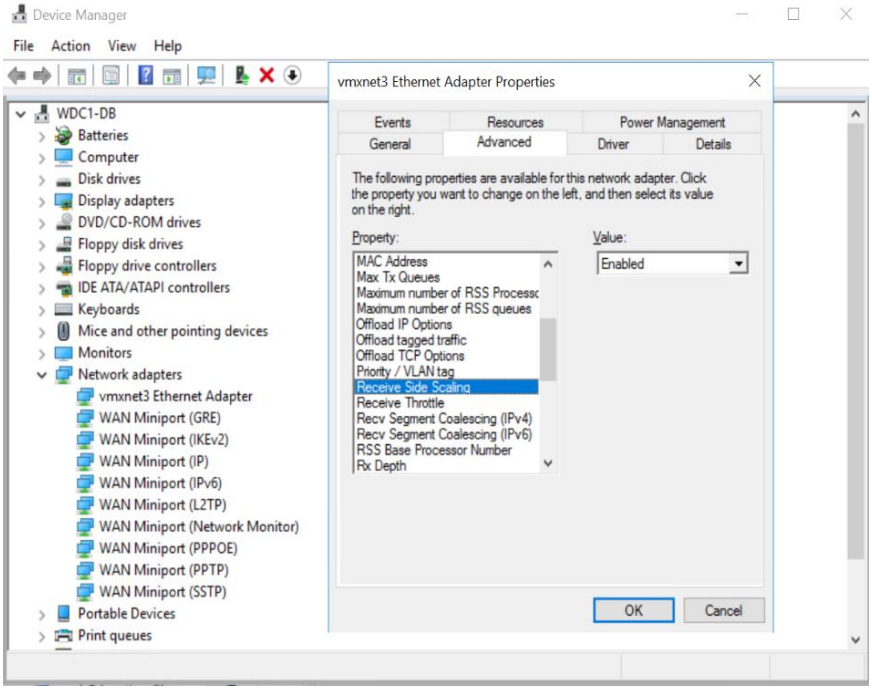
Hardware Recommendations

A. Enable Network Interface Card “Received Side Scaling” for efficient distributions of network receive processing across multiple CPUs on all application servers.

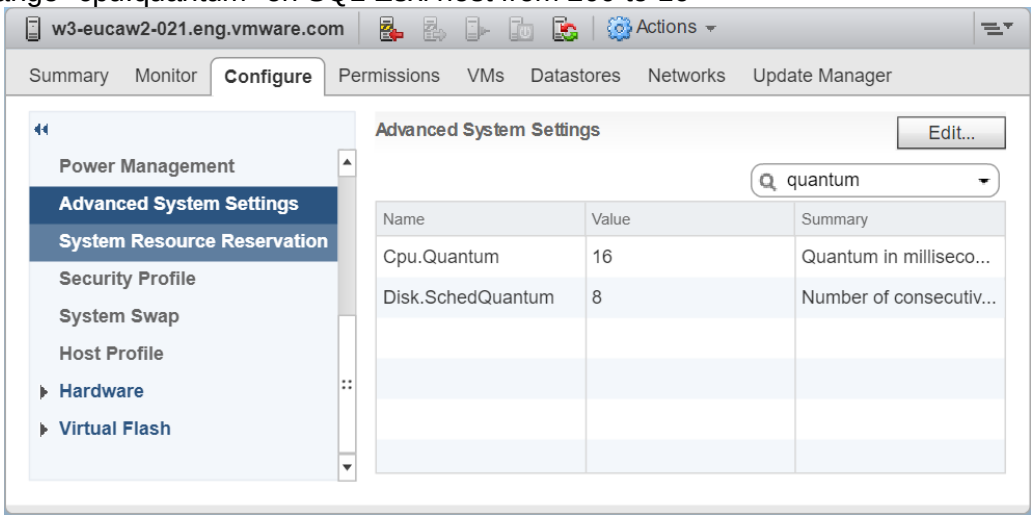
iii) Open *Device Manager* in SQL server and run DEVMGMT.msc from Command Prompt

iv) Expand ***Network adapters***, right click on your adapter and select ***Properties***

v) Select the ***Advanced*** tab and find ***Receive Side Scaling*****.** Set this to ***Enabled*** if it isn’t already.



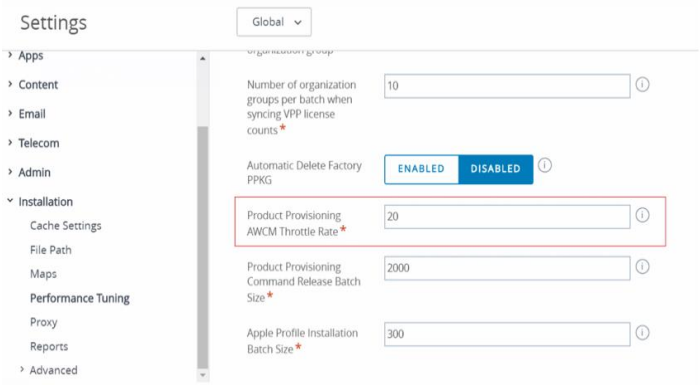
B. Change "cpu.quantum" on SQL Esxi host from 200 to 16



Workspace ONE UEM Application Servers Settings and Recommendations

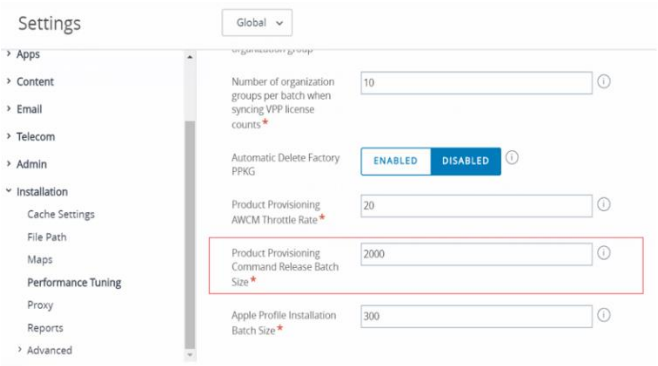
A. Set Product Provisioning AWCM Throttle Rate: 20

a. Navigate to *Settings* > *Installation* > *Performance Tuning*



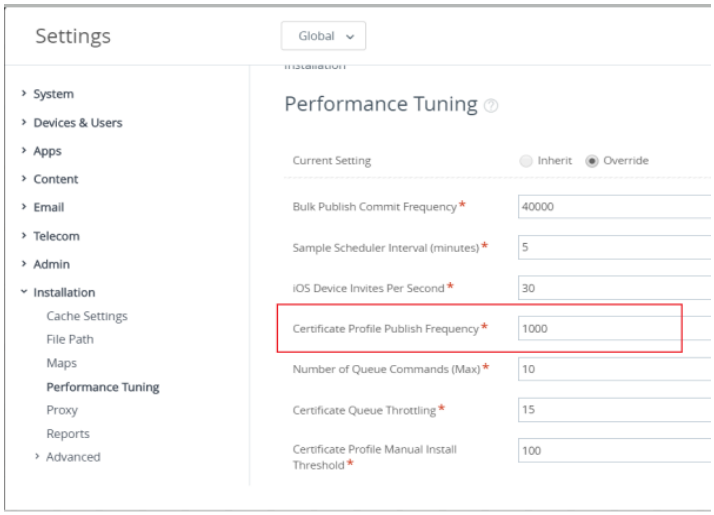
B. Set Product Provisioning Command Release Batch Size: 2000 per 2 mins

I. Navigate to *Settings* > *Installation* > *Performance Tuning*



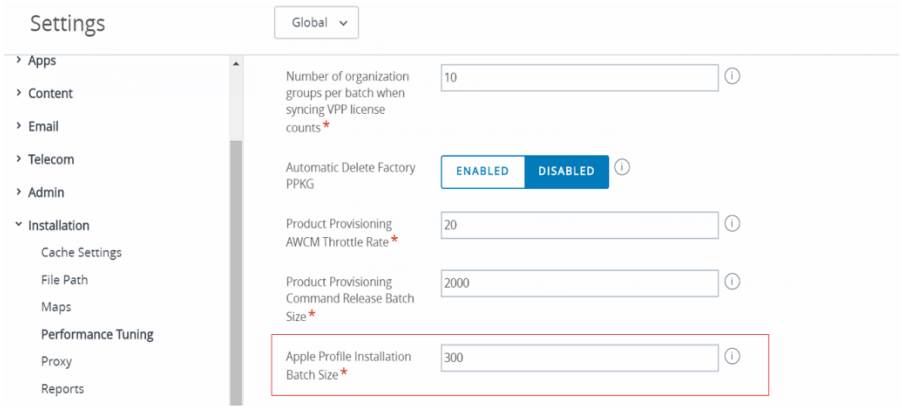
C. Set Certificate Profile Publish Frequency: 1000

a. Navigate to Settings > Installation > Performance Tuning



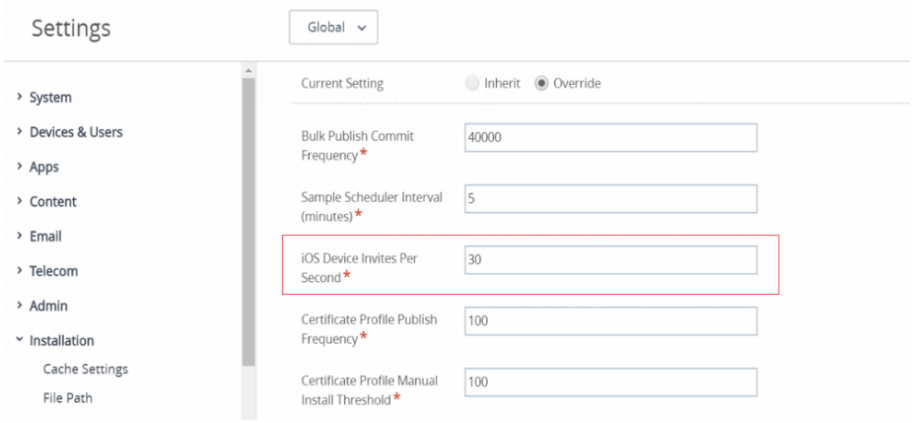
D. Set Apple Profile Installation Batch Size: 300

i. Navigate to *Settings* > *Installation* > *Performance Tuning*



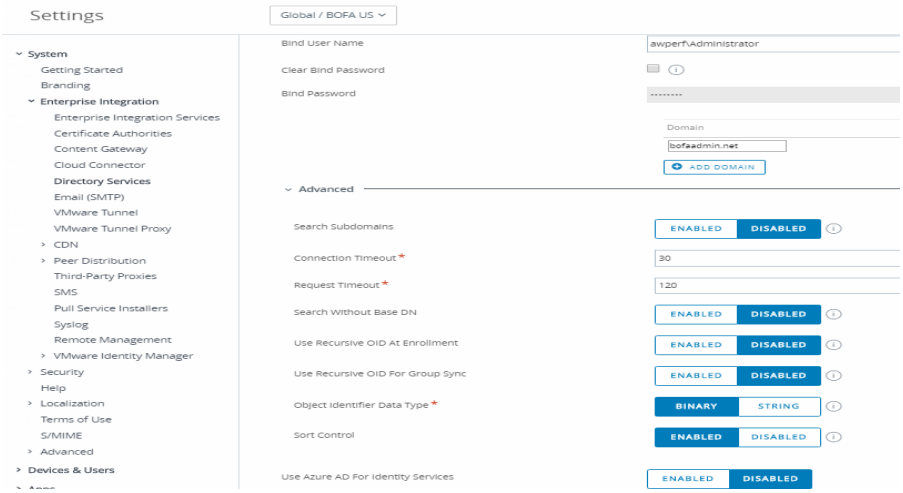
E. Set iOS Device Invites Per Second:30

i. Navigate to *Settings* > *Installation* > *Performance Tuning*



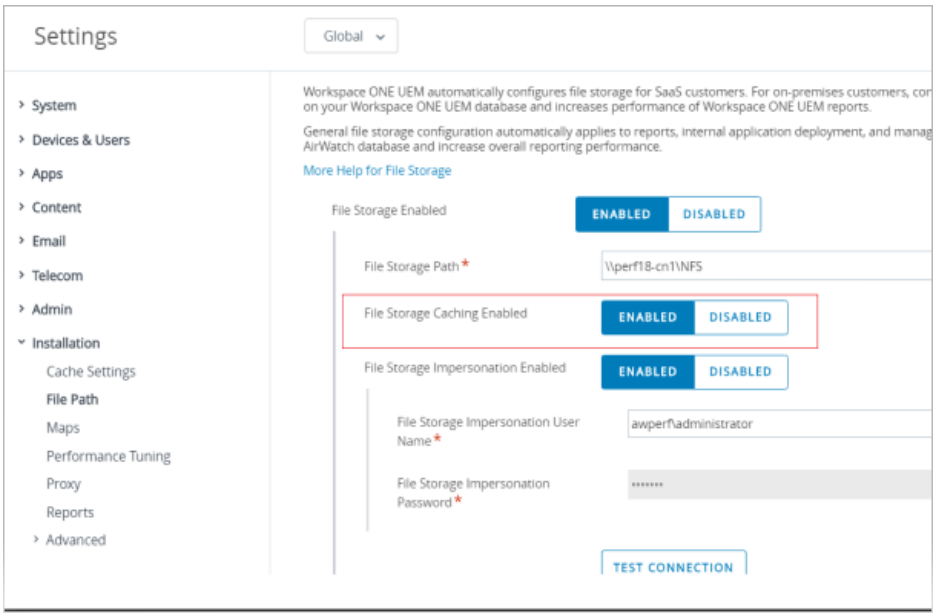
F. Set Use Recursive OID At Enrollment as disabled for Directory Services

i. Navigate to *System > Enterprise Integration > Directory Services > Advanced*



G. Enable File Storage Caching Enabled setting

i. Navigate to *Settings > Installation > File Path*



H. Override the default value in *Systemcode* table for *FastLaneMessageRateMultiple* to 1.5 by updating *Systemcodeoverride* table in DB.