

Tapani Havia

# Microsoft Windows Server 2012

Centrally Managed Basic Services  
for Microsoft Windows 8 Clients

Helsinki Metropolia University of Applied Sciences

Bachelor of Engineering

Information Technology

Bachelor's Thesis

14<sup>th</sup> May 2013

## **PREFACE**

This Bachelor's Thesis is the outcome of my professional knowledge of the Microsoft Windows Server 2012 centrally managed basic services.

I wish to thank my instructors Kari Järvi and Jonita Martelius for their invaluable help and support while writing the study.

Last but not least I wish to thank my wife Mia Havia for her endless patience while writing the study.

Espoo, May 14, 2013

Tapani Havia

Author(s) Title	Tapani Havia Microsoft Windows Server 2012
Number of Pages Date	153 pages + 10 appendices 14th May 2013
Degree	Bachelor of Engineering
Degree Program	Information Technology
Specialization option	Data Networks
Instructor(s)	Kari Järvi, Principal Lecturer
<p>Microsoft published the latest operating system versions; Windows Server 2012 and Windows 8 last autumn. It was the correct time to create a test environment and test how basic services and their centralized remote management could be done nowadays. The purpose was to come up with as versatile an environment as possible which any person interested in the topic could do and continue to the desired direction.</p> <p>The initial plan was to create the test environment in one computer virtually. The environment was done with redundancy of basic services without Network Load Balancing or Failover Clustering features. Finally, the environment within the framework of the study included 11 virtual servers and three virtual workstations. For the host computer's operating system was chosen the Windows Server 2012 Datacenter edition and the needed hypervisor software was chosen between Microsoft Hyper-V and VMware Workstation 9, the environment was done with VMware.</p> <p>These operating system versions contain a good and wide range of tools for remote management. The basic services were almost the same as in the earlier versions, only the Hyper-V feature is new in the Windows 8 x64 editions and the IP Address Management (IPAM) Server feature in the Windows Server 2012 editions. This study contains as many remote management tools as possible.</p> <p>It is possible to make a good test environment for learning the basic services and their remote management tools to one computer with basic home computer components. A virtual environment gives good possibilities to backup and take snapshots of virtual computers to recover the earlier state if needed.</p>	
Keywords	Microsoft, Windows Server 2012, Windows 8

Tekijä(t) Otsikko	Tapani Havia Microsoft Windows Server 2012
Sivumäärä Aika	153 sivua + 10 liitettä 14.5.2013
Tutkinto	Insinööri (AMK)
Koulutusohjelma	Tietotekniikka
Suuntautumisvaihtoehto	Tietoverkot
Ohjaaja(t)	Kari Järvi, yliopettaja
<p>Microsoft julkaisi viime syksynä uusimmat käyttöjärjestelmäversiot: Windows Server 2012:sta ja Windows 8:n. Nyt oli oikea aika tehdä testiympäristö niillä ja testata kuinka perusominaisuudet ja niiden etähallinta voidaan hoitaa nykyään. Tavoite oli tehdä mahdollisimman monipuolinen ympäristö, jonka kuka tahansa kiinnostunut voi tehdä ja jatkaa sitä haluttuun suuntaan.</p> <p>Testiympäristö suunniteltiin niin, että se tehtiin yhdelle tietokoneelle virtuaalisena. Ympäristö tehtiin peruspalveluilla ja niiden mahdollisilla vikasietoratkaisuillaan ilman Network Load Balancing- tai Failover Clustering -palveluita. Loppujen lopuksi ympäristö käsitti tämän työn puitteissa 11 virtuaalipalvelinta sekä 3 virtuaalityöasemaa. Isäntätietokoneen käyttöjärjestelmäksi valittiin Windows Server 2012 Datacenter -editio ja tarvittava virtualisointiohjelmisto valittiin Microsoft Hyper-V:n ja VMware Workstation 9:n väliltä. Ympäristö tehtiin VMwarella.</p> <p>Käyttöjärjestelmäversiot sisältävät hyvän ja laajan skaalan työkaluja etähallintaan. Peruspalvelut ovat melkein samat kuin aikaisemmissa versioissakin. Ainoastaan Hyper-V -palvelu on uusi Windows 8 x64 -editioissa sekä IP Address Management (IPAM) Server -palvelu Windows Server 2012 -editioissa. Tähän työhön sisällytettiin mahdollisimman monta etähallintatyökalua.</p> <p>On mahdollista tehdä hyvä testiympäristö, jolla voi opetella peruspalvelut ja niiden etähallintatyökalut, yhdelle peruskotitietokonekomponenteista rakennetulle tietokoneelle. Virtuaaliympäristö antaa hyvät mahdollisuudet ottaa varmuuskopioita ja reaaliaikaisia tilannevedoksia virtuaalikoneista palatakseen aikaisempaan tilanteeseen, jos tarve niin vaatii.</p>	
Avainsanat	Microsoft, Windows Server 2012, Windows 8

## Abbreviations

.NET	Software framework developed by Microsoft
4G	4 <sup>th</sup> generation of mobile phone communications standards
802.1x	IEEE standard for port-based network access control
AD	Active Directory
ADSI	Active Directory Services Interface
ADSL	Asymmetric Digital Subscriber Line
AG	Aktiengesellschaft (English: Corporation)
AMD	Advanced Micro Devices
API	Application Programming Interface
ASP.NET	Active Server Pages .NET
AT	IBM Personal Computer AT
ATA	AT Attachment
BIOS	Basic Input Output System
CA	Certification Authority
CMAK	Connection Manager Administration Kit
CPU	Central Processing Unit
CRL	Certificate Revocation List
CS	AD Certificate Services
DC	Domain Controller
DDR3	Double Data Rate type 3 SDRAM
DFS	Distributed File System
DHCP	Dynamic Host Configuration Protocol
DMZ	Demilitarized Zone, Perimeter Network
DNS	Domain Name System
DNSSEC	Domain Name System Security Extensions
DOS	Disk Operating System
DS	Domain Services
DVD	Digital Versatile Disc
DVD-ROM	Digital Versatile Disc - Read Only Memory
EFS	Encrypting File System
FQDN	Fully Qualified Domain Name
FS	AD Federation Services
FSRM	File Server Resource Manager
FTP	File Transfer Protocol

GP	Group Policy
GPO	Group Policy Object
GUI	Graphical User Interface
GUID	Globally Unique Identifier
HCAP	Host Credential Authorization Protocol
HDD	Hard Disk Drive
HR	Human Resources
HRA	Health Registration Authority
HTTPS	Hypertext Transfer Protocol Secure
IBM	International Business Machines
ICT	Information and Communications Technology
IE	Internet Explorer
IGMP	Internet Group Management Protocol
IIS	Internet Information Services
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IPAM	Internet Protocol Address Management
IPP	Internet Printing Protocol
IPSec	Internet Protocol Security
iSCSI	Internet Small Computer System Interface
ISE	Integrated Scripting Environment
iSNS	Internet Storage Name Service
LAN	Local Area Network
LDS	AD Light-weight Directory Services
LPD	Line Printer Daemon
LPR	Line Printer Remote Service
ME	Millennium Edition
MMC	Microsoft Management Console
MP3	Audio File
MSC	Microsoft Common Console Document
MSMQ	Microsoft Message Queuing
NAP	Network Access Protection
NAS	Network Attached Storage
NAT	Network Address Translation
NDES	Network Device Enrollment Service

NFS	Network File System
NIC	Network Interface Controller
NIS	Network Information Service
NLB	Network Load Balancing
NPAS	Network Policy and Access Services
NPS	Network Policy Server
NT	New Technology
NTFS	New Technology File System
OData	Open Data
OEM	Original Equipment Manufacturer
OS	Operating System
PC	Personal Computer
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
PKI	Public Key Infrastructure
PSU	Power Supply Unit
PXE	Preboot Execution Environment
QWERTY	The characters from upper left corner of keyboard
R2	Release 2
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
RAS	Remote Access Server
RD	Remote Desktop, Research and Developing
RDC	Remote Differential Compression
RDS	Remote Desktop Services
RIP	Routing Information Protocol
RM	Remote Management
RMS	AD Rights Management Services
RSAT	Remote Server Administration Tools
RTL	Right to Left
RTM	Ready to Manufacture
SAN	Storage Area Network
SATA3	Serial ATA type 3
SDRAM	Synchronous Dynamic RAM
SNMP	Simple Network Management Protocol
SP1	Service Pack 1

SSD	Solid State Drive
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TPM	Trusted Platform Module
UI	User Interface
UNIX	Uniplexed Information and Computing Service, UNICS renamed to UNIX
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
VAS	Volume Activation Services
VL	Volume License
VM	Virtual Machine
VPN	Virtual Private Network
VSS	Volume Snapshot Service
WAN	Wide Area Network
WebDAV	Web Distributed Authoring and Versioning
WDS	Windows Deployment Services
WID	Windows Internal Database
WINS	Windows Internet Name Service
WMI	Windows Management Instrumentation
WoW64	Windows 32-bit on Windows 64-bit
WSUS	Windows Server Update Services
XP	Short of experience



## Contents

1	Introduction	1
2	Latest Microsoft Operating Systems	3
2.1	Microsoft Windows Server 2012	3
2.1.1	Differences to Previous Version	4
2.1.2	System Requirements	6
2.1.3	System Limitations	7
2.1.4	Licensing and Pricing	9
2.1.5	Domain Joinable Editions	9
2.1.6	Upgrade Paths	11
2.1.7	Languages	13
2.2	Microsoft Windows 8	16
2.2.1	Differences from the Previous Version	17
2.2.2	System Requirements	17
2.2.3	System Limitations	18
2.2.4	Licensing and Pricing	19
2.2.5	Domain Joinable Editions	19
2.2.6	Upgrade Paths	20
2.2.7	Languages	21
3	Roles, Role Services, Features and Tools	26
3.1	Roles and Role Services	26
3.1.1	Active Directory Certificate Services (AD CS)	27
3.1.2	Active Directory Domain Services (AD DS)	28
3.1.3	DHCP Server	29
3.1.4	DNS Server	30
3.1.5	Fax Server	31
3.1.6	File and Storage Services	31
3.1.7	Network Policy and Access Services (NPAS)	34
3.1.8	Print and Document Services	35
3.1.9	Remote Access Services (RAS)	36
3.1.10	Windows Deployment Services (WDS)	38
3.1.11	Windows Server Update Server (WSUS)	38
3.1.12	Others	39
3.2	Features	43
3.2.1	Group Policy Management	43

3.2.2	IP Address Management (IPAM) Server	43
3.2.3	User Interfaces and Infrastructure	44
3.2.4	Others	46
3.2.5	Microsoft Windows 8 Features	47
3.3	Tools	48
3.3.1	Applications	48
3.3.2	Microsoft Management Console Snap-Ins	53
3.3.3	PowerShell Modules	55
3.3.4	Remote Server Administration Tools (RSAT)	56
4	Planning and Implementing Test Environment	59
4.1	Platform for Environment	60
4.1.1	Physical Environment	60
4.1.2	Virtual Environment	67
4.1.3	Basic Server Installation with GUI	73
4.1.4	Basic Server Installation with Core User Interface	78
4.1.5	Basic Windows 8 Installation	82
4.1.6	Finalizing Platform	87
4.2	Active Directory Domain Services (AD DS)	97
4.3	DNS Server	103
4.4	DHCP Server	106
4.5	Remote Server Administration Tools (RSAT)	109
4.6	Active Directory Certificate Services (AD CS)	111
4.7	Windows Server Update Server (WSUS)	117
4.8	Group Policy Management	118
4.9	File and Storage Services	124
4.10	Fax Server	128
4.11	Network Policy and Access Services (NPAS)	129
4.12	Remote Access Services (RAS)	131
4.13	Print and Document Services	132
4.14	Windows Deployment Services (WDS)	134
4.15	IP Address Management (IPAM) Server	135
4.16	Default Remote Management Tools	137
5	Conclusion	147
	References	149

## Appendices

Appendix 1. Available Packages for Roles in Different Windows Server 2012 Editions

Appendix 2. Available Packages for Features in Different Windows Server 2012 Editions

Appendix 3. Features of Windows 8

Appendix 4. Windows 8 Display Languages

Appendix 5. Role Dependencies with User Interface Requirements in Server 2012

Appendix 6. Feature Dependencies with User Interface Requirements in Server 2012

Appendix 7. Format Differences between English (United States) and Finnish (Finland)

Appendix 8. Format Differences between SI Decimal and JEDEC Binary Prefixes

Appendix 9. Installed Updates to the Environment

Appendix 10. Costs of Different Storage Options

## 1 Introduction

The aim of the study was to build a testing environment which would be as versatile as possible for Microsoft Windows Server 2012 and Microsoft Windows 8 operating systems with as limited a number of virtual computers as possible. The test environment includes availability and redundancy if it was feasible without Failover Clustering and Network Load Balancing (NLB) features. This all was implemented with the Microsoft Windows Server 2012 Standard edition and the Microsoft Windows 8 x64 Enterprise edition. Third-party technologies were not used in the study. Microsoft's Hyper-V technology was not used either, the virtual environment was implemented at a single computer with the VMware Workstation 9 software. The aim was to create a good learning environment for students interested of the topic.

The study includes all possible basic services and management consoles described in the latest version of Microsoft Windows Server and Microsoft Windows. The environment was built using Standard 180-day evaluation edition in servers and Enterprise x64 90-day evaluation edition in workstations. Microsoft Windows Server 2012 was released September 4, 2012 and Microsoft Windows 8 August 15, 2012.

The study does not include the Active Directory Federation Services (AD FS), Active Directory Light-weight Directory Services (AD LDS), Active Directory Rights Management Services (AD RMS), Hyper-V, Remote Desktop Services (RDS) or Web Server (IIS) roles. Outside of the main features of the study are the Failover Clustering and the Network Load Balancing.

First the study introduces the Microsoft Windows Server 2012 and the Windows 8 product editions, differences to the previous versions, languages, system requirements and limitations, licensing and upgrade paths from earlier versions. The second chapter contains the roles, features and tools explained accurately.

Thirdly the planning and implementing of the environment is introduced in a chronological order, as well as the features and management consoles. The first task was to plan and implement the hardware platform to the environment and the virtual platform in between. After implementing the platform it was time to start to implement the roles and the

features to the different virtual machines. The first roles in the environment were the Active Directory Domain Services (AD DS), DNS Server and DHCP Server roles.

The environment was planned in a way that administrators create remote connections to Remote Management servers and use its tools to manage all of the servers. That was demonstrated next with Remote Server Administration Tools (RSAT) included in server. Roles and features which need Group Policy Objects (GPO) are included next and after these the Group Policy Management feature. Furthermore, the report includes other roles and features chosen according to their importance. However, the operating systems default remote management tools are tested in the study.

Each included role and feature was presented and installed to the test environment with basic properties. Appendices at the end of the study include tables of application packages in different Windows Server 2008 editions, features of Windows 8, Windows 8 support of display languages, role dependencies between editions, user interface dependencies and installed updates in both operating systems.

## 2 Latest Microsoft Operating Systems

Windows Server 2012 is the tenth and latest server operating system version from Microsoft, it continues the series of server operating systems. The first version, Microsoft Windows NT 3.1 was released July 27, 1993. Microsoft has released this year NT kernel based operating systems for 20 years. Between these there were eight different versions; Windows NT 3.5 (1994), Windows NT 3.51 (1995), Windows NT 4.0 (1996), Windows 2000 (2000), Windows Server 2003 (2003), Windows Server 2003 R2 (2006), Windows Server 2008 (2008) and Windows Server 2008 R2 (2009). All versions up to Windows Server 2008 supported the 32 bit architecture. Versions from Windows Server 2008 R2 have been only with the 64 bit architecture. The first 64 bit version was Windows Server 2003, this 64 bit version was released in 2005, two years later of the 32 bit version.

Windows 8 is the fifth NT kernel based and latest workstation operating system from Microsoft, it continues the series of workstation operating systems. The first version, Microsoft Windows 2000 was released Feb 17, 2000. Between these there were three different versions; Windows XP (2001), Windows Vista (2007) and Windows 7 (2009). Earlier DOS based Windows operating systems made history from first 1.0 version released Nov 20, 1985 to last Windows ME version released Jun 19, 2000. Between these there were six different versions; Windows 2.0 (1987), Windows 2.1x (1988), Windows 3.0 (1990), Windows 3.1x (1992), Windows 95 (1995) and Windows 98 (1998). The first versions from Windows 1.0 to Windows 3.1x were with the 16 bit architecture. All newer from Windows 95 were with 32 bit architecture. Windows XP was the first with 64 bit architecture, it was released in 2005, four years later than 32 bit version.

### 2.1 Microsoft Windows Server 2012

Microsoft Server 2012 does not contain any major changes compared to the earlier version. There is only one new role, Volume Activation Services. The limitations in the new version have grown, enabling it to support larger systems. Maybe the largest change is the possibility to change between the core and GUI features without reinstalling and there is the third user interface model between them. Another big change is that it is possible to install almost all the roles and role services to the core user interface. The Appendices contain a detailed list of user interface requirements. The Fax Server role and the Windows Search Service feature only need a full GUI. The biggest visual change is the Start Screen, formerly called the Metro UI. Microsoft changed the name because of potential trademark similarities with another German Metro AG company in August

2012, Microsoft denies that officially [1]. The Start Menu that was introduced with the Windows 95 17 years ago was replaced with the Start Screen. Microsoft Windows Server 2012 also contains the new Charms. The Charms are three different menus in the Charm Bar, which appear with hot key or swiping the cursor to the corner, as shown in Figure 1.

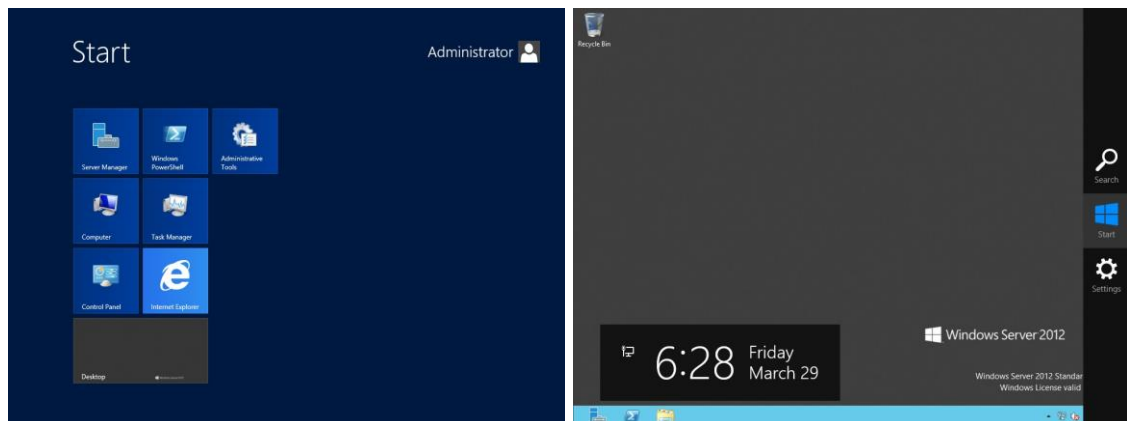


Figure 1: Start Screen on the left and Charm Bar on the right.

Figure 1 shows a new Start Screen feature which replaces the previous Start Menu in Windows Server 2012. Figure 1 presents also a new Charm Bar which includes three different Charms in Windows Server 2012.

### 2.1.1 Differences to Previous Version

This chapter only includes the differences on a general level and only technologies which can be upgraded to the versions in Windows Server 2012.

#### Roles and Role Services

The Active Directory Federation Services (AD FS) has received new versions of web agents and the Application Server role has been upgraded with the .NET Framework 4.5. The name of the File and Storage Services is now File Services and it contains a couple of role service changes; Data Deduplication, File Server VSS Agent Service and two iSCSI role services are new in the Microsoft Windows Server 2012. The Indexing Service is completely removed and the Search Service is moved to features in version 2012. The Remote Access is transferred from role services of the Network Policy and Access Services (NPAS) to a separate role and two Remote Desktop Virtualization Host role services are combined into one.

## Features

The new version contains couple of new features; BitLocker Network Unlock, Client for NFS, Data Center Bridging, Enhanced Storage, IP Address Management (IPAM) Server, iSNS Server Service, Management OData IIS Extension, Media Foundation, Windows Feedback Forwarder, Windows Identity Foundation 3.5, Windows PowerShell 3.0, Windows PowerShell Web Access and Windows Standards-Based Storage Management.

Internet Explorer 9 has been updated to version 10 and Windows Server Update Services 3.0 (WSUS) has been joined to Windows versioning system and upgraded to version 6. The Windows Media Player is the same version 12 and the .NET Framework 3.5.1 Features has been upgraded to version 4.5. The RAS Connection Manager Administration Kit (CMAK) is the old Connection Manager Administration Kit and the Ink and Handwriting Server features are combined into one. The Internet Storage Name Server and the Storage Manager for SANs are removed from version 2012 and the Windows Server Backup features are combined into one.

## Internet Information Services (IIS)

IIS 8 includes new role services as compared to the previous 7.5 version. The Centralized SSL Certificate support is a new security role service. New application development role services are the .NET Extensibility 4.5, the Application Initialization, the ASP.NET 4.5 and the WebSocket Protocol. All other role services are identical with IIS 7.5 in the Microsoft Windows Server 2008 R2.

## Remote Server Administration Tools (RSAT)

Version 2012 includes new tools; Share and Storage Management Tools is a new role service under File Services Tools, it is for Windows Server 2008 R2 and older versions. Hyper-V contains now two separate tools; GUI Management Tools and PowerShell Cmdlets. The same is done with Remote Access Management Tools, there are now two separate tools; the GUI and Command-Line Tools and the PowerShell Cmdlets. Under the Remote Desktop Services Tools role there are only few changes. The Remote Desktop Session Host Tools and the Remote Desktop Connection Broker Tools are removed from the version 2012, but there is one new Remote Desktop Licensing Diagnoser Tools feature. The Volume Activation Tools and the Windows Server Update Services Tools are new in version 2012. The last one includes two separate features, the API and PowerShell Cmdlets and the User Interface Management Console. Microsoft



Windows Server 2012 does not any more include the separate Web Server (IIS) Tools. The previous Failover Clustering Tools feature has been divided into four new features; Failover Cluster Automation Server, Failover Cluster Command Interface, Failover Cluster Management Tools and Failover Cluster Module for Windows PowerShell. The IP Address Management (IPAM) Client, the SNMP Tools and the Windows System Resource Manager RSAT features are new in version 2012.

A few tools have been deprecated. This is the last version in which these still linger on. The Server for NIS Tools and the Windows System Resource Manager RSAT are deprecated tools in Windows Server 2012.

### 2.1.2 System Requirements

The minimum system requirements for the processor, memory and disk space of the Microsoft Windows Server 2012 are 1.4 GHz 64-bit processor, 512 MB RAM and 32 GB disk space in the system drive. They are the same as in the previous Microsoft Windows Server 2008 R2 version. Windows Server 2012 does not support Intel Itanium processors anymore. The resolution requirements have also grown, as shown in Figure 2.

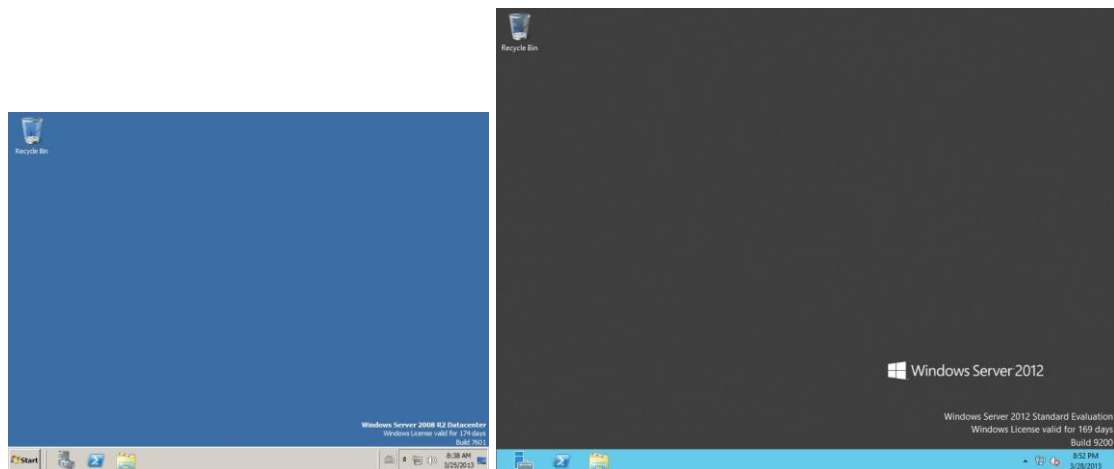


Figure 2: Default desktop differences between Windows Server 2008 R2 and Windows Server 2012.

Figure 2 shows how the Windows Server 2012's 1024x768 default resolution is different to the Windows Server 2008 R2's default 800x600 resolution. Although all Microsoft documents are of the period prior to the product publication and are saying that 800x600 resolution is supported, it is not possible to set 800x600 resolution in the version 2012, as shown in Figure 3 in Chapter 2.1.3. [2][3]

### 2.1.3 System Limitations

The system limitations are different between Windows Server editions and versions. Windows Server 2012 supports larger systems than the previous Windows Server 2008 R2.

#### Processor

Windows Server 2012 supports 64 physical processors and 640 logical processors without Hyper-V role. The Microsoft Windows Server 2008 R2 supports different number of processors, depending on the edition. The Standard edition supports only four physical processors, the Enterprise edition eight processors and the Datacenter edition 64 processors. The Windows Server 2008 R2 version supports 256 logical processors, without Hyper-V role. [4]

#### Memory

The Standard and the Datacenter editions of Windows Server 2012 support 4 TB of RAM and some of the special editions supports less of RAM. The Windows Server 2008 R2 Standard edition only supports 16 GB of RAM, but Enterprise and Datacenter editions 2 TB of RAM. [5]

#### Display Resolution

Windows Server 2012 includes support for different resolutions per display, as shown in Figure 3.

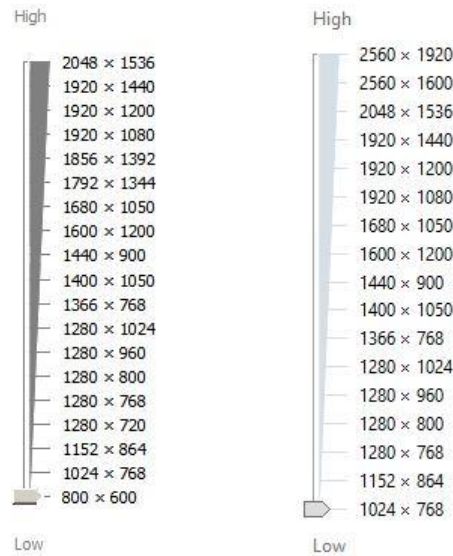


Figure 3: Resolution options in Windows Server 2008 R2 (left) and Windows Server 2012 (right).

Figure 3 shows that the 2012 version includes two larger resolutions than its predecessor. The support for resolutions 800x600, 1280x720, 1792x1344 and 1856x1392 has also been removed.

#### Other Limitations

Windows Server 2012 includes changes of system limitations in the Hyper-V role and the Failover Clustering feature, as shown in Table 1.

Table 1: Hyper-V and Failover Clustering differences between versions [6].

Processor/Memory Feature	Windows Server 2008 R2	Windows Server 2012
<b>Logical processors on hardware</b>	64	320
<b>Physical memory</b>	1 TB	4 TB
<b>Virtual processors per host</b>	512	2,048
<b>Virtual processors per virtual machine</b>	4	64
<b>Memory per virtual machine</b>	64 GB	1 TB
<b>Active virtual machines</b>	384	1,024
<b>Maximum cluster nodes</b>	16	64
<b>Maximum cluster virtual machines</b>	1,000	8,000

Table 1 shows that all the limitations of the system have grown at least four times. These Windows Server 2012 system limitations can be considered in the modern world as opportunities rather than limitations.

#### 2.1.4 Licensing and Pricing

The Standard and the Essentials editions are licensed under the retail, volume license (VL) and OEM programs. The Datacenter edition is licensed under the volume license and OEM programs. The Foundation, the Storage Server and the MultiPoint Server editions are only licensed under the OEM program. The Standard and the Datacenter edition licenses are for two physical processors, the Foundation and the Essentials edition licenses are per server licenses. The Foundation edition is limited for 15 user accounts and the Essentials edition for 25 user accounts.

The Hyper-V Server edition is a free, downloadable edition. The retail license program prices in the Microsoft Store are for the Standard edition \$1215.19 and for the Essential edition \$545.47. The volume license program prices start for the Essentials edition from \$501, for the Standard edition from \$882 and for the Datacenter edition from \$4809. [7][8]

#### 2.1.5 Domain Joinable Editions

The Microsoft Windows Server 2012 product family contains seven different editions. The Standard and the Datacenter editions are the most common editions. These common editions contains the same roles and features. The product family includes five special editions, which do not contain any extra, they contain only fewer roles and features or are priced differently. The special editions contain various system limitations.

##### Microsoft Windows Server 2012 Standard

This edition is for low density or non-virtualized environments. It includes all the roles and the features and do not contain any user limitations.

##### Microsoft Windows Server 2012 Datacenter

This edition is for highly virtualized private or hybrid cloud environments. It includes all the roles and the features and do not contain any user limitations.

### Microsoft Windows Server 2012 Foundation

This low cost edition is for small use of general servers. It does not support Data Duplication, Hyper-V, Remote Desktop Virtualization Host, Windows Server Update Services (WSUS), Failover clustering and Hyper-V tools. It includes a full GUI by default but can be changed to core user interface. This product does not contain an evaluation media, but it is available from Microsoft TechNet service. [9]

### Microsoft Windows Server 2012 Essentials

The Microsoft Windows Server 2012 Essentials edition is the best choice for small companies. It is the latest version from the earlier Windows Server 2008 R2 based Microsoft Small Business Server 2011 product. It covers almost all roles and features, only Data Deduplication, Hyper-V, Remote Desktop Virtualization Host, Windows Server Update Services, Failover Clustering and Hyper-V tools are removed from this edition. The administrators have to be careful with this one, this edition installs almost all roles by default. It includes a full GUI by default but it can be lightened to core user interface. The 180 day evaluation media for this edition is downloadable from Microsoft [10] [11].

The system requirements are higher than in the Standard edition. The minimum speed of the processor is 1.4 GHz with single-core and the recommended speed is 3.1 GHz with multi-core. The minimum amount of memory is 2 GB and the recommended amount is 8 GB. The drive space requirement is 160 GB with a 60 GB system partition. [12]

### Microsoft Hyper-V Server 2012

This edition includes only File Server, Storage Services, Hyper-V and Remote Desktop Virtualization Host role services. It contains only some of the features, the most important of these is the Failover Clustering. This is a free edition and available from Microsoft [13] [14].

### Microsoft Storage Server 2012 Standard

Windows Storage Server 2012 is an advanced storage and file serving edition for all organizations. Microsoft Storage Server 2012 includes two editions, Workgroup for workgroup use and Standard for domain use. These editions contain the same system requirements than the Standard edition. The evaluation media for this edition is downloadable from Microsoft [15] [16].

### Microsoft MultiPoint Server 2012 Premium

Windows MultiPoint Server 2012 is a shared resource computing technology that makes it suitable to low cost educational environments. Microsoft MultiPoint Server 2012 includes two editions, Standard for workgroup use and Premium for domain use. This Windows MultiPoint Server 2012 version is a new version of the Windows Server 2008 R2 based Windows MultiPoint Server 2011. This edition includes different system requirements, a dual core processor and 1 core for each two stations, 2 GB of memory and 0.5 GB of memory per station, 20 GB of drive space is needed. The evaluation media for this edition is downloadable from Microsoft [17] [18].

#### 2.1.6 Upgrade Paths

Microsoft Windows Server 2012 supports in place upgrading from the Microsoft Windows Server 2008 and the Microsoft Windows Server 2008 R2 versions. It is possible to upgrade the Standard and the Enterprise editions either to the Standard or the Datacenter editions. The Web editions are possible to be upgraded to the Standard edition. The Datacenter edition can be upgraded to a Datacenter edition. It is only possible to upgrade inside the same x86 or x64 architecture [19]. There are few differences between technologies and some of new technologies are available to the previous versions. These are not the solutions to remain in the previous versions, these are only first aid when bigger challenges do not allow full operating system upgrade to new version.

The update schedule must be planned according to the Microsoft support lifecycle schedule. It is a good plan to move away from version before the Microsoft support ends totally. Microsoft Windows Server 2012 includes now full support until January 9, 2018 and partial support to January 10, 2023. Microsoft supports both of these upgradable versions in every way to January 13, 2015, including the Standard, Enterprise and Datacenter editions. The Web edition support works in fully to July 9, 2013. All support discontinued for these upgradable versions and their Standard, Enterprise and Datacenter editions January 14, 2020. All support of the Web editions ends July 10, 2018. It is a good plan to schedule the upgrade projects before July 2013 or January 2015 depending on the editions and then use the Windows Server 2012 version latest to January 2018. [20]

Microsoft Windows Server 2003 and Microsoft Windows Server 2003 R2 has limited support until July 14, 2015. These versions are not upgradeable to version 2012 and

they should be replaced with full installation of the latest Windows Server 2012 version.  
[20]

#### Windows Server 2008

The default versions of main technologies in Windows Server 2008 are .NET Framework 3.0, Internet Information Services 7, Internet Explorer 7, Media Player 11, PowerShell 1.0 and Windows Server Update Service 3.0 with SP1. There are no new Windows Server 2012 technologies available automatically from the Microsoft Windows Update Services.

The Microsoft Download Center includes a few new Windows Server 2012 technologies for this version. These are; The .NET Framework 4.5, released October 9, 2012 [21], the Windows Management Framework 3.0 (PowerShell 3.0) (KB2506146), released December 3, 2012 [22] and finally latest version of the Microsoft Security Essentials 4.2.223.1, released February 26, 2013 [23].

Windows Media Player is not upgradable to version 12 and Internet Explorer is only upgradable to version 9. It is possible to upgrade the WebDAV and the FTP role services to version 7.5 in the Internet Information Services 7.0, but not to Windows Server 2012's version 8 [24] [25] [26] [27]. It is possible to upgrade the Windows Server Update Services with its own SP2 but not to the version 6 of Windows Server 2012.

#### Windows Server 2008 R2

The default versions of main technologies in Windows Server 2008 R2 are .NET Framework 3.5.1, Internet Information Services 7.5, Internet Explorer 8, Media Player 12, PowerShell 2.0 and Windows Server Update Service 3.0 with SP2. Only one new Windows Server 2012 technology, the Internet Explorer 10 is available automatically by the Microsoft Windows Update Services. The Internet Explorer 10 for Windows Server 2008 R2 is published February 25, 2013.

The Microsoft Download Center includes few new Windows Server 2012 technologies for this version. These are; The Application Initialization 1.0 for IIS 7.5, released September 18, 2012 [28], the .NET Framework 4.5, released October 9, 2012 [21], the Windows Management Framework 3.0 (PowerShell 3.0) (KB2506146), released December 3, 2012 [22] and finally latest version of the Microsoft Security Essentials 4.2.223.1, released February 26, 2013 [23].

Windows Media Player is the same version in Windows Server 2008 R2 and in Windows Server 2012. The Windows Server Update Service does not include upgrade for Windows Server 2008 R2 to the version 6 of the Windows Server 2012.

### 2.1.7 Languages

Windows Server 2012 includes a wide range of possibilities to configure the language settings and use them in different combinations, as shown in Figure 4.

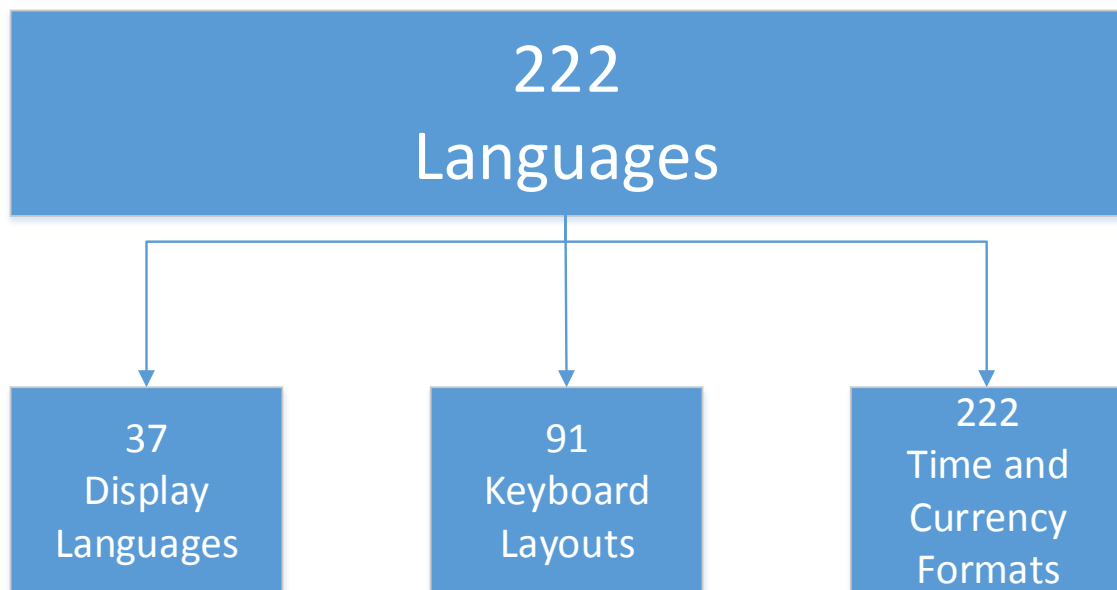


Figure 4: The Windows Server 2012 language possibilities.

Figure 4 shows the different elements of language settings available in Windows Server 2012 installations. It is necessary to plan combinations in such a way that all three parties will benefit, i.e. owners, users and administrators.

#### Display Languages

The Windows Server 2012 installation media is available with 19 different languages. These languages are; Chinese Simplified, Chinese (Hong Kong), Chinese (Taiwan), Czech, Dutch, English (United States), French, German, Hungarian, Italian, Japanese, Korean, Polish, Portuguese (Brazil), Portuguese (Portugal), Russian, Spanish, Swedish and Turkish. [29]



It is also possible to download 18 free language packs for Windows Server 2012 from Microsoft and make own installation media or install the multilanguage installations. These languages are; Arabic, Bulgarian, Croatian, Danish, English (United Kingdom), Estonian, Finnish, Greek, Hebrew, Latvian, Lithuanian, Norwegian (Bokmål), Romanian, Serbian (Latin), Slovak, Slovenian, Thai and Ukrainian [30]. All 37 languages are the same as in the previous Windows Server 2008 R2 version.

### Keyboard Layouts

Windows Server 2012 contains 91 keyboard layouts. For example there are four selectable languages in the Control Panel Language section; Inari Sami, Northern Sami (Finland), Skolt Sami and Swedish (Finland). Inari Sami, Northern Sami (Finland) and Skolt Sami are using the same keyboard layout, Finnish with Sami. These are only default combinations of keyboard layouts with time and currency symbols with or without display languages. The Swedish (Finland) language uses by default Swedish keyboard layout and offers to change the display language to Swedish. There is also Sami Extended Finland-Sweden keyboard layout for own combinations which is not default in any of languages, it differs from the Finnish keyboard layout, as shown in Figure 5.



Figure 5: The Sami Extended Finland-Sweden keyboard layout.

Figure 5 shows that the layout is not the typical QWERTY layout. It contains a number of special characters and because of these it does not contain Q, W, Y and X symbols.

### Time and Currency Formats

The Inari Sami, Northern Sami (Finland), Skolt Sami and Swedish (Finland) contains almost the same typical Finnish settings, only a long date setting is different for all languages. In addition, the Swedish (Finland) uses “€” currency and the Swedish (Sweden) uses “kr” currency.

### RTL Languages

Some of the languages are read from right to left, and the display layouts have to deal with this, as shown in Figure 6.

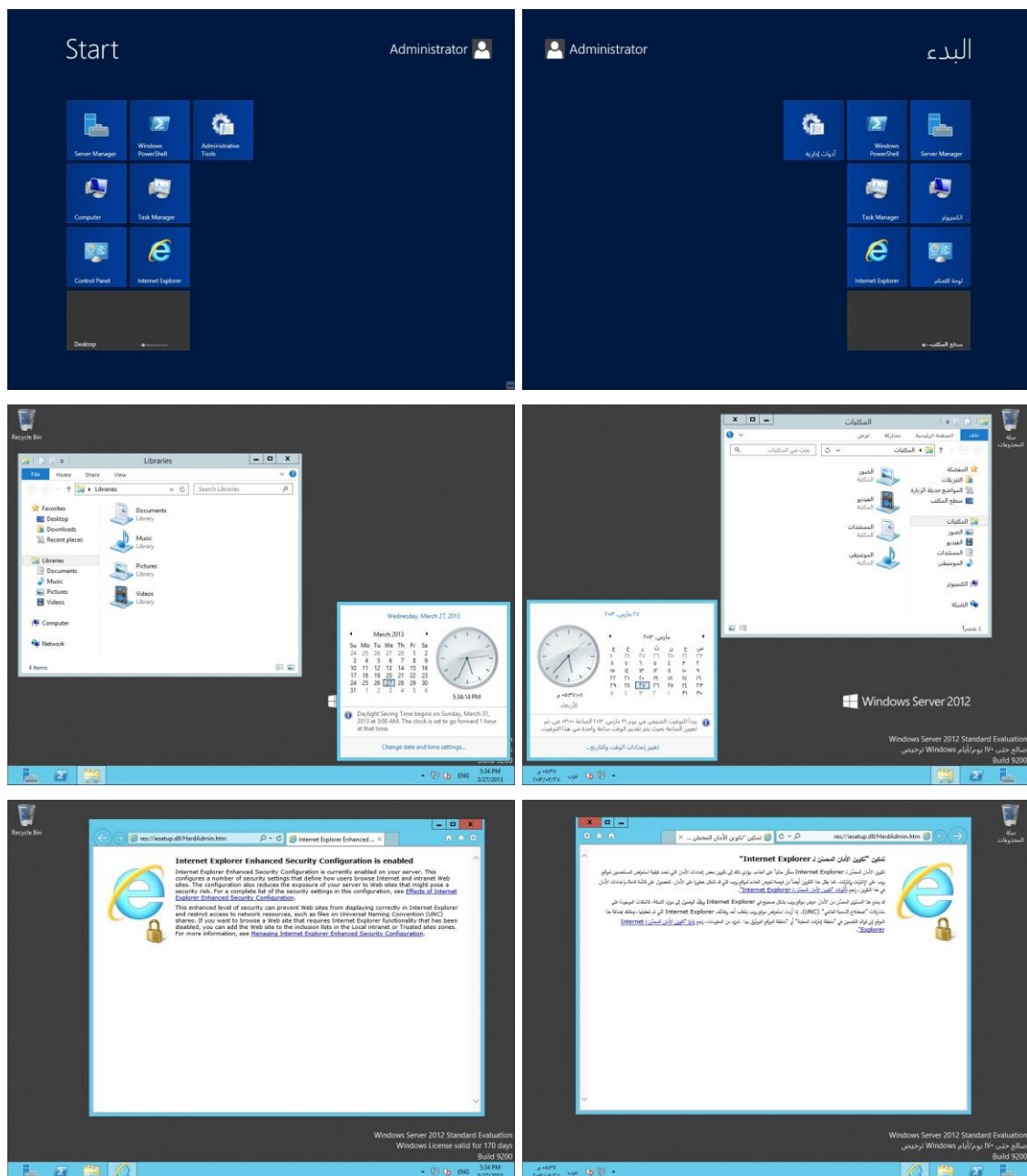


Figure 6: Display layout differences between English and Arabic (Kuwait) languages.

Figure 6 shows the Recycle Bin is on the right. The Taskbar grows from right to left with icons. Clock and Notification Area are on the right. Start Screen grows from right to left. This applies with all displays with RTL languages. All of the applications are not compatible with multilanguage, for example Server Manager is available in English only. One logical problem for western people is that YES and NO buttons are mirrored in these RTL display languages. Windows Server 2012 contains only two RTL languages, Arabic and Hebrew.

## 2.2 Microsoft Windows 8

Microsoft Windows 8 is the latest client operating system by Microsoft. Perhaps the biggest change to the previous Windows 7 version is the default Hyper-V feature, it is now contained in a workstation operating system. The biggest visual change is the Start Screen, formerly called the Metro UI. Microsoft changed the name because of potentially trademark similarities with another German Metro AG company in August 2012, Microsoft denies that officially [1]. The Start Menu that was introduced with the Windows 95, 17 years ago, was replaced with the Start Screen. Microsoft Windows 8 contains a new Charms. The Charms are five different menus in the Charm Bar, which appear with hot key or swiping the cursor to the corner, as shown in Figure 7.



Figure 7: Start Screen on the left and Charm Bar on the right.

Figure 7 shows a new Start Screen feature which replaces a previous Start Menu in Windows 8. Figure 7 also presents a new Charm Bar which includes five different Charms in Windows 8.

### 2.2.1 Differences from the Previous Version

This chapter includes only the differences on a general level. Microsoft Windows 8 includes one big new technology in its workstation operating systems; the Hyper-V feature. The Hyper-V Platform is available only in x64 architecture, but Hyper-V Tools are in both architectures. One big change is also that the Games and the Windows Gadget Platform features has been removed and alternative solutions have been included in the new Start Screen, more applications can be downloaded from the Windows Store to the Start Screen.

Smaller new technologies in Windows 8 are Network Projection, RAS Connection Manager Administration Kit (CMAK), Remote Differential Compression API Support, Windows Identity Foundation 3.5 and Windows Location Provider. The .NET Framework 3.5.1 has been changed to version 4.5 and Internet Explorer 9 to the version 10, but Windows Media Player is same version 12.

IIS 8 includes new role services as compared to the previous 7.5 version. The Centralized SSL Certificate support is a new security role service. New application development role services are the .NET Extensibility 4.5, the Application Initialization, the ASP.NET 4.5 and the WebSocket Protocol. All other role services are identical with IIS 7.5 in the Microsoft Windows 7.

Windows 8 no longer includes these familiar features from Windows 7; all the 12 Games, Indexing Service, Windows DVD Maker, Windows Media Center, Remote Differential Compression, Tablet PC Components and Windows Gadget Platform are removed from the default Windows 8 editions. Windows Media Center is now an add-on for Windows 8 and it is available for purchase from Microsoft for 9.99 €. It is sad that the Gadget Platform was present only in two previous versions, in Windows Vista and Windows 7. The Windows 8 Start Screen applications do not replace the needs to use gadget types of transparent small applications on the desktop. The Gadgets were perfect to show webcams, temperatures, currencies or news on the desktop. One feature is deprecated. The Subsystem for UNIX based applications is a deprecated feature in Windows 8, this is the last version.

### 2.2.2 System Requirements

All the requirements are the same with Windows 7. The Windows 8 specific system requirements are for the processor 1 GHz, 1 GB (x86) or 2 GB (x64) RAM and 16 GB

(x86) or 20 GB (x64) drive space in the system drive. The Hyper-V feature needs the x64 architecture and 4 GB RAM. The resolution requirements have also grown, as shown in Figure 8.

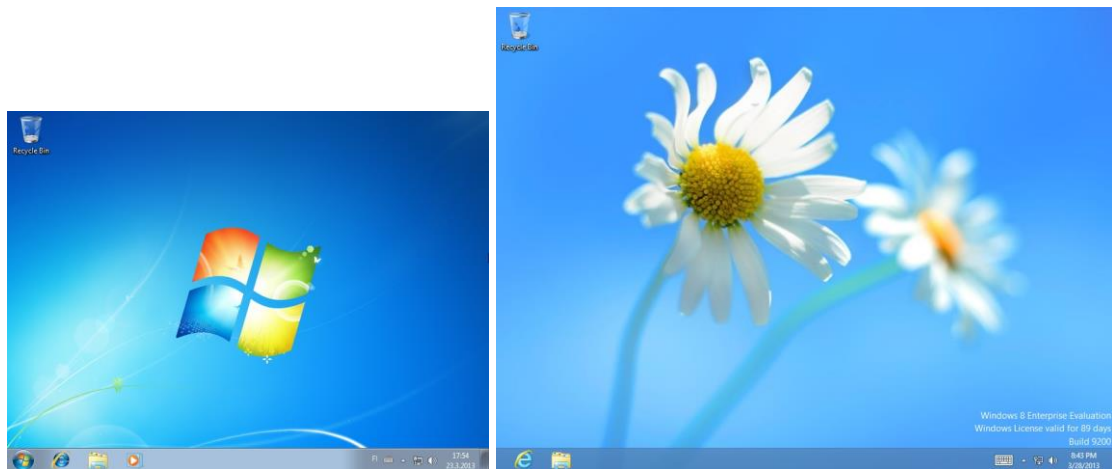


Figure 8: Default desktop differences between Windows 7 and Windows 8.

Figure 8 shows how the Windows 8's 1024x768 default resolution is different to Windows 7's default 800x600 resolution. Microsoft does not tell the system requirements for display directly, it says only that applications from the Windows Store need 1024x768 resolution and the snap applications need 1366x768 resolution. [31][32]

### 2.2.3 System Limitations

There are only few changes in the system limitations between Windows 7 and Windows 8.

#### Processor

Windows 7 and Windows 8 support 32 cores (x86) and 256 cores (x64). The domain joinable editions in both versions support two physical processors.

#### Memory

Windows 8 supports 4 GB (x86) and 512 GB (x64) RAM in the domain joinable editions. Windows 7 supports the same 4 GB (x86), but 192 GB (x64) RAM in the domain joinable editions. [5]

#### Display Resolution

Windows 8 includes support for different resolutions per display, as shown in Figure 9.

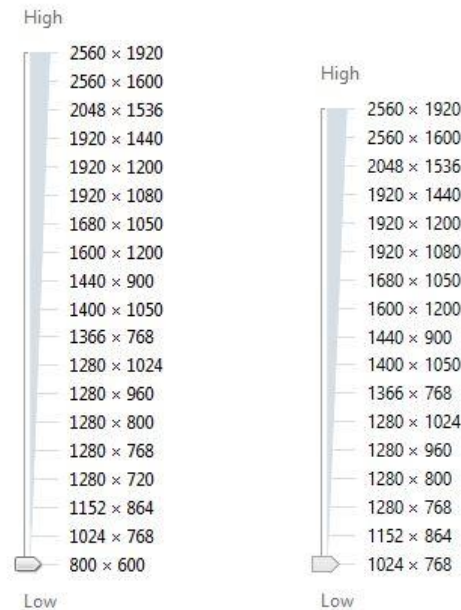


Figure 9: Resolution options in Windows 7 (left) and Windows 8 (right).

Figure 9 shows that Windows 8 contains two options less for resolution. In Windows 8 800x600 and 1280x720 resolutions are not supported any more. Windows 8 supports the same resolutions than Windows Server 2012.

#### Other Limitations

The Hyper-V feature in Windows 8 contains same limitations than Windows Server 2012. These are 64 virtual processors per virtual machine and 512 GB of RAM per virtual machine.

#### 2.2.4 Licensing and Pricing

The Windows 8 Enterprise edition is only available in Volume License (VL) program. The Windows 8 Professional edition is available in retail and OEM license programs. The retail license program price in the Microsoft Store is for the Professional edition \$199.99. [8]

#### 2.2.5 Domain Joinable Editions

Windows 8 is available in many editions but only the Enterprise and the Professional are domain joinable editions. These contain two smaller sub editions, the Microsoft Windows 8 Enterprise N and the Microsoft Windows 8 Professional N. They are own editions to the European market for the European Commission rule in 2004. These editions do not

contain Windows Media Player. It is not required to use these editions in the Europe, it is only needed to be able to buy editions without Windows Media Player. [33]

#### Microsoft Windows 8 Enterprise

The Enterprise edition contains two features more than the Professional edition. These features are the Services for NFS and the Subsystem for UNIX based applications. The latter of these is deprecated in Windows 8. The main reason to choose an Enterprise edition is volume license pricing.

#### Microsoft Windows 8 Professional

This edition gives almost the same features as the Enterprise edition for owners outside volume license programs. The main reason to choose a Professional edition is the need to have only a few licenses.

#### 2.2.6 Upgrade Paths

Microsoft Windows 8 supports full in place upgrading only to the Microsoft Windows 7 version. The Windows 7 Professional and the Windows 7 Ultimate editions are upgradable to the Windows 8 Professional edition. The Windows 7 Professional VL and the Windows 7 Enterprise VL editions are upgradable to the Windows 8 Enterprise VL edition. It is only possible to upgrade inside the same x86 or x64 architecture. There are few differences between technologies and some of few technologies are available to the previous Windows 7 version. These are not the solutions to remain in the previous versions, these are only first aid when bigger challenges do not allow full operating system upgrade to a new version.

The update schedule for client computers must be planned from Microsoft support lifecycle schedule. It is a good plan to move away of version before support ends totally by Microsoft. Microsoft Windows 8 includes now full support until January 9, 2018 and some support until January 10, 2023. Microsoft Windows 7 is the only version which is supported with in place upgrading to Windows 8. Windows 7 includes three editions with the domain membership feature. These are the Professional, the Enterprise and the Ultimate editions. Microsoft supports these Windows 7 editions fully until January 13, 2015 and gives some support until January 15, 2020. It is a good plan to schedule upgrade projects before January 2015 and then use the Windows 8 version at the latest January 2018. [20]

Microsoft Windows Vista is supported on certain level until April 11, 2017 and Microsoft Windows XP is supported somehow until April 8, 2014. The full support of these versions has ended many years ago. These versions are not upgradable to version 8 and they should be replaced with empty drive installations (clean installation) of the latest Windows 8 version. [20]

#### Windows 7

The default versions of main technologies in Windows 7 are .NET Framework 3.5.1, Internet Information Services 7.5, Internet Explorer 8, Media Player 12 and PowerShell 2.0. Only one Windows 8 technology, the Internet Explorer 10 is available automatically with the Microsoft Windows Update Services. Internet Explorer 10 for Windows 7 is published February 25, 2013.

The Microsoft Download Center includes a few new Windows 8 technologies for this version. These are; The Active Directory Lightweight Directory Services (KB975541), released February 16, 2010 [34], the Application Initialization 1.0 for IIS 7.5, x86 version released July 24, 2012 [35] and x64 version released September 18, 2012 [28], the .NET Framework 4.5, released October 9, 2012 [21], Windows Management Framework 3.0 (PowerShell 3.0) (KB2506146), released December 3, 2012 [22] and finally the newest version of the Microsoft Security Essentials 4.2.223.1, released February 26, 2013 [23]. Windows Media Player version is the same in Windows 7 and Windows 8.

#### 2.2.7 Languages

Windows 8 includes a wide range of possibilities to configure the language settings and use them in different combinations, as shown in Figure 10.



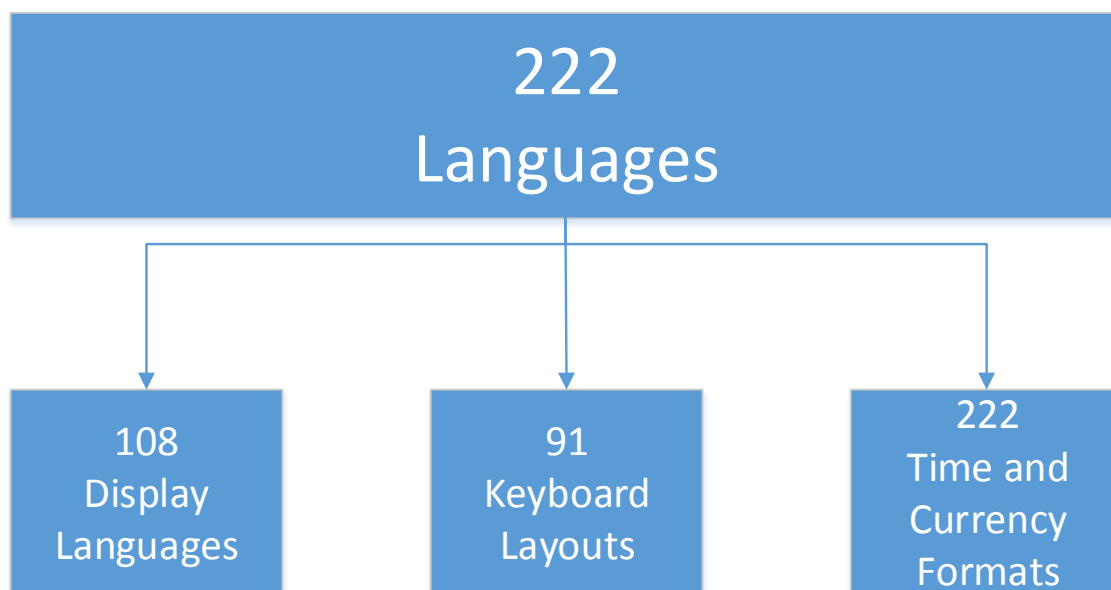


Figure 10: Windows 8 language possibilities.

Figure 10 shows the different elements of language settings to make Windows 8 installations. It is necessary to plan combinations in such a way that all three parties will benefit, the owners, users and administrators. The languages of all other elements are the same as in Windows Server 2012, except the display languages. Windows 8 contains 108 display languages and Windows Server 2012 only 37 display languages.

#### Display Languages

The Windows 8 installation media is available with 37 different languages. These languages are; Arabic, Bulgarian, Chinese Simplified, Chinese (Hong Kong), Chinese (Taiwan), Croatian, Czech, Danish, Dutch, English (United States), English (United Kingdom), Estonian, Finnish, French, German, Greek, Hebrew, Hungarian, Italian, Japanese, Korean, Latvian, Lithuanian, Norwegian (Bokmål), Polish, Portuguese (Brazil), Portuguese (Portugal), Romanian, Russian, Serbian (Latin), Slovak, Slovenian, Spanish, Swedish, Thai, Turkish and Ukrainian. [36]

It is also possible to download 71 free language packs for Windows 8 from Microsoft and make own multilanguage installation media or install many languages to installations. These language packs need the core language and do not operate independently, a typical core language is English. There are 108 display languages in total, it contains 13 new than in the previous Windows 7 version, as shown in Table 2. [37]

Table 2: New display languages in Windows 8.

Language name	Native name	Language Family	In use
Belarusian	беларуская мова	Indo-European	Belarus, Poland
Central Kurdish (Arabic)	سۆزانی	Indo-European	Iran, Iraq
Cherokee (Cherokee)	ᏍᏏᏉᏨᏰᏃᏪ	Iroquoian	United States
K'iche'	Qatzijob'al	Mayan	Guatemala
Kinyarwanda	Ikinyarwanda	Niger-Congo	Rwanda
Punjabi (Arabic)	ਪੰਜਾਬੀ	Indo-European	India
Scottish Gaelic	Gàidhlig	Indo-European	Scotland
Sindhi (Arabic)	سنڌي	Indo-European	Pakistan, India
Tajik (Cyrillic)	тоҷикӣ	Indo-European	Tajikistan
Tigrinya (Ethiopia)	ትግርኛ	Afro-Asiatic	Eritrea
Uyghur	ئۇيغۇرچە	Turkic	China
Valencian	valencià	Indo-European	Spain
Wolof	Wolof	Niger-Congo	Senegal, Gambia, Mauritania

Table 2 lists 13 languages of which seven are Indo-European languages, five languages are from Asia, three languages from Europe, three languages from Africa and two languages from Americas. Some display language has also been removed from Windows 8, as shown in Table 3.

Table 3: From Windows 8 removed display languages.

Language name	Native name	Language Family	In use
Bosnian (Cyrillic)	босански	Indo-European	Bosnia and Herzegovina
Inuktitut (Latin)	Inuktitut	Eskimo-Aleut	Canada

Table 3 shows, there is two display languages less in Windows 8. The keyboard layouts and time and currency formats are the same in Windows Server 2012 and Windows 8, these are presented in Chapter 2.1.6.

RTL Languages

Some of the languages are read from right to left, and display layouts have to deal with this, as shown in Figure 11.



Figure 11: Display layout differences between English and Arabic (Kuwait) languages.

Figure 11 shows the Recycle Bin is on the right. The Taskbar grows from right to left with icons, the Clock and the Notification Area are on the right. This applies with all displays with RTL languages. One logical problem for western people is that YES and NO buttons are mirrored in these RTL display languages. The Start Screen grows from right to left in RTL languages and same logic is in the Charm Bar it is left side of the desktop.

Windows 8 contains five RTL languages, Arabic, Dari, Hebrew, Persian and Urdu. The Arabic and the Hebrew are made with own installation media by the Microsoft and others are downloadable from the Microsoft with other language packs.

### 3 Roles, Role Services, Features and Tools

Microsoft Windows Server 2012 contains many roles, role services and features. Each of these is presented in this chapter, only the parts installed in the test environment are included deeply.

The Microsoft Windows Server 2012 installation contains a minimal number of roles and features by default. These must be installed later, depending on the use of the server. This makes running lighter and gives better server security. The server installation contains a couple of role services and features by default, as shown in Table 4.

Table 4: Default role services and features in the server installation.

Role services			
Role	Role Service	Core	GUI
File And Storage Services	Storage Services	X	X
Features			
Feature		Core	GUI
1. Level	2. Level		
.NET Framework 4.5 Features	.NET Framework 4.5	(O)	X
	TCP Port Sharing	(O)	(O)
User Interfaces and Infrastructure	(basics without name)	X	X
	Graphical Management Tools and Infrastructure		X
	Server Graphical Shell		X
Windows PowerShell	Windows PowerShell 3.0	(O)	X
	Windows PowerShell ISE		(O)
WoW64 Support		(O)	X

Table 4 shows that the basic installation is very light including only basic storage services and user interface services. The “(O)” means optional and it can be removed even though it is installed by default.

#### 3.1 Roles and Role Services

The roles are the highest level of parts in the servers. Almost all roles are dependent of other roles. Different role services in roles depend on different role services in other roles. The dependencies are a very big matrix, the highest level role dependencies are shown

in Appendices. Windows Server 2012 contains many role services which use Internet Information Services (IIS). It is possible to install almost all in the same server, but it is not sensible. Decentralization and replication of roles and role services give high availability and redundancy to the environment, which must be foreseen in the planning of the environment.

### 3.1.1 Active Directory Certificate Services (AD CS)

The Active Directory Certificate Services is used to create certification authorities and related role services, these allow to issue and manage certificates used in different applications. This role provides the certificate infrastructure to enable scenarios such as secure wireless networks, virtual private networks (VPN), Internet Protocol Security (IPSec), Network Access Protection (NAP), encrypting file system (EFS) and a smart card log on. It is important to change the server name, join a domain or promote to a domain controller (DC) before installing the Certificate Services, these tasks are not possible after installation. Specifications of the role are listed in Table 5.

Table 5: Specifications of Active Directory Certificate Services.

Role	Active Directory Certificate Services	
<b>Server Manager</b>	AD CS	
	IIS	
<b>Management Consoles</b>	Certification Authority	%windir%\system32\certsrv.msc
	Certificate Templates	%windir%\system32\certtmpl.msc
	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Online Responder Management	%windir%\system32\ocsp.msc
	Enterprise PKI	%windir%\system32\pkiview.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wlbadm.msc
<b>PowerShell Modules</b>	ADCSAdministration	
	ADCSDeployment	
	WebAdministration	
<b>Others</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Table 5 shows, that the role needs also IIS; only the Certification Authority role service does not need that. This Active Directory Certificate Services contains six role services.

### Certification Authority (CA)

The Certification Authority is used to issue and manage certificates. Multiple CAs can be linked to make a public key infrastructure with two or three tiers.

### Certificate Enrollment Policy Web Service

The Certificate Enrollment Policy Web Service enables users and computers to obtain certificate enrollment policy information even when the computer is not a member of a domain or if a domain joined computer is temporarily outside the security boundary of the corporate network.

### Certificate Enrollment Web Service

The Certificate Enrollment Web Service enables users and computers to enroll and renew certificates even when the computer is not a member of a domain or if a domain joined computer is temporarily outside the security boundary of the computer network.

### Certification Authority Web Enrollment

The Certification Authority Web Enrollment provides a simple web interface that allows users to perform tasks such as request and renew certificates, retrieve certificate revocation lists (CRL) and enroll for smart card certificates.

### Network Device Enrollment Service (NDES)

The Network Device Enrollment Service makes it possible to issue and manage certificates for routers and other network devices that do not have network accounts.

### Online Responder

The Online Responder makes certificates revocation checking data accessible faster to clients in complex network environments.

### 3.1.2 Active Directory Domain Services (AD DS)

The Active Directory Domain Services stores information about objects on the network and makes this information available to users and network administrators. This role uses domain controllers to give network users access to permitted resources anywhere on the network with a single logon process. This role helps administrators securely manage its information and facilitates resource sharing and collaboration between users. This role is also required for directory enabled applications such as the Microsoft Exchange

Server, the Microsoft SharePoint Server and for other Windows Server technologies such as Group Policy (GP). The DNS server is needed with this role. Specifications of the role are given in Table 6.

Table 6: Specifications of Active Directory Domain Services.

Role	Active Directory Domain Services	
<b>Server Manager</b>	AD DS	
<b>Management Consoles</b>	ADSI Edit	%windir%\system32\adsiedit.msc
	Active Directory Domains and Trusts	%windir%\system32\domain.msc
	Active Directory Users and Computers	%windir%\system32\dsa.msc
	Active Directory Sites and Services	%windir%\system32\dssite.msc
<b>PowerShell Modules</b>	ActiveDirectory	
	ADDSDeployment	
	DFSN	
	GroupPolicy	
<b>Others</b>	Active Directory Administrative Center	%windir%\system32\dsac.exe

Table 6 shows, the role contains many tools for remote management. Only joining a computer to the domain installs the ActiveDirectory PowerShell module to the computer. The Active Directory Domain Services role does not include any role services.

### 3.1.3 DHCP Server

The Dynamic Host Configuration Protocol (DHCP) allows servers to assign or lease IP addresses to computers and other devices that are enabled as DHCP clients. Deploying a DHCP server on the network provides computers and other TCP/IP based network devices with valid IP addresses and the additional configuration parameters called DHCP options. This allows computers and devices to connect to other network resources, such as DNS servers and routers. This role needs static IP address. Specifications of the role are in Table 7.



Table 7: Specifications of DHCP Server role.

Role	DHCP Server	
<b>Server Manager</b>	DHCP	
<b>Management Consoles</b>	DHCP	%windir%\system32\dhcpcmgmt.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
<b>PowerShell Modules</b>	DhcpServer	

Table 7 shows, the role is very simple, only one real management console and PowerShell module for this role. Windows Server 2012 contains by default management consoles for Windows Server Backup. Removing a role or feature that contains these also delete those default consoles. These consoles are almost all of the roles and features included but not all, for example DNS Server role does not contain these. The Windows Server Backup Tools feature does not include any of these consoles, only the PowerShell module is included. The easiest way to fix these consoles back is to install any of the simple RSAT feature which includes these consoles.

#### 3.1.4 DNS Server

The Domain Name System (DNS) Server provides name resolution for TCP/IP networks. This role is easier to manage when it is installed on the same server as Active Directory Domain Services. This role provides a standard method for associating names with numeric Internet addresses. This makes it possible for users to refer to network computers by using easy to remember names instead of IP addresses. The DNS provides a hierarchical namespace ensuring that each host name will be unique across a local or wide area network. DNS services can be integrated with DHCP services eliminating the need to add DNS records as computers are added to the network. This role needs static IP address to work. DNS server integration with Active Directory Domain Services automatically replicates DNS data along with other Directory Service data, making it easier to manage DNS. Specifications of this role are shown in Table 8.

Table 8: Specifications of DNS Server.

Role	DNS Server	
<b>Server Manager</b>	DNS	
<b>Management Consoles</b>	DNS	%windir%\system32\dnsmgmt.msc
<b>PowerShell Modules</b>	DnsServer	

Table 8 shows, the role includes only one management console and one PowerShell module.

### 3.1.5 Fax Server

The Fax Server sends and receives faxes and allows administrators to manage fax resources such as jobs, settings, reports and fax devices on this computer or on the network. It is possible to use a Fax Server to share and manage network fax resources from a central location, which enables users to send and receive faxes. Setting up a Fax Server, it is possible to define routing policies and rules for faxes, provide access to faxes that have been previously sent or received and configure activity logging to track the use of fax resources. Specifications of this role are in Table 9.

Table 9: Specifications of Fax Server.

Role	Fax Server	
Server Manager	Fax Server	
Management Consoles	Fax Service Manager	%windir%\system32\fxsadmin.msc
Others	Windows Fax and Scan	%windir%\system32\WFS.exe

Table 9 shows, the role does not contain any PowerShell modules, it contains executable application and management console for management tasks. This role needs full GUI for working.

### 3.1.6 File and Storage Services

The File and Storage Services includes some services that are always installed, as well as functionality that administrators can manage file servers and storages. Specifications of this role are in Table 10.

Table 10: Specifications of File and Storage Services

Role	File and Storage Services	
<b>Server Manager</b>	File and Storage Services	
<b>Management Consoles</b>	DFS Management	%windir%\system32\dfsmgmt.msc
	File Server Resource Manager	%windir%\system32\fsrm.msc
	Services for NFS	%windir%\system32\nfsmgmt.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
<b>PowerShell Modules</b>	Deduplication	
	DFSN	
	FileServerResourceManager	

Table 10 shows, there are specific consoles for DFS, File Server Resource Manager and Server for NFS role services. All role services depends of File Server role service.

#### File Server

The File Server manages shared folders and enables users to access files on this computer from the network.

#### BranchCache for Network Files

The BranchCache for Network Files provides support for BranchCache on file servers. BranchCache is a wide area network (WAN) bandwidth optimization technology that caches content from main office content servers at branch office locations, allowing client computers at branch offices to access the content locally rather than over the WAN.

#### Data Deduplication

The Data Deduplication is a new technology in Windows server 2012 and it saves disk space by storing a single copy of identical data on the volume.

#### DFS Namespaces

The DFS Namespaces enables to group shared folders located on different servers into one or more logically structured namespaces. Each namespace appears to users as a single shared folder with a series of subfolders. The underlying structure of the namespace can consist of numerous shared folders located on different servers and in multiple sites.

### DFS Replication

The DFS Replication is a multimaster replication engine that enables to synchronize folders on multiple servers across local or wide area network (WAN) network connections. It uses the Remote Differential Compression (RDC) protocol to update only the portions of files that have changed since the last replication. This role service can be used in conjunction with DFS Namespaces.

### File Server Resource Manager

The File Server Resource Manager helps to manage and understand the files and folders on a file server by scheduling file management tasks and storage reports, classifying files and folders, configuring folder quotas and defining file screening policies.

### File Server VSS Agent Service

The File Server VSS Agent Service is a new role service in Windows server 2012 and it enables to perform volume shadow copies of applications that store data files on file server.

### iSCSI Target Server

The iSCSI Target Server is a new role service in Windows server 2012 and it provides services and management tools for iSCSI targets.

### iSCSI Target Storage Provider

The iSCSI Target Storage Provider is a new role service in Windows Server 2012 and it enables applications on a server that is connected to an iSCSI target to perform volume shadow copies of data on iSCSI virtual disks.

### Server for NFS

The Server for NFS enables server to share files with UNIX based computers and other computers that use the network file system (NFS) protocol.

### Storage Services

The Storage Services role service cannot uninstall even from core installation, it provides basic storage management functionality.

### 3.1.7 Network Policy and Access Services (NPAS)

The Network Policy and Access Services provides three role services which help safeguard the health and security of environment. Specifications of role are shown in Table 11.

Table 11: Specifications of Network and Access Services

Role	Network Policy and Access Services	
Server Manager	IIS	
	NAP	
Management Consoles	Health Registration Authority	%windir%\system32\HCSCFG.MSC
	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Network Policy Server	%windir%\system32\nps.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
PowerShell Modules	Nps	
	WebAdministration	
Others	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Table 11 shows, the role depends on the Web Server (IIS) role services. All role services depend on the Network Policy Server role service.

#### Network Policy Server (NPS)

The Network Policy Server allows to create and enforce organization wide network access policies for client health, connection request authentication and connection request authorization. With NPS it is possible to deploy Network Access Protection (NAP), a client health policy creation, enforcement and remediation technology.

#### Health Registration Authority

The Health Registration Authority (HRA) issues health certificates to NAP client computers that are compliant with network health requirements.

#### Host Credential Authorization Protocol

The Host Credential Authorization Protocol (HCAP) allows to integrate Microsoft Network Access Protection (NAP) solution with Cisco Network Access Control. When deploying HCAP with Network Policy Server (NPS) and NAP, NPS can perform the authorization of Cisco Network Access Control clients.

### 3.1.8 Print and Document Services

The Print and Document Services enables centralizing print server and network printer management tasks. With this role it is possible to receive scanned documents from network scanners and route the documents to a shared network resource, Windows SharePoint Services site or e-mail addresses. This role includes four role services. Specifications of role are in Table 12.

Table 12: Specifications of Print and Document Services.

Role	Print and Document Services	
<b>Server Manager</b>	IIS	
	Print Services	
<b>Management Consoles</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Print Management	%windir%\system32\printmanagement.msc
	Scan Management	%windir%\system32\ScanManagement.msc
<b>PowerShell Modules</b>	FileServerResourceManager	
	WebAdministration	
<b>Others</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Table 12 shows, the role contains Scan Management console, it does not come with RSAT. It must be installed with Distributed Scan Server role service to Windows Server 2012 or Windows 8 and remote management tasks is possible.

#### Print Server

The Print Server includes the Print Management snap-in which is used for managing multiple printers or print servers and migrating printers to and from other Windows print servers.

#### Distributed Scan Server

The Distributed Scan Server provides the service which receives scanned documents from network scanners and routes them to the correct destinations. Role service includes the Scan Management snap-in which manage network scanners and configure scan processes.

### Internet Printing

The Internet Printing creates a Web site where users can manage print jobs on the server. It enables users who have Internet Printing Client installed to use a Web browser to connect and print to shared printers by using the Internet Printing Protocol (IPP).

### LPD Service

The Line Printer Daemon (LPD) Service enables UNIX based computers or other computers using the Line Printer Remote (LPR) service to print to shared printers.

### 3.1.9 Remote Access Services (RAS)

Remote Access provides seamless connectivity, always on and always managed experience based on DirectAccess. RAS provides traditional VPN services including site to site (branch office or cloud) connectivity. Routing provides traditional routing capabilities including NAT and other connectivity options. This role includes two role services. Specifications of role are in Table 13.

Table 13: Specifications of Remote Access.

Role	Remote Access	
<b>Server Manager</b>	IIS	
	Remote Access	
<b>Management Consoles</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Group Policy Management	%windir%\system32\gpmc.msc
	Group Policy Management Editor	%windir%\system32\gpme.msc
	Group Policy Starter GPO Editor	%windir%\system32\gptedit.msc
	Routing and Remote Access	%windir%\system32\rrasmgmt.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wlbadm.msc
<b>PowerShell Modules</b>	GroupPolicy	
	Nps	
	RemoteAccess	
	WebAdministration	
<b>Others</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe
	RAS Connection Manager Administration Kit (CMAK)	%ProgramFiles%\CMAK\cmak.exe
	Remote Access Management	%windir%\system32\RAMgmtUI.exe

Table 13 shows, this role contains many tools, many of tools are from dependencies. Role depends for example some of Web Server (IIS) role services.

#### DirectAccess and VPN (RAS)

DirectAccess gives users the experience of being seamlessly connected to their corporate network any time they have Internet access. With DirectAccess mobile computers can be managed remotely any time the computer has Internet connectivity, ensuring mobile users stay up to date with security and system health policies. VPN uses the connectivity of the Internet plus a combination of tunneling and data encryption technologies to connect remote clients and remote offices.

#### Routing

Routing provides support for NAT Routers, LAN Routers running RIP and multicast capable routers (IGMP Proxy).



### 3.1.10 Windows Deployment Services (WDS)

The Windows Deployment Services provides a simplified secure means of rapidly and remotely deploying Windows operating systems to computers over the network. Client computers must be PXE enabled. This role requires Active Directory Domain Services, DHCP and DNS services on the network. An NTFS partition is required also for file store. This role includes two role services, both are installed by default. Specifications of the role are in Table 14.

Table 14: Specifications of Windows Deployment Services.

Role	Windows Deployment Services	
<b>Server Manager</b>	WDS	
<b>Management Consoles</b>	Windows Deployment Services	%windir%\system32\WdsMgmt.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc

Table 14 shows, the role does not contain any PowerShell modules. It does contain management console for management tasks.

#### Deployment Server

The Deployment Server provides the full functionality of a role which administrators can use to configure and remotely install Windows operating systems. With role service administrators can create and customize images.

#### Transport Server

The Transport Server provides a subset of the functionality of Windows Deployment Services. It contains only the core networking parts, which is used to transmit data using multicasting on a standalone server.

### 3.1.11 Windows Server Update Server (WSUS)

The Windows Server Update Services allows network administrators to specify the Microsoft updates that should be installed, create separate groups of computers for different sets of updates and get reports on the compliance levels of the computers and the updates that must be installed. This role includes three role services, WSUS Services

is main role service and one of the two database role services is needed. Specifications of role are in Table 15.

Table 15: Specifications of Windows Server Update Server.

Role	Windows Server Update Services	
<b>Server Manager</b>	IIS	
	WSUS	
<b>Management Consoles</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Update Services	%ProgramFiles%\Update Services\AdministrationSnapin\wsus.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
<b>PowerShell Modules</b>	UpdateServices	
	WebAdministration	
<b>Others</b>	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Table 15 shows, one management console handles the management tasks of this role. The role depends also on the Web Server (IIS) role.

#### WSUS Services

The WSUS Services installs the services used by Windows Server Update Services.

#### WID Database

The WID Database installs the database used by WSUS into Windows Internal Database (WID).

#### Database

The Database role service installs the database used by WSUS. It is not possible to choose both Database role services for WSUS, WID Database is a default selection.

#### 3.1.12 Others

This study includes only the basic roles and their role services. Large roles were left out, they must be treated as separate entities. Windows Server 2012 server includes a few roles which were impossible to implement to the test environment, these are also

excluded from the test environment. The excluded roles and their specifications are listed in Table 16.

Table 16: Excluded roles and their specifications.

Role	Active Directory Federation Services (AD FS)	
Server Manager	AD FS	
	IIS	
Management Consoles	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	AD FS Management	%windir%\ADFS\Microsoft.IdentityServer.msc
PowerShell Modules	ADFS	
	WebAdministration	
Others	AD FS Federation Server Proxy Configuration Wizard	%windir%\ADFS\FspConfigWizard.exe
	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Role	Active Directory Lightweight Directory Services (AD LDS)	
Server Manager	AD LDS	
Management Consoles	Active Directory Sites and Services	%windir%\system32\dssite.msc
	ADSI Edit	%windir%\system32\adsiedit.msc
PowerShell Modules	Active Directory	
Others	Active Directory Lightweight Directory Services Setup Wizard	%windir%\ADAM\adaminstall.exe

Role	Active Directory Rights Management Services (AD RMS)	
Server Manager	AD FS	
	AD RMS	
	IIS	
Management Consoles	Active Directory Rights Management Services	%windir%\system32\AdRmsAdmin.msc
	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wlbadm.msc
PowerShell Modules	ADRMS	
	ADRMSAdmin	
	WebAdministration	
Others	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Role	Application Server	
Server Manager	App Server	
	IIS	
Management Consoles	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
PowerShell Modules	MSMQ	
	WebAdministration	
Others	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe

Role	Hyper-V	
Server Manager	Hyper-V	
Management Consoles	Hyper-V Manager	%windir%\system32\virtmgmt.msc
PowerShell Modules	Hyper-V	
	NetWNV	
Others	Hyper-V Virtual Machine Connection	%windir%\system32\vmconnect.exe

Role	Remote Desktop Services (RDS)	
Server Manager	IIS	
	NAP	
	Remote Desktop Services	
Management Consoles	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	RD Licensing Diagnoser	%windir%\system32\lsdiag.msc
	Remote Desktop Gateway Manager	%windir%\system32\tsgateway.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
PowerShell Modules	Nps	
	RemoteDesktopServices	
	WebAdministration	
Others	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe
	Remote Desktop Licensing Manager	%windir%\system32\licmgr.exe

Role	Volume Activation Services	
Server Manager	VA Services	
Management Consoles	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wbadmin.msc
Others	Volume Activation Tools	%windir%\system32\vmw.exe

Role	Web Server (IIS)	
Server Manager	IIS	
Management Consoles	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc
	Internet Information Services (IIS) 6.0 Manager	%windir%\system32\inetsrv\iis6.msc
PowerShell Modules	WebAdministration	
Others	Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\InetMgr.exe
	Internet Information Services (IIS) 6.0 Manager	%windir%\system32\inetsrv\InetMgr6.exe

Table 16 shows, the Hyper-V and the Volume Activation Services roles are impossible to implement in the test environment. The Hyper-V role does not work in a virtual machine and The Volume Activation Services role needs a volume license key to work. The Active Directory Lightweight Directory Services role and the Application Server role do not

provide anything new, these are for special purposes. All others are big and not basic roles and it is better to leave them outside the scope of the study, only dependencies to leaved role services are included to the study.

## 3.2 Features

Windows Server 2012 contains 115 installable features. The features also contain user interface dependencies; all dependencies of features with roles and other features are shown in Appendices with user interface requirements.

### 3.2.1 Group Policy Management

The Group Policy Management consists of three scriptable Microsoft Management Console snap-ins, providing administrative tools for managing Group Policies across the enterprise. Basic specifications of this feature are shown in Table 17.

Table 17: Specifications of Group Policy Management.

Feature	Group Policy Management	
<b>Management Consoles</b>	Group Policy Management	%windir%\system32\gpmc.msc
	Group Policy Management Editor	%windir%\system32\gpme.msc
	Group Policy Starter GPO Editor	%windir%\system32\gptedit.msc
<b>PowerShell Modules</b>	GroupPolicy	

Table 17 shows, the feature includes three Management Consoles and one PowerShell Module.

### 3.2.2 IP Address Management (IPAM) Server

The IP Address Management Server provides a central framework for managing IP address space and corresponding infrastructure servers such a DHCP and a DNS. This feature supports automated discovery of infrastructure servers in an Active Directory forest. It allows to manage dynamic and static IPv4 and IPv6 address spaces, tracks IP address utilization trends and supports monitoring and management of DNS and DHCP services on network. Basic specifications of this feature are shown in Table 18.

Table 18: Specifications of IP Address Management (IPAM) Server.

Feature	IP Address Management (IPAM) Server	
<b>Server Manager</b>	IPAM	
<b>Management Consoles</b>	DHCP	%windir%\system32\dhcpgmt.msc
	DNS	%windir%\system32\dnsmgmt.msc
	Group Policy Management	%windir%\system32\gpmmc.msc
	Group Policy Management Editor	%windir%\system32\gpme.msc
	Group Policy Starter GPO Editor	%windir%\system32\gptedit.msc
	Windows Server Backup	%windir%\system32\wbadmin.msc
	Local Backup	%windir%\system32\wlbadadmin.msc
<b>PowerShell Modules</b>	DhcpServer	
	DnsServer	
	GroupPolicy	
	IpamServer	

Table 18 shows, the feature includes seven management consoles and four PowerShell modules, the feature adds IPAM object to Server Manager. The feature does not include any own management consoles of its own, all are from dependencies. Only one PowerShell module is specific for this feature, all others are from dependencies. This feature contains only user interface in the Server Manager to manage DHCP and DNS roles in one tool.

### 3.2.3 User Interfaces and Infrastructure

The User Interfaces and Infrastructure feature controls which user interface is in use, is it core, minimal or GUI. There are possibilities to change between user interfaces, from GUI to core with this command.

```
Uninstall-WindowsFeature Server-Gui-Mgmt-Infra
```

Without “-remove” parameter that is safe operation and binary files are not deleted from installation. Another way to change from core user interface to GUI is with this command.

```
Install-WindowsFeature Server-Gui-Shell
```

## Graphical Management Tools and Infrastructure

The Graphical Management Tools and Infrastructure sub feature provides minimal user interface to the core user interface. This user interface does not contain File Explorer, Internet Explorer, Control Panel or Paint applications. No purpose was found for this in the test environment it was always possible to use the core user interface. The possible purpose of use is the File Server Services, when it is needed to limit the rights of administrators to the folder level, without seeing the contents of the file level. By removing the minimal user interface or GUI, the installation removes no longer working parts. By activating the minimal user interface or GUI, the installation does not automatically activate graphical parts of the installed roles, role services or features and these must be known to do manually.

## Server Graphical Shell

The Server Graphical Shell feature provides full Windows graphical user interface (GUI) from the minimal user interface including File Explorer, Internet Explorer, Control Panel and Paint applications. Uninstalling the shell reduces the servicing footprint of the installation, while leaving the ability to run local GUI management tools, as part of the minimal server interface.

## Desktop Experience

The Desktop Experience feature contains extra features to GUI. Basic specifications of this feature are shown in Table 19.

Table 19: Specifications of Desktop Experience.

Feature	Desktop Experience	
Others	Snipping Tool	%windir%\system32\SnippingTool.exe
	Sound Recorder	%SystemRoot%\system32\SoundRecorder.exe
	Windows Media Player	%ProgramFiles(x86)%\Windows Media Player\wmplayer.exe
	Math Input Panel	%CommonProgramFiles%\Microsoft Shared\Ink\mip.exe
	Character Map	%windir%\system32\charmap.exe
	Disk Cleanup	%windir%\system32\cleanmgr.exe

Table 19 shows, the feature contains features of Windows 8, such as Character Map, Disk Cleanup, Snipping Tool, Sound Recorder and Windows Media Player. It includes



all sort of features and this is problematic in environments which like to activate for example just snipping tool.

### 3.2.4 Others

Others contain three categories of features. The first category is for features which include GUI remote management tools, but are not included to this test environment. These features in first category are Failover Clustering, Windows System Resource Manager and WINS Server. Failover Clustering is technology for the dedicated servers which need high availability. Windows System Resource Manager is deprecated in this Windows Server 2012 version and WINS Server is part of an old technology which is not anymore used. Basic specifications of these features are shown in Table 20.

Table 20: Specifications of Failover Clustering, Windows System Resource Manager and WINS Server features.

Feature	Failover Clustering	
Management Consoles	Failover Cluster Manager	%windir%\system32\Cluadmin.msc
	Failover Cluster Manager	%windir%\system32\FailoverClusters.SnapInHelper.msc
PowerShell Modules	FailoverClusters	
Others	Cluster-Aware Updating	%windir%\system32\ClusterUpdateUI.exe

Feature	Windows System Resource Manager	
Management Consoles	Windows System Resource Manager	%windir%\system32\wsrm.msc

Feature	WINS Server	
Management Consoles	WINS Server	%windir%\system32\winsmgmt.msc

Table 20 shows, these features do not add anything to Server Manager and only Failover Clustering includes PowerShell module.

The second category is for features which contain only PowerShell remote management tools. Windows Server 2012 contains nine features which only include PowerShell modules for management, as shown in Table 21.

Table 21: Features with only PowerShell modules for remote management.

Feature	PowerShell Module
BitLocker Drive Encryption	BitLocker
Data Center Bridging	DcbQos
Message Queuing	MSMQ
Multipath I/O	MPIO
Network Load Balancing	NetworkLoadBalancingClusters
Windows PowerShell	ISE, PowerShellWebAccess
Windows Server Backup	WindowsServerBackup
Windows Standards-Based Storage Management	SMISConfig

Table 21 shows, Windows PowerShell feature contains two modules, one comes with PowerShell ISE sub feature and another with PowerShell Web Access sub feature. Data Center Bridging, Windows PowerShell Web Access and Windows Standards Based Storage Management are new in Windows Server 2012. All of these second category features are not included to this study and test environment.

The third category is all other smaller features without graphical Microsoft management console tools or PowerShell modules, these are not included to this study and the test environment.

### 3.2.5 Microsoft Windows 8 Features

Windows 8 do not contain any roles or role services, it contain only features, even though they are the same with roles and role services in Windows Server 2012. These features can be divided to three categories. The first category is for features which include GUI remote management tools, but are not included to the test environment in Windows 8 installations. These features in the first category are Active Directory Lightweight Directory Services, Hyper-V, Internet Information Services, Print and Document Services and Services for NFS. These features are included to Chapter 3.1, basic specifications of these features are the same as in Windows Server 2012.

The second category is for features which contain only PowerShell modules for management. Windows 8 contains only Microsoft Message Queue (MSMQ) Server feature which only include MSMQ module for management. This feature is not included to this study and the test environment.

The third category is all other smaller features without graphical Microsoft Management Console tools or PowerShell modules, these are not included to this study and the test environment.

### 3.3 Tools

Microsoft Windows Server 2012 and Microsoft Windows 8 contain many tools for remote management tasks. There are three main type tools, Applications are the oldest type of tools, Microsoft Management Consoles are standardized GUI tools and PowerShell modules are scripts to shell without GUI. All of these tools need some firewall exceptions, these exceptions must be built for every environment and by its security requirements.

#### 3.3.1 Applications

Windows Server 2012 contains by default five remote management applications. It contains also Event Viewer (eventvwr.exe) and Performance Monitor (perfmon.exe) applications, but these are the same with their MSC files and included in next chapter.

#### Microsoft Management Console (MMC)

The Microsoft Management Console is platform to add snap-ins and use them to manage different services locally and remotely as shown in Figure 12.

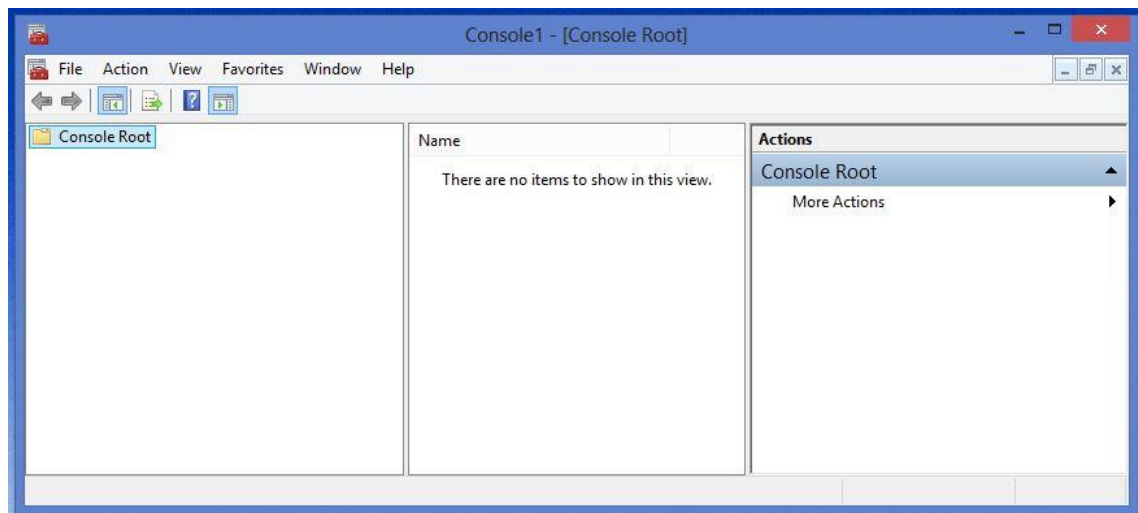


Figure 12: Microsoft Management Console application.

Figure 12 shows on the left Console Root tree for snap-ins, active snap-in opens to center of window and possible actions are on the right of the window. It is possible to

save own consoles for later use. The Microsoft Management Console is not in Start Screen and it is in this address.

```
%windir%\system32\mmc.exe
```

### PowerShell

The PowerShell is upgraded to version 3.0 on Windows Server 2012 and Windows 8. Version 3.0 is recognized by “Copyright (C) 2012” text as shown in Figure 13.



Figure 13: PowerShell application.

Figure 13 shows the window colors differ from Command Prompt and the font is also different. Previous 2.0 version is recognized by text “Copyright (C) 2009”. It is possible to use the version 2.0 with command:

```
Powershell -version 2.0
```

This command opens the version 2.0 engine over version 3.0 and it is possible come back to version 3.0 with command “exit”. Management possibilities are grown with version 3.0 as shown in Table 22.

Table 22: PowerShell commands in different editions.

<b>Edition</b>	<b>Modules</b>	<b>3.0</b>	<b>2.0</b>
Default Windows 8	47	994	410
Fully utilized Windows 8	51	1278	410
Default Windows Server 2012 core	44	1081	410
Fully utilized Windows Server 2012 core	72	2206	410
Default Windows Server 2012 minimal user interface	55	1160	410
Fully utilized Windows Server 2012 minimal user interface	86	2377	410
Default Windows Server 2012 GUI	55	1160	410
Fully utilized Windows Server 2012 GUI	86	2377	410

Table 22 shows that the difference between version 2.0 and 3.0 is the increased number of commands in the newer version in the different editions. The PowerShell application is in Start Screen and it is found also in this address.

```
%windir%\system32\WindowsPowerShell\v1.0\powershell.exe
```

Remote Management with PowerShell is possible with command.

```
Enter-PSSession [Computer name] -credential  
[Domain\User Name]
```

The computer name can be short, for example "MOMDDC1" and the credentials can be for example "thesis.local\administrator". The cmdlet asks for a password later when running this command.

### Registry Editor

The Registry Editor application is used to manage system configuration information which is stored centrally in a hierarchical database called the registry as shown in Figure 14.

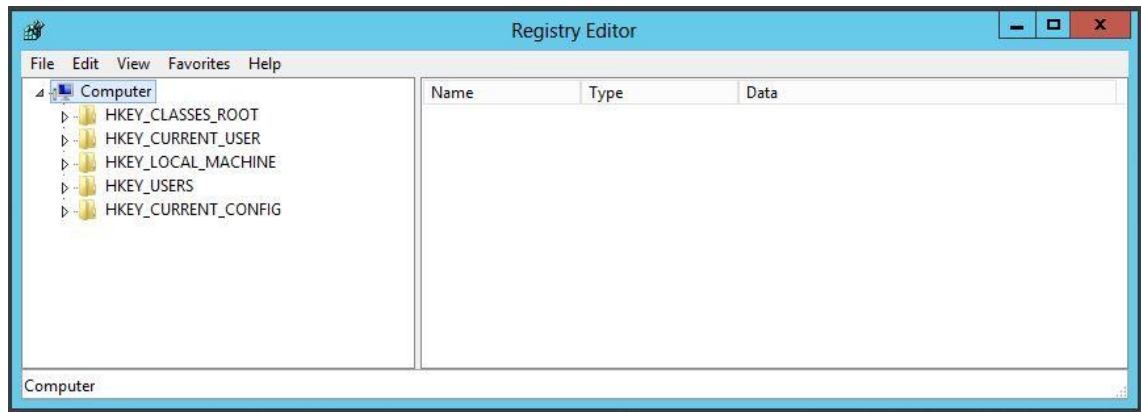


Figure 14: Registry Editor application.

Figure 14 shows five main folders in the registry, maybe most used folder is HKEY\_LOCAL\_MACHINE and it contains settings for computer. Another popular is HKEY\_USERS which contains settings for all user profiles in the computer. All changes to registry are in use directly and a restart is not needed. It is possible connect to another computer registry in this application. The Registry Editor is not in Start Screen and it is in this address.

```
%windir%\regedit.exe
```

### System Information

The System Information is only system information reading application. It shows details about computer, operating system, hardware and software including drivers, as shown in Figure 15.

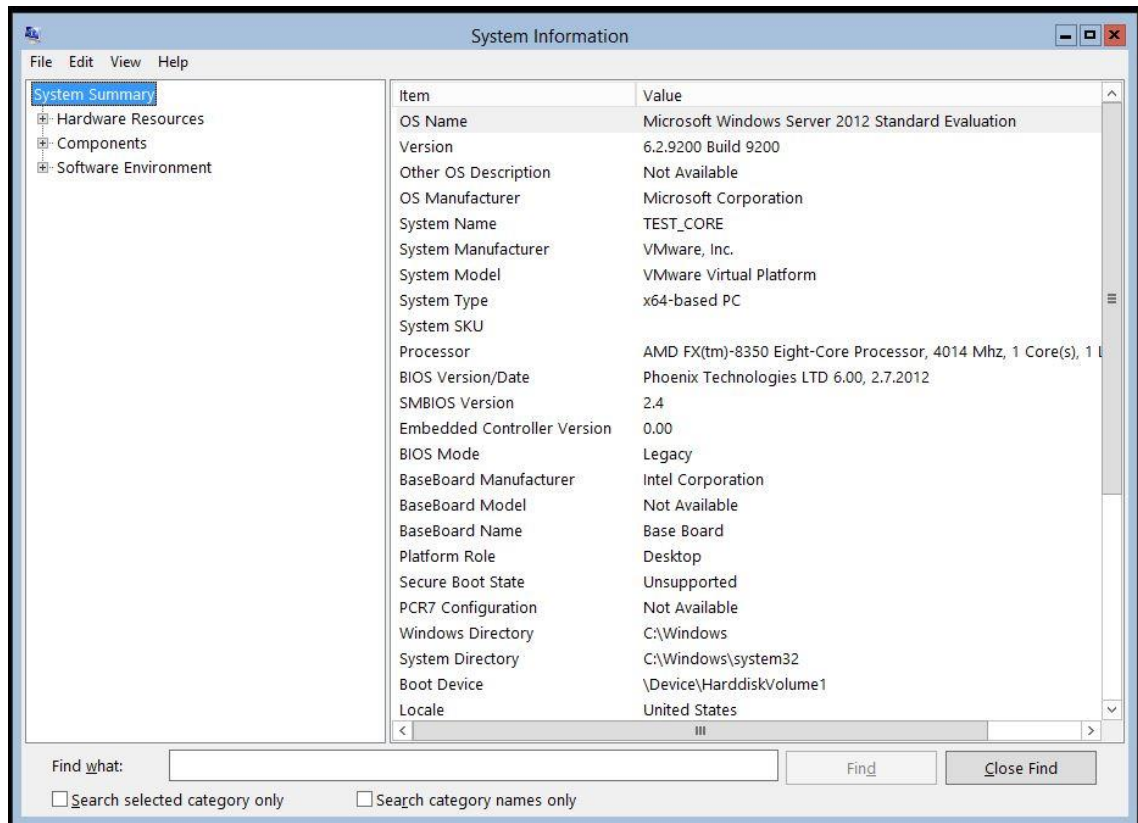


Figure 15: System Information application.

Figure 15 shows the application giving detailed information of the target computer. It can be used to read information of remote computers also. The System Information is in Start Screen on Windows Server 2012 and it is in this address.

```
%windir%\system32\msinfo32.exe
```

### Remote Desktop Connection

The Remote Desktop Connection is a way to take full control remotely to computer with target's user interface. Making connection is a simple task, as shown in Figure 16.



Figure 16: Remote Desktop Connection application.

Figure 16 shows, it is only necessary to write the computer name to make the connection. Under Show Options there are settings for example for resolution. There are also possibilities to save settings and make own shortcuts to every needed target computers. The Remote Desktop Connection application is in Start Screen and it is found also in this address.

```
%windir%\system32\mstsc.exe
```

### 3.3.2 Microsoft Management Console Snap-Ins

The Microsoft Management Console snap-ins, later MSC files, are standardized tools which are made ready for some tasks or it is possible to do own MSC files from snap-ins in Microsoft Management Console software. The Microsoft Windows Server 2012 with GUI contains by default 23 MSC files and Windows 8 less, as shown in Table 23.



Table 23: Default Microsoft Management Consoles in different editions.

Name	File	Server 2012 with Core UI	Server 2012 with minimal UI	Server 2012 with GUI	Windows 8	RM in MSC-file	RM in Snap-in
ActiveX Control	only Snap-in	S	S	S		-	Local
Authorization Manager	%windir%\system32\azman.msc	B	B	B		Local	Local
Certificates - Current User	%windir%\system32\certlm.msc	B	B	B		Local	Local
Certificates - Local Machine	%windir%\system32\certmgr.msc	B	B	B		X	X
Component Services	%windir%\system32\comexp.msc	B	B	B		X	X
Computer Management	%windir%\system32\compmgmt.msc	B	B	B		X	X
Device Manager	%windir%\system32\devmgmt.msc	B	B	B		Local	X
Disk Management	%windir%\system32\diskmgmt.msc	B	B	B		Local	X
Event Viewer	%windir%\system32\eventvwr.msc	B	B	B		X	X
Group Policy Object Editor	%windir%\system32\gpedit.msc	B	B	B		Local	X
IP Security Monitor	only Snap-in	S	S	S		-	X
IP Security Policy Management	only Snap-in	S	S	S		-	X
Local Backup	%windir%\system32\wlbadmin.msc	B	B			Local	Local
Local Users and Groups	%windir%\system32\lusrmgr.msc	S	B	B		Local	X
NAP Client Configuration	%windir%\system32\napclcfg.msc	B	B	B		Local	Local
Performance Monitor	%windir%\system32\perfmon.msc	B	B	B		X	X
Print Management	%windir%\system32\printmanagement.msc				B	X	X
Resultant Set of Policy	%windir%\system32\rsop.msc	B	B	B		X	X
Security Configuration and Analysis	only Snap-in	S	S	S		-	Local
Security Settings	%windir%\system32\secpol.msc	B	B	B		Local	-
Security Templates	only Snap-in	S	S	S		-	Local
Services	%windir%\system32\services.msc	B	B	B		X	X
Shared Folders	%windir%\system32\fsmgmt.msc	B	B	B		X	X
Task Scheduler	%windir%\system32\taskschd.msc	B	B	B		X	X
Telephony	%windir%\system32\tapingmt.msc	B	B			X	X
TPM Management	%windir%\system32\tpm.msc	B	B	B		Local	X
Windows Server Backup	%windir%\system32\wbadmin.msc	B	B			Local	Local
Windows Firewall with Advanced Security	%windir%\system32\WF.msc	B	B	B		Local	X
WMI Control	%windir%\system32\wmimgmt.msc	B	B	B		X	X

Table 23 shows some consoles or snap-ins for only local management tasks. Some MSC files allow only local tasks, but adding snap-in to own console makes it possible to remote manage other computers. Table contain “B” and “S” characters, “B” like a both means that edition contains MSC-file and snap-in. “S” like a snap-in means that edition contains only snap-in. Two last columns tell is it possible to make remote management with MSC file or snap-in, “X” means that remote management is possible.

### 3.3.3 PowerShell Modules

The PowerShell modules are packages of commands which can be used locally or remotely in every computer. Microsoft Windows Server 2012 with GUI contains by default 55 modules for PowerShell, as shown in Figure 17.

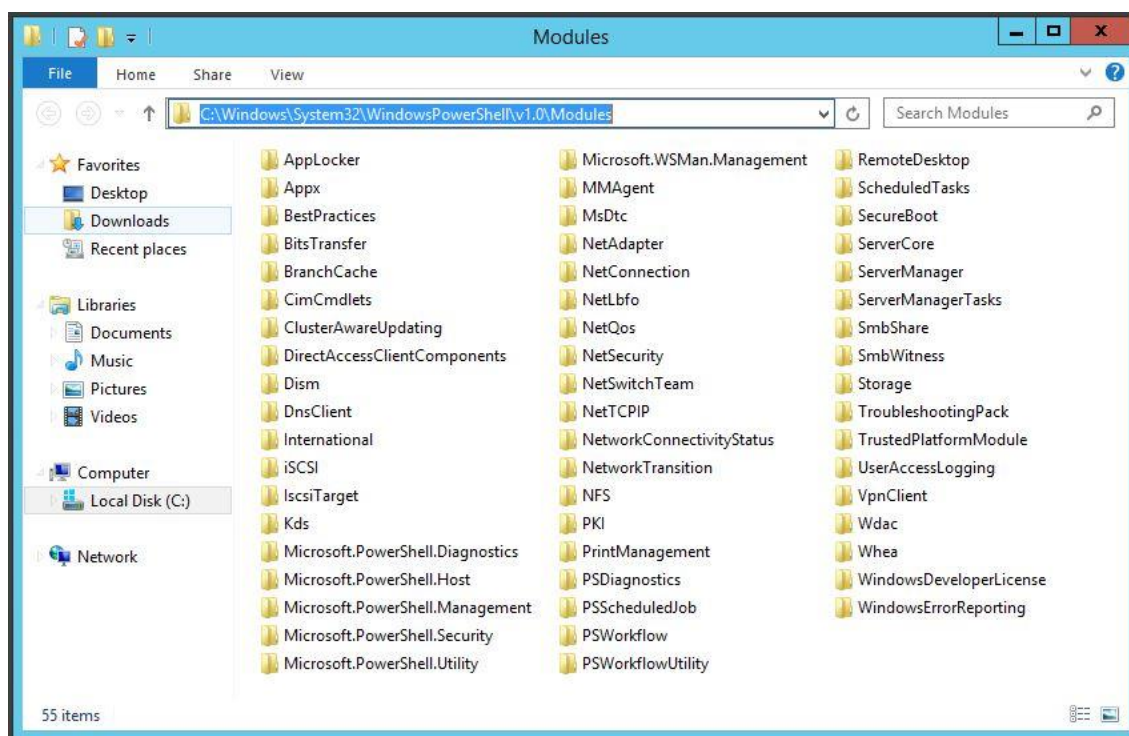


Figure 17: Default PowerShell modules in Windows Server 2012.

Figure 17 shows a lot of modules and every one of these contains many commands. Maybe most important and used of these are Microsoft.PowerShell.Management and ServerManager modules. For example Appx module is for management of Start Screen applications. It is possible to list available commands of module with the command.

```
Get-command -module [module name]
```

Windows Server 2012 with core user interface contains less of these modules. It contains by default 44 modules. It does not contain Appx, ClusterAwareUpdating, MMAgent, PrintManagement, ScheduledTasks, SecureBoot, TroubleshootingPack, TrustedPlatformModule, VpnClient, Whea and WindowsDeveloperLicense modules.

Windows 8 contains also less modules than Windows Server 2012 with GUI, it contains by default 47 modules. It does not contain BestPractices, ClusterAwareUpdating,

IscsiTarget, NFS, RemoteDesktop, ServerCore, ServerManager, ServerManagerTasks, UserAccessLogging and Whea modules. Windows 8 contains BitLocker, ISE modules by default which are options to Windows Server 2012.

### 3.3.4 Remote Server Administration Tools (RSAT)

Windows Server 2012 and Windows 8 supports different Remote Server Administration Tools for Windows Server 2012. The Windows Server 2012 media contains its own tools, but the Windows 8 compatible tools must be downloaded from the Microsoft Download Center [38]. The Windows Server 2012 remote tools are same tools than local tools are for it.

#### Microsoft Management Consoles

The Microsoft Management Consoles for Windows Server 2012 are little different to Windows 8 as shown in Table 24.

Table 24: Remote Administration Tools in different editions.

Name	File	Windows 8	Windows 8 RSAT	Windows Server 2012	Windows Server 2012 RSAT	RM in MSC-file	RM in Snap-In
Active Directory Domains and Trusts	%windir%\system32\domain.msc	X	(O)	X	X	X	X
Active Directory Rights Management Services	%windir%\system32\AdRmsAdmin.msc		(O)	X	X	X	X
Active Directory Sites and Services	%windir%\system32\dsite.msc	(O)	X	(O)	X	X	X
Active Directory Users and Computers	%windir%\system32\dsa.msc		X	(O)	X	X	X
AD FS Management	%windir%\ADFS\Microsoft.IdentityServer.msc			(O)		Local	Local
ADSI Edit	%windir%\system32\adsiedit.msc	(O)	X	(O)	X	X	X
Certificate Templates	%windir%\system32\certtmpl.msc		X	(O)	X	X	X
Certification Authority	%windir%\system32\certsrv.msc		X	(O)	X	X	X
DFS Management	%windir%\system32\dfsmgmt.msc		X	(O)	X	X	X
DHCP	%windir%\system32\dhcpcmgmt.msc		X	(O)	X	X	X
DNS	%windir%\system32\dnsmgmt.msc		X	(O)	X	X	X
Enterprise PKI	%windir%\system32\pkiview.msc		X	(O)	X	X	X
Failover Cluster Manager	%windir%\system32\Cluadmin.msc		X	(O)	X	X	X
Failover Cluster Manager	%windir%\system32\FailoverClusters.SnapInHelper.msc		X	(O)	X	X	X
Fax Service Manager	%windir%\system32\fxsadmin.msc			(O)	X	Local	X
File Server Resource Manager	%windir%\system32\fsrm.msc		X	(O)	X	X	X
Group Policy Management	%windir%\system32\gpmmc.msc		X	(O)	X	X	X
Group Policy Management Editor	%windir%\system32\gpme.msc		X	(O)	X	X	X
Group Policy Starter GPO Editor	%windir%\system32\gptedit.msc		X	(O)	X	X	X
Health Registration Authority	%windir%\system32\HCSCFG.MSC			(O)	X	Local	X
Hyper-V Manager	%windir%\system32\virtmgmt.msc	(O)		(O)	X	X	X
Internet Information Services (IIS) 6.0 Manager	%windir%\system32\inetsrv\iis6.msc	(O)		(O)		X	X
Internet Information Services (IIS) Manager	%windir%\system32\inetsrv\iis.msc	(O)		(O)		X	X
Local Backup	%windir%\system32\wbadmin.msc			(O)	X	Local	Local
Network Policy Server	%windir%\system32\nps.msc			(O)	X	Local	X
Online Responder Management	%windir%\system32\ocsp.msc		X	(O)	X	X	X
Print Management	%windir%\system32\printmanagement.msc	X	X	(O)	X	X	X
RD Licensing Diagnoser	%windir%\system32\lsdiag.msc		X	(O)	X	X	X
Remote Desktop Gateway Manager	%windir%\system32\tsgateway.msc		X	(O)	X	X	X
Routing and Remote Access	%windir%\system32\rrasmgmt.msc		X	(O)	X	X	X
Scan Management	%windir%\system32\ScanManagement.msc	(O)		(O)		X	X
Services for NFS	%windir%\system32\dfsmanagement.msc	(O)		(O)	X	X	X
Share and Storage Management	%windir%\system32\StorageMgmt.msc		X	(O)	X	X	X
Update Services	%ProgramFiles%\Update Services\AdministrationSnapin\wsus.msc			(O)	X	X	X
Windows Deployment Services	%windir%\system32\WdsMgmt.msc			(O)	X	X	X
Windows Server Backup	%windir%\system32\wbadmin.msc			(O)	X	Local	Local
Windows System Resource Manager	%windir%\system32\wsrm.msc		X	(O)	X	X	X
WINS	%windir%\system32\winsmgmt.msc			(O)	X	X	X

Table 24 shows, there is no possibility to use all the remote tools in Windows 8. This table only includes editions with GUI, core user interface do not include support for Microsoft Management Consoles. It includes some MSC files, but they are not executable. These differences must be known before implementing any remote management computer to environment. Some tools only allow remote management by snap-in but not with directly running MSC files. “(O)” means that tool is optional in editions

own media. There are also tools for remote management which do not come with RSAT but are optional in editions own media, for example tools for Internet Information Services, Hyper-V and Scan Management. It is good to know that AD FS Management tools are only for local use.

## Server Manager

The Server Manager is a default application in Windows Server 2012 with GUI and minimal user interfaces. It is included for remote management in Remote Server Administration Tools for Windows 8. Basic view is shown in Figure 18.

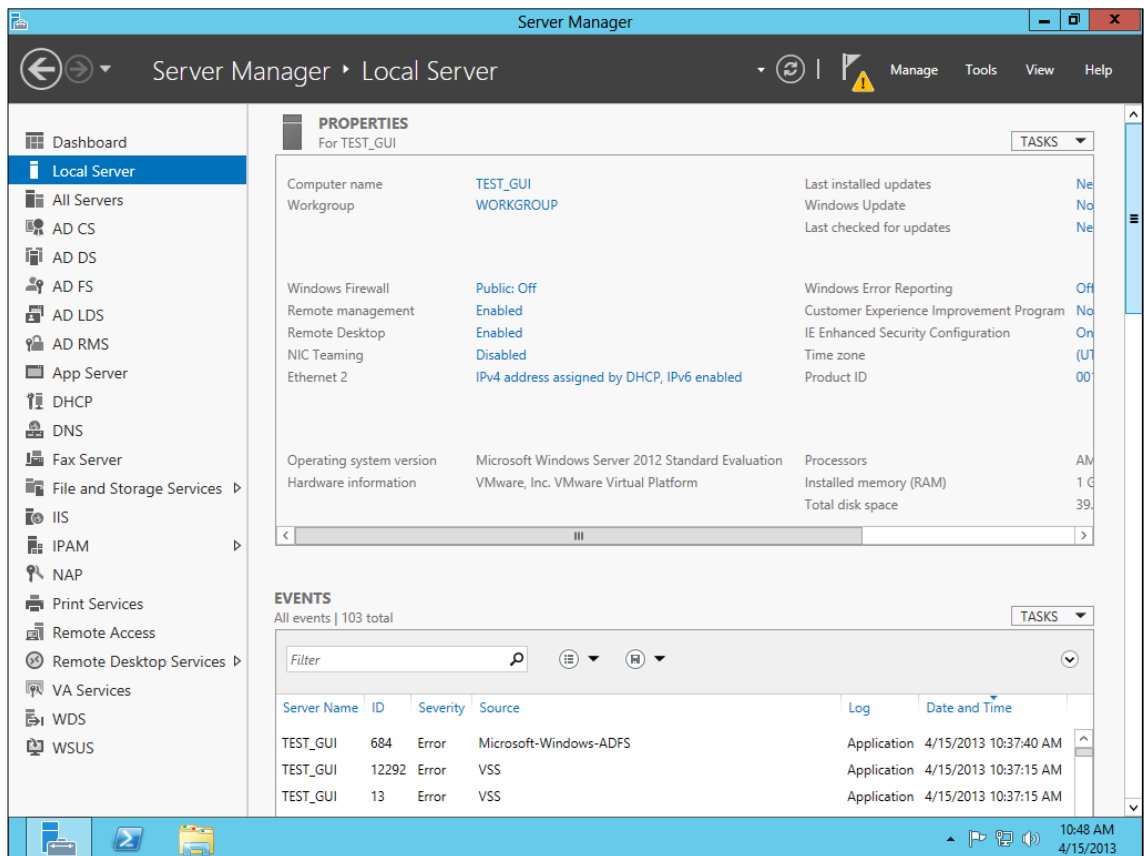


Figure 18: Fully utilized Server Manager.

Figure 18 shows different roles and features in left. The IPAM is the only feature which is in the Server Manager. It is easy to install or remove roles or features from remote servers with this application. All Microsoft Management Consoles are also easy to run and target to remote computers. Server Manager manages the File and Storage Services role and IPAM feature, these management tasks are not included in any MSC file.

#### **4 Planning and Implementing Test Environment**

The aim of this study was to build a testing environment which would be as versatile as possible for the Microsoft Windows Server 2012 and the Microsoft Windows 8 operating systems with as limited a number of virtual machines as possible. All of this was possible by designing a fictional company environment which includes two offices.

The branch office includes a finance department as well as a research and development department. They need an isolated area as well as different security specifications within the organization. The main office includes all other departments. The ICT services are acquired from three different service providers. The corporate level services from one service provider and both offices' local services from local service providers. The corporate level servers and services are protected separately from the office level local services, servers and workstations and at least AD DS, DNS, DHCP and AD CS services are redundancy. All the servers are Microsoft Windows Server 2012 Standard edition operating system installations and all workstations are Microsoft Windows 8 Enterprise x64 edition operating system installations.

All of this is possible on a general level with two forests and a domain tree in one of these forests. Two forests enable forest trusts and a domain tree enables direct external trusts between the forests. Figure 19 shows a sketch of the environment.

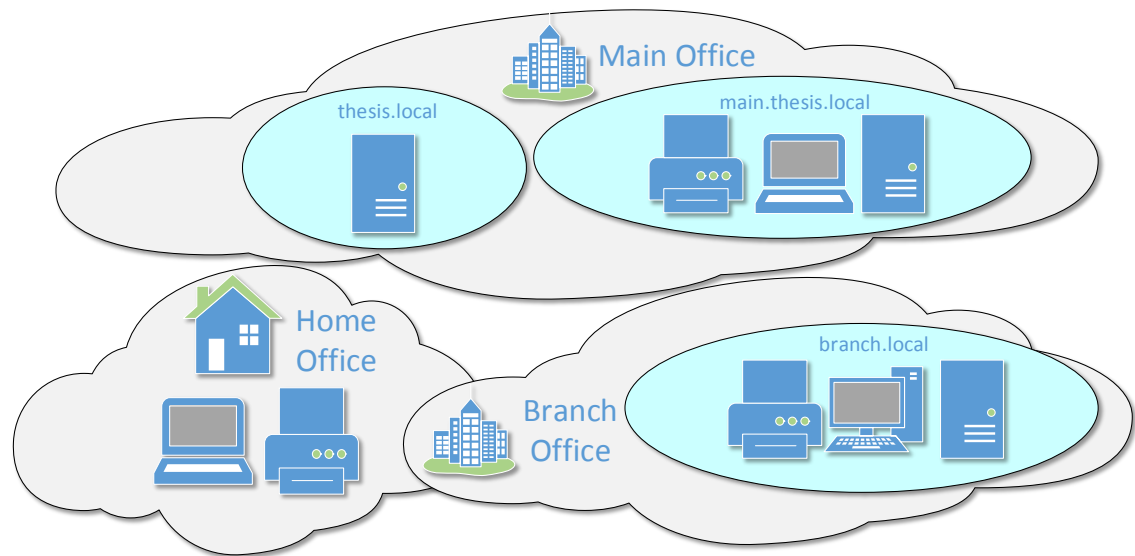


Figure 19: Fictitious enterprise for the study.

Figure 19 shows the Main office contains two domains; thesis.local for the corporate services and main.thesis.local for the local services in this office. As FQDN names says, the main.thesis.local is subdomain for the thesis.local. The branch office contains one domain, the branch.local in different forest for financial and research and development departments. The home office is the third separate part of the environment and its task is to demonstrate the remote access to the main and the branch offices.

#### 4.1 Platform for Environment

This chapter describes how the platform was made. The important physical components in the host computer are processor, motherboard, memory, mass memory controllers, mass memory devices, network adapters, operating system and hypervisor software. The virtual environment include virtual networks, virtual network switches and virtual machines.

##### 4.1.1 Physical Environment

The host computer needs the most efficient processor virtualization. The powerful processor virtualization contains as much frequency and as many cores as possible. The maximum amount of memory is needed for allowing multiple virtual machines to run

simultaneously. The decision to the environment must be made between 8 / 16 / 32 / 64 GB RAM variations. The system disk should be a SSD disk and data drives can be hard disks in the host computer. The host computer includes seven hard disks for data drives in the test environment, six of these disks are configured to the Storage Pool in a simple mode, it is similar than the RAID0. The new Storage Pool feature in the Microsoft Windows Server 2012 is the best option of its own technologies to the environment.

All the other devices; keyboard, mouse, display adapter, two displays, CPU cooler, four network adapters, optical drive, PSU, UPS, switch and router are typical basic devices and the environment is not dependent on their properties.

### Processor

The virtual machines handle the power with an isolated number of the cores and amount of the memory. Higher frequency gives more opportunities to share the CPU time to the different processes. The AMD FX-8350 processor is currently the most powerful workstation processor with eight 4 GHz cores [39]. Its introduction date to market was October 23, 2012 [40].

$$\text{Frequency} * \text{number of cores} = 4000 \text{ MHz} * 8 = 32000$$

The best competitor by Intel is the Intel Core i7-3970X Extreme edition with six 3.5 GHz cores [41]. Its introduction date to markets was November 12, 2012 [42]:

$$\text{Frequency} * \text{number of cores} = 3500 \text{ MHz} * 6 = 21000$$

The host computer was built with a single AMD FX-8350 processor.

### Motherboard

The host computer was built with a motherboard by an ASUS, it is a Sabertooth 990FX R2.0 model which was published on August 2012. The motherboard supports 32 GB memory. It contains also eight SATA3 mass memory connectors and needed card buses for the test environment's network adapters, display controller card and mass memory controller. When building the physical platform one had to understand the different bus technologies and their theoretical speeds, as shown in Table 25. [43]



Table 25: Different bus technologies in the study.

Technology	Commercial	Theoretical and Real	
Fast Ethernet (100BASE-TX)	100 Mbit/s	100 Mbit/s	12,5 MB/s
USB 2.0	480 Mbit/s	480 Mbit/s	60 MB/s
Gigabit Ethernet (1000BASE-T)	1 Gbit/s	1 Gbit/s	128 MB/s
PCI (32-bit/66 MHz)	-	2,1 Gbit/s	266 MB/s
SATA2 (SATA-300)	300 MB/s	2,4 Gbit/s	307,2 MB/s
USB 3.0	5 Gbit/s	3,2 Gbit/s	409,6 MB/s
SATA3 (SATA-600)	600 MB/s	4,8 Gbit/s	614,4 MB/s
PCIe 2.0 x1	-	5 Gbit/s	640 MB/s
PCIe 2.0 x4	-	20 Gbit/s	2000 MB/s
PCIe 2.0 x8	-	40 Gbit/s	4000 MB/s
PCIe 2.0 x16	-	80 Gbit/s	8000 MB/s

Table 25 shows the different bus speeds of main technologies. The commercial speeds are typically the nearest whole number. It is sensible to connect the devices and the busses in between from larger to smaller, in order to avoid bottlenecks which would slow down a quicker device towards the end of the line and prevent it from communicating in its full potential. It is sensible to connect mass storage controller cards with eight or more SATA3 connectors only to the PCIe 2.0 x8 or the PCIe 2.0 x16 buses. It also shows that it is not sensible to use additional PCIe 2.0 x1 card with multiple USB3 or SATA3 connectors. The additional cards with many Gigabit Ethernet connectors are sensible combinations and it is sensible to use external SATA3 buses than USB 3.0 buses for backups.

The host computer is built according to the maximum efficiency, the motherboard's own mass storage controller was sufficient and it was not necessary to buy a separate PCIe 2.0 x8 controller card. All the network adapters got their own buses, and there was no need to consider additional multiport network interface cards.

### Memory

The host computer is equipped with two kits of Kingston KVR13N9K2/16 memory modules. The KVR13N9K2/16 kits include 1333 MHz DDR3 memory chips in two 8 GB modules, these was released in May 2012. Together these two kits make 32 GB of RAM. The motherboard supports faster modules but that is not necessary in this study. The amount is more important in virtualizing than frequency. [44]

### Mass Memory Controllers

The motherboard is built with two SATA3 mass storage controllers. The main controller is included in AMD SB950 Southbridge chipset with six SATA3 connectors. The additional controller in the motherboard is the ASMedia PCIe SATA with two SATA3 connectors. The third mass storage controller was installed to the test environment, it is made by HighPoint. It is RocketRAID 640 model with Marvell 88SE912x chip including two SATA3 connectors in PCIe 2.0 x1 card [45].

The SSD disk is connected with a DVD-ROM optical device to the ASMedia's controller. The 1 TB hard disks are connected to the AMD SB950 controller and the 3 TB hard disk is connected to HighPoint RocketRAID 640 controller.

### Mass Memory Devices

The mass storage devices are one SSD device for operating system and seven hard disk devices for data use. The host computer includes Transcend SSD320 series 128 GB SSD device for system drive use and seven NAS use designed Western Digital Red series hard drives for data use. The SSD320 series was released in August 2012 and the Red series on July 2012. All the mass storage devices are with SATA3 bus. Six Red series WD10EFRX 1TB hard drives are configured for virtual machines in daily use. These hard drives are configured to the Storage Pool in the simple mode, it is similar than striped RAID0. The Red series WD30EFRX 3 TB hard disk is for backups and installation media. These made drives contain different technologies and different speeds, as shown in Figure 20. [46] [47]

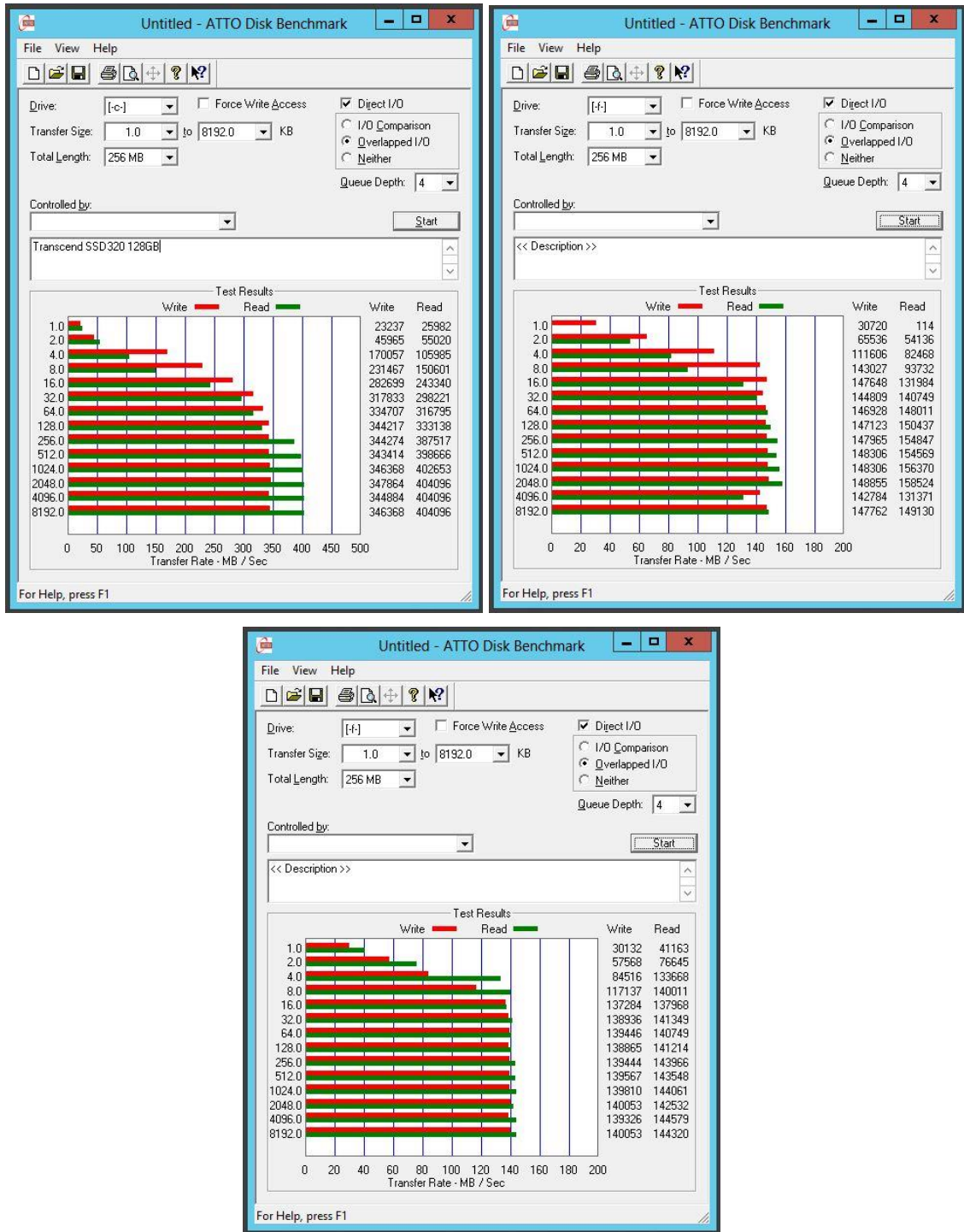


Figure 20: Different mass memory devices in the host computer.

Figure 20 shows different mass memory technologies and their speeds of the host computer. The upper left window shows the results of the Transcend SSD320 (TS128GSSD320) 128 GB SATA3 SSD device, it is used for system drive and the speed is between 350 MB/s and 400 MB/s. The upper right window shows the results of one Western Digital Red (WD10EFRX) 1 TB SATA3 HDD, a combination of six is used for

virtual machines in daily use. The speed of one WD10EFRX is about 140 MB/s. The lower window shows the results of Western Digital Red (WD30EFRX) 3 TB SATA3 HDD for backups and installation media, its speed is also about 140 MB/s. The mass memory drive for virtual machines was tested with different configurations, as shown in Figure 21.

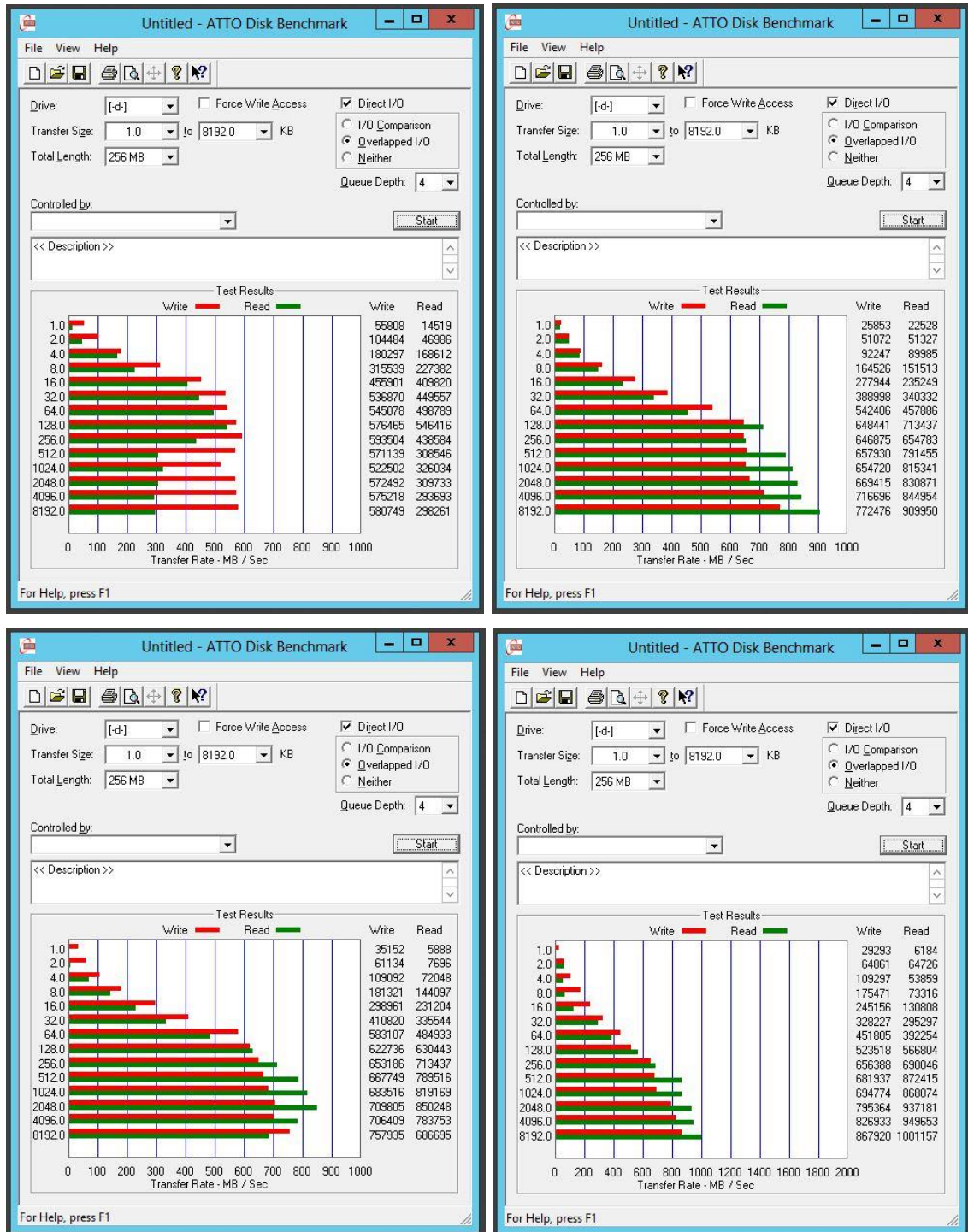


Figure 21: Different mass memory configurations.

Figure 21 shows different hard disk configurations with the six Western Digital Red (WD10EFRX) 1 TB SATA3 hard disk devices. The upper left corner is the RAID5 configuration with motherboards RAID controller, it works only with speed between 300 MB/s and 500 MB/s. The upper right shows the results of the RAID0 configuration with the motherboard's RAID controller, it works better and with speed between 650 MB/s and 900 MB/s. The lower left is the RAID0 configuration with the Microsoft Windows Server 2012 software RAID feature, it works with speed between 600 MB/s and 850 MB/s. Finally the lower right is the Simple Storage Pool configuration with the Microsoft Windows Server 2012 feature, it works fastest with the maximum speed 1000 MB/s. The test environment is built with striped Simple Storage Pool configuration. The mass memory device costs affected how the environment was built are shown in Appendices.

#### Network Adapters

The host computer was built with four 1 Gbps network adapters, all with a Realtek's chip. The host computer uses all of these. One adapter is only for the host computer to use and the second adapter is for permanent virtual machines. One of the permanent Windows 8 virtual machine is for writing this study with the Microsoft Office 2013 software in real time in parallel with the test environment. The third adapter is for home office connection in the test environment and the fourth adapter is for office connections in the test environment.

#### Operating System

The operating system in the host computer is the Microsoft Windows Server 2012 Datacenter edition [48]. The backups are made three times a day; 0:00, 12:00 and 18:00. The last failed, typically 0:00 midnight backup runs in the morning when the host computer starts up again. This study began by making daily backups and later moved to these three backups, the daily backups were not enough. The frequent backups are needed, Storage Pool in simple mode does not contain redundancy. The backups are bare metal copies of the system drive and storage pool drive and these are stored in the 3 TB hard disk in the same computer.

The backups were tested by making full restore after the first backup. One way would have been to make the Windows Server Backup schedule for each virtual machine but these are difficult to interlace independently of each other. Virtual machine specific backups would have enabled each machine to return with their own tools. It is harder to

the processor to make many backups from the same drive or to same drive simultaneously than one backup. One backup in the host computer does not enable making restore from the virtual machine with its tools. The VMware Workstation snapshots would have been one option but this would have increased required storage space for virtual machine drive.

#### Hypervisor Software

One option would have been to use Microsoft Windows Server 2012 Hyper-V technology but that test environment was built with other the VMware Workstation 9 software [49]. The most stable test environment run with all the virtual machines in the VMware Workstation with a resolution of 1024x768 and if some of the virtual machines is required in a full screen mode, it is possible to make a Remote Desktop Connection.

The combination use of the VMware Player and the VMware Workstation worked fine with six virtual machines but then it brought down the entire host machine. The virtual machines of the test environment was used with VMware Workstation in one display and permanent Microsoft Office virtual machine was in full screen mode in VMware Player in second display. A CPU load increased suddenly and permanently to 100 % and the host computer froze. This was the reason to tighten the backup schedule task from once a day to three times a day. The VMware Player may be able to handle all the virtual machines themselves but VMware Workstation software with other options are better for using many virtual machines.

#### 4.1.2 Virtual Environment

The hypervisor software usually contains possibilities to use virtual networks, virtual network adapters and virtual network switches. The VMware Workstation 9 supports ten virtual networks and ten virtual network adapters per virtual machine. One useful way to use these virtual networks is when it is necessary to simulate different networks in the same environment, as shown in Figure 22.

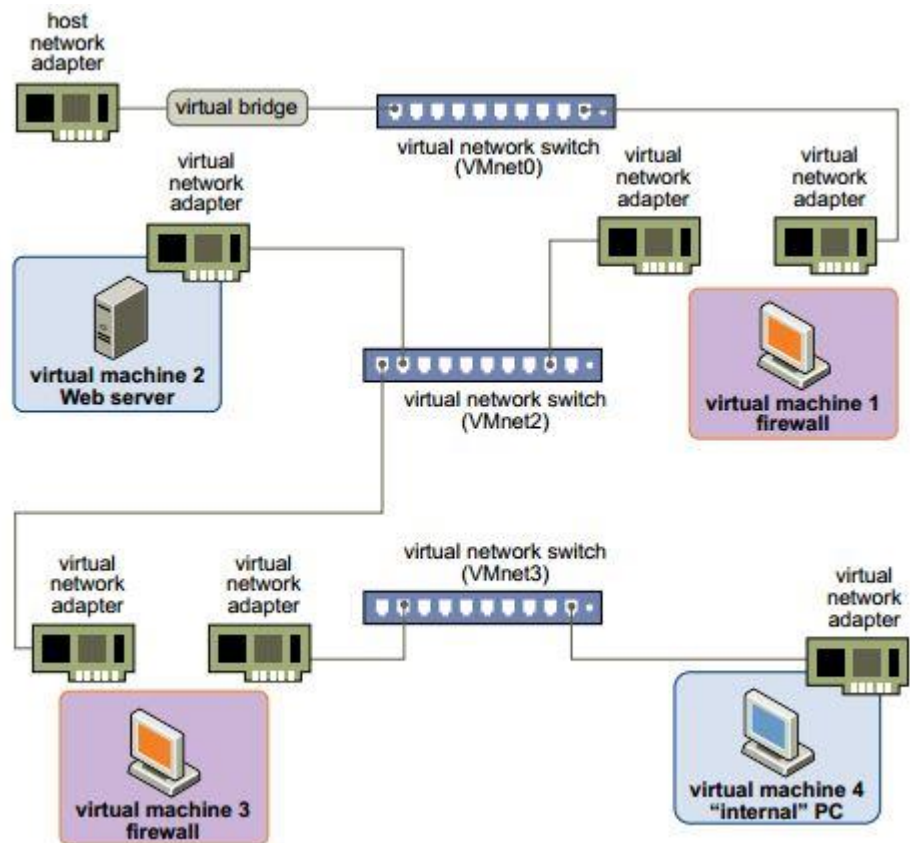


Figure 22: Example of virtual networks in the VMware Workstation 9. [50, 175]

Figure 22 shows how it is possible to create a virtual environment which contains two virtual firewall computers and virtual perimeter network (DMZ) between them. This example environment needs three virtual networks and two virtual computers for routing and firewall roles.

## Networks

This study needs five virtual networks, as shown in Figure 23.

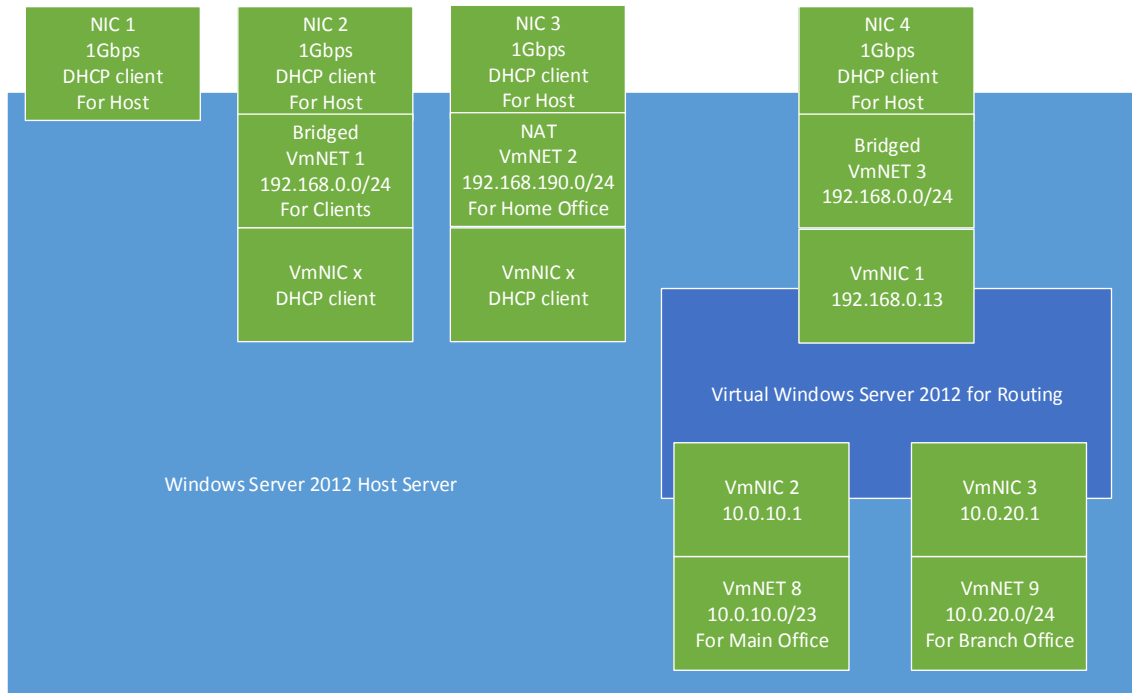


Figure 23: The virtual networks in this study.

Figure 23 illustrates the virtual network environment in this study. The NIC 1 is only for the host and the NIC 2 is for permanent clients, such as the Microsoft Windows 8 client with the Microsoft Office 2013 for writing the report. The NIC 3 and the NIC 4 are for the temporary virtual environment use such as the test environment. The NIC 3 is for the network traffic of the home office and the NIC 4 is for the network traffic of the main office and the branch office. The environment contains one virtual machine with routing features for analyzing and controlling network traffic between offices and external network. The operating system is Microsoft Windows Server 2012 Standard edition with Remote Access role and this role is configured to a LAN routing only [49]. The VMware Virtual Network Editor is used to make the virtual networks, as shown in Figure 24.



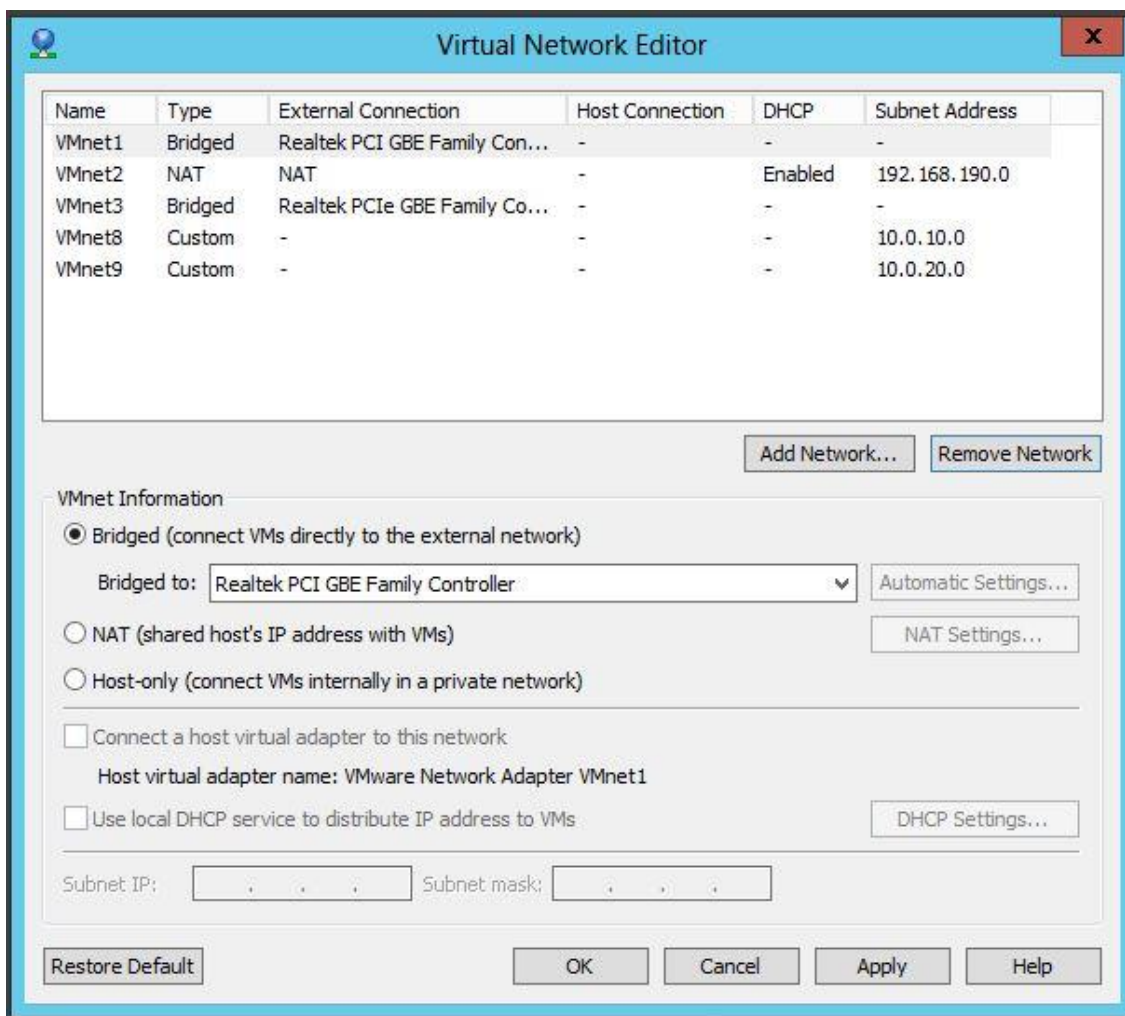


Figure 24: VMware Virtual Network Editor and the test environment.

Figure 24 shows, the main office uses IPv4 network 10.0.10.0/23 and the branch office uses IPv4 network 10.0.20.0/24. Only the DNS and DHCP servers use static IP addresses in the final environment. More detailed information on the networks is given in Table 26.

Table 26: IP addresses in the environment.

	<b>Main Office 10.0.10.0/23</b>		<b>Branch Office 10.0.20.0/24</b>
	10.0.10.0	10.0.11.0	10.0.20.0
x.x.x.1	Gateway	-	Gateway
x.x.x.2 – x.x.x.9	-		
x.x.x.10 – x.x.x.49	Servers with static / dynamic IP addresses		
x.x.x.50 – x.x.x.199	DHCP use		
x.x.x.200 – x.x.x.254	DHCP use	Printers and other devices with static IP addresses	

Table 26 shows, in the main office the gateway from network is 10.0.10.1. The servers with static or dynamic IP addresses are allocated to areas 10.0.10.10 - 10.0.10.49 and 10.0.11.10 - 10.0.11.49. For the DHCP use are allocated IP addresses 10.0.10.50 - 10.0.10.199 and 10.0.11.50 - 10.0.11.199. For printers or other devices with static IP addresses are allocated to the areas 10.0.10.200 – 10.0.10.254 and 10.0.11.200 - 10.0.11.254.

The branch office network includes the same idea. The gateway from the network is 10.0.20.1. Allocated static IP addresses for the local level servers are 10.0.20.10 - 10.0.20.49. The DHCP will be use the allocated IP addresses of area 10.0.20.50 - 10.0.20.199 and printers and others devices use allocated area 10.0.20.200 - 10.0.20.254.

The home office environment in the study is a typical remote access environment. It can include an ADSL or a 4G WAN connection. The VMware Workstation can control a bandwidth and a packet loss like other virtual networks. In this test environment the bandwidth is set to 10 Mbps to home office and 1 Mbps from home office. The LAN has access to WAN through NAT and the home office network includes a DHCP service and computers use these settings. Virtualizing the home office in this study was made by the isolated network 192.168.190.0/24.

#### Virtual servers and computers

The environment was designed and built in this study with 14 virtual computers. The environment includes 11 virtual servers, three virtual workstations and two virtual printers. One of the servers is for router role and one workstation is for report writing with

the Microsoft Office 2013 software. The fictive enterprise environment contains 11 virtual servers, two virtual workstations and two virtual printers.

The test environment contains three servers in main corporate domain, as shown in Figure 25.

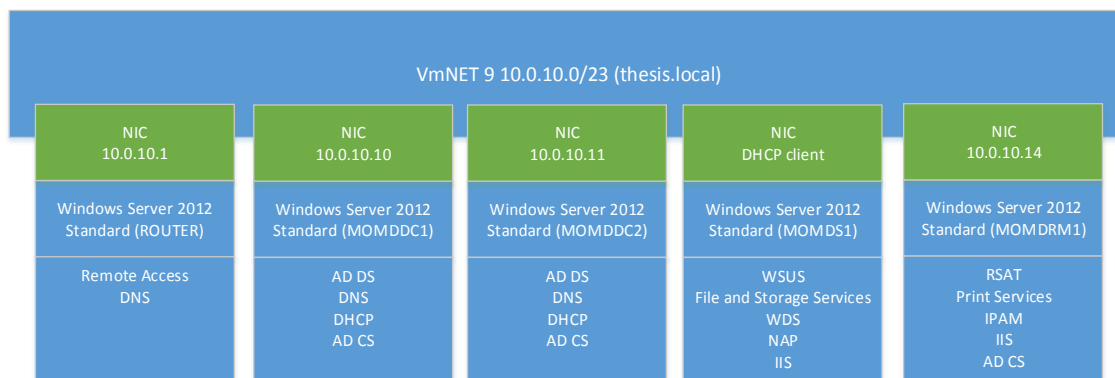


Figure 25: The main office environment for corporate level domain, thesis.local.

Figure 25 shows that the corporate domain contains two domain controllers, file server, router and remote management server. The subdomain at the same tree has two domain controller servers, as shown in Figure 26.

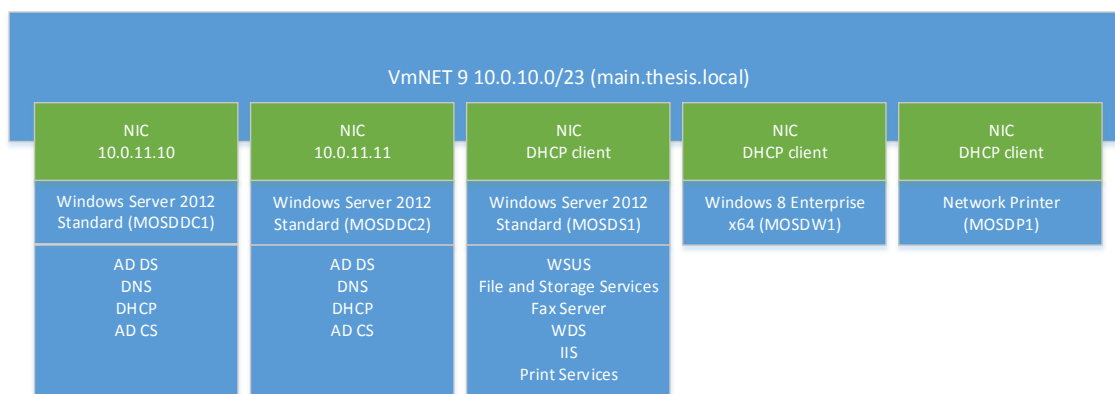


Figure 26: The main office environment for the subdomain, main.thesis.local.

Figure 26 shows that the subdomain keeps local services independent from the corporate domain services and thus possibly removable elsewhere in future. The isolation of local network will also increase opportunities for security management. The workstations and printers are included in the subdomain in the main office.

The branch office in the test environment includes three servers, as shown in Figure 27.

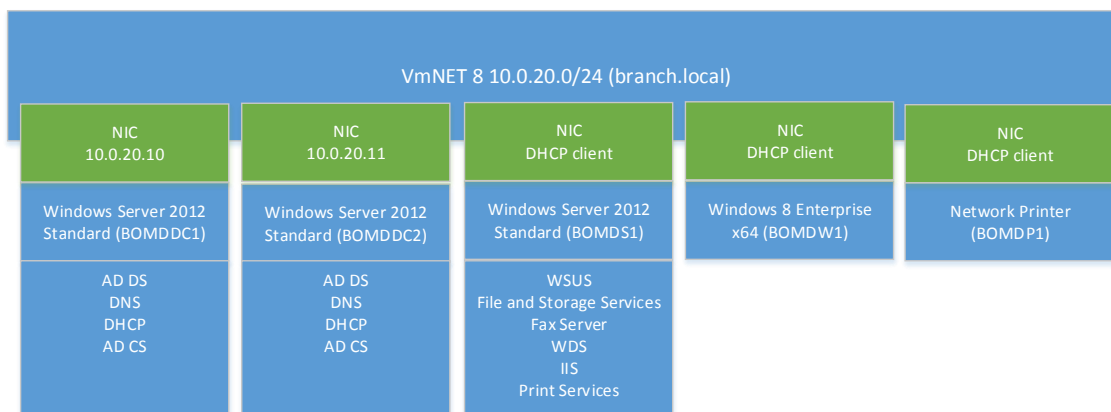


Figure 27: The branch office environment in branch.local domain and forest.

Figure 27 shows the servers, two domain controllers and a file server. It contains an additional workstation and a network printer, all in the same domain with the servers.

The home office environment can be whatever network and WAN connection with a DHCP service and a network printer, as shown in Figure 28.

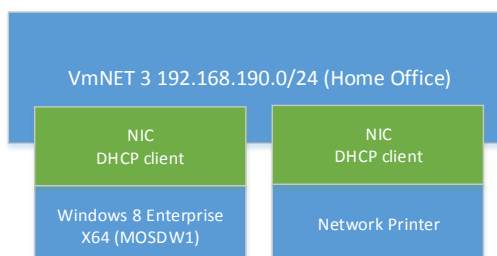


Figure 28: The home office environment.

Figure 28 illustrates the home office is made simple, there are no servers. All workstations in the main office or branch office can connect to the home office network and simulate remote access from the home offices.

#### 4.1.3 Basic Server Installation with GUI

This installation process is shared to three sections, the virtual machine hardware profile, the operating system installation and the operating system customization. The test environment contains many servers with GUI, the installation process is told only in this chapter.

### Virtual Machine Hardware Profile

The virtual machine hardware profiles for servers were made in the “Typical (recommended)” way in the VMware Workstation software. The servers in the test environment were installed from 180 day evaluation media [51] [52]. The selected version were “Windows Server 2012 Standard”. The server names were designed in a specific manner, and they contain a certain logic, as shown in Table 27.

Table 27: The server names in this study.

MOMDDC1	MO = Main Office	MD = Main Domain	DC = Domain Controller	1 = 1 <sup>st</sup>
MOMDDC2				2 = 2 <sup>nd</sup>
MOMDS1			S = Server	1 = 1 <sup>st</sup>
MOMDRM1			RM = Remote Management	1 = 1 <sup>st</sup>
MOSDDC1		SD = SubDomain	DC = Domain Controller	1 = 1 <sup>st</sup>
MOSDDC2				2 = 2 <sup>nd</sup>
MOSDS1			S = Server	1 = 1 <sup>st</sup>
BOMDDC1	BO = Branch Office	MD = Main Domain	DC = Domain Controller	1 = 1 <sup>st</sup>
BOMDDC2				2 = 2 <sup>nd</sup>
BOMDS1			S = Server	1 = 1 <sup>st</sup>

Table 27 shows, the first two characters are for office, then third and fourth characters tells the domain. The fifth and sixth characters tell the types of the servers and the last number tells the number of the server in the type, in the domain, in the office. The server names in the VMware Workstation hardware profiles are the same as their future DNS names and all the servers are installed to the “d:\thesis\[server name]” folder.

The default settings was 60 GB disk capacity in several 2 GB files, this had to be changed to one increasing 40 GB file. By default, one core and 2048 MB RAM was not correctly to the test environment, it had to be changed to one core and 1024 MB RAM. The hardware profile was completed after removing the printer device and changing the correct network adapter interface. Before starting had to be changed “Update VMware tools automatically” and “Synchronize guest time with host”. The virtual machine hardware profile was now complete for an operating system installation.

### Operating System Installation

The virtual machine was started up with “Power On to BIOS” command. Some changes were needed to make to BIOS; serial ports, parallel port and floppy disk controller were disabled, these are no longer needed in computers. If a floppy disk controller is enabled in BIOS, the operating system shows the A: drive in its own programs without real physical device. Disabling only the diskette drive in BIOS is not enough. The last task was to save the BIOS changes.

The first selected option in the Microsoft Windows Server 2012 installation was regional settings. This multi-cultural test environment was built with English weekday names and month names. That happened by leaving the “English (United States)” time and currency format, but by changing the keyboard or the input method to “Finnish”.

That installation media includes the Standard and the Datacenter editions of Microsoft Windows Server 2012. These virtual machines are installed with “Windows Server 2012 Standard Evaluation (Server with a GUI) x64 7/26/2012” option. The test environment was built to empty disks, so had to choose “Custom: Install Windows only (advanced)” option. The entire 40 GB virtual disk was used for the system drive. The installation was completed when the Server Manager is started to desktop.

### Operating System Customization

The reason for some of the customizations is simply to improve the visual outcome but many of them have to be made in order to finalize the basic server installation. It was easier to first change the Server Manager to not start up automatically.

By changing “always show all icons and notifications on the taskbar” was a more visual result to administrators. The big taskbar was not needed, changing the taskbar buttons to small size takes up less space on desktop. The small icons on desktop are more efficient and auto arranged icons are easier to find in alphabetical order, as shown in Figure 29.

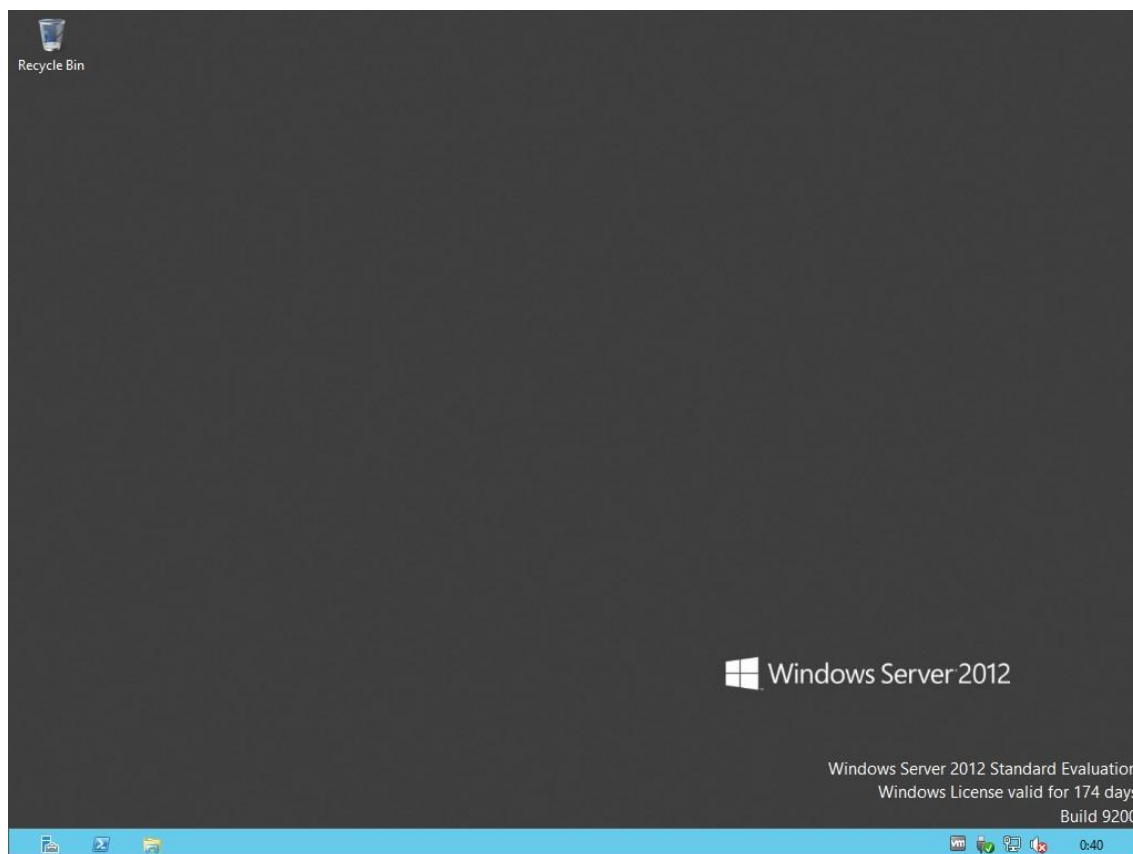


Figure 29: The desktop layout after some changes.

Figure 29 shows small Taskbar at the bottom and small Recycle Bin icon on the left corner.

Internet Explorer started with a pop-up window the first time, at this time, it was a good choice to select “Use recommended security and compatibility settings”. The first task was to change home page to the “about:blank”. Finally it was a good idea to change the following points in browser settings. “Delete Browsing history on exit”, but by adding the “Download History” to deleted items. The other changes were to use only the minimum 8 MB for stored pages, check for new versions of pages “Every time I visit the webpage”, keep 0 days browsing history and not allow websites caches and databases.

By changing the small icons to a Control Panel all possible necessary icons are one or two clicks closer. Next the static network settings were made, as shown in Table 28.

Table 28: The temporary static network settings for the servers.

Server	Host	Network Mask	Gateway	DNS server
MOMDDC1	10.0.10.10	255.255.254.0	10.0.10.1	10.0.10.1
MOMDDC2	10.0.10.11	255.255.254.0	10.0.10.1	10.0.10.1
MOMDS1	10.0.10.12	255.255.254.0	10.0.10.1	10.0.10.1
MOMDRM1	10.10.10.14	255.255.254.0	10.0.10.1	10.0.10.1
MOSDDC1	10.0.11.10	255.255.254.0	10.0.10.1	10.0.10.1
MOSDDC2	10.0.11.11	255.255.254.0	10.0.10.1	10.0.10.1
MOSDS1	10.0.11.12	255.255.254.0	10.0.10.1	10.0.10.1
BOMDDC1	10.0.20.10	255.255.255.0	10.0.20.1	10.0.20.1
BOMDDC2	10.0.20.11	255.255.255.0	10.0.20.1	10.0.20.1
BOMDS1	10.0.20.12	255.255.255.0	10.0.20.1	10.0.20.1

Table 28 shows temporary static network settings for all servers. These four attributes are needed to configure right settings for network adapters.

The Power options in High performance power plan were changed next, “never turn off display” is a good option for the virtual machines. The host computer is managed by turning off the display. Next it was time to change region settings, the test environment uses Finnish formats but the long data type is in the English format. That makes it possible that the week day names and names of the months are in English. The home location option can be changed on the location tab which will affect for instance to the Internet Explorer and the Start Screen applications. The effect of the option is that it places local applications on the top of the list of the Store service, the test environment uses the United States for location. These new settings were copied onto Welcome Screen and new user accounts from the program’s own tab. Removing not needed languages from input methods in the language settings made language settings simple, the test environment uses only the Finnish input method. The final task in Control Panel was to change the computer name to same with the name of the virtual machine and shutdown the virtual machine.

Removing the installation media and changing an optical drive to physical K: drive to hardware profile in the host computer was the next task. After that it was needed to remove a floppy device from VM hardware profile and the “autoinst.flp” file from virtual machine’s personal folder. Starting up the virtual machine and installing complete VMware Tools installation, were the next tasks.



After the restart it was time to configure the Windows Update, installing updates automatically and included with recommended updates were good settings for the test environment. Searching, downloading and installing latest updates, restarted computer if needed, but rerun the process so many times that it not find updates anymore.

The Windows SmartScreen was turned on as recommended, when prompted to the Action Center in a Notification area. The paging file was changed from automatically managed mode to custom size between its minimum (16 MB) and recommended size (1024 MB). This will stop the file of the uncontrolled growth of fault conditions. The operating system does not create automatically recommended size file, it creates a size what is really needed. One task was to disable hibernation feature, it was done with command.

```
Powercfg -h off
```

The hibernation feature is not needed for virtualized installations. The last visualizing task to the servers was to make more simple browsing windows by deleting My Music, My Pictures and My Videos libraries and removing “Recent places” from Favorites section. Now the server installation is ready for the roles and the features.

#### 4.1.4 Basic Server Installation with Core User Interface

The server installations with core user interface do not differ much from installations with GUI, only for hardware profile it was needed to select “Server 2012 Standard Core” and for installation it was needed to select “Windows Server 2012 Standard Evaluation (Server Core Installation) x64 7/26/2012” installation option, all others are shown in Chapter 4.1.3.

#### Operating System Customization

In the core user interface all customizing settings was made to finalize a basic server installation. Almost all customization changes has made with Sconfig application, as shown in Figure 30.



Figure 30: The Sconfig application for customizing Core user interface installation.

Figure 30 shows options to change the most popular settings. First was changed the server name, time zone and network settings. After these changes it was time to turn off the server. The core installation was turned off with command.

```
Stop-Computer
```

It is also possible to restart with command.

```
Restart-Computer
```

Removing the installation media and changing an optical drive to physical K: drive to hardware profile in the host computer were the next tasks. After that it was necessary to remove a floppy device from VM hardware profile and the “autoinst.flp” file from virtual machine’s personal folder. Starting up the virtual machine and installing complete VMware Tools installation, were the next tasks.

After the restart it was time to configure the Windows Update, installing updates automatically and included with recommended updates were good settings for the test environment, the easiest way to achieve this was with the Sconfig application. Searching, downloading and installing the latest updates, restarting the computer if needed, and

rerunning the process so many times that it did no longer find any updates. The default core user interface is much reduced, as shown in Figure 31.

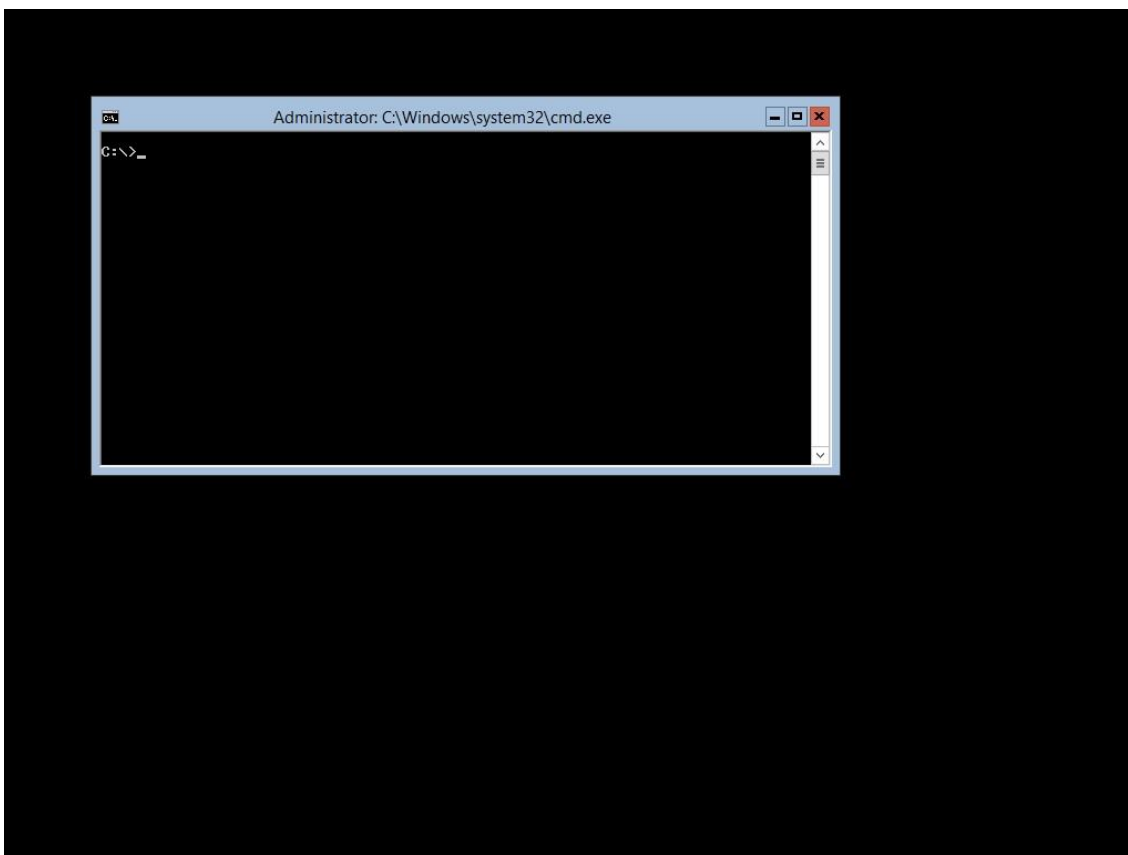


Figure 31: Basic Core user interface in Windows Server 2012.

Figure 31 shows that the core user interface do not include the GUI desktop feature, only the Command Prompt shell. The core installations do not contain for example Internet Explorer or File Explorer features. The Command Prompt shell is possible change to PowerShell shell with command.

```
Set-ItemProperty -Path  
'HKLM:\SOFTWARE\Microsoft\Windows  
NT\CurrentVersion\Winlogon' -name Shell -Value  
'PowerShell.exe -noExit'
```

It contains different settings with core interface by default than with GUI. It was necessary to change the colors and other settings after restart when PowerShell is the shell. The necessary changes were activate QuickEdit Mode, change font to Lucida Console with size 12. The layout was changed to 1024x768 resolution; Screen Buffer Size with width

141 and height 3000. Windows Size with width 141 and height 60 and Window Position from left 0 and from top 0 without let system position window. The colors were changed; Screen Text (238,237,240), Screen Background (1, 36, 86), Popup Text (0,128,128) and Popup Background (255,255,255), color options are (red, green, blue). The options, Font and Colors were now set the same with PowerShell in the GUI, as shown in Figure 32.

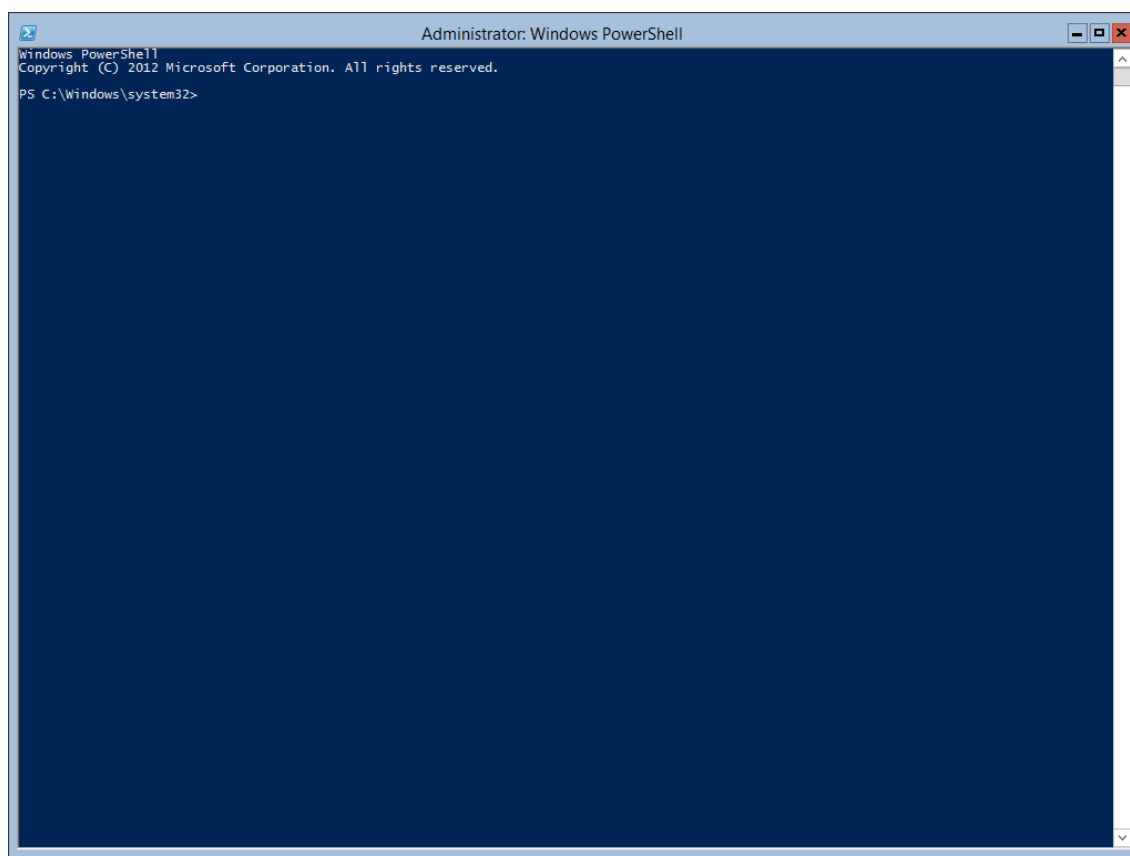


Figure 32: Core user interface with PowerShell shell, optimized to 1024x768 resolution.

Figure 32 shows there is no longer small Command Prompt shell with visible unused black background. The shell is now PowerShell shell with optimized size for display resolution.

The next task was to change time and currency formats right with command.

```
Control intl.cpl
```

The power settings was a two piece task. The first task was to change the “Turn off display after” setting to 0 in right Power Scheme. It was done with command.

```
Powercfg /setacvalueindex 8c5e7fda-e8bf-4a96-9a85-
a6e23a8c635c 7516b95f-f776-4464-8c53-06167f40cc99
3c0bc021-c8a8-4e07-a973-6b14cbcb2b7e 0
```

The command included three GUIDs. The first was for the power scheme and the second for a subgroup in this scheme, the last GUID was for changed power settings. The second task was to change active Power Scheme to that High Performance plan with command.

```
Powercfg /s 8c5e7fda-e8bf-4a96-9a85-a6e23a8c635c
```

Next the power settings were changed right for the environment. One task was to disable the hibernation feature and it was done with command.

```
Powercfg -h off
```

The hibernation feature is not needed for virtualized installations. Now the server with core user interface was ready for management computer and roles and features.

#### 4.1.5 Basic Windows 8 Installation

This installation process was shared to three sections, the virtual machine hardware profile, the operating system installation and the operating system customization. The test environment contains a couple of Windows 8 workstations and the installation process is explained only once in this chapter.

##### Virtual Machine Hardware Profile

The virtual machine hardware profiles for workstations were made in “Typical (recommended)” way in the VMware Workstation software. The workstations in the test environment were installed from 90 day evaluation media [53] [54]. The workstation names were designed in a specific manner and they contain a certain logic, as shown in Table 29.

Table 29: The workstation names in the study.

MOSDW1	MO = Main Office	SD = SubDomain	W = Workstation	1 = 1 <sup>st</sup>
BOMDW1	BO = Branch Office	MD = Main Domain		1 = 1 <sup>st</sup>

Table 29 shows that the first two characters are for office, then the third and fourth characters tell the domain. The fifth and sixth characters tell the types of the servers and the last number tells the number of the server in the type, in the domain, in the office. The workstation names in the VMware Workstation hardware profiles are the same as their future DNS names. All the workstations are installed to the same folder with servers to the “d:\thesis\[workstation name]” folder.

The default settings were 60 GB disk capacity in several 2 GB files, this had to be changed to one increasing 40 GB file. By default, one core and 2048 MB RAM was correct to the test environment. The hardware profile was completed after removing the printer and changing correct network adapter interface. Before starting “Update VMware Tools automatically” and “Synchronize guest time with host” had to be changed. The virtual machine hardware profile was now complete for an operating system installation.

#### Operating System Installation

The virtual machine was started up with “Power On to BIOS” command. Some changes were needed to make to BIOS; serial ports, parallel port and floppy disk controller was disabled, these are no longer needed in computers. If floppy disk controller is enabled in BIOS, the operating system shows A: drive with its own programs without real physical device in the host computer. Disabling only the diskette drive in BIOS is not enough. The last task was to save the BIOS changes.

The first selected option in the Microsoft Windows 8 installation was regional settings. This multi-cultural test environment was built with English (United States) weekday names and month names. That was done by leaving the “English (United States)” time and currency format, but by changing the keyboard or input method to “Finnish”.

Time and currency format selection in the installation process selects the language of week day names and month names but it also selects input language and location

setting. Input language affects to the programs in the Start Screen and location setting to contents of the Windows Store, as shown in Figure 33.

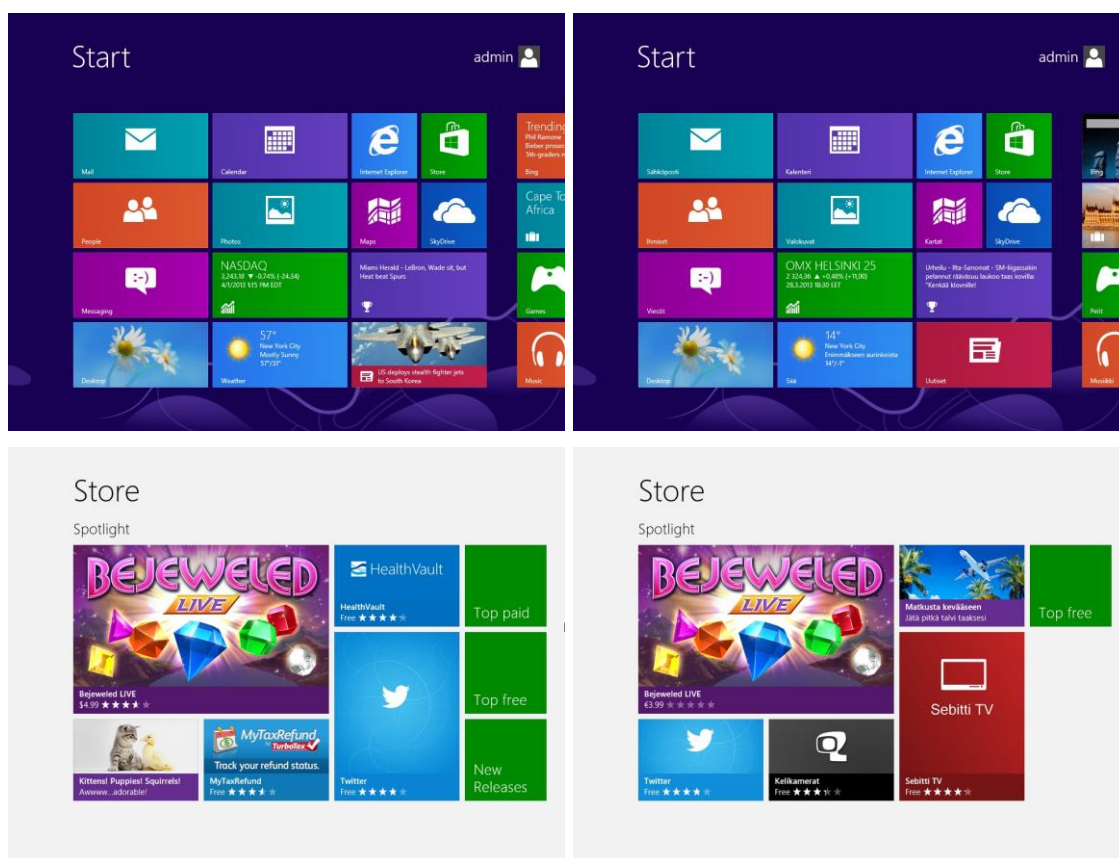


Figure 33: Installations with “Finnish (Finland)” time and currency format on the left and with “English (United States)” on the right.

Figure 33 shows program names with different languages in the Start Screens, only Internet Explorer, Desktop, Bing, SkyDrive and Store are the same in both. The Windows Store shows local applications in its main page depending different location setting. The test environment was built with English input language with Finnish keyboard layout and United States location setting. These language settings can be changed later from the Control Panel and Language application.

That used installation media includes only Enterprise x64 90 day evaluation edition of the Microsoft Windows 8. The test environment was built to empty disks, so one had to choose “Custom: Install Windows only (advanced)” option and the entire 40 GB virtual disk is used for the system drive. The computer names are the same as when making virtual machine hardware profiles and the test environment used express settings this time installation process when it asks. Signing to computer took place without a Microsoft

account with a local account. The installation was completed when the computer started to new Start Screen.

### Operating System Customization

The reason for some of the customizations is simply to improve the visual outcome but many of them have to be made in order to finalize the workstation installation. After starting up to desktop it was possible to install the VMware Tools with complete installation from the VMware Workstation software's toolbar.

Changing "always show all icons and notifications on the taskbar" was a more visual result to administrators. The big taskbar was not needed, changing the taskbar buttons to small size take up less space on desktop. The small icons on desktop are more efficient and auto arranged icons are easier to find in alphabetical order, as shown in Figure 34.

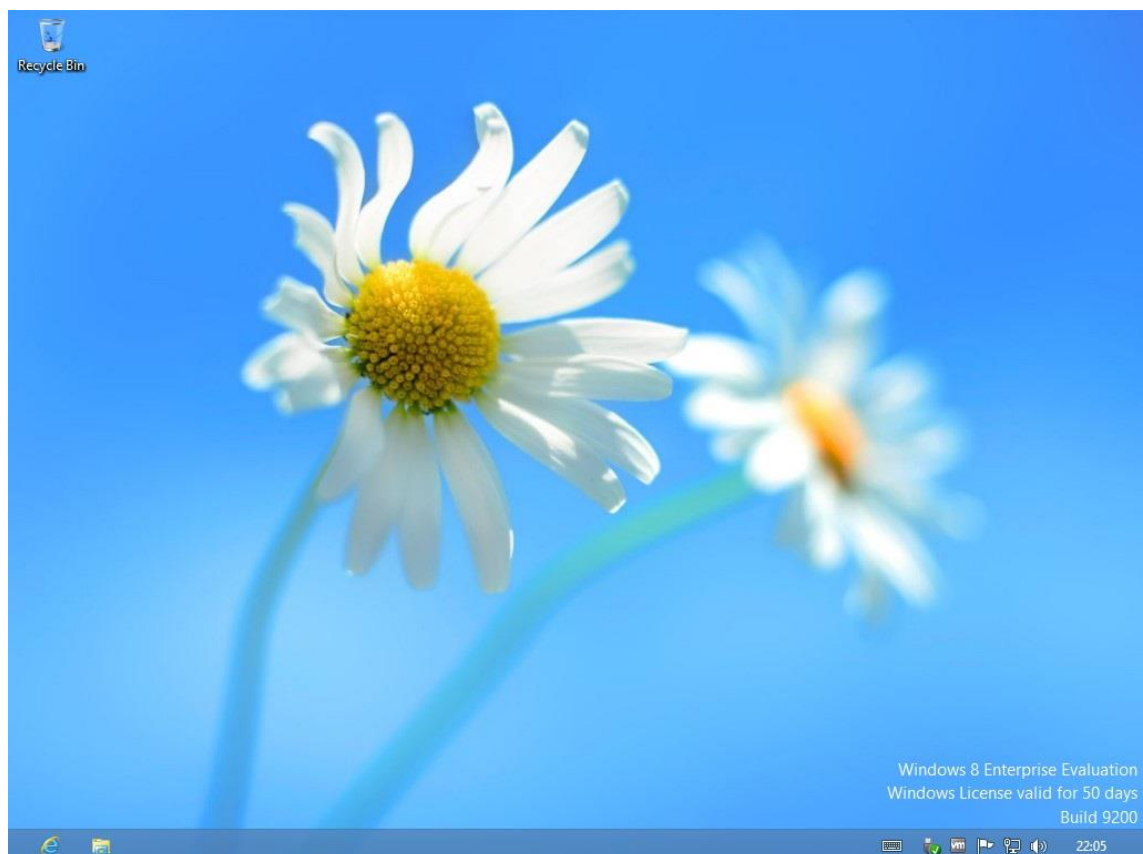


Figure 34: The desktop layout after some changes.

Figure 34 shows small Taskbar at the bottom and small Recycle Bin icon on the left corner.



The Internet Explorer settings were made next. The first task was to change home page to the “about:blank”. Finally it was a good idea to change the following points in the browser settings. “Delete Browsing history on exit”, but by adding “Download History” to deleted items with others. The other changes were to use only the minimum 8 MB for stored pages, check for new versions of pages “Every time I visit the webpage”, keep 0 days browsing history and not allow websites caches and databases.

By changing the small icons to Control Panel all the possible necessary icons are one or two clicks closer. The static network settings were made, as shown in Table 30.

Table 30: The temporary static network settings for the workstations.

Server	Host	Network Mask	Gateway	DNS server
MOSDW1	10.0.10.30	255.255.254.0	10.0.10.1	10.0.10.1
BOMDW1	10.0.20.30	255.255.255.0	10.0.20.1	10.0.20.1

Table 30 shows the temporary static settings for all workstations. These four attributes are needed to configure the right settings for network adapters.

The power options in high performance power plan was changed next, “Never turn off display” and “Never put the computer to sleep” were a good options for the virtual machines, the host computer is managed by turning off the display. Next it was time to change the region settings, the test environment uses Finnish formats but long data type is in the English format. That makes it possible for the week day names and names of the months to be in English. The home location option can be changed on the location tab which will affect for instance to Internet Explorer and Start Screen applications. The effect of the option is that it places local applications on the top of the list of Windows Store service, the test environment uses United States for location. These new settings were copied onto Welcome Screen and new user accounts from the program’s own tab. Removing not needed languages from Input methods in the language settings made language settings simple, the test environment uses only the Finnish input method. The last task in the Control Panel was Folder Options; clearing “Hide empty drives in the Computer folder”, “Hide extensions from known file types”, “Use check boxes to select items”.

The paging file was changed from automatically managed mode to custom size between its minimum (16 MB) and recommended size (2047 MB). This will stop the file of the uncontrolled growth of fault conditions. The operating system does not create automatically recommended size file, it creates a size only what is really needed. One task was to disable hibernate feature, it was done with command.

```
Powercfg -h off
```

The hibernate feature is not needed for virtualized installations. The final task was now to shut down the computer.

Removing installation media and changing an optical drive to physical K: drive in hardware profile in the host computer were the next tasks. After that it was needed to remove a floppy device from VM hardware profile that was the final task at this point to the hardware profile.

After restart it was time to configure the Windows Update, installing critical updates automatically included with the recommended updates were right settings for the test environment. Searching, downloading and installing latest updates, restarted computer if needed, but rerun the process so many times that it not find updates anymore. Updating the Start Screen applications from Windows Store service if Store application shows available updates was last updating task. Now the workstation installation was ready for the domain roles and features.

#### 4.1.6 Finalizing Platform

The test environment uses about 10 % of the processor and about 20 GB of memory. Now was the time to optimize and finalize the platform as well as to accept the installation of the roles and the features.

## Startup Benchmarks

All measurements are made with VMware Workstation software's autologin feature and disabling network. The autologin removes some variables of measurements. Enabled network dispersed measurements and needs to be disabled. The Paging File's PeakUsage information was taken with command as soon as possible after startup like all other results.

```
wmic pagefile get /format:list
```

The Microsoft's minimum system requirements are one 1.4 GHz processor and 512 MB of memory for Windows Server 2012, which was tested with test environment and shown in Table 31.

Table 31: Startup benchmarks of Windows Server 2012 Standard edition with GUI.

Memory	Startup Time	Physical Memory			Paging File		
		In Use	Modified	Available	Recommended	Allocated	Used
256 MB	44 s	248 MB	0	7 MB	1024 MB	256 MB	124 MB
512 MB	40 s	344 MB	5 MB	162 MB	1024 MB	256 MB	12 MB
1024 MB	39 s	363 MB	11 MB	649 MB	1024 MB	256 MB	0
2048 MB	36 s	390 MB	11 MB	1646 MB	2047 MB	384 MB	0
4096 MB	40 s	483 MB	11 MB	3601 MB	3583 MB	704 MB	0
8192 MB	40 s	648 MB	11 MB	7532 MB	4607 MB	1216 MB	0
16384 MB	41 s	990 MB	11 MB	15383 MB	5631 MB	2304 MB	0
24836 MB	42 s	1345 MB	11 MB	23479 MB	6688 MB	3328 MB	0

Table 31 shows the Microsoft Windows Server 2012 edition starts up with 256 MB memory and best startup time was with 2 GB of memory, 512 MB and under it was used paging file. 1024 MB is a good choice for the test environment. The startup time was measured at the time of when their desktop icons were loaded and the Physical Memory results are from the Resource Monitor.

The in use memory means the memory used by processes, drivers or operating system, the modified memory means the memory which contents must be written to disk before it can be used for another purpose and the available memory means the amount of memory including standby and free that is immediately available for use by processes,

drivers or operating system. Standby memory means the memory that contains cached data and code that is not actively in use and free memory means the memory that does not contain any valuable data and that will be used first when processes, drivers or operating system need more memory.

Different processor core virtualizing changes the startup times in a client computer. It made no difference if virtualizing took place to processors or cores, as shown in Table 32.

Table 32: Startup times with different processor combinations of the Windows Server 2012 Standard edition with GUI.

Processors	Cores	Startup Time
1	1	39 s
1	2	41 s
2	1	39 s
1	4	45 s
2	2	45 s
4	1	46 s
1	6	51 s
1	8	57 s
2	4	56 s
4	2	58 s

Table 32 shows the fastest startup times were with one or two virtualized cores and then the time was between 39 seconds and 41 seconds. All measurements were made with 1024 MB of memory.

The Microsoft Server 2012 Standard edition with core user interface uses the same system requirements as than with GUI. The measurement results are shown in Table 33.

Table 33: Startup benchmarks of Windows Server 2012 Standard edition with core user interface.

Memory	Startup Time	Physical Memory			Paging File		
		In Use	Modified	Available	Recommended	Allocated	Used
256 MB	48 s	228 MB	0	27 MB	1024 MB	256 MB	44 MB
512 MB	47 s	278 MB	8 MB	225 MB	1024 MB	256 MB	0
1024 MB	47 s	305 MB	7 MB	711 MB	1024 MB	256 MB	0
2048 MB	49 s	335 MB	7 MB	1705 MB	2047 MB	384 MB	0
4096 MB	47 s	418 MB	7 MB	3670 MB	3583 MB	704 MB	0
8192 MB	48 s	592 MB	7 MB	7592 MB	4607 MB	1216 MB	0
16384 MB	49 s	927 MB	7 MB	15449 MB	5631 MB	2304 MB	0
24836 MB	49 s	1277 MB	7 MB	23551 MB	6688 MB	3328 MB	0

Table 33 shows Microsoft Windows Server 2012 starts up with 256 MB memory and all startup times were between 47 seconds and 49 seconds. Only combination with 256 MB uses paging file and 1024 MB is a good choice for the test environment. The startup time was measured at the time of when prompt was loaded and the physical memory results are by Task Manager.

Different processor core virtualizing changes the startup times in a client computer. It made no difference if virtualizing took place to processors or cores, as shown in Table 34.

Table 34: Startup times with different processor combinations of Windows Server 2012 Standard edition with core user interface.

Processors	Cores	Startup Time
1	1	47 s
1	2	47 s
2	1	47 s
1	4	52 s
2	2	51 s
4	1	53 s
1	6	57 s
1	8	1 m 03 s
2	4	1 m 04 s
4	2	1 m 03 s

Table 34 shows the fastest startup times were with one or two virtualized cores, fastest time was 47 seconds. The core user interface is slower than GUI and all measurements were made with 1024 MB of memory.

The Microsoft's minimum system requirements are one 1 GHz processor and 2 GB of memory for the Windows 8 x64 editions and it was tested using a test environment, as shown in Table 35.

Table 35: Startup benchmarks of the Windows 8 Enterprise x64 edition.

Memory	Startup Time	Physical Memory			Paging File		
		In Use	Modified	Available	Recommended	Allocated	Used
256 MB	1 m 37 s	240 MB	0	15 MB	1024 MB	1024 MB	194 MB
512 MB	49 s	447 MB	0	64 MB	1024 MB	1024 MB	22 MB
1024 MB	47 s	634 MB	25 MB	364 MB	1024 MB	1024 MB	0
2048 MB	47 s	681 MB	18 MB	1348 MB	2047 MB	2048 MB	0
4096 MB	47 s	802 MB	19 MB	3274 MB	3583 MB	3584 MB	0
8192 MB	47 s	954 MB	19 MB	7218 MB	4607 MB	4608 MB	0
16384 MB	52 s	1302 MB	18 MB	15063 MB	5631 MB	5632 MB	0
24836 MB	54 s	1660 MB	18 MB	23157 MB	6688 MB	6689 MB	0

Table 35 shows that the Microsoft Windows 8 Enterprise x64 edition starts up with 256 MB memory and best startup time was with memory between 1024 MB and 8192 MB, time was 47 seconds. Only combination with 512 MB or less uses paging file. 2048 MB is a good choice for the test environment and does not need to be changed in virtual machines. The startup time was measured at the time of when Start Screen is loaded and the physical memory results are by Resource Monitor.

Different processor core virtualizing changes startup times in client computer. It made no difference if virtualizing took place to processors or cores, as shown in Table 36.

Table 36: Startup times with different processor combinations of Windows 8 Enterprise x64 edition.

Processors	Cores	Startup Time
1	1	47 s
1	2	42 s
2	1	41 s
1	4	45 s
2	2	44 s
1	6	49 s
1	8	50 s
2	4	50 s

Table 36 shows the fastest startup times were with two virtualized cores, fastest times were between 41 seconds and 42 seconds and actually two or four virtualized cores were faster than one virtualized core. It was needed to change one virtualized core to two virtualized core in the test environment. All measurements were made with 2048 MB of memory.

The Microsoft's minimum system requirements are 1 GHz processor and 1 GB of memory for the Windows 8 x86 editions. That x86 edition can use only 3072 MB of memory that was tested with the test environment as shown in Table 37.

Table 37: Startup benchmarks of Windows 8 Enterprise x86 edition.

		Physical Memory			Paging File		
Memory	Startup Time	In Use	Modified	Available	Recommended	Allocated	Used
256 MB	1 m 20 s	220 MB	0	35 MB	1024 MB	1024 MB	307 MB
512 MB	36s	344 MB	40 MB	127 MB	1024 MB	1024 MB	198 MB
1024 MB	34s	519 MB	131 MB	373 MB	1024 MB	1024 MB	115 MB
2048 MB	34s	556 MB	127 MB	1364 MB	2047 MB	2048 MB	98 MB
3072 MB	34s	586 MB	129 MB	2356 MB	3071 MB	3072 MB	0

Table 37 shows that the Microsoft Windows 8 Enterprise x86 edition starts up with 256 MB memory and best startup time was with memory 1024 MB or more, time was 34 seconds. With 2048 MB and under it was used paging file and the x86 edition uses paging file more than x64 edition with same amount of memory. The startup time was measured at the time of when Start Screen is loaded and the physical memory results are by Resource Monitor.

Different processor core virtualizing changes the startup times in client computer. It made no difference if virtualizing took place to processors or cores, as shown in Table 38.

Table 38: Startup times with different processor combinations of Windows 8 Enterprise x86 edition.

Processors	Cores	Startup Time
1	1	34s
1	2	30s
2	1	30s
1	4	41s
2	2	41s
1	6	43s
1	8	44s
2	4	44s

Table 38 shows the fastest startup time was with two virtualized cores, this time was 30 seconds. All measurements were made with 2048 MB of memory.

These measurements were very difficult to realize, they contained so many variables. Several repetitions gave two sets of same kind of results and could be considered as acceptable results. These results are comparable with one another, but they are only guidelines to other systems. They are the results of this system after basic installations, each installed role, feature and program change results in the future. If necessary, the system must be optimized again in future by adding more memory or virtualized cores to a virtual machine that needs them or even updating the virtual machines used by the disk space faster.

#### Mass Storage

The temporary basic virtual machines spent a total of 250 GB hard drive capacity. Hard drives can grow and they will.

$$\begin{aligned} \text{Number of VMs} * \text{maximum size of one virtual hard disk} &= \\ 14 * 40 \text{ GB} &= 560 \text{ GB} \end{aligned}$$



The test environment startup time is acceptable, with simple Storage Pool it takes about 24 minutes to start up all 14 virtual machines. One virtual machine starts about a two minutes, it is a double of startup time with one independent hard disk device. When all virtual machines were running and when backup process was running also this made changes in performance, as shown in Figure 35.

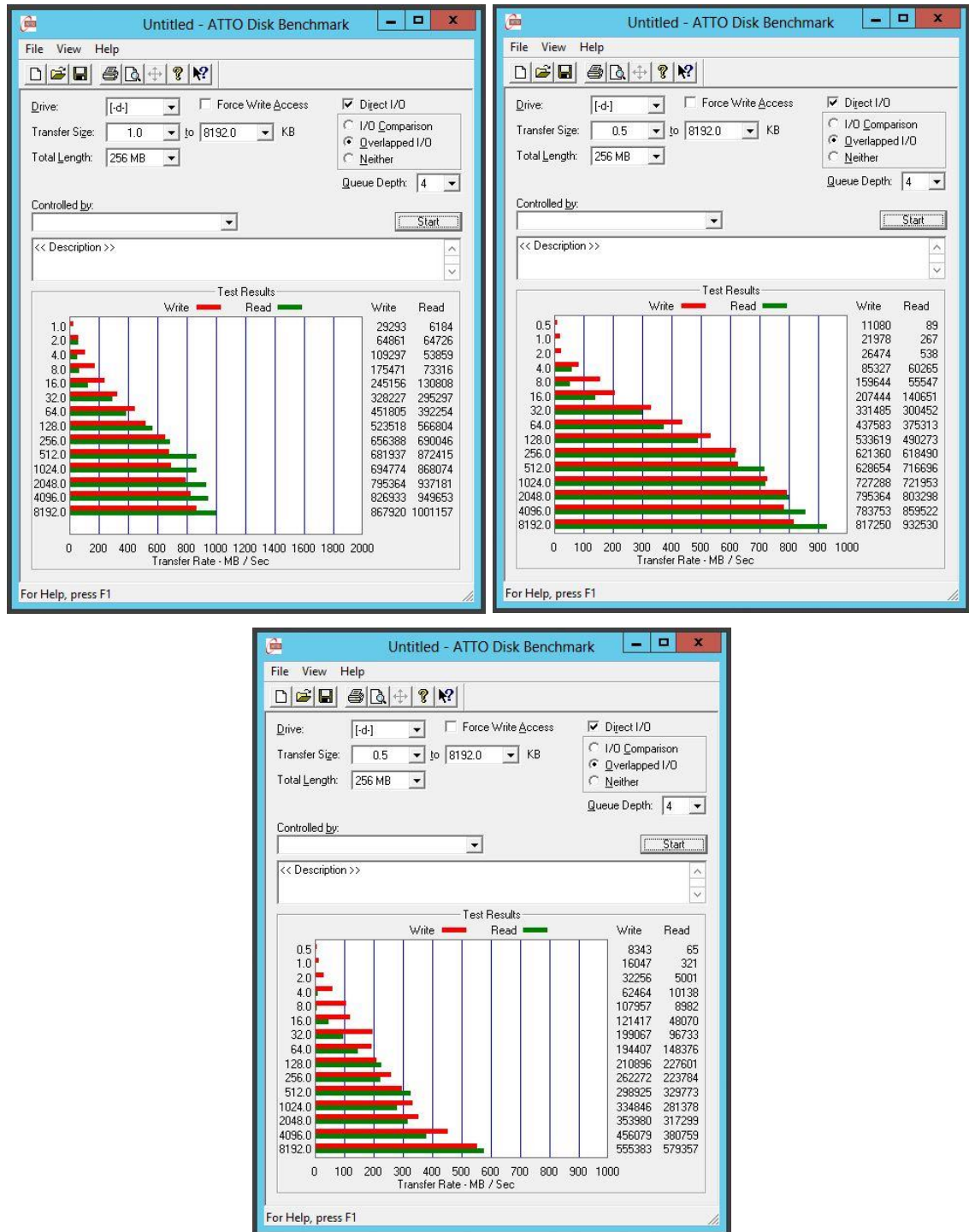


Figure 35: Test benchmarks of simple Storage Pool.

Figure 35 shows normal results on upper left corner. Normal average for read speed was 570 MB/s and for write speed 530 MB/s. It shows results when all 14 virtual machines were running on upper right corner. These 14 virtual machines work well, they takes about 5 % or more of average write speed capacity and about 10 % or more of average read speed capacity. It also shows the results when all 14 virtual machines were running plus the backup process was running also at the bottom of figure. The backup process takes all power of storage pool and therefore its use slows down considerably. The backup process takes about 50 % or more of average write speed capacity and about 60 % or more of average read speed capacity. The backup process takes about 80 minutes. These were hard to measure, the results changed every time, and these are the best results.

The last optimization task was to change NTFS cluster sizes from default 4 kB to 64 kB in the virtual machines drive and backup drive, also the virtual machine's drives were changed from default 4 kB to 64 kB NTFS cluster size with VMware vCenter Converter software, that all affected for use of the environment positively [55] [56]. After that the test environment's startup time was 15 minutes, it is 9 minutes (37 %) less than earlier and the backup process took only 50 minutes, it is 30 minutes (37 %) less than earlier. Changing the size of the NTFS clusters increased processor utilization approximately to 20 % that is double than the previous one.

#### Updates

Appendices lists all installed updates until 1<sup>st</sup> of May 2013. There are several updates to Windows Server 2012 and Windows 8. Some highlights from updates are shown in Table 39.

Table 39: Highlights of the security updates for Windows Server 2012 and Windows 8.

Description
Vulnerabilities in Windows shell could allow remote code execution, November 13, 2012
Vulnerability in DirectPlay could allow remote code execution, December 11, 2012
Vulnerability in IP-HTTPS component could allow security feature bypass, December 11, 2012
Vulnerabilities in Microsoft SSL implementation could allow security feature bypass, January 8, 2013
Vulnerabilities in Windows kernel could allow elevation of privilege, February 12, 2013
Vulnerabilities in Windows kernel-mode driver could allow elevation of privilege, February 12, 2013
Vulnerability in TCP/IP could allow denial of service, February 12, 2013
Vulnerability in vector markup language could allow remote code execution, February 12, 2013
Vulnerabilities in Windows Kernel-Mode drivers could allow elevation of privilege, March 12, 2013

Table 39 shows that newer operating systems have vulnerabilities in DirectPlay, IP-HTTPS component, Microsoft SSL implementation, TCP/IP, vector markup language, Windows kernel, Windows kernel-driver and Windows shell. The vulnerabilities are denial of service, elevation of privilege, remote code execution and security feature bypass.

The test environment was now ready for roles and features to servers and that way to builds working and efficient environment for fictive enterprise, as shown in Figure 36.

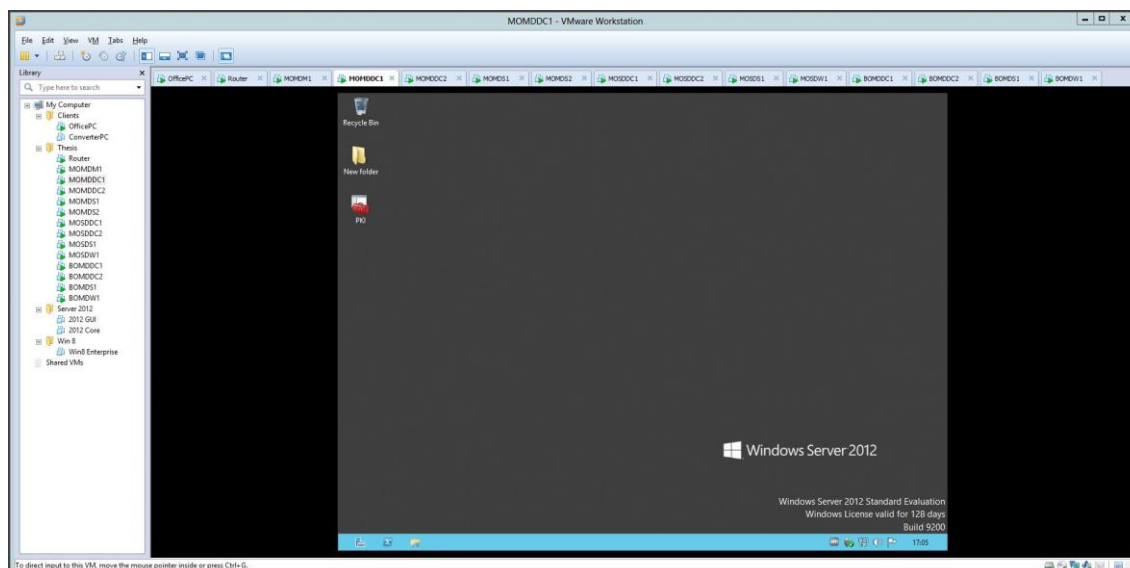


Figure 36: The ready test environment in the VMware Workstation 9 software.

Figure 36 shows library of the virtual machines on the left side and the tabs helps moving between virtual machines. The VMware Workstation only remember ten last virtual machines on the tabs and it was needed to re-put them after every startup to their place.

#### 4.2 Active Directory Domain Services (AD DS)

Installing the Active Directory Domain Services began by construction of the domain environment. It offer also to install the Group Policy Management feature. The test environment includes six domain controllers, servers which includes Active Directory Domain Services role. The environment contains two domain controllers per every domain, two because it is important to replicate this role to get needed high availability and redundancy to the environment.

##### MOMDDC1 + MOMDDC2

First the Active Directory Domain Services was installed to the environment's main server which is the MOMDDC1. The forest and the domain functional levels were selected to Windows Server 2012 and the DNS Server role was elected to use in all domain controllers. The second domain controller with name MOMDDC2 was made to the environment next, it was made to the earlier forest not to a new own forest.

### MOSDDC1 + MOSDDC2

Thirdly the Active Directory Domain Services was installed in subdomain to server MOSDDC1 first. The second domain controller with name MOSDDC2 was made to the subdomain next, it was made to the earlier subdomain not to any new own forest or domain.

### BOMDDC1 + BOMDDC2

Fifth the Active Directory Domain Services was installed to main server of branch office which is in the environment BOMDDC1 and the second domain controller with name BOMDDC2 was made next. It was made to the earlier branch office's forest not to any new own forest or domain.

### Active Directory Users and Computers

This management console (dsa.msc) was used for managing users, computers, security groups and other objects in this forest and role, as shown in Figure 37.

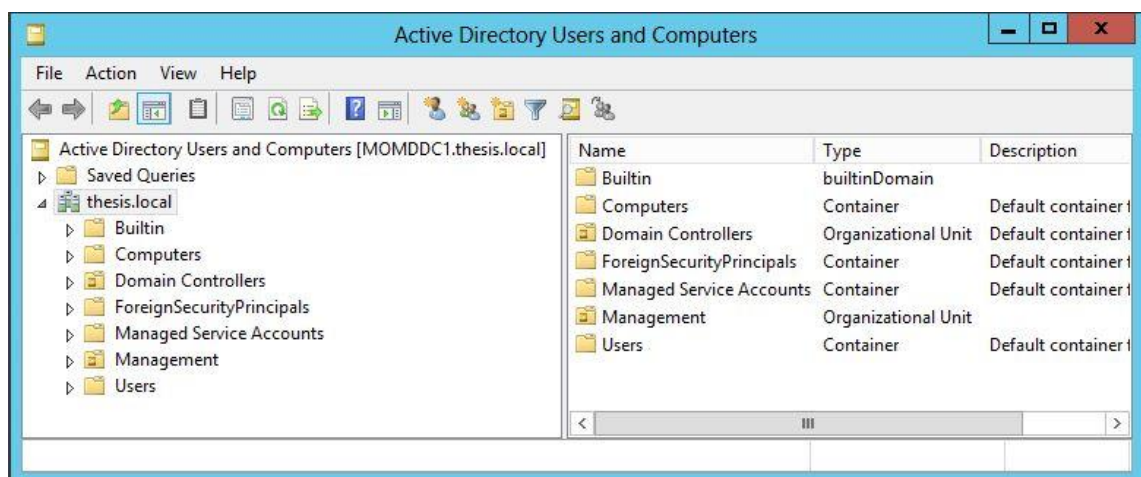


Figure 37: The Active Directory Users and Computers MMC.

Figure 37 shows for example new organizational unit for management, its name is Management. That includes user accounts for administrators and every domain includes own Management organizational unit for administrators.

The environment also includes a remote management console (lusrmgr.msc) for member servers and their local users and groups, as shown in Figure 38.

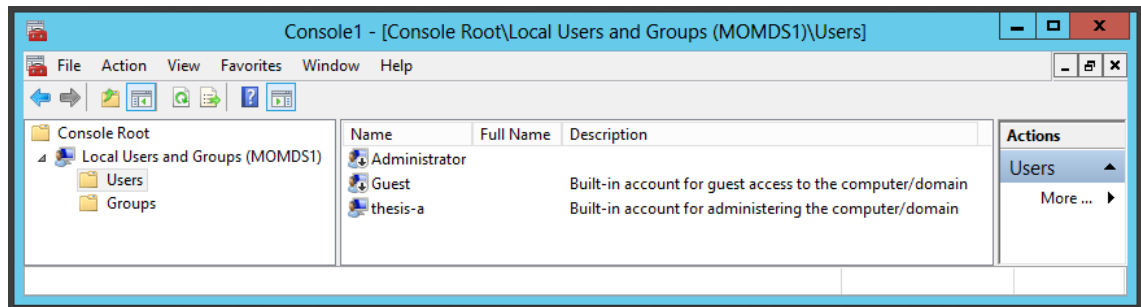


Figure 38: Local Users and Groups management console.

Figure 38 shows a view to MOMDS1 server. Remote management is only possible with MMC application, not directly from MSC file. Figure shows also that the default “Administrator” account was renamed to “Thesis-a” and was to made new disabled user level account with “Administrator” name for hackers.

#### Active Directory Sites and Services

This management console (dssite.msc) was used for create sites to manage the replication of Active Directory information. Default site name Default-first-Site-Name was changed more descriptive and Figure 39 shows how these were named in the test environment.

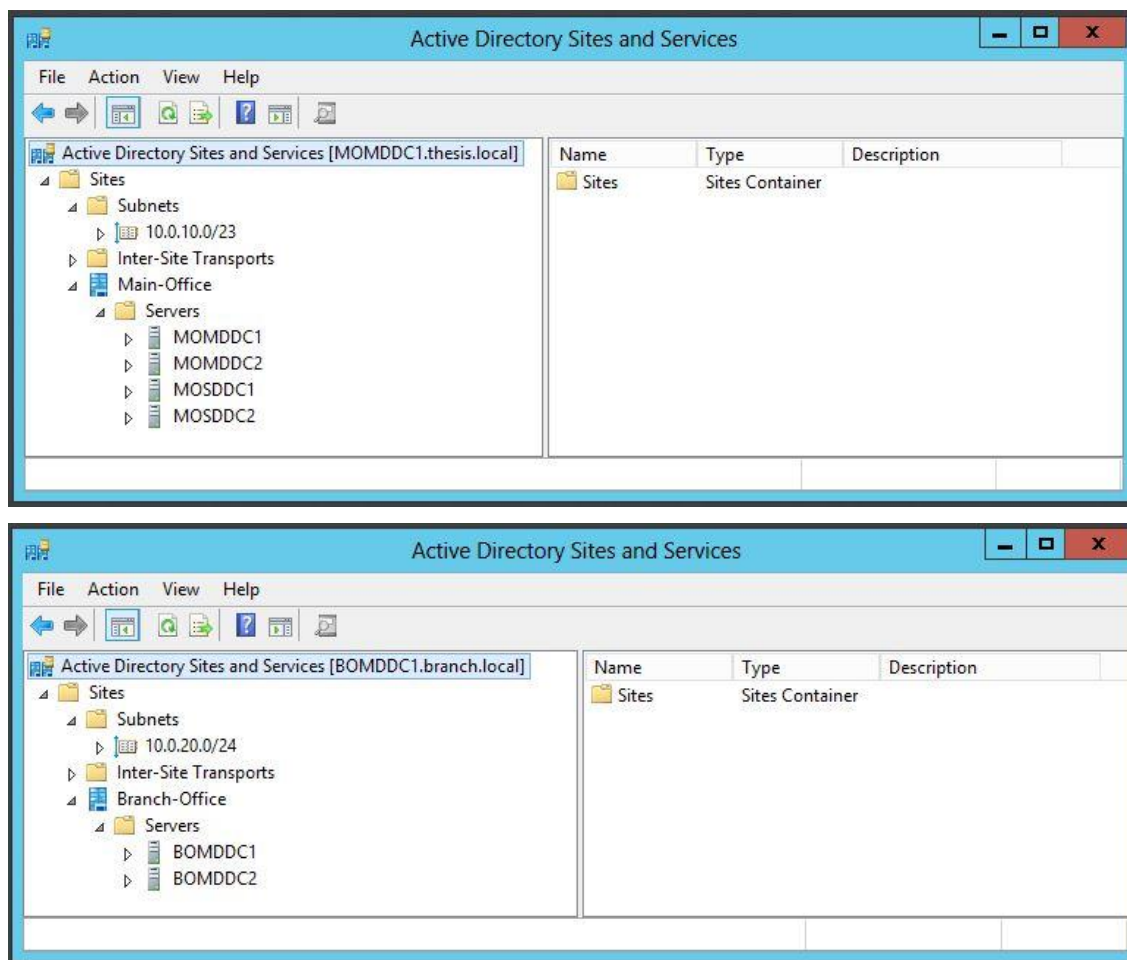


Figure 39: Active Directory Sites and Services in different offices.

Figure 39 shows that main office uses name Main-Office and in branch office uses name Branch-Office, site names cannot include spaces or underscores.

#### Active Directory Domains and Trusts

This management console (domain.msc) was used to manage the trust relationships between domains. The built trust relationships are shown in Figure 40.

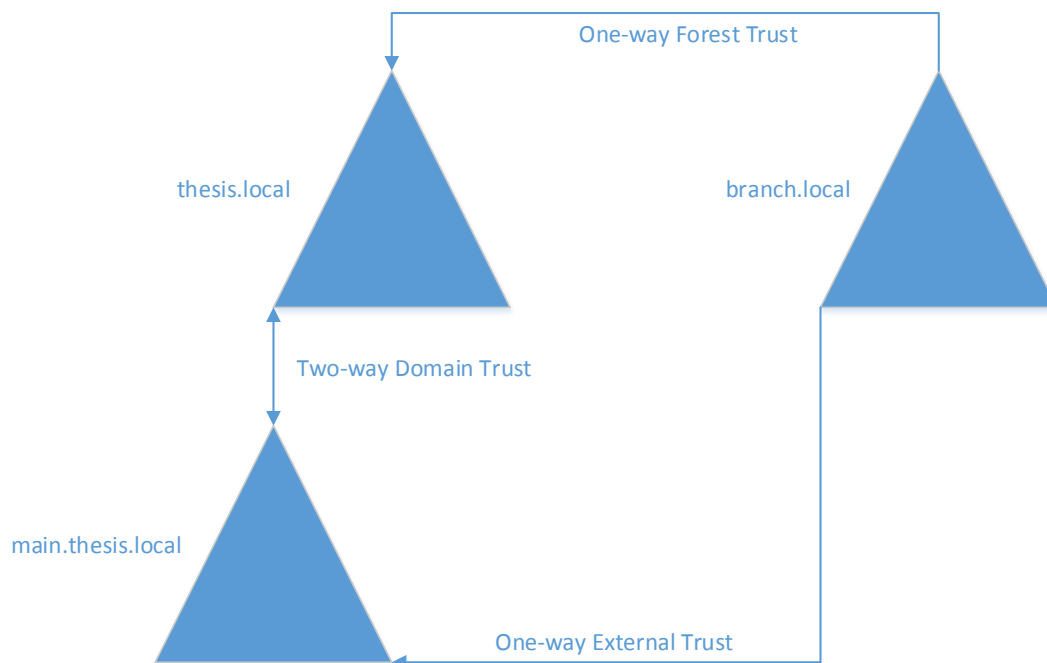


Figure 40: Forest and domain trusts in test environment.

Figure 40 shows two forests and only one-way trust between them. The domain tree made it possible to make an external trust between two forests that is also one-way trust. These trusts are shown for example when giving rights to folders or files illustrated in Figure 41.

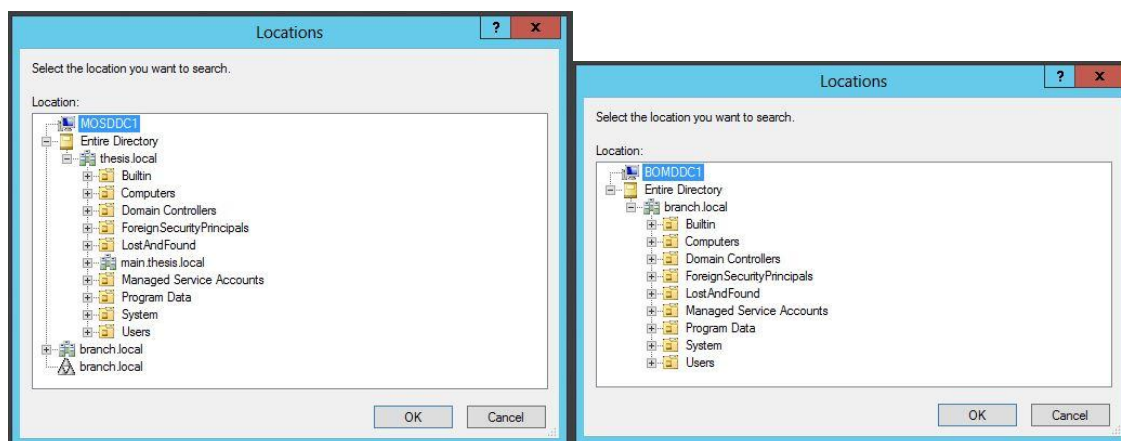


Figure 41: Location selection in right giving process for example a folder.

Figure 41 shows the thesis.local forest trusts the branch.local forest, then in the main.thesis.local domain (left) is possibilities give rights to objects of the branch.local forest. The thesis.local or the main.thesis.local domains are not showable in the



branch.local forest (right), because the branch.local forest does not trust thesis.local forest.

### Active Directory Administrative Center

The Active Directory Administrative Center (dsac.exe) is a default and new application in Windows Server 2012 with Active Directory Domain Services and GUI or minimal user interfaces. It comes also for remote management to Windows 8 with Remote Server Administration Tools. The basic view is shown in Figure 42.

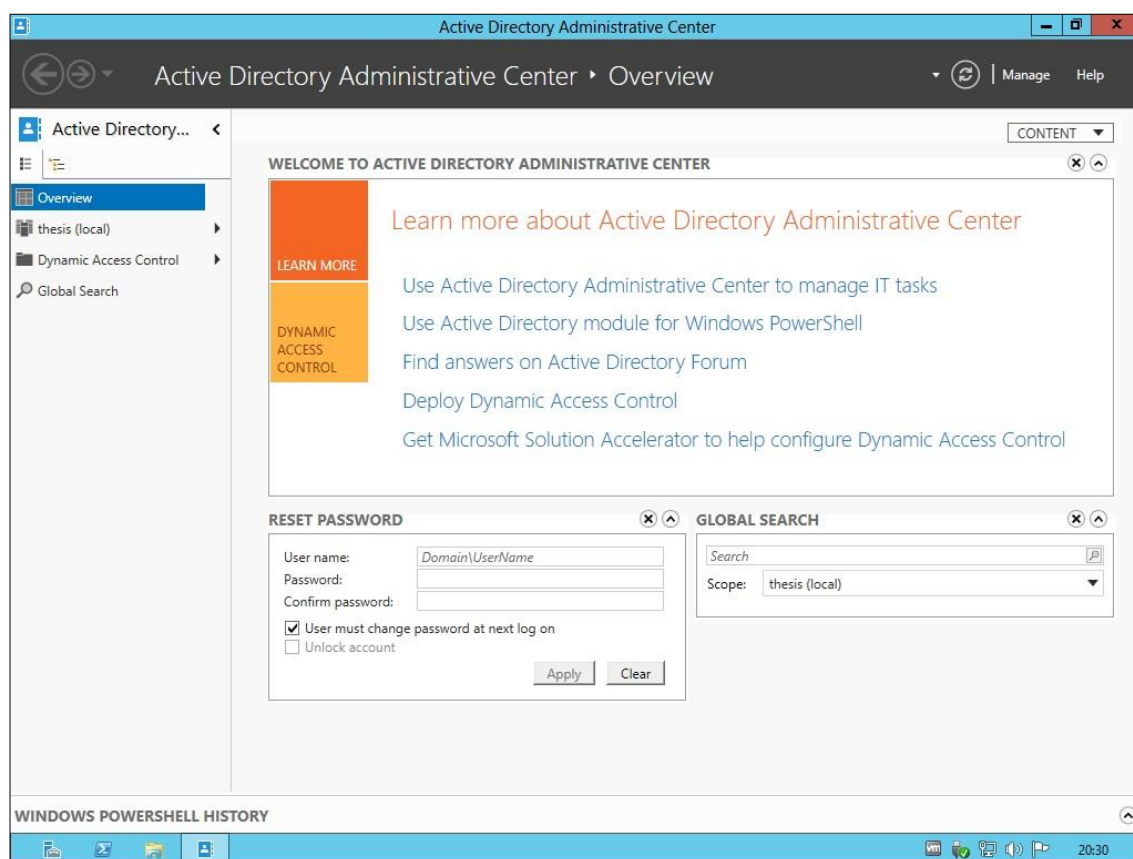


Figure 42: Basic view to Active Directory Administrative Center.

Figure 42 shows shortcuts on the left. The first shortcut with domain name gives possibilities to explore active directory objects and Global Search gives possibilities to search objects from Active Directory and the main page contains the most often needed password resetting tool. It is not possible to use that tool from the management computer which is a member of a workgroup.

Future tasks with Active Directory Domain Services are to make different accounts and groups for administrators and users, other tasks would be different security policies

with Group Policy Objects. All remote management consoles works if user are joined to domain and use account with rights to use them.

#### 4.3 DNS Server

The DNS Server role is a basic role for all environments. It makes possible to use names and IP addresses together, it works in the background. The Active Directory Domain Services offer install this role by default. DNS server role was needed to make redundancy, it was handled by making a DNS role to all Domain controllers and only secured queries and registrations were allowed, that allows only domain members to register these DNS servers in the test environment. Figure 43 shows DNS zones in the test environment.

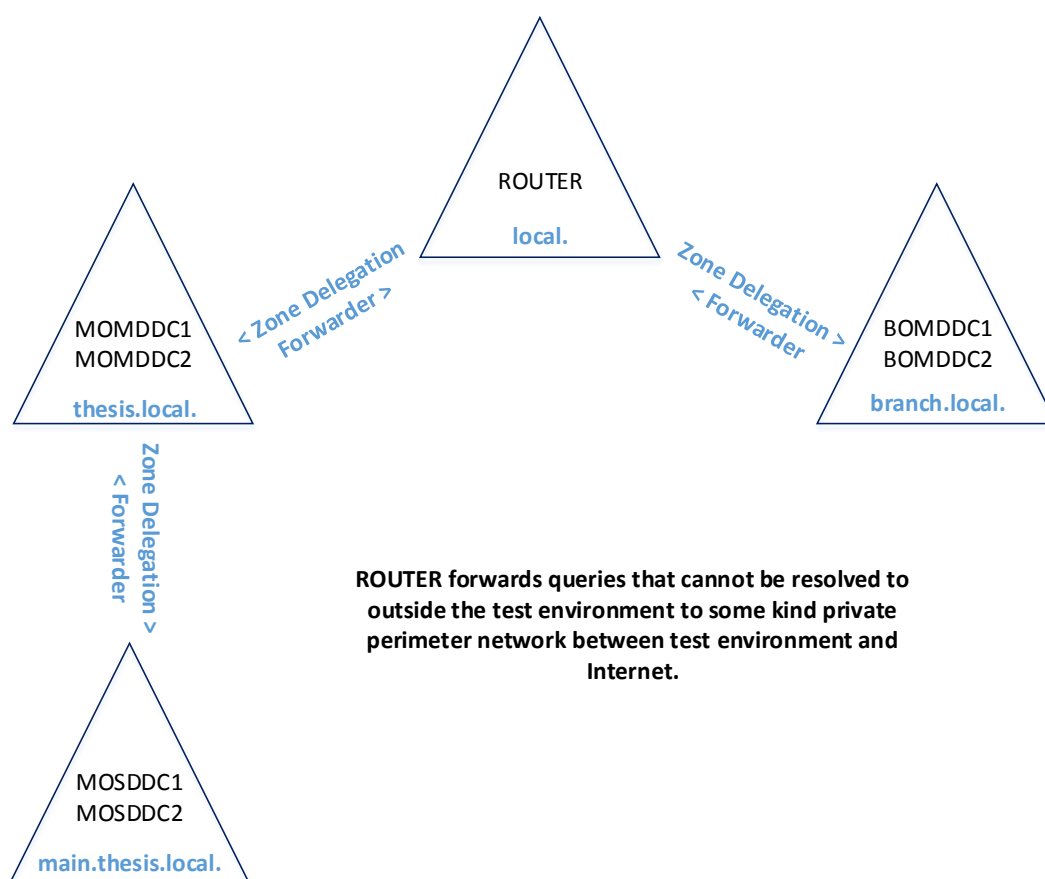


Figure 43: DNS zones in the test environment.

Figure 43 shows the environment does not use conditional forwarders, all name resolution between thesis.local and branch.local goes via ROUTER server. Public domain thesis.com is somewhere and it is not included to the test environment, it can

be for example in DMZ network. Settings in DNS servers were configured with DNS Manager management console (dnsmgmt.msc) as shown in Figure 44.

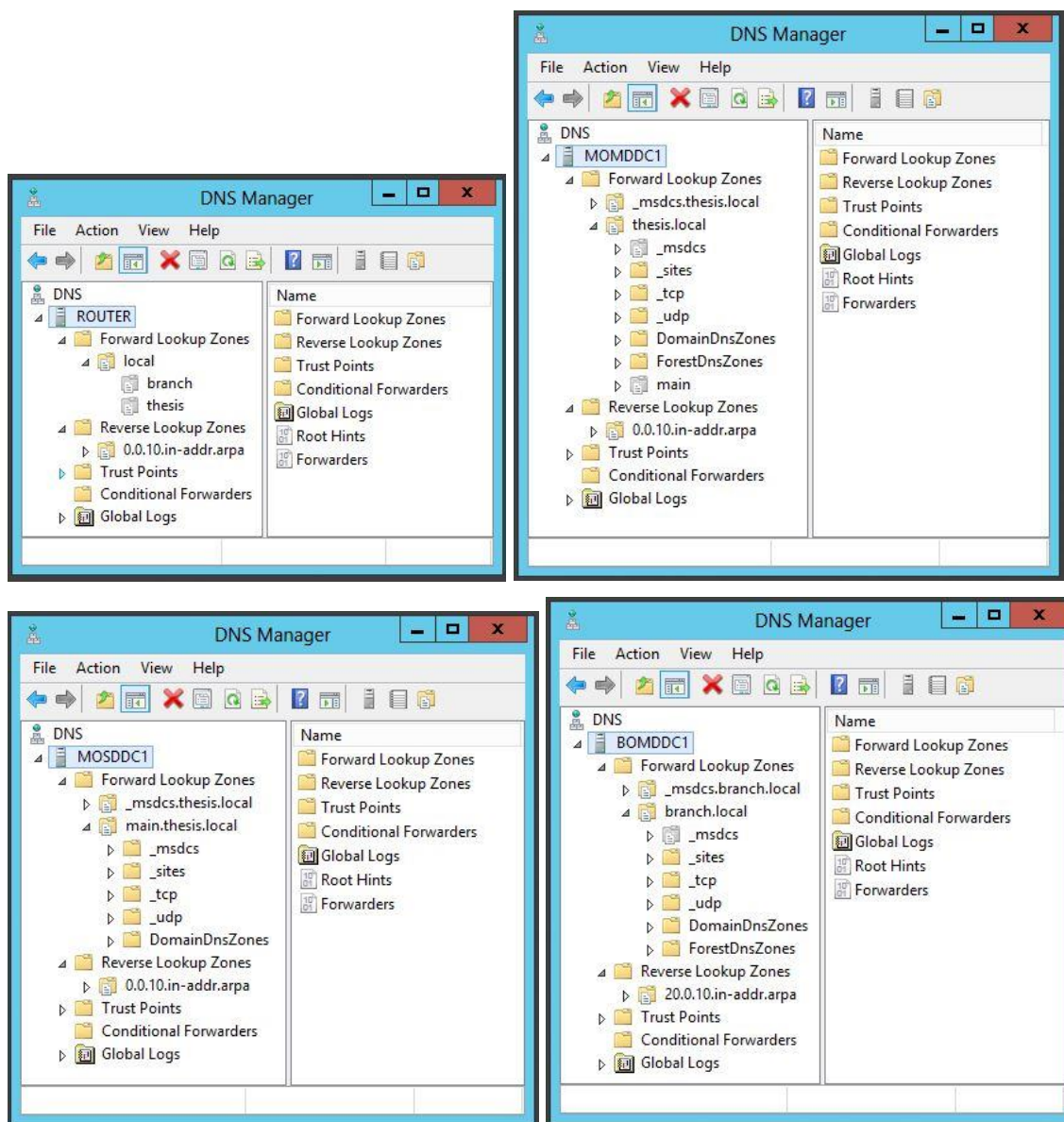


Figure 44: DNS Server settings in different zones.

Figure 44 shows four different zones, the upper left corner is local. zone of ROUTER and upper right is thesis.local. zone of MOMDDC1 or MOMDDC2. Bottom left is main.thesis.local. zone of MOSDDC1 or MOSDDC2 and bottom right is branch.local. zone of BOMDDC1 or BOMDDC2. The role contains only one management console, DNS (dnsmgmt.msc).

## ROUTER

First DNS Server role was installed to the ROUTER server. It was needed for local zone and two delegations to it, each for branch.local. zone and thesis.local. zone and it also needed forwarder IP addresses of outside the test environment.

## MOMDDC1 + MOMDDC2

The first domain controller was MOMDDC1 in the new thesis.local forest, promoting server to domain controller role made thesis.local as primary DNS zone to this server. Reverse lookup zone was made for retrieving IP addresses to names and delegation was needed to configure to forward subdomain DNS requests to their DNS servers. Redundancy DNS server was installed when promoting MOMDDC2 to domain controller to existing domain thesis.local., it replicates all settings from MOMDDC1. Forwarder for this DNS Server is ROUTER and DNS server's own DNS server IP address setting must change of default 127.0.0.1 to server's real IP address, after that notification area shows wanted information of Internet access, that must done to all DNS servers.

## MOSDDC1 + MOSDDC2

The first domain controller was MOSDDC1 in the new main.thesis.local subdomain, promoting server to domain controller role made main.thesis.local as primary DNS zone to this server. Reverse lookup zone was made for retrieving IP addresses to names. That domain does not include subdomains so delegations were not need to configure. Forwarders for this DNS server are MOMDDC1 and MOMDDC2 and redundancy DNS server was installed when promoting MOSDDC2 to domain controller to existing domain main.thesis.local., it replicated all settings from MOSDDC1.

## BOMDDC1 + BOMDDC2

The first domain controller was BOMDDC1 in the new branch.local forest, promoting server to domain controller role made branch.local as primary DNS zone to this server. Reverse lookup zone was made for retrieving IP addresses to names and that domain does not include subdomains so delegations were not need to configure. Forwarder for this DNS Server is ROUTER server and redundancy DNS server was installed when promoting BOMDDC2 to domain controller to existing domain branch.local., it replicated all settings from BOMDDC1.

The DNSSEC feature are potentially next task implement to test environment and DNS Server role. The test environment's remote management console view is shown in Figure 45.

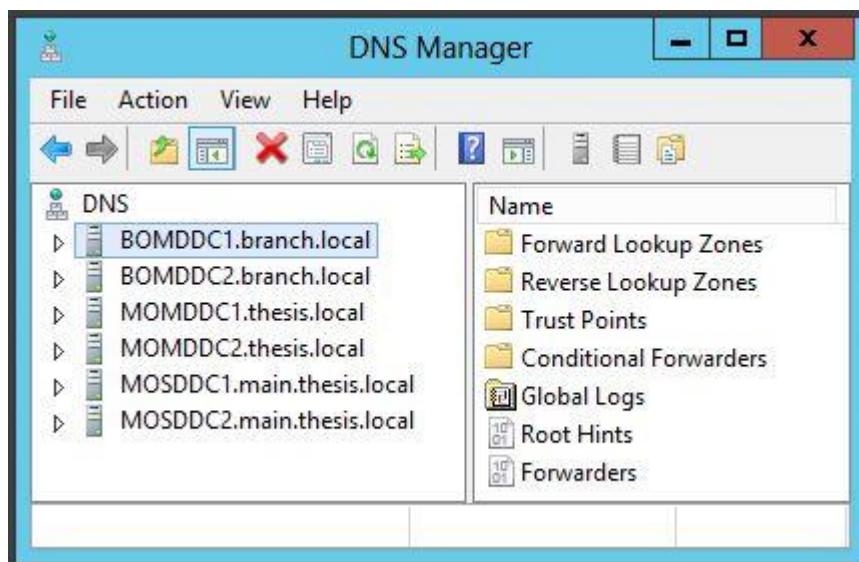


Figure 45: DNS Manager on Remote Management Computer.

Figure 45 shows, it is possible connect to all six DNS servers and console remembers connected servers.

#### 4.4 DHCP Server

The DHCP Server role is a basic role for all environments. It makes it easier to manage network settings for client computers and devices. The DHCP failover is a new feature in the Microsoft Windows Server 2012 and gives good redundancy possibilities to environment, sharing servers and workstations to another scopes gives more redundancy.

Authorizing DHCP server is a mandatory security task and typical settings witch DHCP server share are IP address, Network Mask, Gateway address, DNS server addresses and domain name. Using allow lists makes harder to administer network but standard users cannot change static network settings in the workstations and allow lists are easy way to protect the DHCP network settings. The role contain only one management console, DHCP.

## MOMDDC1 + MOMDDC2

The first step in taking the first DHCP Server role to use in the test environment was installing of DHCP server role with tools to the MOMDDC1 server. Complete configuration was authorized and new scope got name MOMDS (Main Office Main Domain Servers). The IP address range 10.0.10.30 – 10.0.10.49 and 23bit (255.255.254.0) mask was configured to this scope, DHCP scope settings of thesis.local domain are shown in DHCP management console (dhcpmgmt.msc) in Figure 46.

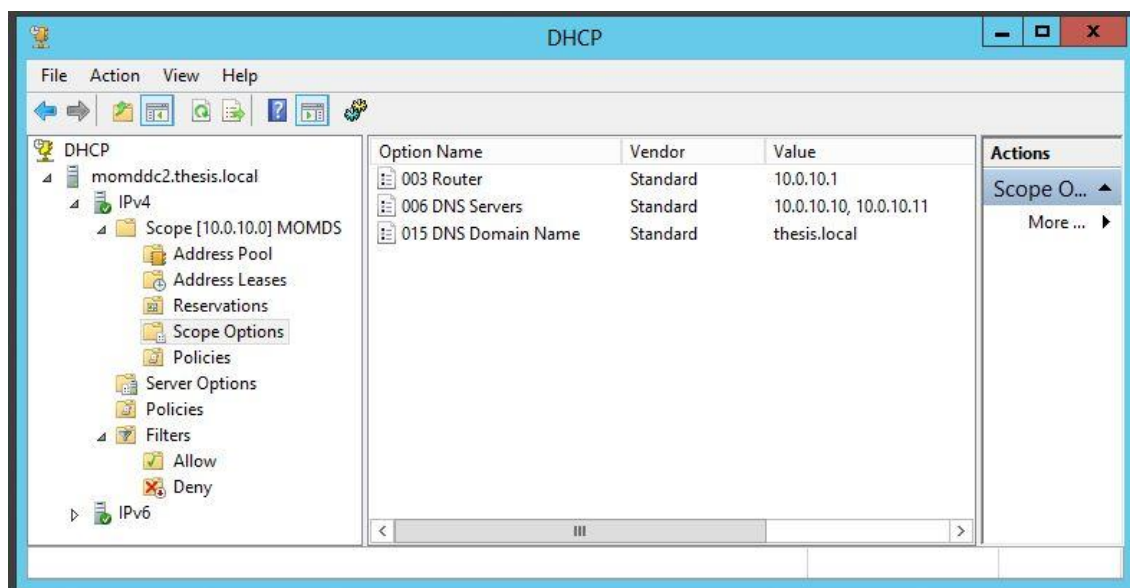


Figure 46: DHCP scope options of thesis.local domain.

Figure 46 shows the environment gets the router, DNS servers' IP addresses and domain name by the DHCP server, the router option was set to 10.0.10.1, DNS server option was set to 10.0.10.10 and 10.0.10.11. and the domain option was set to thesis.local. Now it was time to change MOMDS1 to use DHCP. The test environment needed failover for DHCP and the next step was installing DHCP server role with tools to the MOMDDC2 server. Then it was time to configure DHCP failover between MOMDDC1 and MOMDDC2, process was made from MOMDDC1. It started by giving a name to the relationship, it was momddc1.thesis.local-momddc2.thesis.local and the relationship type is load balance with 50 % / 50 %.

## MOSDDC1 + MOSDDC2

The next step was to install DHCP Server roles to MOSDDC1 and MOSDDC2 servers on main.thesis.local domain. That was started from MOSDDC1 server installing role and tools. The scope name got MOW and IP address range was 10.0.10.50 – 10.0.11.199 with exclusion range 10.0.10.200 – 10.0.11.49 and mask was 23bit (255.255.254.0). DHCP scope settings of main.thesis.local domain are shown in Figure 47.

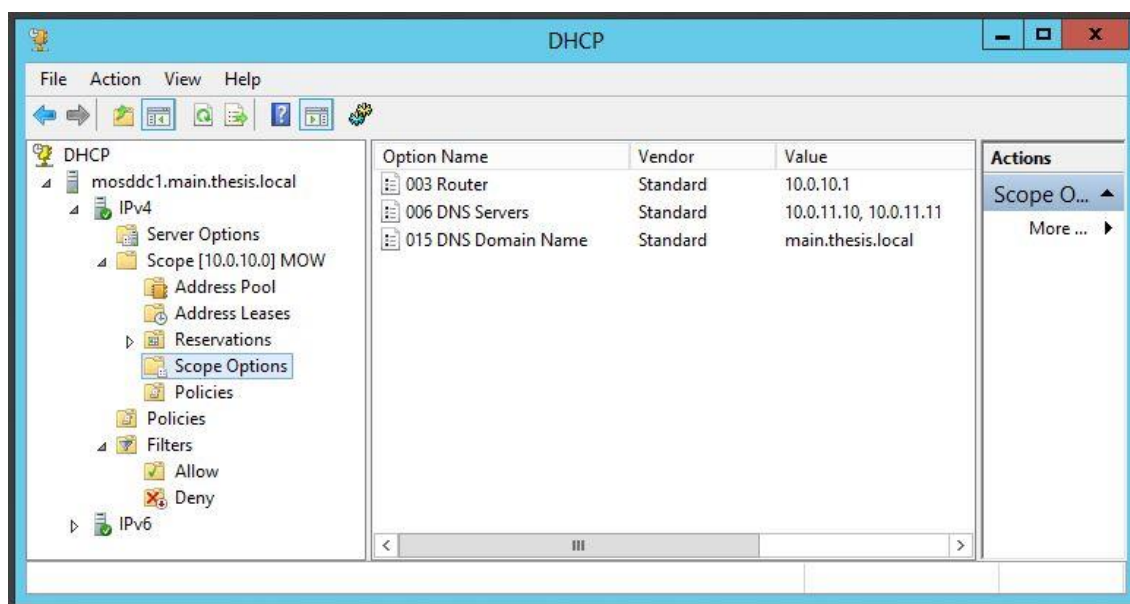


Figure 47: DHCP scope options of main.thesis.local domain.

Figure 47 shows the scope options were for this scope; Router option 10.0.10.1, DNS Server option 10.0.11.10 and 10.0.11.11 and the domain name was now main.thesis.local. Now it was time to change MOSDS1 and MOSDW1 to use DHCP. The test environment needs failover for DHCP and the next step was installing DHCP server role with tools to the MOSDDC2 server. Now it was time to configure DHCP failover between MOSDDC1 and MOSDDC2, process was made from MOSDDC1. It started by giving a name to the relationship, it was mosddc1.main.thesis.local-mosddc2.main.thesis.local and the relationship type is load balance with 50 % / 50 %.

## BOMDDC1 + BOMDDC2

Then was the time to configure the last couple of DHCP servers to the branch office. It started with installing DHCP Server role with tools to BOMDDC1 server. The scope name was made BO and IP address range 10.0.20.30-10.0.20.199, 24 bit length (255.255.255.0), as Figure 48 shows.

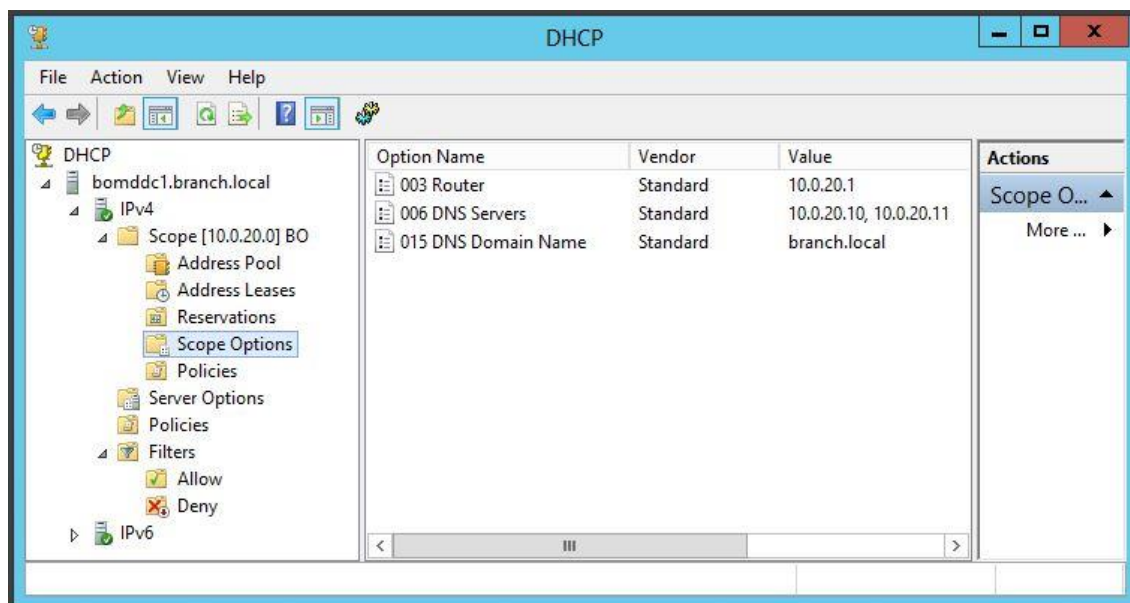


Figure 48: DHCP scope options of branch.local domain.

Figure 48 shows the scope options were for router 10.0.20.1, DNS Server option was 10.0.20.10 and 10.0.20.11, and the domain name option was branch.local. Next it is possible to change BOMDS1 and BOMDW1 to use DHCP. Now it was time to configure DHCP failover between BOMDDC1 and BOMDDC2 servers, process was made from BOMDDC1. It started by giving a name to the relationship, it was Bomddc1.branch.local-bomddc2.branch.local and the relationship type is load balance with 50 % / 50 %.

More scope options is potentially the next task to be implemented to the test environment and DHCP Server role. Remote management does not work to both forest at the same time in same console, it is necessary to manage the forests separately.

#### 4.5 Remote Server Administration Tools (RSAT)

The environment should include three management servers for every ICT service providers. In this study there is only one management server with the name MOMDRM1, the real management servers differ only with the user rights and attached servers. The server in this study was attached to all servers. The platform for the management server was a basic server installation with GUI.

It is also possible to use Windows 8 installation with its own Remote Server Administration Tools, but it includes restrictions shown in Table 40.



Table 40: Remote Management tools which do not include in RSAT for Windows 8.

Role / Feature	Management Console
Active Directory Rights Management Services	Active Directory Rights Management Services
Active Directory Federation Services	AD FS Management
Fax Server	Fax Service Manager
Network Policy and Access Services	Network Policy Server
	Health Registration Authority
Windows Deployment Services	Windows Deployment Services
Windows Server Backup	Windows Server Backup
	Local Backup
Windows Server Update Services	Update Services
WINS Server	WINS

Table 40 includes some usually needed but not included consoles, for example for Windows Server Backup and Windows Server Update Services. These all are installable to Windows Server 2012 for remote management. The consoles for Active Directory Federation Services and Windows Server Backup are only for local use in Windows Server 2012.

#### Firewall exceptions

The firewall exceptions for management tasks and tools are very complicated tasks and depends on corporate security requirements and management tools. The test environment was first built with disabled firewalls to know that tools work remotely, the easiest way to achieve disabling in every network interface was with command.

```
netsh advfirewall set allprofiles state off
```

Then firewalls were enabled as soon as possible with some exceptions. The exceptions must be enabled in both computers in remote management tasks, the test environment was configured with Group Policy Object to activate all default exceptions. The Device Manager and the Disk Management consoles were difficult to configure working remotely from outside the domain. There was needed at least Plug and Play, Remote Registry and Virtual Disk services for remote management.

## Server Manager

The Server Manager had to connect to the managed servers and had to create a server groups for them, as shown in Figure 49.

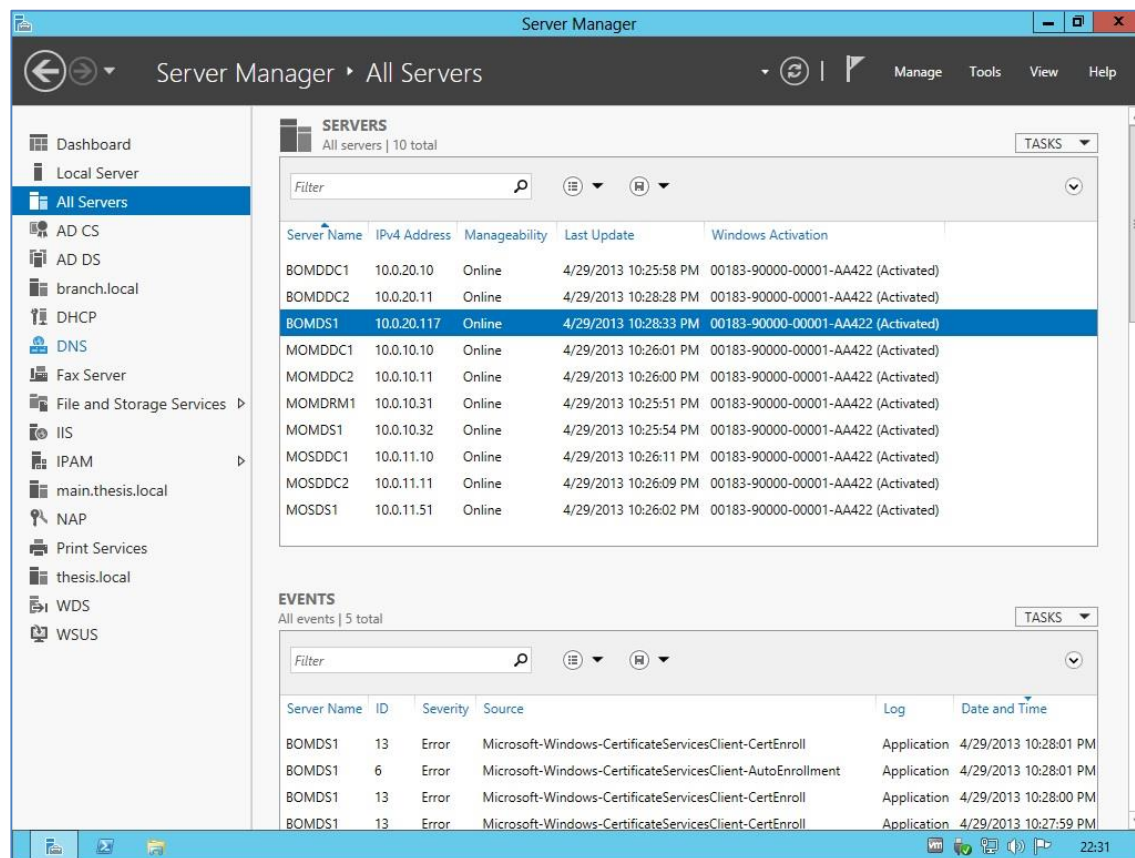


Figure 49: View of Server Manager in the management server.

Figure 49 shows the Server Manager includes all roles from connected servers on the left, there are also manually made server groups and the test environment contains thesis.local, main.thesis.local and branch.local server groups.

### 4.6 Active Directory Certificate Services (AD CS)

Active Directory Certificate Services contains six Role Services, only Certificate Authority (CA) is included to the test environment. For Certificate Authorities can be many different configuration, depending how many tiers are in environment. The test environment was made with two tiers, then it needed standalone root CA and many enterprise subordinate CAs, shown in default Enterprise PKI management console (pkiview.msc) in Figure 50.

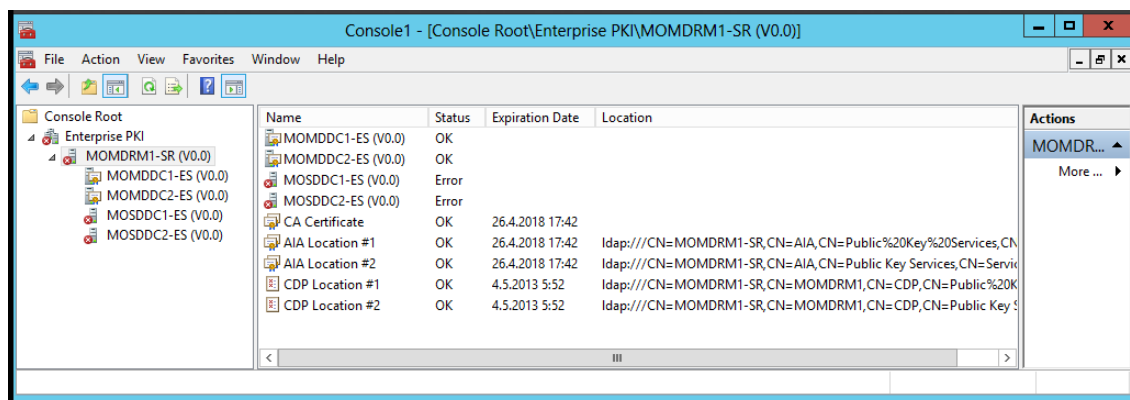


Figure 50: Enterprise PKI management console in the test environment.

Figure 50 shows, it is not possible to see CAs of branch.local forest and subdomains CAs shows error but are manageable by Manage CA task of servers. The console contains also management function to manage containers in Active Directory. Remote management was possible inside the certificate environment.

First Certificate Authority was in the test environment Standalone Root CA, it was installed to MOMDRM1 server. Typically in production environment that is installed to separate server and kept offline and in a safe place every time when it is not needed. Root CA in the Certification Authority management console (certsrv.msc) in the test environment is shown in Figure 51.

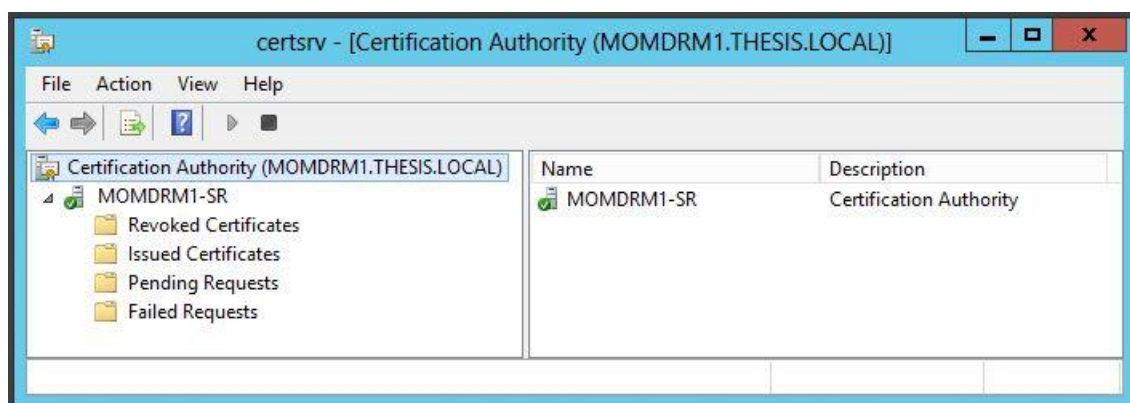


Figure 51: Standalone Root CA in the MOMDRM1.

Figure 51 shows four folders, one folder for failed certificate requests, one folder for waiting certificate requests, one folder for issued certificates and one folder for revoked certificates. Root CA only approves and confirms the Issuing CAs with certificates for environment.

Certificate environment contains certificate templates, these were managed with own Certificate Templates management console (certtmpl.msc) as shown in Figure 52.

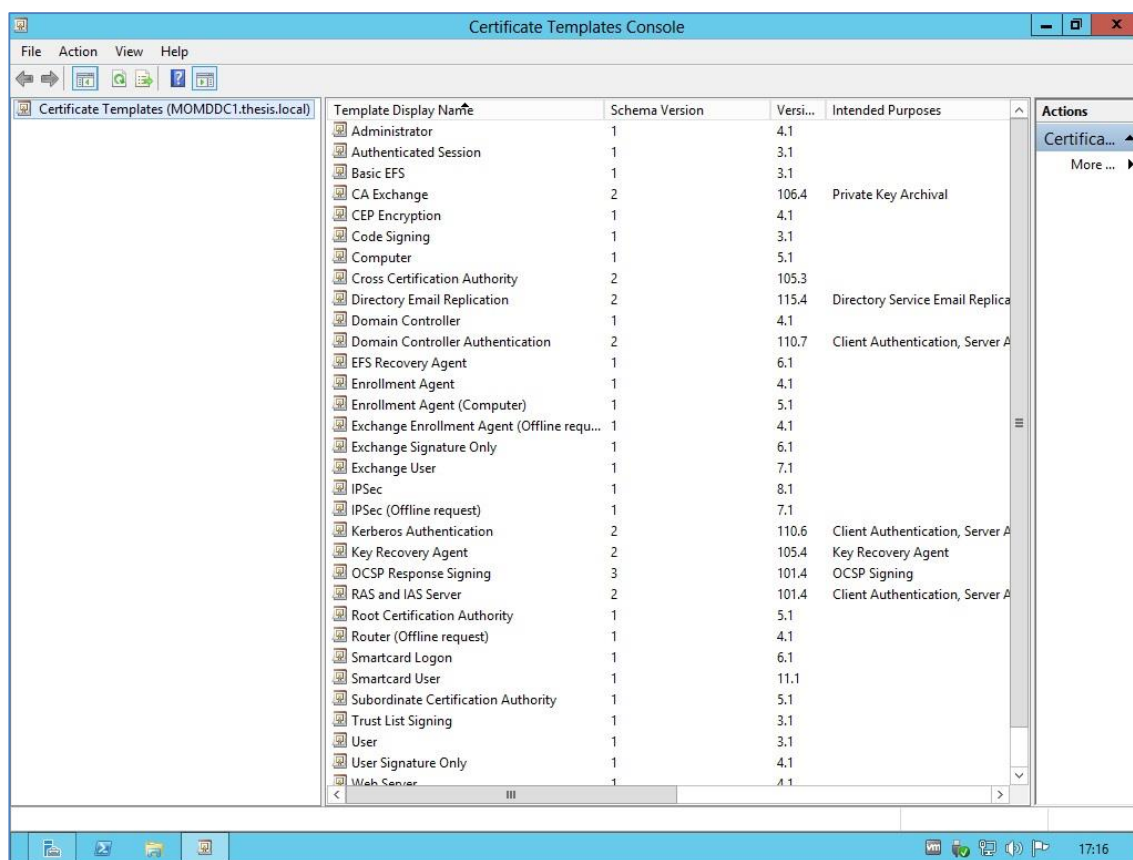


Figure 52: Certificate Templates management console.

Figure 52 shows, certificate environment contains all versions of certificates. These do not contain new version 4 templates by default, version 4 is new in Windows Server 2012. It is possible to duplicate template and make a new own template or take in use a default template. One task was needed to do to all templates, enroll right must be given. The test environment contains enroll rights to authenticated users.

After implementing Root CA it is time to implement Issuing CAs, the test environment contains six Issuing CAs. Two Issuing CA per domain, one per each domain controller. It was needed to change default security settings for every Issuing CA, that CAs only issues certificates to own area, computers and users. Authenticated users were changed to [domain]\Domain Users and [domain]\Domain Computers objects. Issuing CA management console is shown in Figure 53.

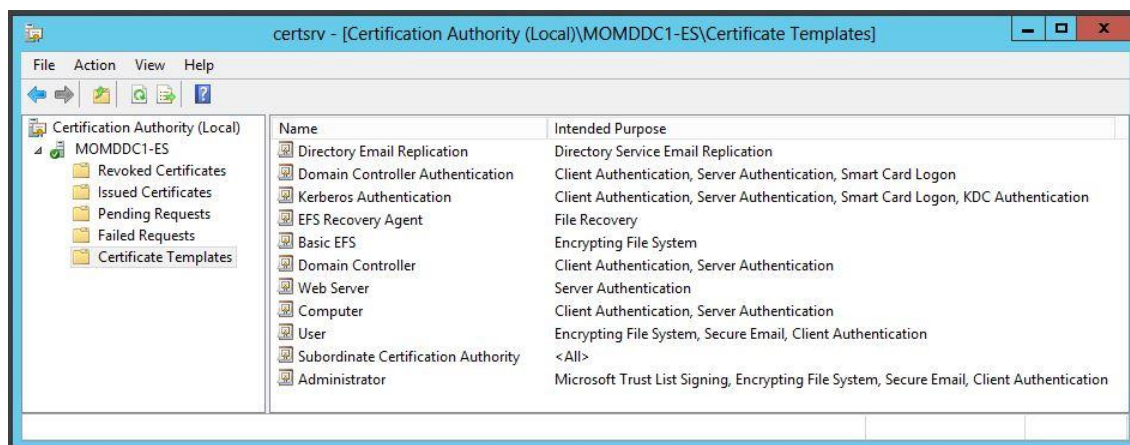


Figure 53: Certificate Authority management console.

Figure 53 shows the basic certificate services environment contains eleven certificate templates. These templates are not in Root CA management console, these are only in Issuing CAs.

The next used management console was Certificates of Local Computer (certlm.msc) as shown in Figure 54.

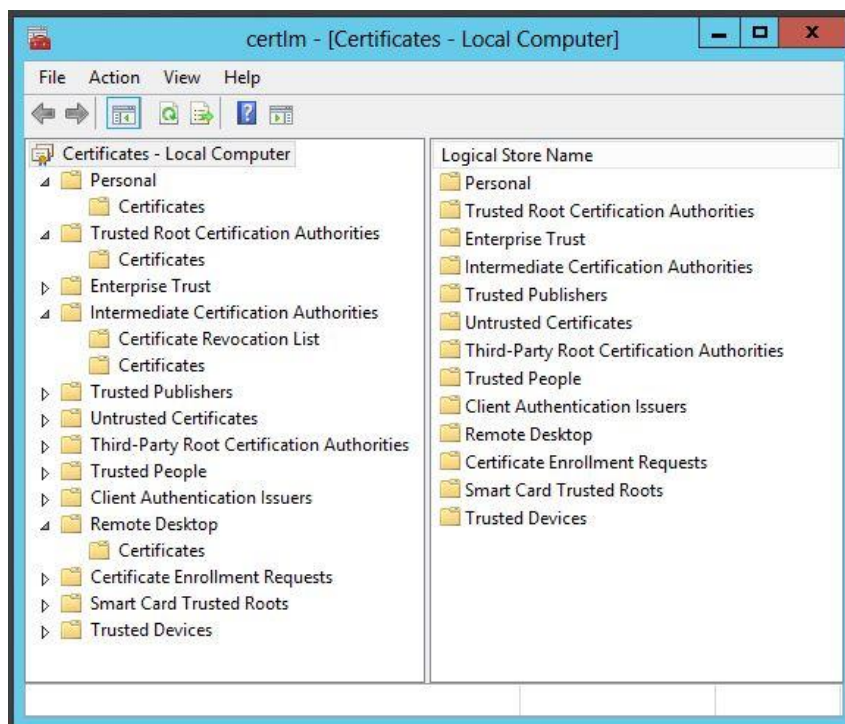


Figure 54: Certificates of local computer.

Figure 54 shows five important folders, one for this computer, one for root certificate authority, two for issuing certificate authority and one for Remote Desktop connection.

The next management console used was Certificates of Current User (certmgr.msc), shown in Figure 55.

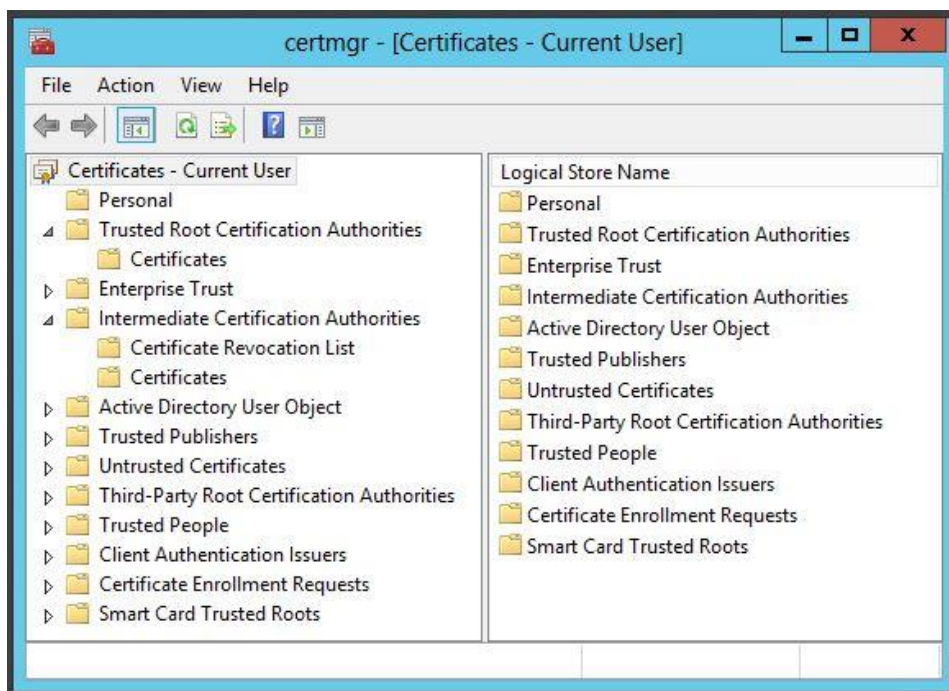


Figure 55: Certificates of current user.

Figure 55 shows four important folders, one for this computer, one for root certificate authority and two for issuing certificate authority.

When implementing Certificate Services was sometimes needed to clean the system of not needed misconfigured keys, certificates or reinstall default templates. That was possible with Domain Services ADSI Edit management console (adsiedit.msc) as shown in Figure 56.

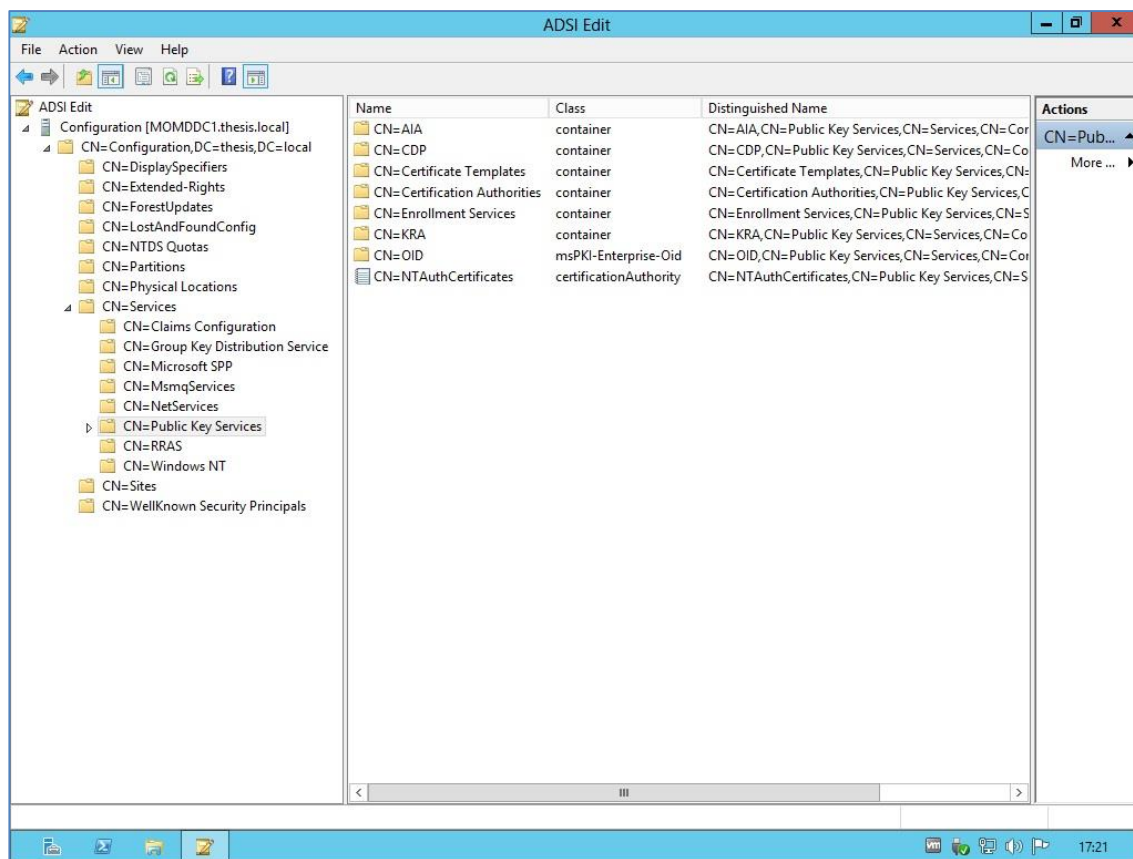


Figure 56: ADSI Edit management console and Public Key Services in Active Directory.

Figure 56 shows Public Key Services object in Active Directory that was found in Configuration Naming Context. It was needed to delete all unnecessary attributes under that object, including sub objects and default certificate templates were reinstalled if needed with command.

```
certutil -installdefaulttemplates
```

Certificate Authority must be shutdown before reinstalling templates.

The next possible task with the Certificate Services would be to try different security settings with templates or how is it possible to implement over forest certificate enrollment, now it works in the test environment only manually between forests.

#### 4.7 Windows Server Update Server (WSUS)

Remote management and local management was made with roles own Update Services (wsus.msc) management console as shown in Figure 57.

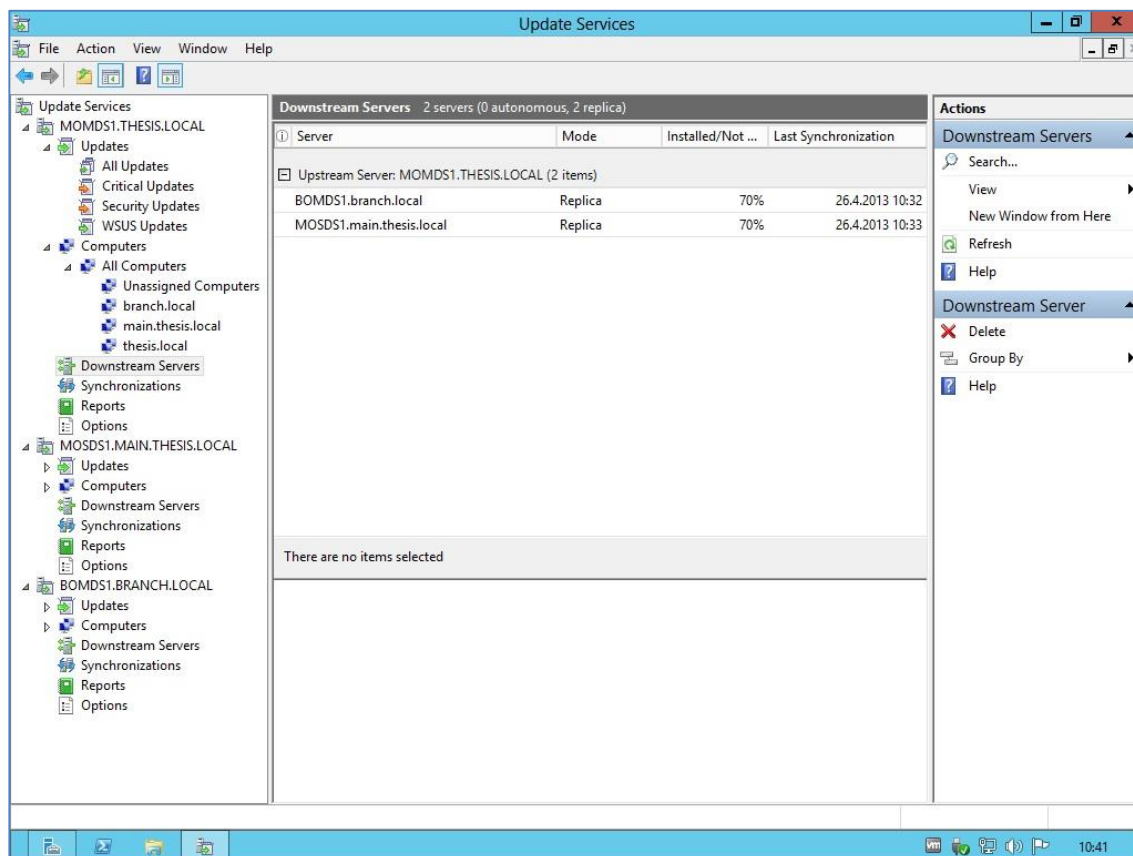


Figure 57: Management tool of Windows Server Update Services.

Figure 57 shows all three servers with that role can be in the same tool and two of these servers are replica servers of MOMDS1 server. The test environment configuration contains all products and classifications. Update files are downloaded direct from Microsoft Update to computers and all update are approved to computers, that way these do not use drive space in WSUS servers. The environment includes information over 29000 updates. It was needed to download Microsoft Report Viewer 2008 to view WSUS reports, it was not included to Windows Server 2012 media [57]. WSUS in Windows Server 2012 do not support Report Viewer 2010 or Report Viewer 2012. Next task would be in the test environment to implement SSL to WSUS network traffic.



## 4.8 Group Policy Management

The group policies are powerful way to manage environment centralized. It was needed to do to the test environment Group Policy Objects (GPO) for Windows Server Update Services, Remote Server Administration Tools and Active Directory Certificate Services. Environment includes also GPOs for IPAM Server feature. Main tool for group policies is console (gpmc.msc) as shown in Figure 58.

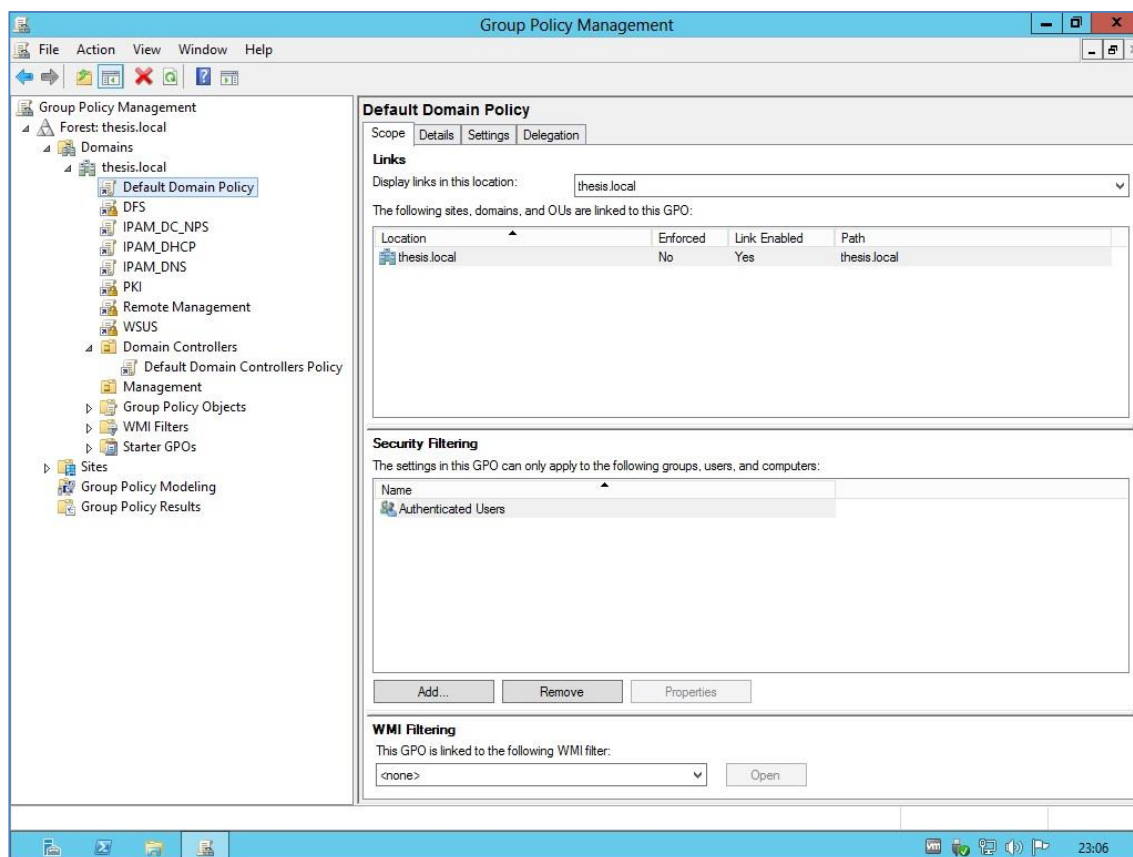


Figure 58: Group Policy Management console.

Figure 58 shows default domain policy and default domain controllers policy GPOs and these were left in the original state and new GPOs were made for each reason in the test environment.

The Resultant Set of Policy management console (rsop.msc) was useful tool to learn which policies comes with which GPOs and that kind tasks. Figure 59 shows an example when "Thesis-a" user was login to MOMDDC1.

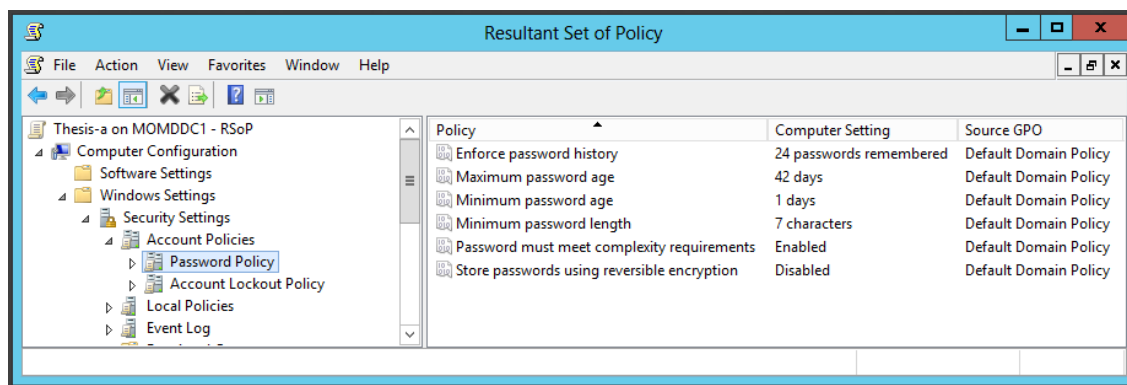


Figure 59: Resultant Set of Policy console

Figure 59 shows that Account Policies are by Default Domain Policy GPO. It is possible to use this console remotely running Change Query task after local query.

#### GPO for Active Directory Domain Services

The Default Domain Policy GPO did not need changes in the test environment and default Account Policies are shown with Group Policy Management Editor console (gpme.msc) in Figure 60.

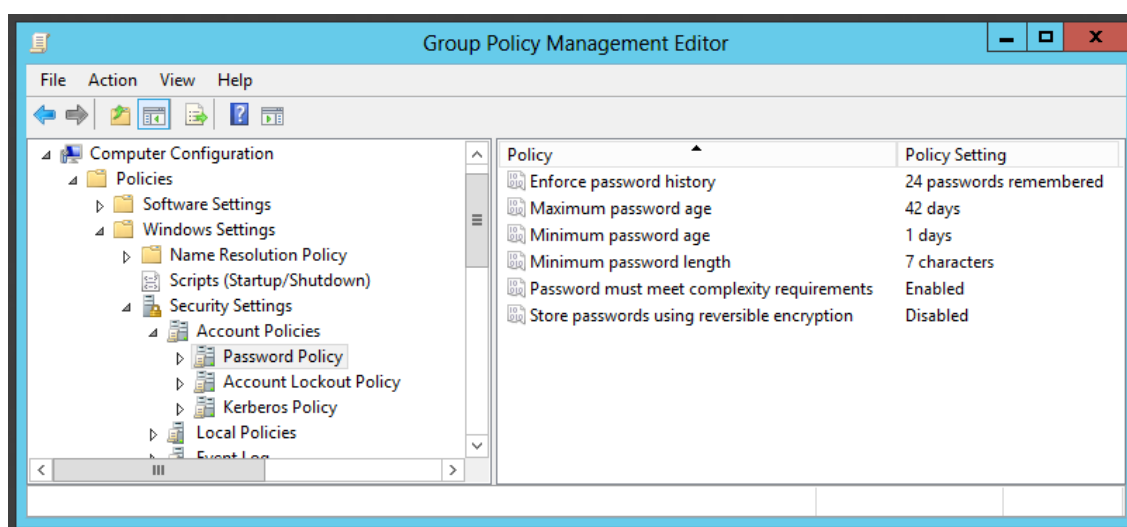


Figure 60: Account Policies for domain environment.

Figure 60 shows the maximum password age was set to seven weeks, password can be changed once a day and it must be contain even characters and meet complexity requirements.

Minimum complexity requirements in Windows Server 2012 Domain environment are:

- Cannot contain the user's account name or parts of the user's full name that exceed two consecutive characters
- Must be at least six characters in length
- Must be characters from three of the following four categories:
  - English uppercase characters (A through Z)
  - English lowercase characters (a through z)
  - Base 10 digits (0 through 9)
  - Non-alphabetic characters (!, \$, #, %)

These policy settings are defaults in the test environment, there was no need to change these. Account Policies also contains Account Lockout Policy settings for how accounts behave when they are lockout. [58]

Local Policies and its User Account Control policies are shown with Group Policy Management Editor console in Figure 61.

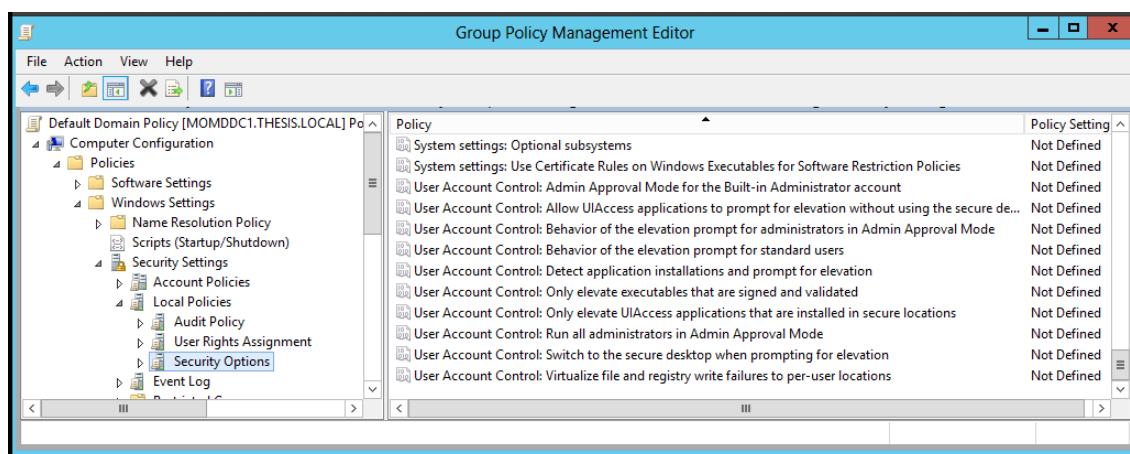


Figure 61: Local Policies for domain environment.

Figure 61 shows policy settings control when elevation credentials are needed or is elevation consent allowed and policies also denies elevation requests if it is needed. These settings are also defaults in the test environment.

#### GPO for Remote Server Administration Tools

It was needed to make GPO for computers to ensure their firewall exceptions with Group Policy Management Editor console as shown in Figure 62.

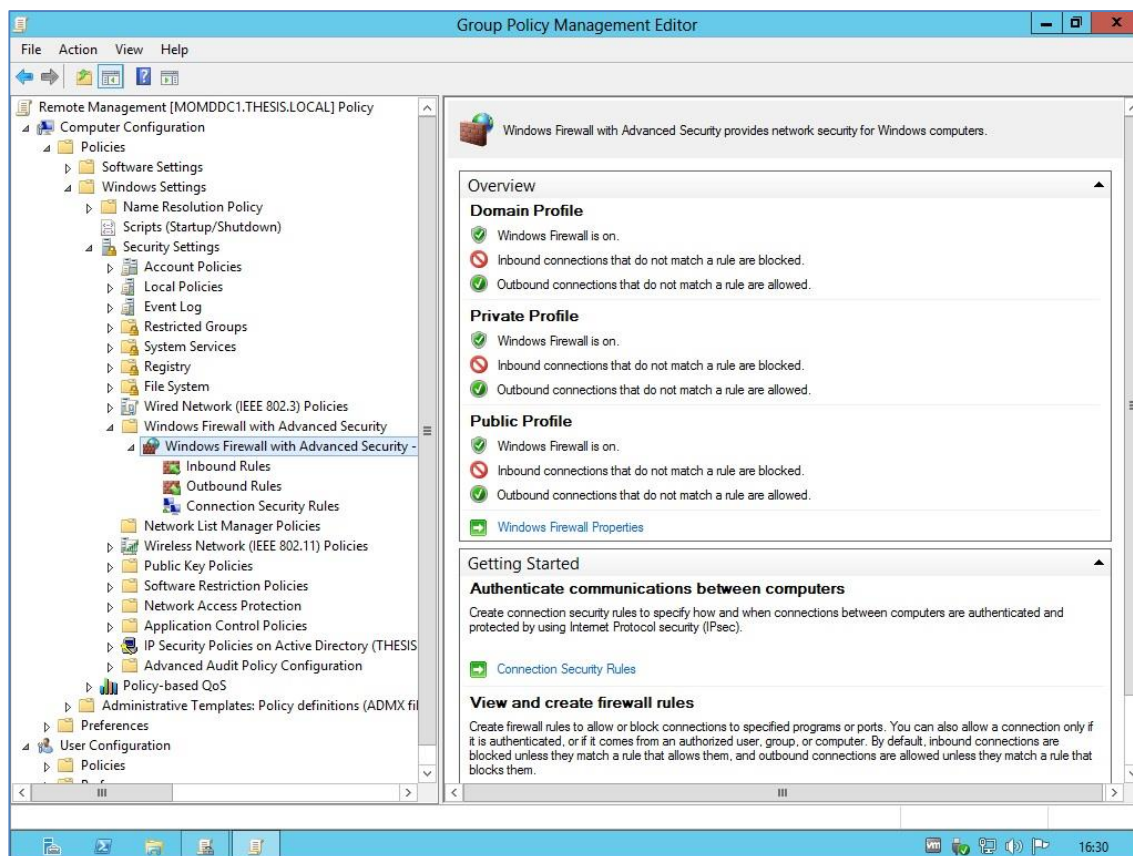


Figure 62: GPO settings for Remote Server Administration Tools.

Figure 62 shows settings under Computer Configuration \ Policies \ Windows Settings \ Security Settings \ Windows Firewall with Advanced Security. The most important policy setting is “Inbound Rules”, the test environment was made allowing all default inbound and outbound rules.

### GPO for Active Directory Certificate Services

It was needed to make GPO for computers to help their certificate use with Group Policy Management Editor console as shown in Figure 63.

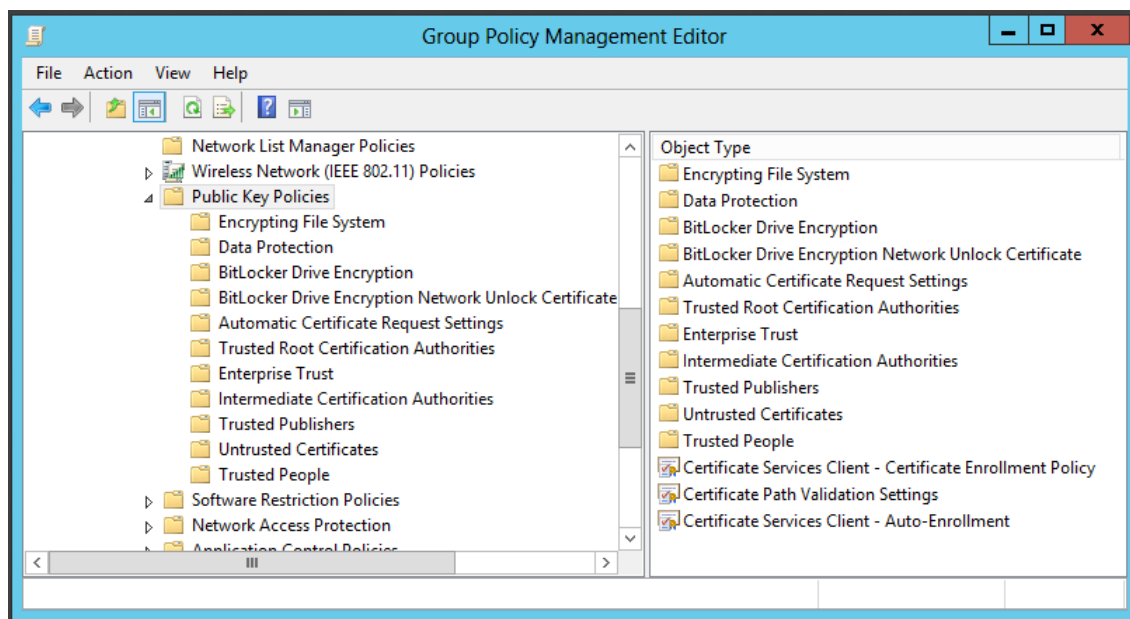


Figure 63: GPO settings for Active Directory Certificate Services.

Figure 63 shows settings under Computer Configuration \ Policies \ Windows Settings \ Security Settings \ Public Key Policies. The most important policy setting is “Certificate Services Client – Auto-Enrollment”, it controls how enrollment for certificates are handled.

#### GPO for Windows Server Update Services

It was needed to make GPO for computers to ensure their WSUS use as shown in Figure 64.

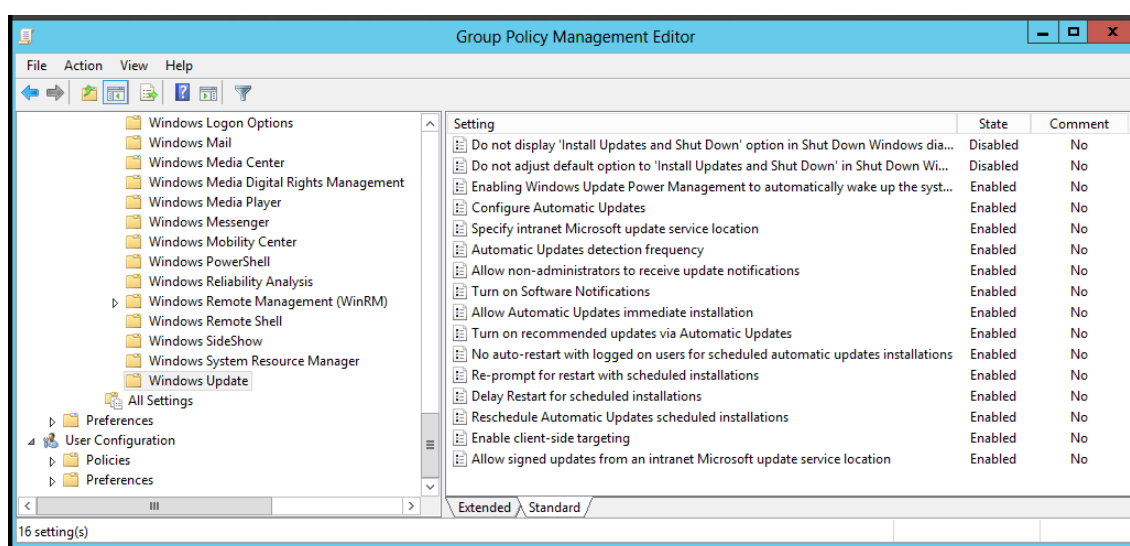


Figure 64: GPO settings for Windows Server Update Services.

Figure 64 shows settings under Computer Configuration \ Policies \ Administrative Templates \ Windows Components \ Windows Update. The most important policy settings are “Configure Automatic Updates” and “Specify intranet Microsoft update service location”, these are settings to configure centralized update services.

The environment also includes a management console for Local Policies (gpedit.msc) shown Figure 65.

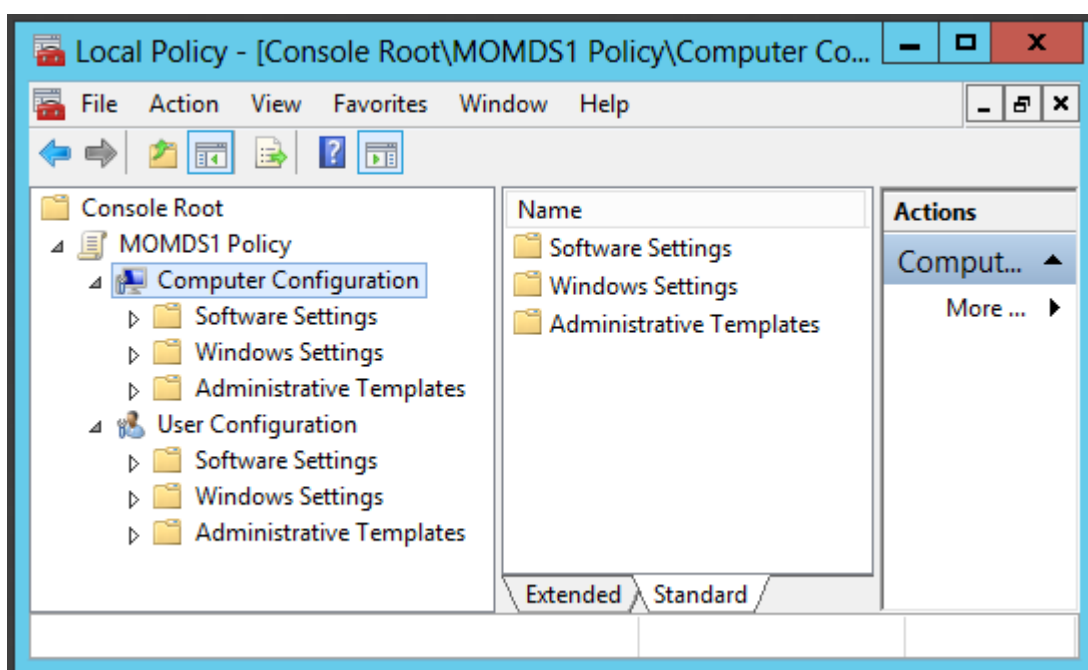


Figure 65: Local Policy remotely from MOMDS1 to MOMDRM1.

Figure 65 shows same folders than in domain level Group Policy Objects. That console only manage one computer directly and all Group Policy Objects from domain level overwrite these policies.

The next tasks with Group Policy Management feature would be device and software restrictions. Management tools worked fine inside domain.

## 4.9 File and Storage Services

The File and Storage Services are the oldest services in servers. This study only includes the biggest and newest role services of it. The File and Storage Services are in a popular role in smaller environments but Microsoft SharePoint environments are coming more popular and take responsibility of this to manage files in storages.

### File Server

The File Server role service is not default in servers but it is needed when sharing folders. Figure 66 shows view to host computer's File and Storage Services.

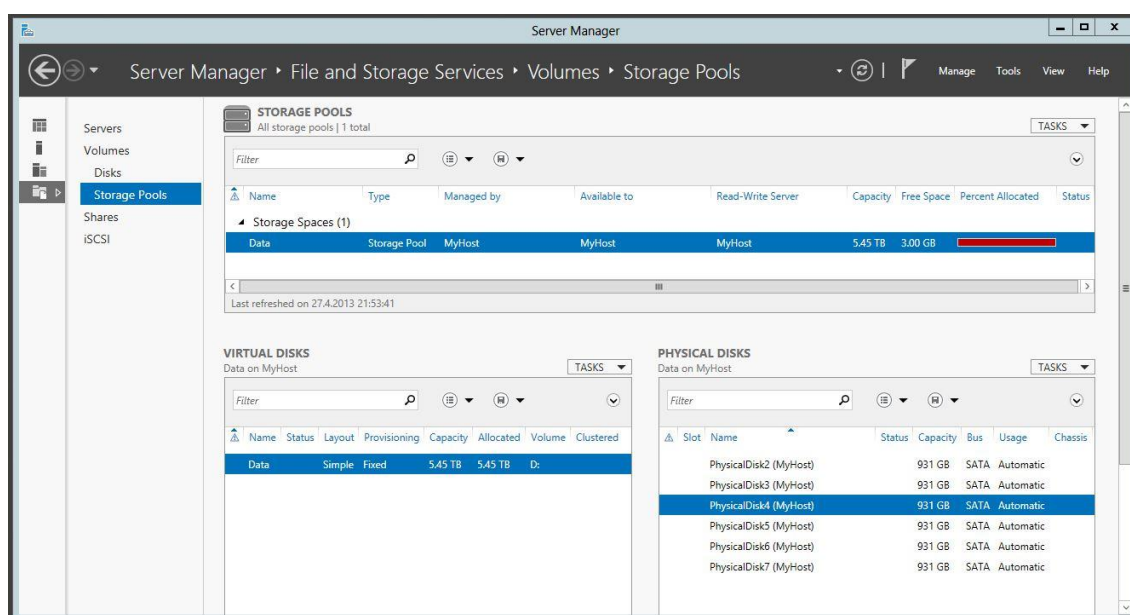


Figure 66: File and Storage Services in Server Manager.

Figure 66 shows Storage Pools of Host computer, there is striped storage pool made with six 1 TB hard disks. That tool in Server Manager contains same and new features than older Disk Management console (diskmgmt.msc) as shown in Figure 67.

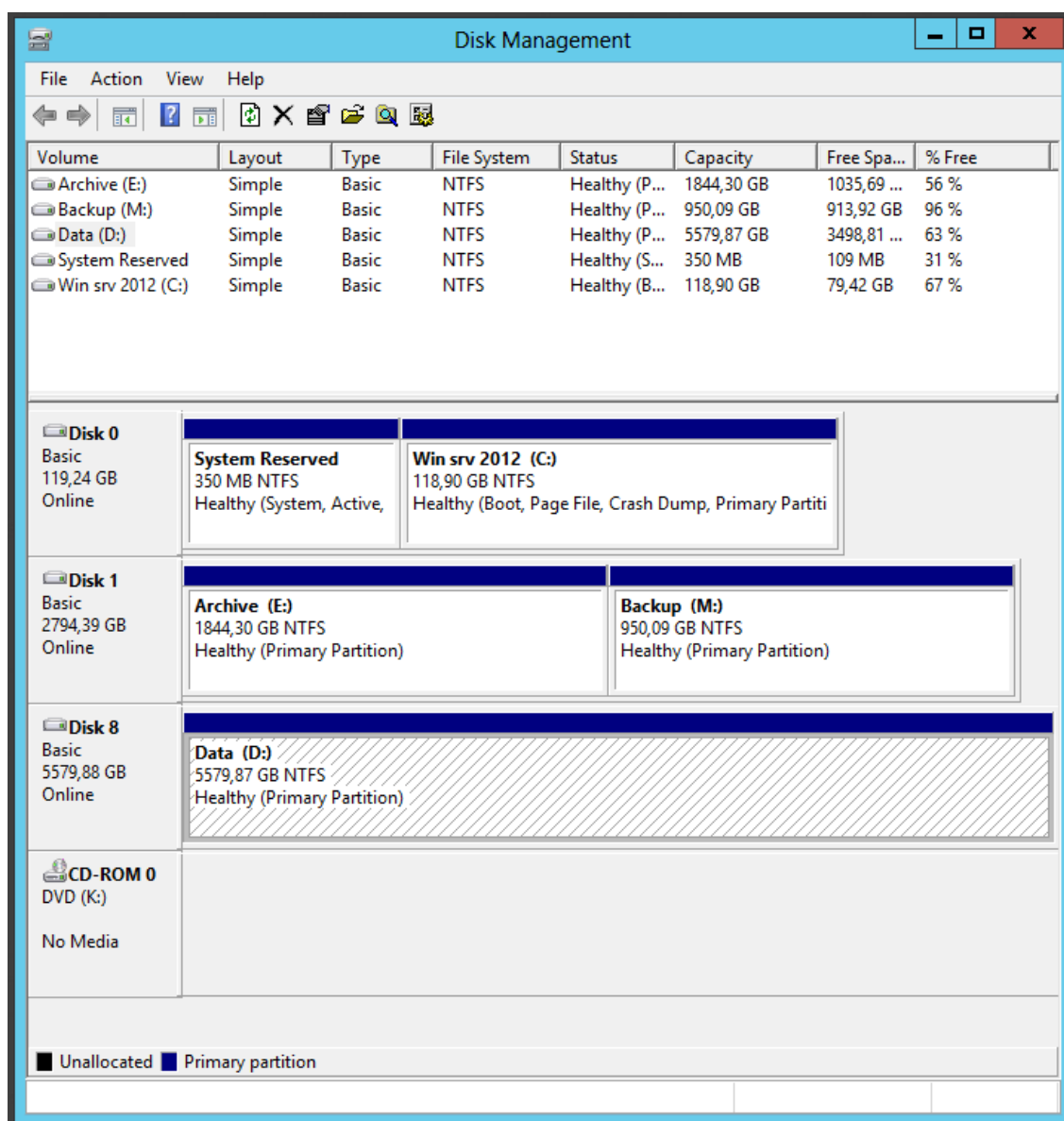


Figure 67: Disk Management console.

Figure 67 shows the same storage pool drive as in Server Manager. One default console in all Windows installations is Shared Folders console (fsmgmt.msc) shown in Figure 68.



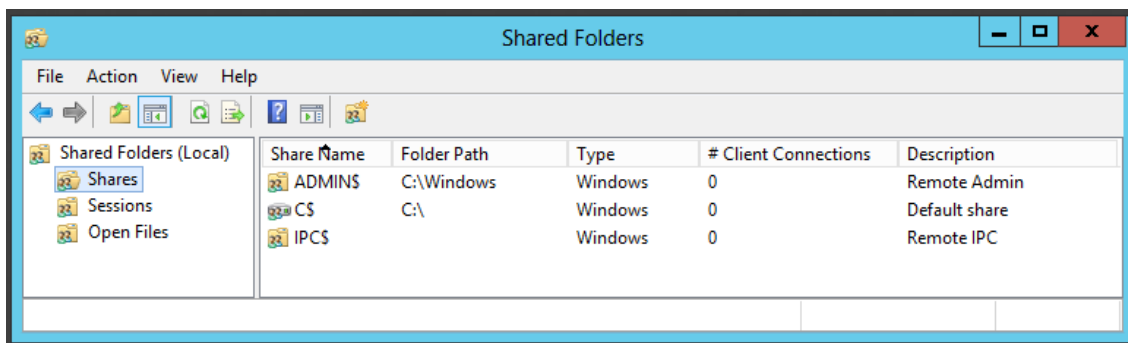


Figure 68: Shared Folders console.

Figure 68 shows all default shares, for example administrative share for C: drive with share name C\$. Both Disk Management and Shared folders consoles can be used remotely.

#### DFS Namespace and DFS Replication

The DFS Namespace was made for whole environment to MOMDS1 server and it was named to NetDrives, the DFS Replication are configured for Windows Deployment services. These are shown in Figure 69.

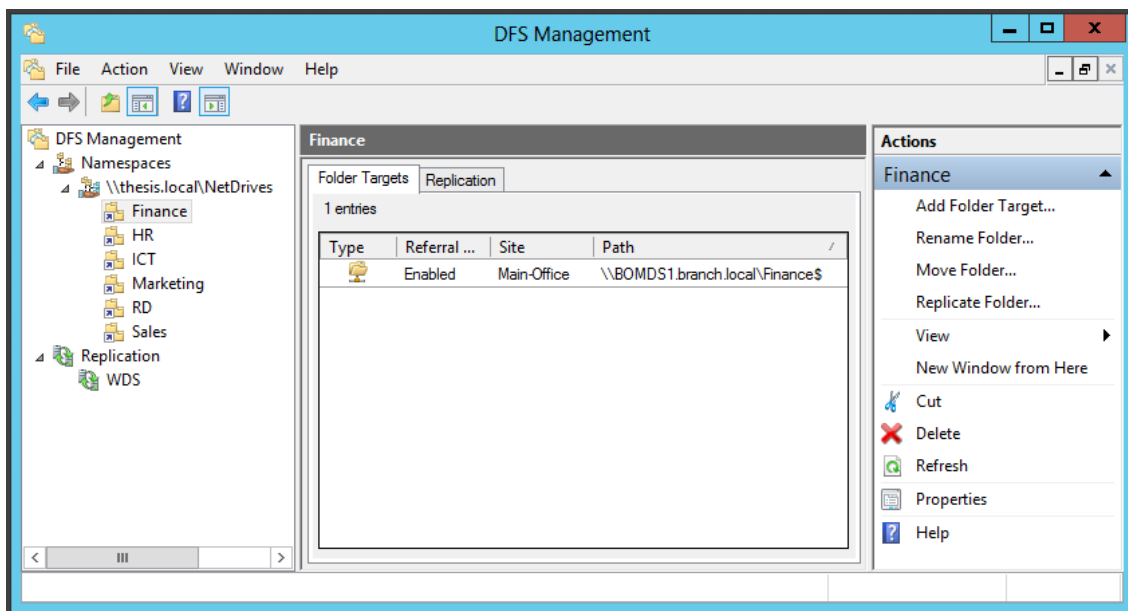


Figure 69: DFS Management console.

Figure 69 shows DFS Namespaces and DFS Replication are in same management console (dfsmgmt.msc). The test environment includes six different shares from three

different servers and domains. Finance, HR and RD are from branch office. Sales and Marketing are from main.thesis.local and ICT is from thesis.local. DFS replication with name WDS is for Windows Deployment Services that all images are on all WDS servers. In the test environment was mapped that Namespace to N: drive with group policy as Figure 70 shows.

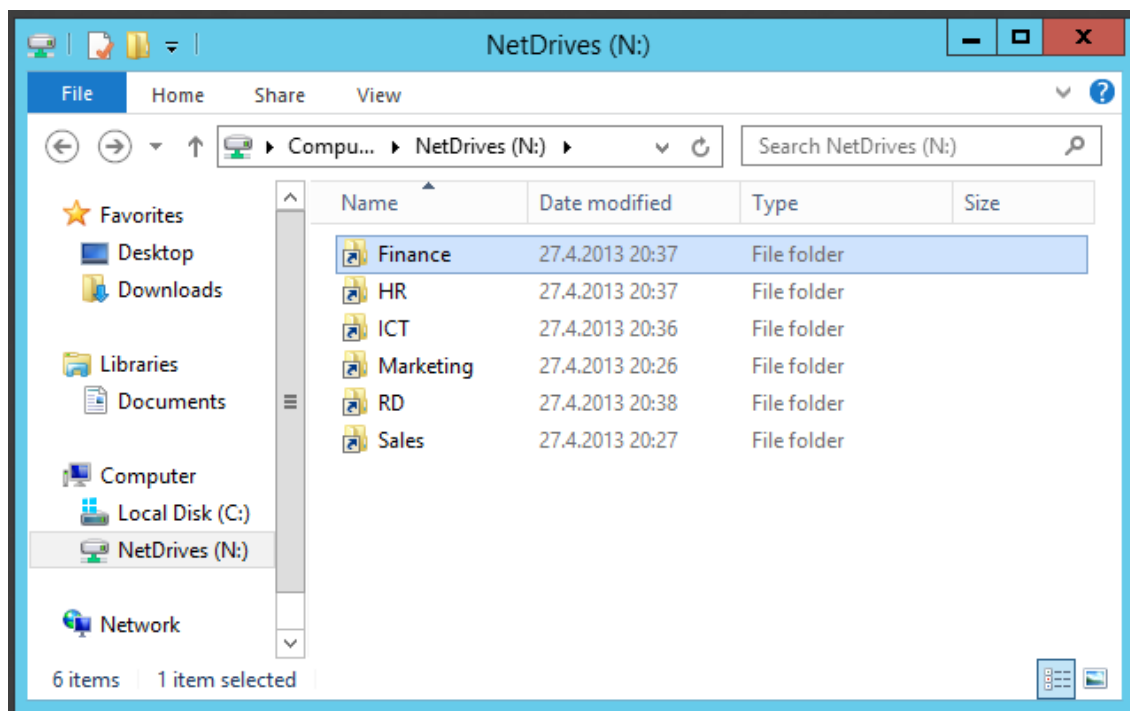


Figure 70: Drive Mapping of DFS Namespace.

Figure 70 shows a Group Policy configuration in User Configuration \ Preferences \ Windows Settings \ Drive Maps and there was made configuration that \\MOMDS1\NetDrives mapping to N: drive.

#### File Services Resource Manager

The File Services Resource Manager includes two important features, Quota and File Screening. Quota manages how much each can use hard drive space and File Screening controls what type of files can be saved to hard drives. Both are managed from same console (fsrm.msc) shown in Figure 71.

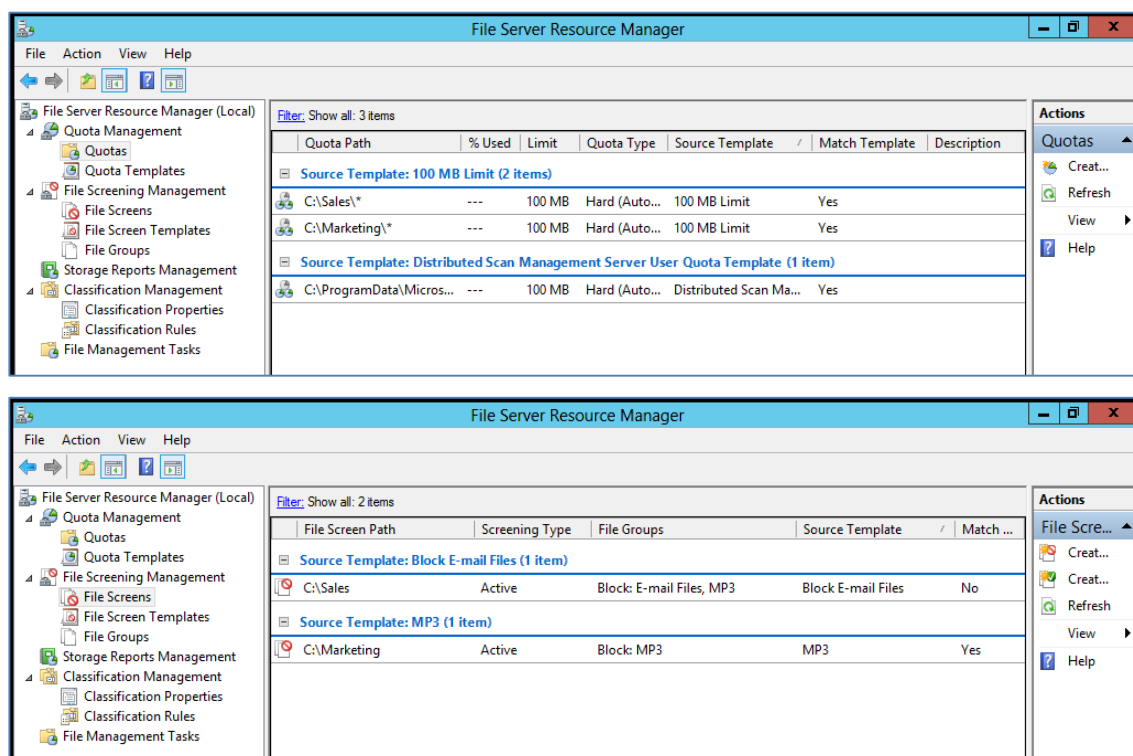


Figure 71: Quota and File Screening management in same console.

Figure 71 shows two Quotas and two File Screens for each department folders. For example there was blocked E-Mail and MP3 files to be saved to Sales folder and only MP3 files to Marketing folder.

The following steps in the test environment and that role are more difficult Quotas and File Screens. Remote management console allows only one server to console.

#### 4.10 Fax Server

The Fax Server is maybe less used in the future but it was included to test environment in the servers MOSDS1 and BOMDS1. It includes Fax Service Manager management console (fxsadmin.msc), as shown in Figure 72.

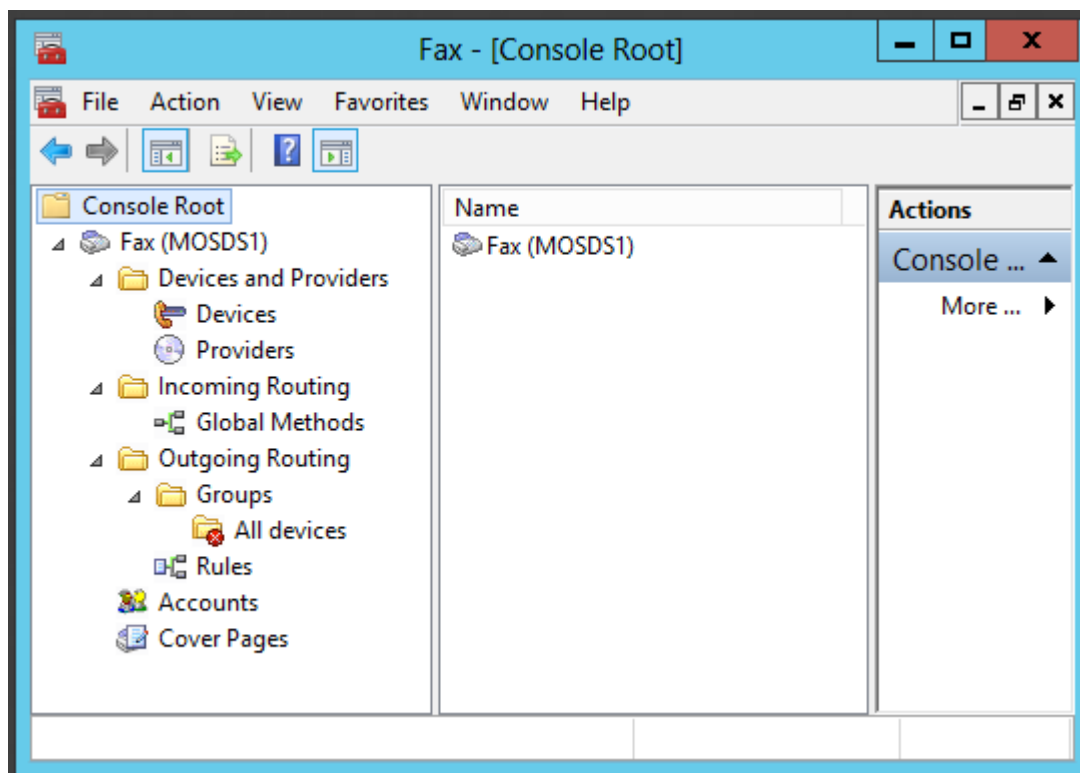


Figure 72: Fax Service Manager management console.

Figure 72 shows, it was possible to remotely manage Fax Server role, but console must be built every time with the MMC application because saved consoles do not work and tools worked only inside forest if target server includes right local user rights to connect remotely. The Fax Service Manager console works only in Windows Server 2012. Role includes also Windows Fax and Scan application (WFS.exe), but that is only possible to use locally.

#### 4.11 Network Policy and Access Services (NPAS)

The Network Policy and Access Services can give very multiple possibilities to manage network access to wireless and wired networks. It can use DHCP enforcement, 802.1x access point enforcement, VPN server enforcement and Remote Desktop Gateway enforcement. This role was installed to the MOMDS1, Network Policy Server management console (nps.msc) is shown in Figure 73.

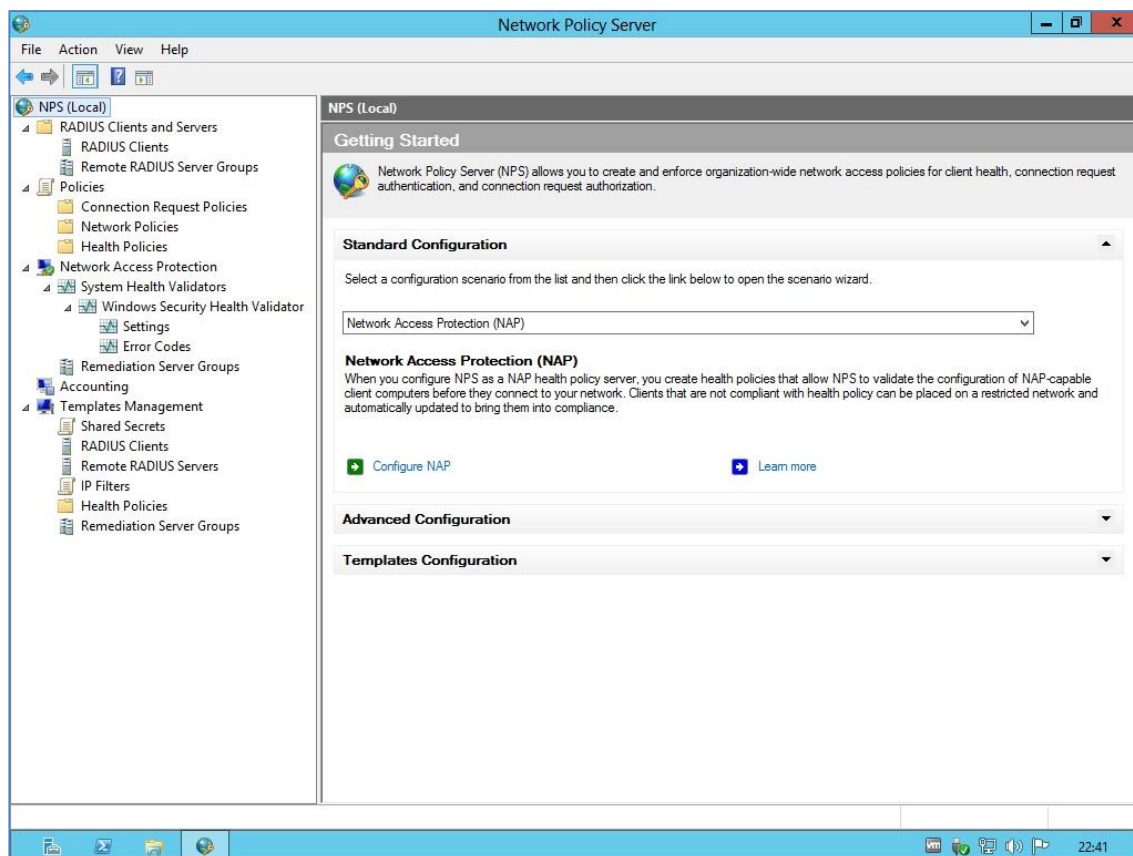


Figure 73: Network Policy Server management console.

Figure 73 shows a Network Access Protection (NAP) configuration with DHCP enforcement to the test environment. The role also includes Health Registration Authority management console (HCSCFG.msc), as shown in Figure 74.

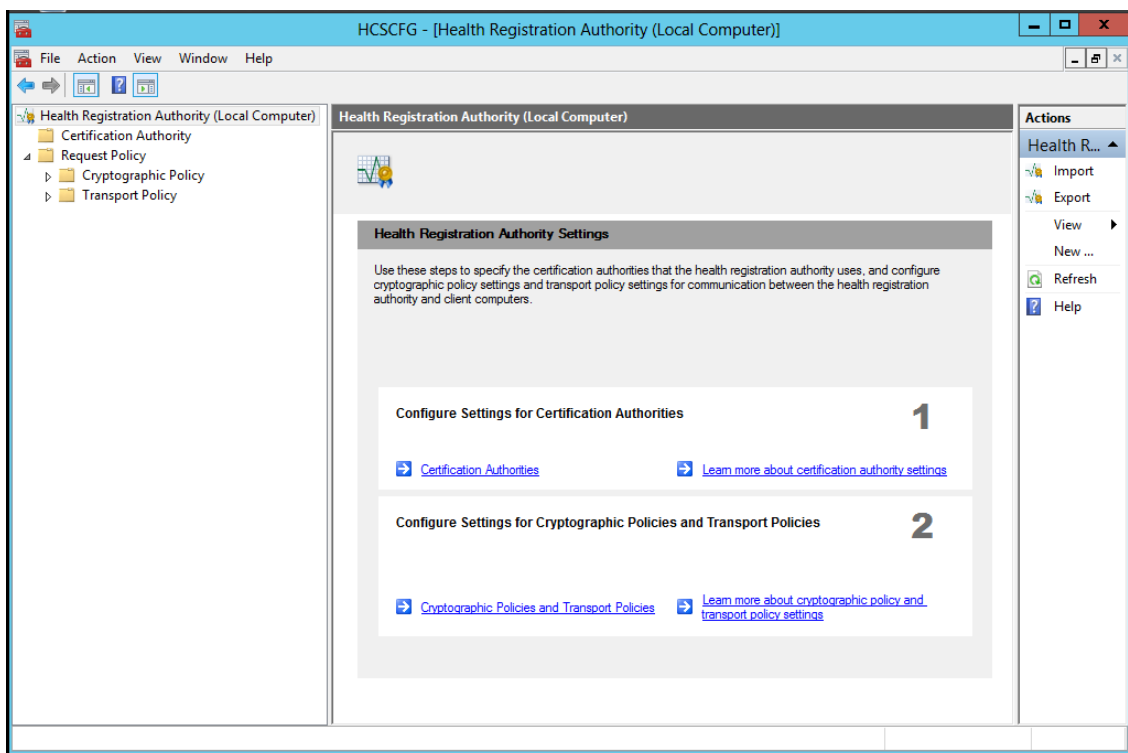


Figure 74: Health Registration Authority management console.

Figure 74 shows how HRA communicate with Certification Authorities and client computers. These both consoles for this role works only in Windows Server 2012 and the next tasks with this role would be to build and test different configurations.

#### 4.12 Remote Access Services (RAS)

The Remote Access Services role was only possible to install with Routing role service to the test environment. Other role service is DirectAccess and VPN (RAS), which needs public IP address and it was not possible to the test environment. That reason made remote connections from home office impossible with Windows Server 2012 own tools. Role contains only Routing and Remote Access management console, typical view of console (rrasmgmt.msc) is shown in Figure 75.

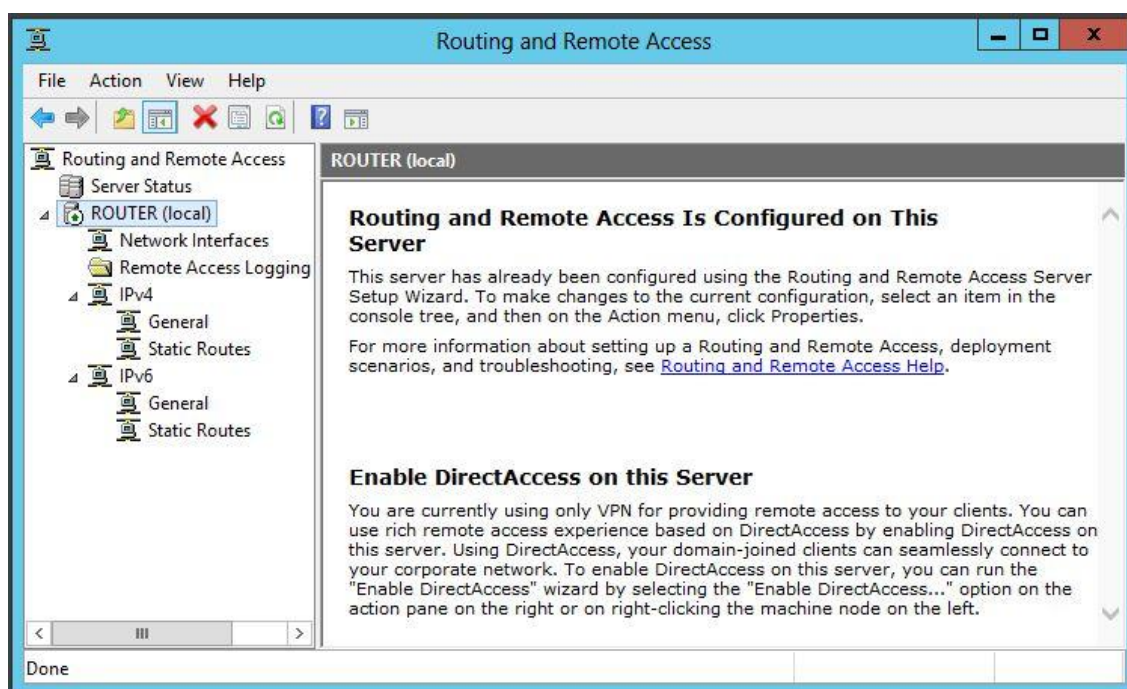


Figure 75: Routing and Remote Access management console.

Figure 75 shows four folders on the left. One for interfaces, one for logs and folders for IP protocol versions 4 and 6. The Routing role service was installed to ROUTER server, it routes network traffic between main office, branch office and internet. This role service was ready to use after installation without complex configuration in the test environment.

Next task with this role would be trying to bypass this IP address requirement. Role contains also Remote Access Management application (RAMgmtUI.exe), also it was impossible to connect from domain joined MOMDRM1 server remotely to workstation joined ROUTER server.

#### 4.13 Print and Document Services

The Print and Document Services includes four role services, only two were implemented to the test environment. The test environment includes Print Server role service in MOSDS1 and BOMDS1 servers. Distributed Scan Server role service was installed to same servers plus it was needed to MOMDRM1 server for remote management of Distributed Scan Server.

## Print Server

The Print Server contains Print Management console (printmanagement.msc) for collecting printers, drivers and their jobs to the same console. Console contains possibilities to collect information of many print servers, as shown in Figure 76.

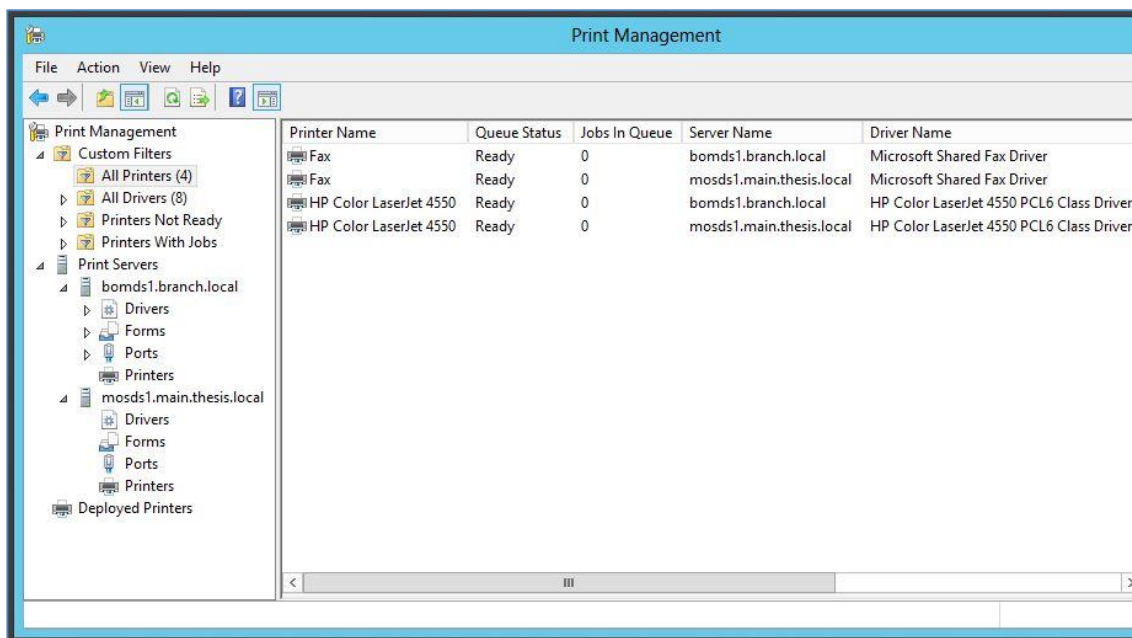


Figure 76: Print Management tool.

Figure 76 shows, all the print servers can be added to the same management console. The test environment contains two fictive network printers, only drivers were installed to their office's print server. Next task with Print Server role service would be to try different settings with different installed printers.

## Distributed Scan Server

The Distributed Scan Server's management console (ScanManagement.msc) is not included to RSAT for Windows 8 or tools in Windows Server 2012. It must be installed locally before computer includes possibilities to connect another scan servers. The Distributed Scan Server is included in both Windows 8 and Windows Server 2012. Installation contain Scan Management console, as shown in Figure 77.



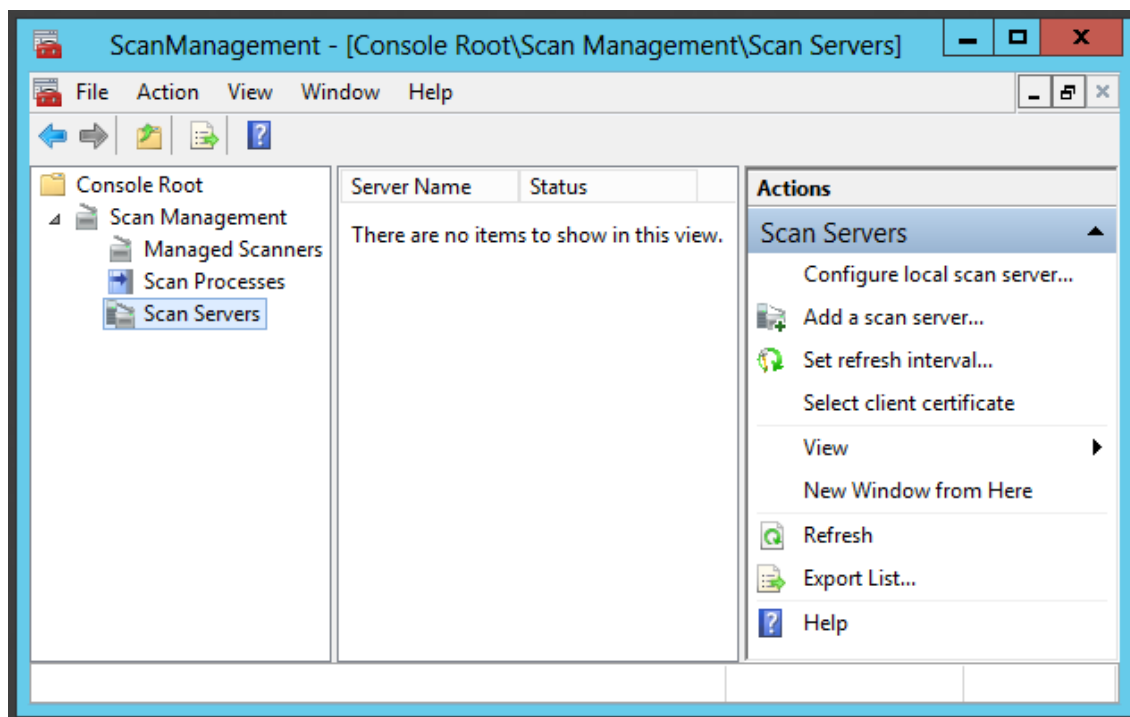


Figure 77: Scan Management console.

Figure 77 shows basic view of console without added scan servers (MOSDS1 or BOMDS1). The test environment does not include any scanners and it was not possible to install only drivers. It was possible to add Scan Server of MOSDS1 to remote management server after adding correct local user rights to MOSDS1 server's Scan Operators group. A possible next task with this role is to build working remote management, it would need physical network scanners.

#### 4.14 Windows Deployment Services (WDS)

The Windows Deployment Services role was implemented to the test environment to three servers MOMDS1, MOSDS1 and BOMDS1. These servers includes DFS Replication between MOMDS1 and MOSDS1 servers. Trust relationships between forests do not allow replication and it must be done manually with network share in MOMDS1 server to BOMDS1 server. Management console (WdsMgmt.msc) in Figure 78.

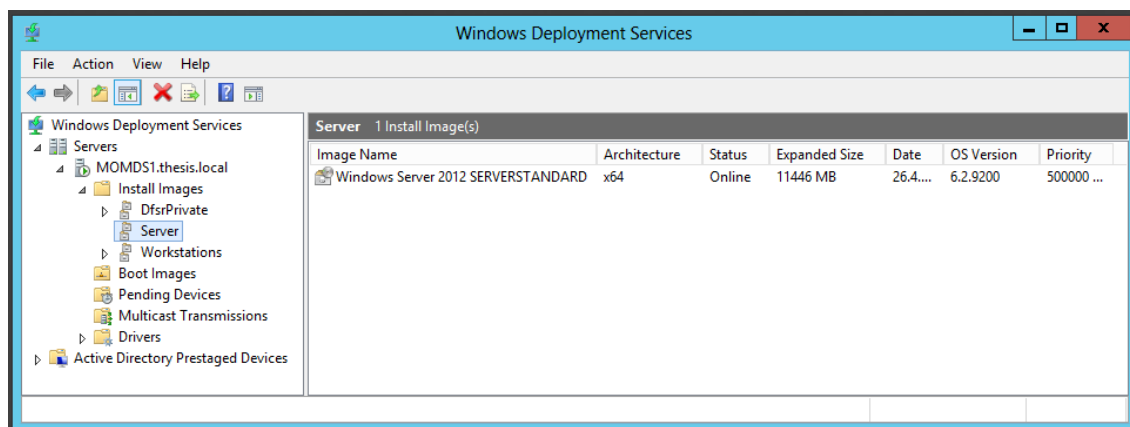


Figure 78: Windows Deployment Services management console.

Figure 78 shows, MOMDS1 contains images for Windows Server 2012 Standard and Windows 8 Enterprise editions in install images folder with own server and workstation image groups.

A possible next tasks in the test environment and with that role are DFS replication between forests and own mixed images to WDS Servers. Management console only allows remote management in the test environment with separate consoles for each server.

#### 4.15 IP Address Management (IPAM) Server

The IPAM Server feature is only forest wide Server Manager connection to DHCP, DNS and NPS servers. This feature was installed to MOMDRM1 server as shown in Figure 79.

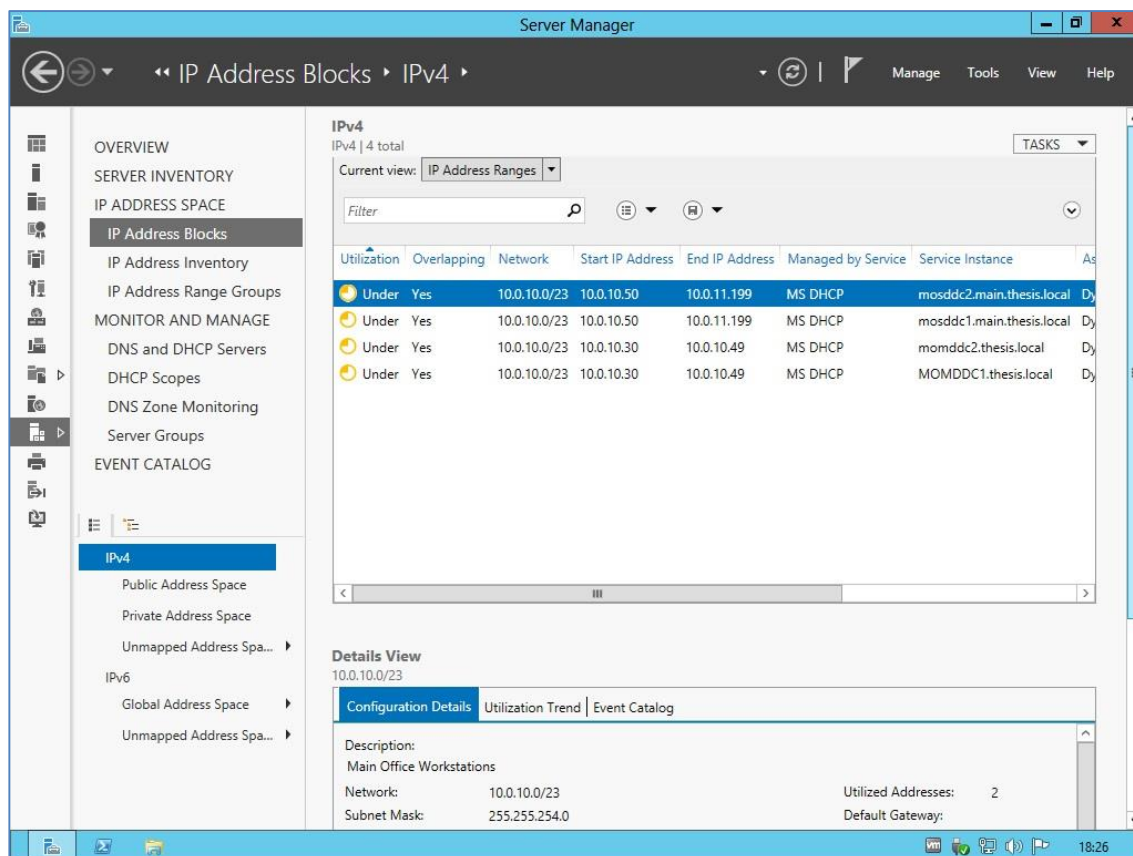


Figure 79: Typical IPAM view in Server Manager.

Figure 79 shows recognized four DHCP scopes, actually two with failover scopes. This configuration was needed many tasks, it was needed to run wizard in Server Manager but also PowerShell commands.

```
Invoke-IPAMGpoProvisioning -Domain thesis.local -
GpoPrefixName IPAM -IpamServerFqdn momds1.thesis.local
```

```
Invoke-IPAMGpoProvisioning -Domain main.thesis.local -
GpoPrefixName IPAM -IpamServerFqdn momds1.thesis.local
```

```
Set-IPAMConfiguration
```

The first two commands made the needed GPOs to domains, the last command made the needed firewall exceptions to management server MOMDRM1. Also it was needed to put right user accounts to local IPAM\* groups in MOMDRM1, the test environment use Domain Administrators groups from environments two domains. [59]

#### 4.16 Default Remote Management Tools

Default management tools are management consoles which comes in both Windows Server 2012 and Windows 8 installations by default and they give possibilities to remote management tasks. These do not join directly to any roles or features and are typically for operating system management tasks. These tools were only tested for remote management possibilities in the test environment.

##### Component Services

The Component Services management console (comexp.msc) was given possibilities to manage COM+ components remotely as shown Figure 80.

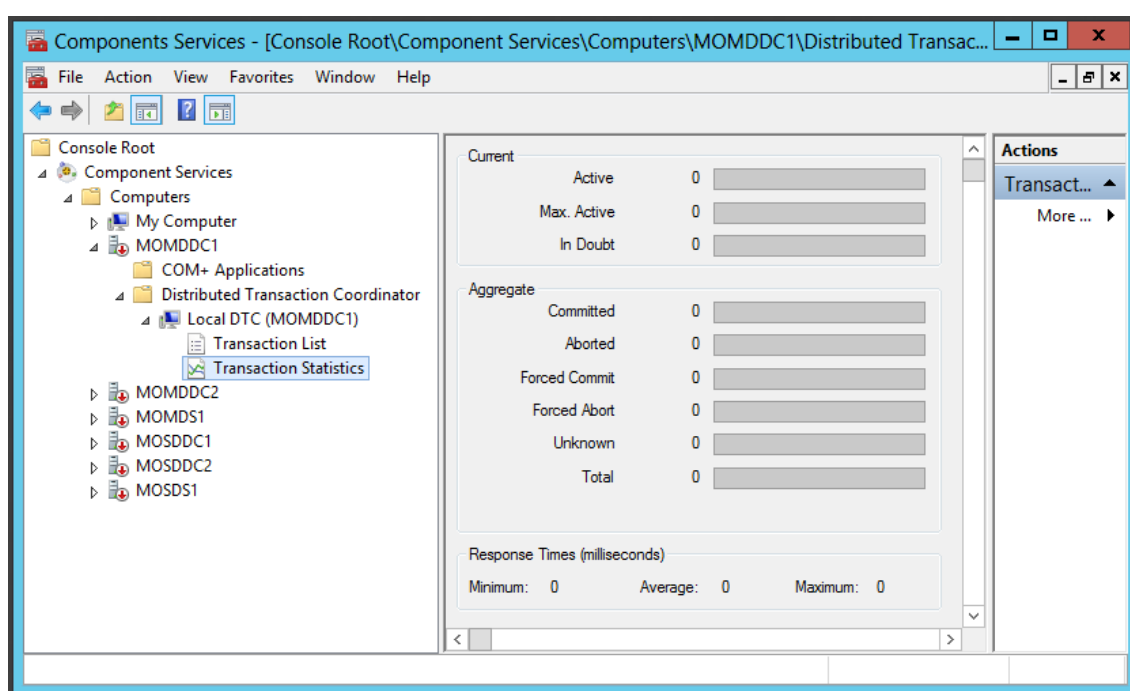


Figure 80: Component Services management console.

Figure 80 shows, all remote computers were possible to add to the same console.

## Computer Management

The Computer Management console (compmgmt.msc) is a collection of another consoles remotely as Figure 81 shows.

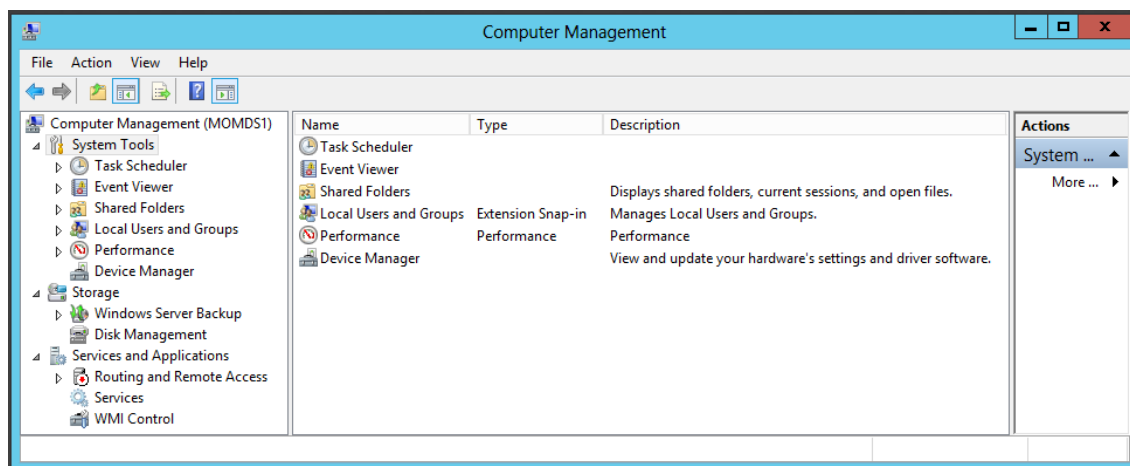


Figure 81: Computer Management console.

Figure 81 shows Task Scheduler, Event Viewer, Shared Folders, Local Users and Groups, Performance, Device Manager, Windows Server Backup, Disk Management, Routing and Remote Access, Services and WMI Control consoles of one remote computer in one console.

## Event Viewer

The Event Viewer management console (eventvwr.msc) was given view to remote computer's event logs as Figure 82 shows.

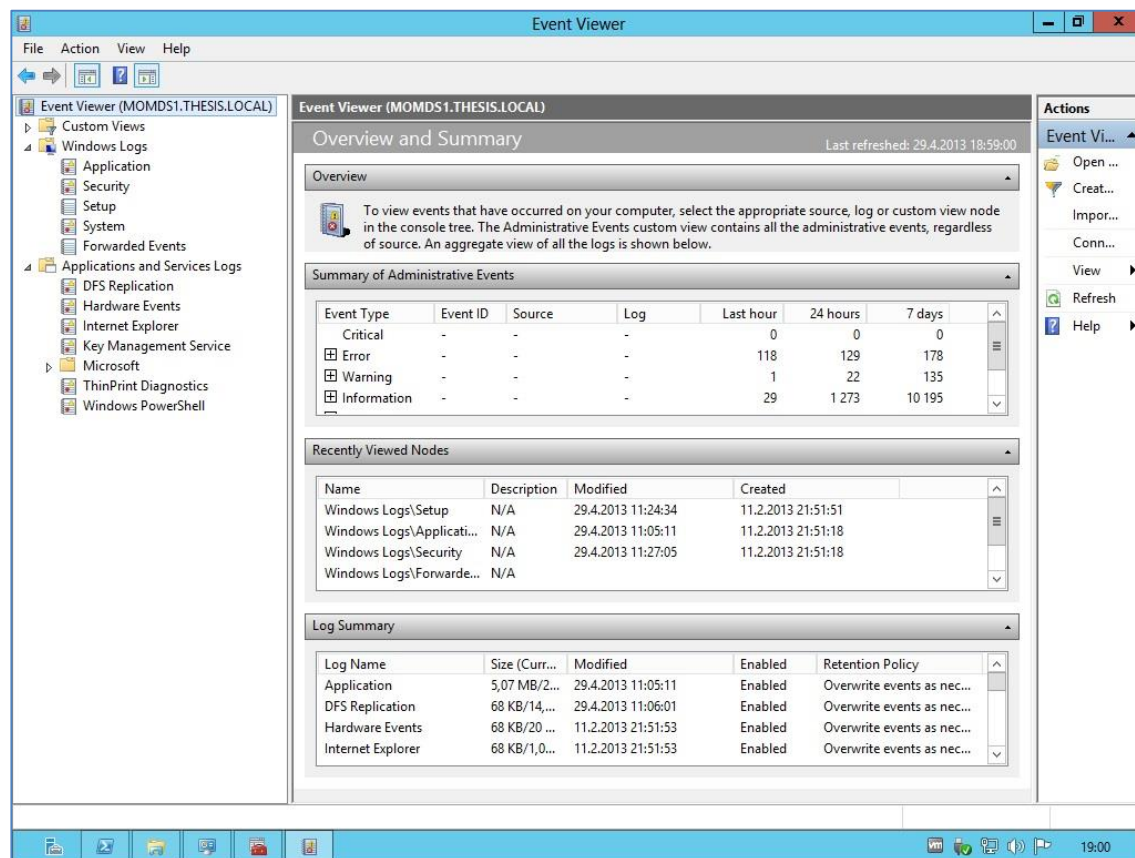


Figure 82: Event Viewer management console.

Figure 82 shows, it categorizes events to Application, Security, Setup and System folders. It is also possible to watch same events categorized by Applications and Services.

## Performance Monitor

The Performance Monitor management console (perfmon.msc) gives possibilities to collect performance data of remote computers as Figure 83 shows.

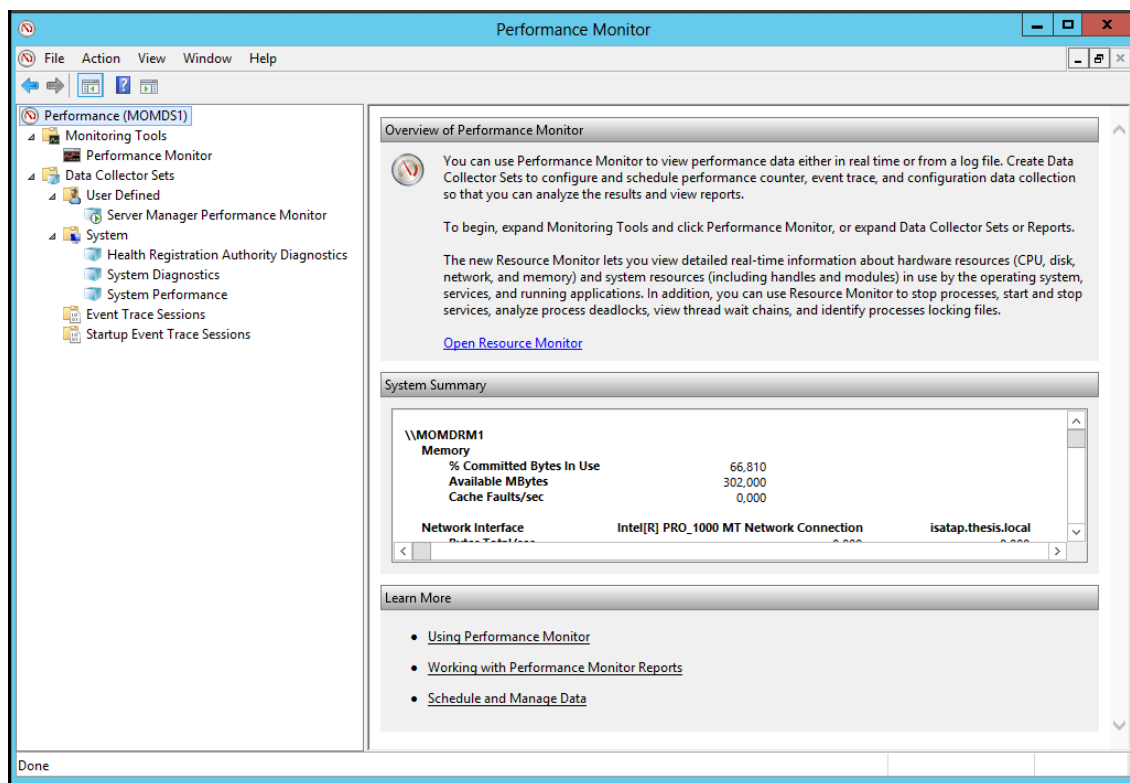


Figure 83: Performance Monitor management console.

Figure 83 shows an option to open Resource Monitor, it opens local Resource Monitor even when the console is open to remote computer.

## Services

The Services management console (services.msc) gives possibilities to work with services remotely as Figure 84 shows.

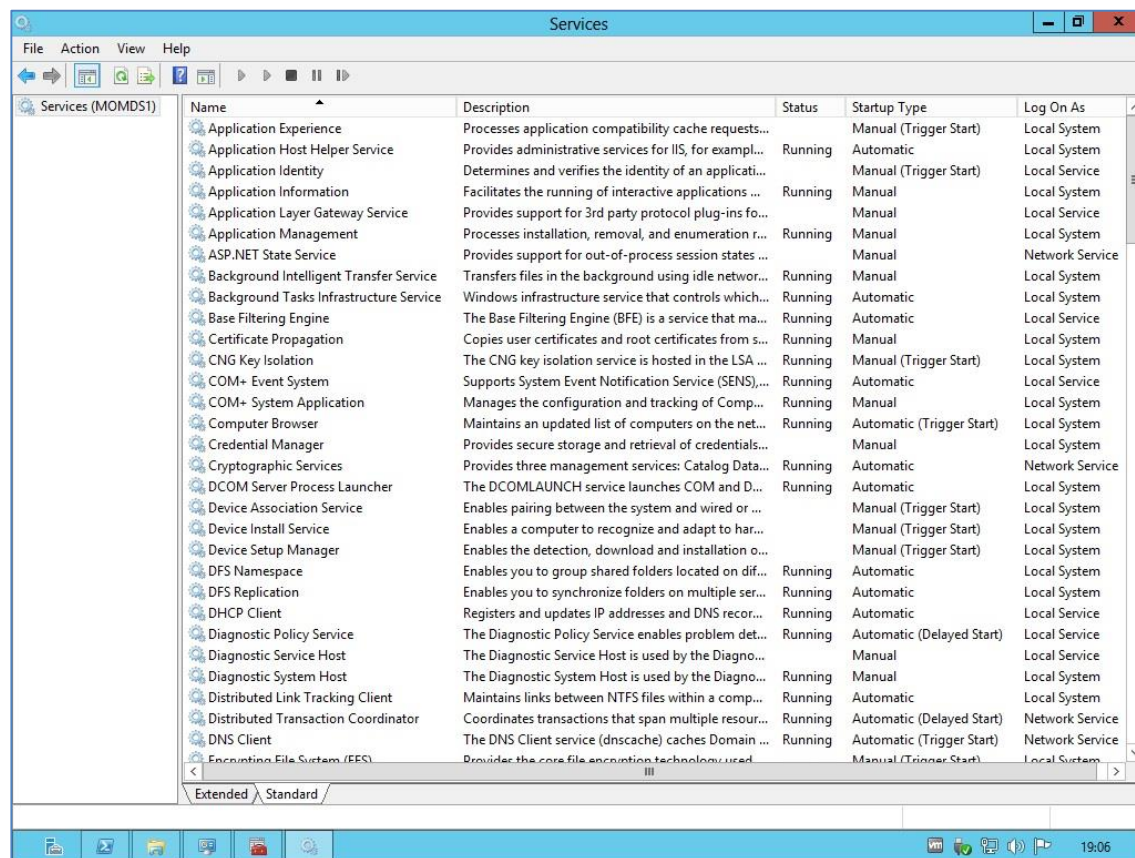


Figure 84: Services management console.

Figure 84 shows possibilities to change status, start-up type and log on as properties.



## Task Scheduler

The Task Scheduler management console (taskschd.msc) gives possibilities to manage scheduled tasks and schedule new tasks remotely as Figure 85 shows.

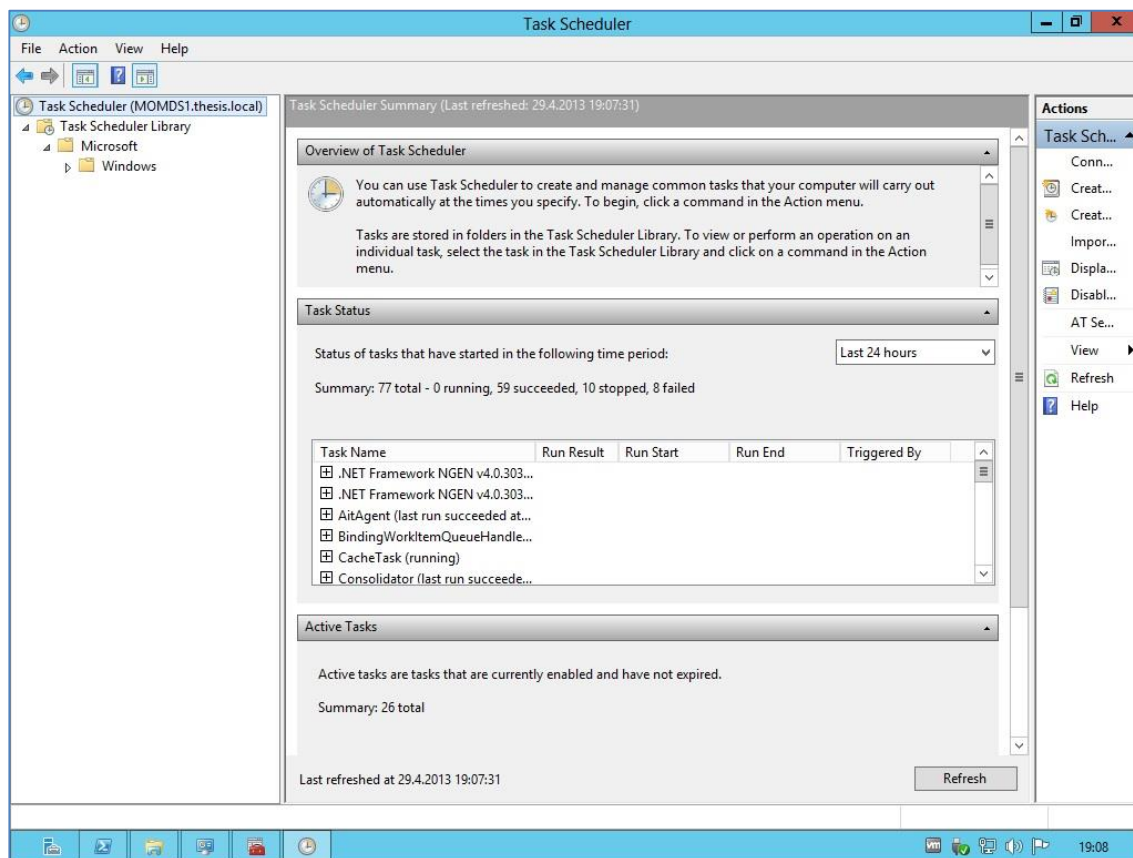


Figure 85: Task Scheduler management console.

Figure 85 shows 77 tasks were tried to run, 59 succeeded, 10 stopped and 8 failed.

## Telephony

The Telephony management console (tapimgmt.msc) gives possibilities to manage Telephony service of Windows Server 2012 computers remotely shown in Figure 86.

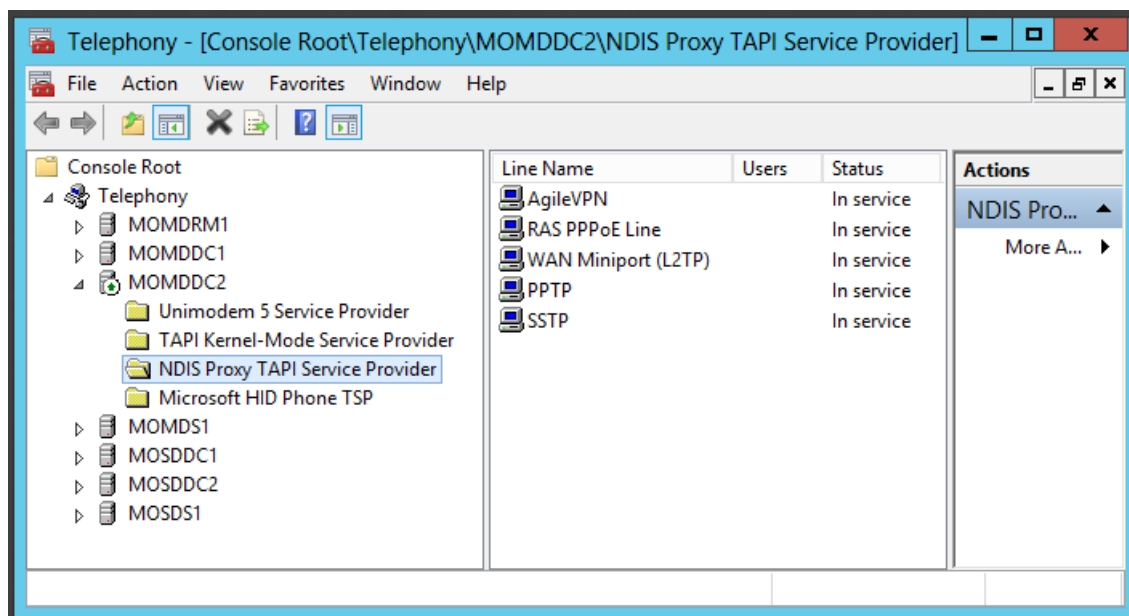


Figure 86: Telephony management console.

Figure 86 shows a possibility to add all remote computers to the same console inside the same forest. That console is not included in Windows 8.

## Windows Firewall with Advanced Security

The Windows Firewall with Advanced Security management console (WF.msc) gives possibilities to manage remote firewalls in advanced level remotely as Figure 87 shows.

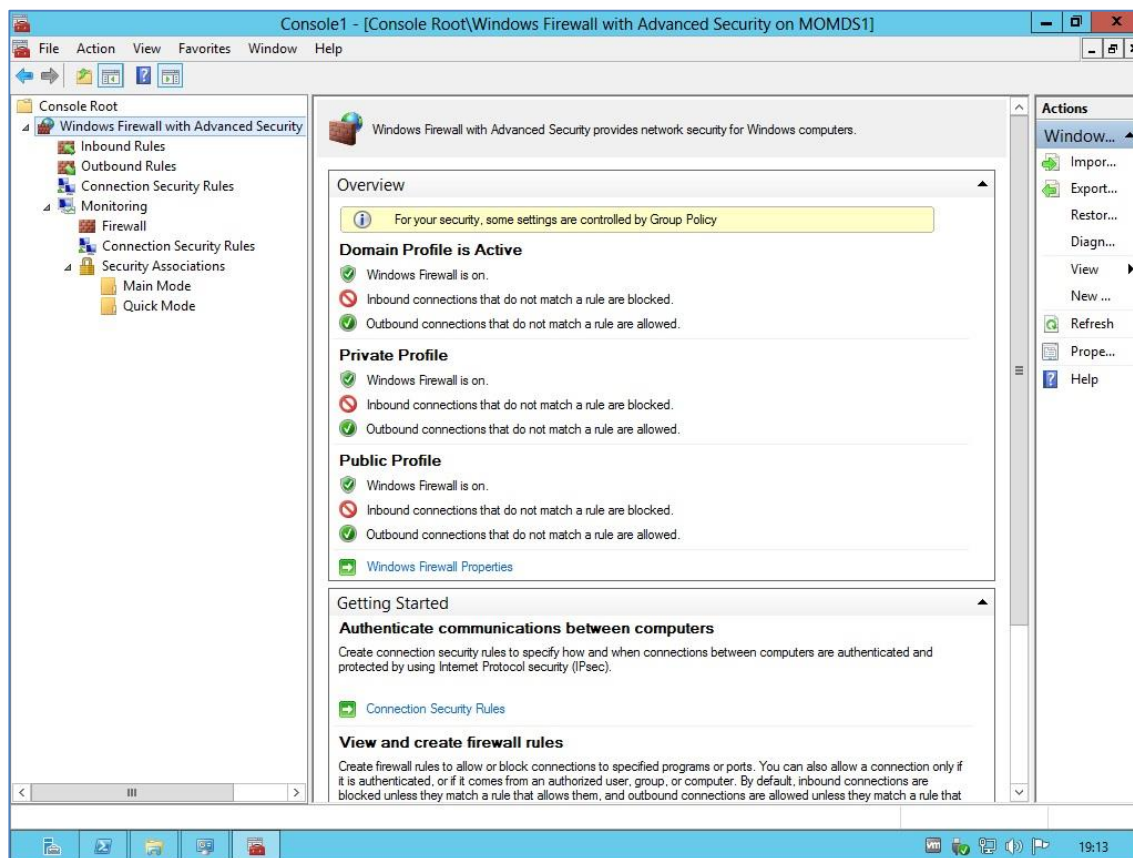


Figure 87: Windows Firewall and Advanced Security management console.

Figure 87 shows, remote management was possible with this console. This works only remotely with remote computers by MMC application.

## WMI Control

The WMI Control management console (WmiMgmt.msc) gives possibilities to manage Windows Management Instrumentation (WMI) Service remotely as Figure 88 shows.

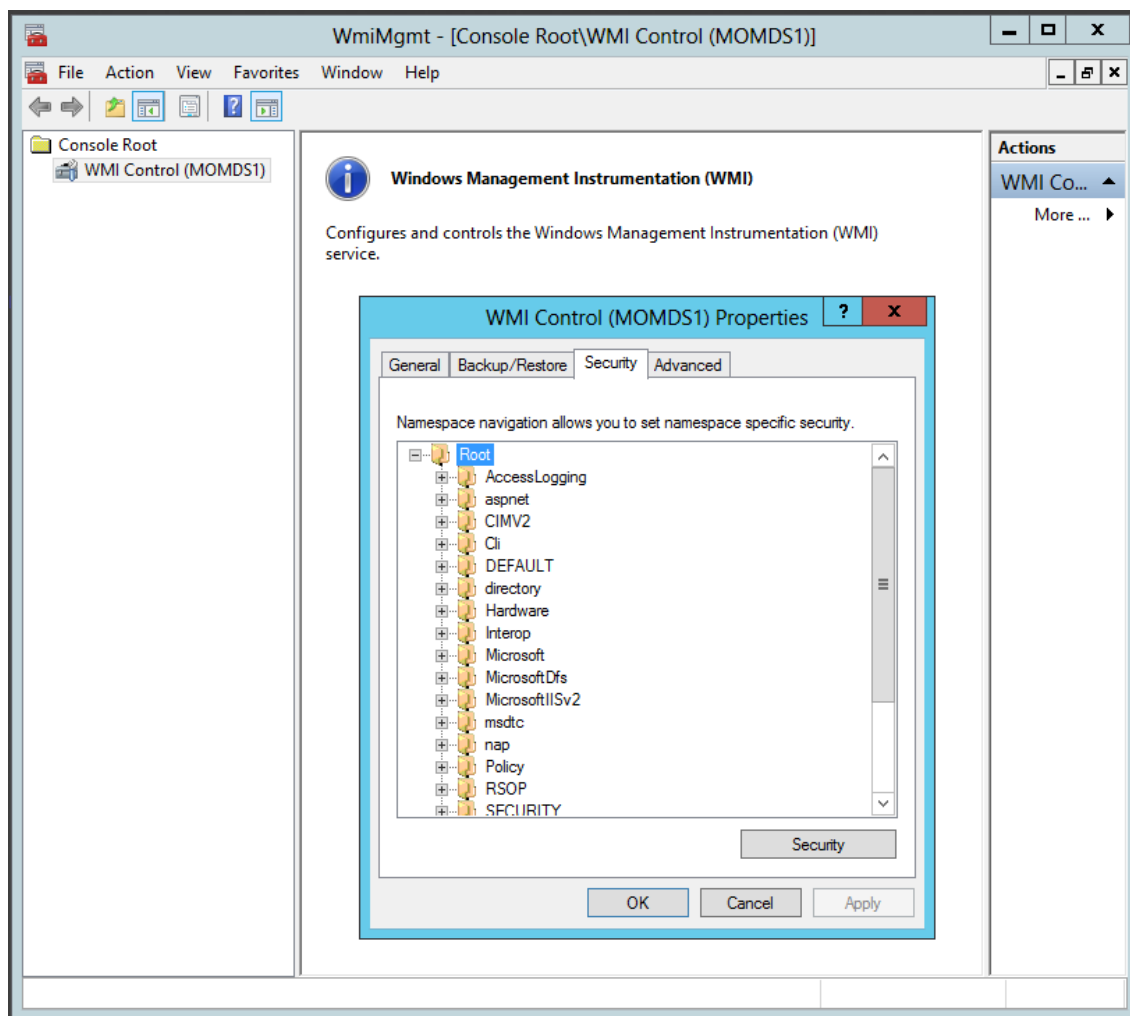


Figure 88: WMI Control management console.

Figure 88 shows, there are many possibilities to manage this service. Maybe it includes right tools to configure not remotely working management consoles to working but it was left outside of this study.

Device Manager, Windows Server Backup and Local Backup management consoles include option to manage remote computers but these do not work easily in the test environment even inside domain. The TPM Management console worked to remote computer but it needs compatible Trusted Platform Module (TPM) and it was not possible in virtual environments. The IP Security Monitor and the IP Security Policy Management

consoles, only snap-ins, include possibilities to manage remote computers but IPsec is outside of this study.

## 5 Conclusion

The Microsoft Windows Server 2012 looks good for today's needs and it does not include any barriers to move on from previous versions. Almost all new features deserve a place in the operating system media. The only question is if the IP Address Management (IPAM) and the Active Directory Administrative Center are really needed or is it possible to make all the same tasks in the future with older management consoles.

The Microsoft Windows 8 is also good for today's needs and it does not include any barriers to move on from previous versions, unless the Start Screen and its Store create challenges for organizations implementing security practices. Similarly, the lack of the Gadget platform in Windows 8 may delay any possible organizations who have made custom applications to this platform. The Hyper-V is a benefit to the workstation operating system features in the x64 architecture editions.

The test environment platform should have been the RAID10 (striped and mirrored) mass storage system but that would have increased the system costs significantly. The same would have happened with the SSD devices, these would have had the capacity that could have been sufficient, but considerably smaller than with the hard disks. A hardware router, for example from Cisco was needed, it was replaced by a virtual machine in the test environment. The IPv6 technology should have been present at the study. The platform was changed according to the needs during the project and in the end, it was sufficient to carry out the project. It would be good to build environments of this size with 64 GB of memory available in the host computer. The virtual machines were built with the acceptable but minimum amount of memory so that the 32 GB of memory in the host computer was sufficient. The weakest link in the platform was not redundant power supply.

Changing from core user interface to GUI did not work perfectly. Almost every time a change was interrupted by missed installation files. Several guided attempts of mounting the installation file (install.wim) to the virtual machine, as media installation by specifying the virtual machine's optical drive did not succeed. After all, all machines in the environment were built with GUI and it gave the possibility to later change to core user interface or a minimal interface and back to GUI, if possible with the installed roles or features.

Every management console includes different methods to connect remotely, opened firewall and domain administrators user rights were not enough to some tools. Even the asked extra services were not enough. Solving these problems was too big of a challenge on the study schedule. The given forest trusts were not enough for most tools and security requirements to a branch office must be implemented with different technologies.

It was hard to make decisions on which roles, role services and features to include in the study. Finally the answer was found in the remote management consoles. The study included the role services and features which include remote management consoles and excluded only deprecated or big role services and features. Windows Server 2012 and Windows 8 installations default management consoles were also included in the study but only with testing remote management possibilities. Including these the remote management of basic services in the topic was described fully in the study. Every included role or feature includes basic functions and all extra functions were dropped out of the study. The roles and features could have been included more deeply and therefore each possible next implementing task is presented in the study.

## References

- 1 Microsoft change Metro name [online]. BBC, United Kingdom; Aug 3, 2012. <http://www.bbc.co.uk/news/technology-19108952>. Accessed Mar 27, 2013.
- 2 Microsoft Windows Server 2012 system requirements [online]. Microsoft Corporation, USA: Washington; May 31, 2012. [http://technet.microsoft.com/library/jj134246#BKMK\\_sysreq](http://technet.microsoft.com/library/jj134246#BKMK_sysreq). Accessed Mar 27, 2013.
- 3 Microsoft Windows Server 2008 R2 system requirements [online]. Microsoft Corporation, USA: Washington; Mar 29, 2010. [http://technet.microsoft.com/en-us/library/dd379511\(v=WS.10\).aspx](http://technet.microsoft.com/en-us/library/dd379511(v=WS.10).aspx). Accessed Mar 27, 2013.
- 4 Microsoft Windows Server system maximums [online]. Microsoft Corporation, USA: Washington; Mar 29, 2010. <http://blogs.technet.com/b/matthts/archive/2012/10/14/windows-server-sockets-logical-processors-symmetric-multi-threading.aspx>. Accessed Mar 27, 2013.
- 5 Memory Limits for Windows Releases [online]. Microsoft Corporation, USA: Washington; Oct 26, 2012. [http://msdn.microsoft.com/en-us/library/windows/desktop/aa366778\(v=vs.85\).aspx](http://msdn.microsoft.com/en-us/library/windows/desktop/aa366778(v=vs.85).aspx). Accessed Mar 27, 2013.
- 6 Hyper-V Comparison Guide [online]. Microsoft Corporation, USA: Washington. [http://download.microsoft.com/download/2/C/A/2CA38362-37ED-4112-86A8-FDF14D5D4C9B/WS%202012%20Feature%20Comparison\\_Hyper-V.pdf](http://download.microsoft.com/download/2/C/A/2CA38362-37ED-4112-86A8-FDF14D5D4C9B/WS%202012%20Feature%20Comparison_Hyper-V.pdf). Accessed Mar 28, 2013.
- 7 Microsoft Windows Server 2012 – How To Buy [online]. Microsoft Corporation, USA: Washington; 2013. <http://www.microsoft.com/en-us/server-cloud/windows-server/buy.aspx>. Accessed Mar 29, 2013.
- 8 Microsoft Store [online]. Microsoft Corporation, USA: Washington; 2013. <http://www.microsoftstore.com/store/msstore/home>. Accessed Mar 29, 2013.
- 9 Microsoft Windows Server 2012 Foundation [DVD]. en\_windows\_server\_2012\_storage\_server\_and\_foundation\_x64\_dvd\_915793.iso. Microsoft Corporation, USA: Washington; Built Jul 26, 2012.
- 10 Microsoft Windows Server 2012 Essentials 180-day evaluation [online]. Microsoft Corporation, USA: Washington; 2013. <http://technet.microsoft.com/en-us/evalcenter/jj659306.aspx>. Accessed Mar 27, 2013.
- 11 Microsoft Windows Server 2012 Essentials 180-day evaluation [DVD]. WindowsServer2012Essentials-English-Install.iso. Microsoft Corporation, USA: Washington; Built Sep 8, 2012.
- 12 Microsoft Windows Server 2012 Essentials system requirements [online]. Microsoft Corporation, USA: Washington; Oct 4, 2012. <http://technet.microsoft.com/library/jj200132>. Accessed Mar 27, 2013.



- 13 Microsoft Windows Hyper-V Server 2012 [online]. Microsoft Corporation, USA: Washington; 2013. <http://www.microsoft.com/en-us/server-cloud/hyper-v-server/default.aspx>. Accessed Mar 27, 2013.
- 14 Microsoft Windows Hyper-V Server 2012 [DVD]. en\_microsoft\_hyper-v\_server\_2012\_x64\_dvd\_915600.iso. Microsoft Corporation, USA: Washington; Built Jul 26, 2012.
- 15 Microsoft Windows Storage Server 2012 180-day evaluation [online]. Microsoft Corporation, USA: Washington; 2013. <http://www.microsoft.com/en-us/download/details.aspx?id=34592>. Accessed Mar 27, 2013.
- 16 Microsoft Windows Storage Server 2012 180-day evaluation [DVD]. 9200.16384.WIN8\_RTM.120725-1247\_X64FRE\_SERVERSTORAGE\_EVAL\_EN-US-HRM\_SSTO\_X64FREE\_EN-US\_DV5.iso. Microsoft Corporation, USA: Washington; Built Jul 26, 2012.
- 17 Microsoft Windows MultiPoint Server 2012 Premium 180-day evaluation [online]. Microsoft Corporation, USA: Washington; 2013. <http://www.microsoft.com/en-us/download/details.aspx?id=35821>. Accessed Mar 27, 2013.
- 18 Microsoft Windows MultiPoint Server 2012 Premium 180-day evaluation [DVD]. EN-US\_WMS\_PREM\_InstallDVD.iso. Microsoft Corporation, USA: Washington; Built Nov 1, 2012.
- 19 Upgrade paths [online]. Microsoft Corporation, USA: Washington; Mar 6, 2013. <http://technet.microsoft.com/en-us/library/jj574204.aspx>. Accessed Mar 30, 2013.
- 20 Microsoft Support Lifecycle [online]. Microsoft Corporation, USA: Washington; 2013. <http://support.microsoft.com/common/international.aspx?RDPATH=%2flifecycle%2fdefault.aspx>. Accessed Mar 26, 2013.
- 21 .NET Framework 4.5 [online]. Microsoft Corporation, USA: Washington; Oct 9, 2012. <http://www.microsoft.com/en-us/download/details.aspx?id=30653>. Accessed Mar 26, 2013.
- 22 Windows Management Framework 3.0 (KB2506146) [online]. Microsoft Corporation, USA: Washington; Dec 3, 2012. <http://www.microsoft.com/en-us/download/details.aspx?id=34595>. Accessed Mar 26, 2013.
- 23 Microsoft Security Essentials 4.2.223.1 [online]. Microsoft Corporation, USA: Washington; Feb 26, 2013. <http://www.microsoft.com/en-us/download/details.aspx?id=5201>. Accessed Mar 26, 2013.
- 24 WebDAV 7.5 for IIS 7.0 x86 [online]. Microsoft Corporation, USA: Washington; Mar 12, 2009. <http://www.microsoft.com/en-us/download/details.aspx?id=3490>. Accessed Mar 26, 2013.
- 25 WebDAV 7.5 for IIS 7.0 x64 [online]. Microsoft Corporation, USA: Washington; Mar 12, 2009. <http://www.microsoft.com/en-us/download/details.aspx?id=4946>. Accessed Mar 26, 2013.

- 26 FTP 7.5 for IIS 7.0 x86 [online]. Microsoft Corporation, USA: Washington; Aug 3, 2009. <http://www.microsoft.com/en-us/download/details.aspx?id=14045>. Accessed Mar 26, 2013.
- 27 FTP 7.5 for IIS 7.0 x64 [online]. Microsoft Corporation, USA: Washington; Aug 3, 2009. <http://www.microsoft.com/en-us/download/details.aspx?id=22045>. Accessed Mar 26, 2013.
- 28 Application Initialization 1.0 x64 for IIS 7.5 [online]. Microsoft Corporation, USA: Washington; Sep 18, 2012. <http://www.microsoft.com/en-us/download/details.aspx?id=30433>. Accessed Mar 26, 2013.
- 29 Microsoft Windows Server 2012 installation media languages [online]. Microsoft Corporation, USA: Washington; 2013. <https://technet.microsoft.com/en-us/subscriptions/securedownloads/default.aspx#searchTerm=&ProductFamilyId=483>. Accessed Feb 26, 2013.
- 30 Microsoft Windows Server 2012 language packs [online]. Microsoft Corporation, USA: Washington; 2013. [http://oem.microsoft.com/downloads/agreement/Windows\\_Server\\_2012\\_LP/Win\\_SVR\\_2012\\_64BIT\\_Multi\\_Language\\_LP\\_OEM.img](http://oem.microsoft.com/downloads/agreement/Windows_Server_2012_LP/Win_SVR_2012_64BIT_Multi_Language_LP_OEM.img). Accessed Feb 26, 2013.
- 31 Microsoft Windows 8 system requirements [online]. Microsoft Corporation, USA: Washington; 2013. <http://windows.microsoft.com/en-us/windows-8/system-requirements>. Accessed Mar 28, 2013.
- 32 Microsoft Windows 7 system requirements [online]. Microsoft Corporation, USA: Washington; 2013. <http://windows.microsoft.com/en-us/windows7/products/system-requirements>. Accessed Mar 28, 2013.
- 33 Judgment of the Court of First Instance – Microsoft Corp. v Commission of the European Communities – Case T-201/04. European Union; Sep 17, 2007. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:62004A0201:EN:NOT>. Accessed Mar 28, 2013.
- 34 Active Directory Lightweight Directory Services (KB975541) [online]. Microsoft Corporation, USA: Washington; Feb 16, 2010. <http://www.microsoft.com/en-us/download/details.aspx?id=14683>. Accessed Mar 26, 2013.
- 35 Application Initialization 1.0 x86 for IIS 7.5 [online]. Microsoft Corporation, USA: Washington; Jul 24, 2012. <http://www.microsoft.com/en-us/download/details.aspx?id=30434>. Accessed Mar 26, 2013.
- 36 Microsoft Windows 8 installation media [online]. Microsoft Corporation, USA: Washington; 2013. <https://technet.microsoft.com/en-us/subscriptions/securedownloads/hh442904#searchTerm=&ProductFamilyId=481>. Accessed Feb 26, 2013.
- 37 Microsoft Windows 8 language packs [online]. Microsoft Corporation, USA: Washington; 2013. <http://windows.microsoft.com/en-US/windows/language-packs#lptabs=win8>. Accessed Feb 26, 2013.

- 38 Remote Server Administration Tools for Windows 8 [online]. Microsoft Corporation, USA: Washington; Sep 13, 2012. <http://www.microsoft.com/en-us/download/details.aspx?id=28972>. Accessed Apr 1, 2013.
- 39 AMD FX-8350 [online]. Advanced Micro Devices, Inc., USA: California; 2013. <http://products.amd.com/en-us/DesktopCPUDetail.aspx?id=809>. Accessed Feb 17, 2013.
- 40 AMD FX-8350 introduction date [online]. <http://www.cpu-world.com/CPUs/Bulldozer/AMD-FX-Series%20FX-8350.html>. Accessed Feb 20, 2013.
- 41 Intel Core i7-3970X Extreme Edition [online]. Intel Corporation, USA: California. [http://ark.intel.com/products/70845/Intel-Core-i7-3970X-Processor-Extreme-Edition-15M-Cache-3\\_50-GHz](http://ark.intel.com/products/70845/Intel-Core-i7-3970X-Processor-Extreme-Edition-15M-Cache-3_50-GHz). Accessed Feb 17, 2013.
- 42 Intel Core i7-3970X Extreme Edition introduction date [online]. [http://www.cpu-world.com/CPUs/Core\\_i7/Intel-Core%20i7-3970X%20Extreme%20Edition.html](http://www.cpu-world.com/CPUs/Core_i7/Intel-Core%20i7-3970X%20Extreme%20Edition.html). Accessed Feb 20, 2013.
- 43 ASUS Sabertooth 990FX R2.0 [online]. ASUSTek Computer Inc., Taipei, Taiwan; [http://www.asus.com/Motherboards/SABERTOOTH\\_990FX\\_R20](http://www.asus.com/Motherboards/SABERTOOTH_990FX_R20). Accessed Mar 26, 2013.
- 44 Kingston KVR13N9K2/16 specification sheet [online]. Kingston Technology Company, Inc., USA: California; May 23, 2012. [http://www.kingston.com/dataSheets/KVR13N9K2\\_16.pdf](http://www.kingston.com/dataSheets/KVR13N9K2_16.pdf). Accessed Feb 17, 2013.
- 45 HighPoint RocketRAID 620 series overview [online]. HighPoint, Inc., USA: California; 2011. [http://highpoint-tech.com/USA\\_new/series\\_rr600-overview.htm](http://highpoint-tech.com/USA_new/series_rr600-overview.htm). Accessed Feb 28, 2013.
- 46 Transcend SSD320 series specification sheet [online]. Transcend Information, Inc., Taiwan; 2012. [http://fi.transcend-info.com/support/dlcenter/edm/ProductSheet\\_SATAIIIseries.pdf](http://fi.transcend-info.com/support/dlcenter/edm/ProductSheet_SATAIIIseries.pdf). Accessed Feb 17, 2013.
- 47 Western Digital Red series specification sheet [online]. Western Digital Technologies, USA: California; Aug 2012. <http://www.wdc.com/wdproducts/library/SpecSheet/ENG/2879-771442.pdf>. Accessed Feb 17, 2013.
- 48 Microsoft Windows Server 2012 [DVD]. en\_windows\_server\_2012\_x64\_dvd\_915478.iso. Microsoft Corporation, USA: Washington; Published Sep 4, 2012.
- 49 VMware Workstation 9 [computer program]. VMware-workstation-full-9.0.2-1031769.exe. VMware, Inc., USA: California; Build Feb 26, 2013.
- 50 Using VMware Workstation [online]. VMware Inc., USA: California; 2012. <http://www.vmware.com/pdf/desktop/ws90-using.pdf>. Accessed Mar 26, 2013.

- 51 Microsoft Windows Server 2012 180-day evaluation [online]. Microsoft Corporation, USA: Washington; 2013. [http://technet.microsoft.com/en-US/evalcenter/hh670538.aspx?ocid=&wt.mc\\_id=TEC\\_108\\_1\\_33](http://technet.microsoft.com/en-US/evalcenter/hh670538.aspx?ocid=&wt.mc_id=TEC_108_1_33). Accessed Apr 1, 2013.
- 52 Microsoft Windows Server 2012 180-day evaluation [DVD]. 9200.16384.WIN8\_RTM.120725-1247\_X64FRE\_SERVER\_EVAL\_EN-US-HRM\_SSS\_X64FREE\_EN-US\_DV5.iso. Microsoft Corporation, USA: Washington; Built Jul 26, 2012.
- 53 Microsoft Windows 8 x64 90-day evaluation [online]. Microsoft Corporation, USA: Washington; 2013. <http://technet.microsoft.com/en-us/evalcenter/hh699156.aspx>. Accessed Apr 1, 2013.
- 54 Microsoft Windows 8 x64 90-day evaluation [DVD]. 9200.16384.WIN8\_RTM.120725-1247\_X64FRE\_ENTERPRISE\_EVAL\_EN-US-HRM\_CENA\_X64FREE\_EN-US\_DV5.iso. Microsoft Corporation, USA: Washington; Built Jul 26, 2012.
- 55 VMware vCenter Converter [online]. VMware Inc., USA: California. <http://www.vmware.com/products/converter/>. Accessed Apr 9, 2013.
- 56 VMware vCenter Converter [computer program]. VMware-converter-all-5.0.1-875114.exe. VMware, Inc., USA: California; Build Oct 15, 2012.
- 57 Microsoft Report Viewer 2008 SP1 [online]. Microsoft Corporation, USA: Washington; Aug 20, 2008. <http://www.microsoft.com/en-us/download/details.aspx?id=3841>. Accessed Apr 29, 2013.
- 58 Domain Policy Settings [online]. Microsoft Corporation, USA: Washington; Feb 27, 2008. <http://technet.microsoft.com/en-us/library/cc264456.aspx>. Accessed Apr 30, 2013.
- 59 IP Address Management (IPAM) Server [online]. Microsoft Corporation, USA: Washington; Feb 29, 2012. <http://technet.microsoft.com/en-us/library/hh831622.aspx>. Accessed Apr 28, 2013.

## Available Packages for Roles in Different Windows Server 2012 Editions

Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
<input type="checkbox"/> Active Directory Certificate Services	AD-Certificate	A	A	A	A	I	A	A	
<input type="checkbox"/> Certification Authority	ADCS-Cert-Authority	A	A	A	A	I	A	A	
<input type="checkbox"/> Certificate Enrollment Policy Web Service	ADCS-Enroll-Web-Pol	A	A	A	A	A	A	A	
<input type="checkbox"/> Certificate Enrollment Web Service	ADCS-Enroll-Web-Svc	A	A	A	A	A	A	A	
<input type="checkbox"/> Certification Authority Web Enrollment	ADCS-Web-Enrollment	A	A	A	A	I	A	A	
<input type="checkbox"/> Network Device Enrollment Service	ADCS-Device-Enrollment	A	A	A	A	A	A	A	
<input type="checkbox"/> Online Responder	ADCS-Online-Cert	A	A	A	A	A	A	A	
<input type="checkbox"/> Active Directory Domain Services	AD-Domain-Services	A	A	A	A	I	A	A	
<input type="checkbox"/> Active Directory Federation Services	AD-Federation-Services	R	A	A	A	A	A	A	
<input type="checkbox"/> Federation Service	ADFS-Federation	R	A	A	A	A	A	A	
<input type="checkbox"/> AD FS 1.1 Web Agents	ADFS-Web-Agents	R	A	A	A	A	A	A	
<input type="checkbox"/> AD FS 1.1 Claims-aware Agent	ADFS-Claims	R	A	A	A	A	A	A	
<input type="checkbox"/> AD FS 1.1 Windows Token-based Agent	ADFS-Windows-Token	R	A	A	A	A	A	A	
<input type="checkbox"/> Federation Service Proxy	ADFS-Proxy	R	A	A	A	A	A	A	
<input type="checkbox"/> Active Directory Lightweight Directory Services	ADLDS	A	A	A	A	A	A	A	
<input type="checkbox"/> Active Directory Rights Management Services	ADRMS	A	A	A	A	A	A	A	
<input type="checkbox"/> Active Directory Rights Management Server	ADRMS-Server	A	A	A	A	A	A	A	
<input type="checkbox"/> Identity Federation Support	ADRMS-Identity	R	A	A	A	A	A	A	
<input type="checkbox"/> Application Server	Application-Server	R	A	A	A	A	A	A	
<input type="checkbox"/> .NET Framework 4.5	AS-NET-Framework	R	A	A	A	A	A	A	
<input type="checkbox"/> COM+ Network Access	AS-Ent-Services	R	A	A	A	A	A	A	
<input type="checkbox"/> Distributed Transactions	AS-Dist-Transaction	R	A	A	A	A	A	A	
<input type="checkbox"/> WS-Atomic Transactions	AS-WS-Atomic	R	A	A	A	A	A	A	
<input type="checkbox"/> Incoming Network Transactions	AS-Incoming-Trans	R	A	A	A	A	A	A	
<input type="checkbox"/> Outgoing Network Transactions	AS-Outgoing-Trans	R	A	A	A	A	A	A	
<input type="checkbox"/> TCP Port Sharing	AS-TCP-Port-Sharing	R	A	A	A	A	A	A	
<input type="checkbox"/> Web Server (IIS) Support	AS-Web-Support	R	A	A	A	A	A	A	
<input type="checkbox"/> Windows Process Activation Service Support	AS-WAS-Support	R	A	A	A	A	A	A	
<input type="checkbox"/> HTTP Activation	AS-HTTP-Activation	R	A	A	A	A	A	A	
<input type="checkbox"/> Message Queuing Activation	AS-MSMQ-Activation	R	A	A	A	A	A	A	
<input type="checkbox"/> Named Pipes Activation	AS-Named-Pipes	R	A	A	A	A	A	A	
<input type="checkbox"/> TCP Activation	AS-TCP-Activation	R	A	A	A	A	A	A	
<input type="checkbox"/> DHCP Server	DHCP	A	A	A	A	A	A	A	
<input type="checkbox"/> DNS Server	DNS	A	A	A	A	I	A	A	
<input type="checkbox"/> Fax Server	Fax	R	A	A	A	A	A	A	
<input type="checkbox"/> File And Storage Services	FileAndStorage-Services	I	I	I	I	I	I	I	
<input type="checkbox"/> File and iSCSI Services	File-Services	A	A	A	A	A	I	A	I
<input type="checkbox"/> File Server	FS-FileServer	A	A	A	A	A	I	A	I
<input type="checkbox"/> BranchCache for Network Files	FS-BranchCache	A	A	A	A		A	A	A
<input type="checkbox"/> Data Deduplication	FS-Data-Deduplication	A	A	A				A	
<input type="checkbox"/> DFS Namespaces	FS-DFS-Namespace	A	A	A	A		A	A	A
<input type="checkbox"/> DFS Replication	FS-DFS-Replication	A	A	A	A		A	A	A
<input type="checkbox"/> File Server Resource Manager	FS-Resource-Manager	A	A	A	A		A	A	A
<input type="checkbox"/> File Server VSS Agent Service	FS-VSS-Agent	A	A	A	A		A	A	A
<input type="checkbox"/> iSCSI Target Server	FS-iSCSITarget-Server	A	A	A	A		A	A	A
<input type="checkbox"/> iSCSI Target Storage Provider (VDS and VSS hardware providers)	iSCSITarget-VSS-VDS	A	A	A	A		A	A	A
<input type="checkbox"/> Server for NFS	FS-NFS-Service	A	A	A	A		A	A	A
<input type="checkbox"/> Storage Services	Storage-Services	I	I	I	I	I	I	I	I
<input type="checkbox"/> Hyper-V	Hyper-V	A	A	A		I		A	A

Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
<input type="checkbox"/> Network Policy and Access Services	NPAS	R	A	A	A		I		A
<input type="checkbox"/> Network Policy Server	NPAS-Policy-Server	R	A	A	A		I		A
<input type="checkbox"/> Health Registration Authority	NPAS-Health	R	A	A	A		A		A
<input type="checkbox"/> Host Credential Authorization Protocol	NPAS-Host-Cred	R	A	A	A		A		A
<input type="checkbox"/> Print and Document Services	Print-Services	A	A	A	A		A	A	I
<input type="checkbox"/> Print Server	Print-Server	A	A	A	A		A	A	I
<input type="checkbox"/> Distributed Scan Server	Print-Scan-Server	R	A	A	A		A	A	A
<input type="checkbox"/> Internet Printing	Print-Internet	R	A	A	A		A	A	A
<input type="checkbox"/> LPD Service	Print-LPD-Service	A	A	A	A		A	A	A
<input type="checkbox"/> Remote Access	RemoteAccess	A	A	A	A		A		A
<input type="checkbox"/> DirectAccess and VPN (RAS)	DirectAccess-VPN	A	A	A	A		A		A
<input type="checkbox"/> Routing	Routing	A	A	A	A		A		A
<input type="checkbox"/> Remote Desktop Services	Remote-Desktop-Services	A	A	A	A	A	I		I
<input type="checkbox"/> Remote Desktop Connection Broker	RDS-Connection-Broker	A	A	A	A		A		A
<input type="checkbox"/> Remote Desktop Gateway	RDS-Gateway	R	A	A	A		I		A
<input type="checkbox"/> Remote Desktop Licensing	RDS-Licensing	A	A	A	A		A		I
<input type="checkbox"/> Remote Desktop Session Host	RDS-RD-Server	R	A	A	A		A		I
<input type="checkbox"/> Remote Desktop Virtualization Host	RDS-Virtualization	A	A	A		A			A
<input type="checkbox"/> Remote Desktop Web Access	RDS-Web-Access	R	A	A	A		A		A
<input type="checkbox"/> Volume Activation Services	VolumeActivation	A	A	A	A		A		A
<input type="checkbox"/> Web Server (IIS)	Web-Server	A	A	A	A		I	A	A
<input type="checkbox"/> Web Server	Web-WebServer	A	A	A	A		I	A	A
<input type="checkbox"/> Common HTTP Features	Web-Common-Http	A	A	A	A		I	A	A
<input type="checkbox"/> Default Document	Web-Default-Doc	A	A	A	A		I	A	A
<input type="checkbox"/> Directory Browsing	Web-Dir-Browsing	A	A	A	A		I	A	A
<input type="checkbox"/> HTTP Errors	Web-Http-Errors	A	A	A	A		I	A	A
<input type="checkbox"/> Static Content	Web-Static-Content	A	A	A	A		I	A	A
<input type="checkbox"/> HTTP Redirection	Web-Http-Redirect	A	A	A	A		I	A	A
<input type="checkbox"/> WebDAV Publishing	Web-DAV-Publishing	A	A	A	A		I	A	A
<input type="checkbox"/> Health and Diagnostics	Web-Health	A	A	A	A		I	A	A
<input type="checkbox"/> HTTP Logging	Web-Http-Logging	A	A	A	A		I	A	A
<input type="checkbox"/> Custom Logging	Web-Custom-Logging	A	A	A	A		I	A	A
<input type="checkbox"/> Logging Tools	Web-Log-Libraries	A	A	A	A		I	A	A
<input type="checkbox"/> ODBC Logging	Web-ODBC-Logging	A	A	A	A		I	A	A
<input type="checkbox"/> Request Monitor	Web-Request-Monitor	A	A	A	A		I	A	A
<input type="checkbox"/> Tracing	Web-Http-Tracing	A	A	A	A		I	A	A
<input type="checkbox"/> Performance	Web-Performance	A	A	A	A		I	A	A
<input type="checkbox"/> Static Content Compression	Web-Stat-Compression	A	A	A	A		I	A	A
<input type="checkbox"/> Dynamic Content Compression	Web-Dyn-Compression	A	A	A	A		I	A	A
<input type="checkbox"/> Security	Web-Security	A	A	A	A		I	A	A
<input type="checkbox"/> Request Filtering	Web-Filtering	A	A	A	A		I	A	A
<input type="checkbox"/> Basic Authentication	Web-Basic-Auth	A	A	A	A		I	A	A
<input type="checkbox"/> Centralized SSL Certificate Support	Web-CertProvider	A	A	A	A		I	A	A
<input type="checkbox"/> Client Certificate Mapping Authentication	Web-Client-Auth	A	A	A	A		I	A	A
<input type="checkbox"/> Digest Authentication	Web-Digest-Auth	A	A	A	A		I	A	A
<input type="checkbox"/> IIS Client Certificate Mapping Authentication	Web-Cert-Auth	A	A	A	A		I	A	A
<input type="checkbox"/> IP and Domain Restrictions	Web-IP-Security	A	A	A	A		I	A	A
<input type="checkbox"/> URL Authorization	Web-Url-Auth	A	A	A	A		I	A	A
<input type="checkbox"/> Windows Authentication	Web-Windows-Auth	A	A	A	A		I	A	A

Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
<input type="checkbox"/> Application Development	Web-App-Dev	A	A	A	A		I	A	A
<input type="checkbox"/> .NET Extensibility 3.5	Web-Net-Ext	A	A	A	A		A	A	A
<input type="checkbox"/> .NET Extensibility 4.5	Web-Net-Ext45	A	A	A	A		I	A	A
<input type="checkbox"/> Application Initialization	Web-AppInit	A	A	A	A		A	A	A
<input type="checkbox"/> ASP	Web-ASP	A	A	A	A		I	A	A
<input type="checkbox"/> ASP.NET 3.5	Web-Asp-Net	A	A	A	A		A	A	A
<input type="checkbox"/> ASP.NET 4.5	Web-Asp-Net45	A	A	A	A		I	A	A
<input type="checkbox"/> CGI	Web-CGI	A	A	A	A		A	A	A
<input type="checkbox"/> ISAPI Extensions	Web-ISAPI-Ext	A	A	A	A		I	A	A
<input type="checkbox"/> ISAPI Filters	Web-ISAPI-Filter	A	A	A	A		I	A	A
<input type="checkbox"/> Server Side Includes	Web-Includes	A	A	A	A		I	A	A
<input type="checkbox"/> WebSocket Protocol	Web-WebSockets	A	A	A	A		A	A	A
<input type="checkbox"/> FTP Server	Web-Ftp-Server	A	A	A	A		A	A	A
<input type="checkbox"/> FTP Service	Web-Ftp-Service	A	A	A	A		A	A	A
<input type="checkbox"/> FTP Extensibility	Web-Ftp-Ext	A	A	A	A		A	A	A
<input type="checkbox"/> IIS Hostable Web Core	Web-WHC	A	A	A	A		A	A	A
<input type="checkbox"/> Management Tools	Web-Mgmt-Tools	A	A	A	A		I	A	A
<input type="checkbox"/> IIS Management Console	Web-Mgmt-Console	R	A	A	A		I	A	A
<input type="checkbox"/> IIS 6 Management Compatibility	Web-Mgmt-Compat	A	A	A	A		I	A	A
<input type="checkbox"/> IIS 6 Metabase Compatibility	Web-Metabase	A	A	A	A		I	A	A
<input type="checkbox"/> IIS 6 Management Console	Web-Lgcy-Mgmt-Console	R	A	A	A		I	A	A
<input type="checkbox"/> IIS 6 Scripting Tools	Web-Lgcy-Scripting	A	A	A	A		I	A	A
<input type="checkbox"/> IIS 6 WMI Compatibility	Web-WMI	A	A	A	A		I	A	A
<input type="checkbox"/> IIS Management Scripts and Tools	Web-Scripting-Tools	A	A	A	A		I	A	A
<input type="checkbox"/> Management Service	Web-Mgmt-Service	A	A	A	A		I	A	A
<input type="checkbox"/> Windows Deployment Services	WDS	R	A	A	A		A		A
<input type="checkbox"/> Deployment Server	WDS-Deployment	R	A	A	A		A		A
<input type="checkbox"/> Transport Server	WDS-Transport	R	A	A	A		A		A
<input type="checkbox"/> Windows Server Update Services	UpdateServices	A	A	A					A
<input type="checkbox"/> WID Database	UpdateServices-WidDB	A	A	A					A
<input type="checkbox"/> WSUS Services	UpdateServices-Services	A	A	A					A
<input type="checkbox"/> Database	UpdateServices-DB	A	A	A					A

- A = Binaries available in installation  
D = Binaries deleted from installation  
I = Installed by default to this edition

## Available Packages for Features in Different Windows Server 2012 Editions

Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
[ ] .NET Framework 3.5 Features	NET-Framework-Features	A	A	A	A	A	A	A	A
[ ] .NET Framework 3.5 (includes .NET 2.0 and 3.0)	NET-Framework-Core	R	R	R	R	R	R	R	R
[ ] HTTP Activation	NET-HTTP-Activation	A	A	A	A	I	A	A	A
[ ] Non-HTTP Activation	NET-Non-HTTP-Activ	A	A	A	A	I	A	A	A
[ ] .NET Framework 4.5 Features	NET-Framework-45-Fea*	I	I	I	I	A	I	I	I
[ ] .NET Framework 4.5	NET-Framework-45-Core	I	I	I	I		I	I	I
[ ] ASP.NET 4.5	NET-Framework-45-ASPNET	A	A	A	A		I	A	A
[ ] WCF Services	NET-WCF-Services45	I	I	I	I		I	I	I
[ ] HTTP Activation	NET-WCF-HTTP-Activat*	A	A	A	A		I	A	A
[ ] Message Queuing (MSMQ) Activation	NET-WCF-MSMQ-Activat*	A	A	A	A		A	A	A
[ ] Named Pipe Activation	NET-WCF-Pipe-Activat*	A	A	A	A		A	A	A
[ ] TCP Activation	NET-WCF-TCP-Activati*	A	A	A	A		A	A	A
[ ] TCP Port Sharing	NET-WCF-TCP-PortShar*	I	I	I	I		I	I	I
[ ] Background Intelligent Transfer Service (BITS)	BITS	A	A	A	A	A	A	A	A
[ ] IIS Server Extension	BITS-IIS-Ext	R	A	A	A		A	A	A
[ ] Compact Server	BITS-Compact-Server	A	A	A	A	A	A	A	A
[ ] BitLocker Drive Encryption	BitLocker	A	A	A	A	A	A	A	A
[ ] BitLocker Network Unlock	BitLocker-NetworkUnlock	R	A	A	A		A		A
[ ] BranchCache	BranchCache	A	A	A	A		A	A	A
[ ] Client for NFS	NFS-Client	A	A	A	A		A	A	A
[ ] Data Center Bridging	Data-Center-Bridging	A	A	A	A	A	A	A	A
[ ] Enhanced Storage	EnhancedStorage	A	A	A	A	A	A	A	A
[ ] Failover Clustering	Failover-Clustering	A	A	A	A	A		A	A
[ ] Group Policy Management	GPMC	A	A	A	A		I	A	A
[ ] Ink and Handwriting Services	InkAndHandwritingSer*	R	A	A	A		I	A	I
[ ] Internet Printing Client	Internet-Print-Client	R	A	A	A		A	A	A
[ ] IP Address Management (IPAM) Server	IPAM	R	A	A	A		A	A	A
[ ] iSNS Server service	ISNS	A	A	A	A		A	A	A
[ ] LPR Port Monitor	LPR-Port-Monitor	R	A	A	A		A	A	A
[ ] Management OData IIS Extension	ManagementOdata	A	A	A	A		A	A	A
[ ] Media Foundation	Server-Media-Foundation	A	A	A	A	A	I	A	I
[ ] Message Queuing	MSMQ	A	A	A	A		A	A	A
[ ] Message Queuing Services	MSMQ-Services	A	A	A	A		A	A	A
[ ] Message Queuing Server	MSMQ-Server	A	A	A	A		A	A	A
[ ] Directory Service Integration	MSMQ-Directory	A	A	A	A		A	A	A
[ ] HTTP Support	MSMQ-HTTP-Support	A	A	A	A		A	A	A
[ ] Message Queuing Triggers	MSMQ-Triggers	A	A	A	A		A	A	A
[ ] Multicasting Support	MSMQ-Multicasting	A	A	A	A		A	A	A
[ ] Routing Service	MSMQ-Routing	A	A	A	A		A	A	A
[ ] Message Queuing DCOM Proxy	MSMQ-DCOM	A	A	A	A		A	A	A
[ ] Multipath I/O	Multipath-IO	A	A	A	A	A	A	A	A
[ ] Network Load Balancing	NLB	A	A	A	A		A	A	A
[ ] Peer Name Resolution Protocol	PNRP	A	A	A	A		A	A	A
[ ] Quality Windows Audio Video Experience	qWave	A	A	A	A		A	A	A
[ ] RAS Connection Manager Administration Kit (CMAK)	CMAK	R	A	A	A		A	A	A
[ ] Remote Assistance	Remote-Assistance	R	A	A	A		A	A	A
[ ] Remote Differential Compression	RDC	A	A	A	A		A	A	I



Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
[ ] Remote Server Administration Tools	RSAT	A	A	A	A	A	I	A	I
[ ] Feature Administration Tools	RSAT-Feature-Tools	A	A	A	A	A	A	A	A
[ ] SMTP Server Tools	RSAT-SMTP	R	A	A	A		A	A	A
[ ] BitLocker Drive Encryption Administration Utilities	RSAT-Feature-Tools-B*	A	A	A	A	A	A	A	A
[ ] BitLocker Drive Encryption Tools	RSAT-Feature-Tools-B*	R	A	A	A		A	A	A
[ ] BitLocker Recovery Password Viewer	RSAT-Feature-Tools-B*	R	A	A	A		A	A	A
[ ] BITS Server Extensions Tools	RSAT-Bits-Server	R	A	A	A		A	A	A
[ ] Failover Clustering Tools	RSAT-Clustering	A	A	A	A	A	A	A	A
[ ] Failover Cluster Management Tools	RSAT-Clustering-Mgmt	R	A	A	A	A	A	A	A
[ ] Failover Cluster Module for Windows PowerShell	RSAT-Clustering-Powe*	A	A	A	A	A	A	A	A
[ ] Failover Cluster Automation Server	RSAT-Clustering-Auto*	A	A	A	A	A	A	A	A
[ ] Failover Cluster Command Interface	RSAT-Clustering-Cmdl*	A	A	A	A		A	A	A
[ ] IP Address Management (IPAM) Client	IPAM-Client-Feature	R	A	A	A		A	A	A
[ ] Network Load Balancing Tools	RSAT-NLB	R	A	A	A		A	A	A
[ ] SNMP Tools	RSAT-SNMP	R	A	A	A		A	A	A
[ ] Windows System Resource Manager RSAT [Deprecated]	WSRM-RSAT	R	A	A	A		A	A	A
[ ] WINS Server Tools	RSAT-WINS	R	A	A	A		A	A	A
[ ] Role Administration Tools	RSAT-Role-Tools	A	A	A	A	A	I	A	I
[ ] AD DS and AD LDS Tools	RSAT-AD-Tools	A	A	A	A		I	A	A
[ ] Active Directory module for Windows ...	RSAT-AD-PowerShell	A	A	A	A		I	A	A
[ ] AD DS Tools	RSAT-ADDS	A	A	A	A		I	A	A
[ ] Active Directory Administrative Center	RSAT-AD-AdminCenter	A	A	A	A		I		A
[ ] AD DS Snap-Ins and Command-Line Tools	RSAT-ADDS-Tools	A	A	A	A		I	A	A
[ ] Server for NIS Tools [DEPRECATED]	RSAT-NIS	R	A	A	A		A	A	A
[ ] AD LDS Snap-Ins and Command-Line Tools	RSAT-ADLDS	A	A	A	A		A	A	A
[ ] Hyper-V Management Tools	RSAT-Hyper-V-Tools	A	A	A		A		A	A
[ ] Hyper-V GUI Management Tools	Hyper-V-Tools	R	A	A				A	A
[ ] Hyper-V Module for Windows PowerShell	Hyper-V-PowerShell	A	A	A		A		A	A
[ ] Remote Desktop Services Tools	RSAT-RDS-Tools	R	A	A	A		A	A	I
[ ] Remote Desktop Gateway Tools	RSAT-RDS-Gateway	R	A	A	A		A	A	A
[ ] Remote Desktop Licensing Diagnoser Tools	RSAT-RDS-Licensing-D*	R	A	A	A		A	A	I
[ ] Remote Desktop Licensing Tools	RDS-Licensing-UI	R	A	A	A		A	A	I
[ ] Windows Server Update Services Tools	UpdateServices-RSAT	A	A	A	A		A	A	A
[ ] API and PowerShell cmdlets	UpdateServices-API	A	A	A	A		A	A	A
[ ] User Interface Management Console	UpdateServices-UI	R	A	A	A		A	A	A
[ ] Active Directory Certificate Services Tools	RSAT-ADCS	R	A	A	A		I	A	A
[ ] Certification Authority Management Tools	RSAT-ADCS-Mgmt	R	A	A	A		I	A	A
[ ] Online Responder Tools	RSAT-Online-Responder	R	A	A	A		A	A	A
[ ] Active Directory Rights Management Services Tools	RSAT-ADRMS	R	A	A	A		A	A	A
[ ] DHCP Server Tools	RSAT-DHCP	R	A	A	A		A	A	A
[ ] DNS Server Tools	RSAT-DNS-Server	A	A	A	A		I	A	A
[ ] Fax Server Tools	RSAT-Fax	R	A	A	A		A	A	A
[ ] File Services Tools	RSAT-File-Services	R	A	A	A		A	A	A
[ ] DFS Management Tools	RSAT-DFS-Mgmt-Con	R	A	A	A		A	A	A
[ ] File Server Resource Manager Tools	RSAT-FSRM-Mgmt	R	A	A	A		A	A	A
[ ] Services for Network File System Management Tools	RSAT-NFS-Admin	R	A	A	A		A	A	A
[ ] Share and Storage Management Tool	RSAT-CoreFile-Mgmt	R	A	A	A		A	A	A
[ ] Network Policy and Access Services Tools	RSAT-NPAS	R	A	A	A		A	A	A
[ ] Print and Document Services Tools	RSAT-Print-Services	R	A	A	A		A	A	I

Display Name	Name	Windows Server 2012 Core	Windows Server 2012 MUI	Windows Server 2012 GUI	Windows Server 2012 Foundation	Windows Hyper-V Server 2012	Windows Server 2012 Essentials	Windows Storage Server 2012 Standard	Windows MultiPoint Server 2012 Premium
[ ] Remote Access Management Tools	RSAT-RemoteAccess	A	A	A	A		I	A	A
[ ] Remote Access GUI and Command-Line Tools	RSAT-RemoteAccess-Mgmt	R	A	A	A		A	A	A
[ ] Remote Access module for Windows PowerShell	RSAT-RemoteAccess-Po*	A	A	A	A		I	A	A
[ ] Volume Activation Tools	RSAT-VA-Tools	R	A	A	A		A	A	A
[ ] Windows Deployment Services Tools	WDS-AdminPack	R	A	A	A		A	A	A
[ ] RPC over HTTP Proxy	RPC-over-HTTP-Proxy	A	A	A	A		I	A	A
[ ] Simple TCP/IP Services	Simple-TCP/IP	R	A	A	A		A	A	A
[ ] SMTP Server	SMTP-Server	R	A	A	A		A	A	A
[ ] SNMP Service	SNMP-Service	A	A	A	A	A	A	A	A
[ ] SNMP WMI Provider	SNMP-WMI-Provider	A	A	A	A	A	A	A	A
[ ] Subsystem for UNIX-based Applications [Deprecated]	Subsystem-UNIX-Apps	A	A	A	A		A	A	A
[ ] Telnet Client	Telnet-Client	A	A	A	A	A	A	A	A
[ ] Telnet Server	Telnet-Server	R	A	A	A		A	A	A
[ ] TFTP Client	TFTP-Client	R	A	A	A		A	A	A
[ ] User Interfaces and Infrastructure	User-Interfaces-Infra	I	I	I	I		I	I	I
[ ] Graphical Management Tools and Infrastructure	Server-Gui-Mgmt-Infra	R	I	I	I		I	I	I
[ ] Desktop Experience	Desktop-Experience	R	A	A	A		I	A	I
[ ] Server Graphical Shell	Server-Gui-Shell	R	A	I	I		I	I	I
[ ] Windows Biometric Framework	Biometric-Framework	R	A	A	A		A	A	A
[ ] Windows Feedback Forwarder	WFF	A	A	A	A	A	A	A	A
[ ] Windows Identity Foundation 3.5	Windows-Identity-Fou*	R	A	A	A		A	A	A
[ ] Windows Internal Database	Windows-Internal-Dat*	A	A	A	A		A	A	A
[ ] Windows PowerShell	PowerShellRoot	I	I	I	I	I	I	I	I
[ ] Windows PowerShell 3.0	PowerShell	I	I	I	I	I	I	I	I
[ ] Windows PowerShell 2.0 Engine	PowerShell-V2	R	R	R	R	A	R	R	R
[ ] Windows PowerShell ISE	PowerShell-ISE	R	I	I	I		I	I	I
[ ] Windows PowerShell Web Access	WindowsPowerShellWeb*	A	A	A	A		A	A	A
[ ] Windows Process Activation Service	WAS	A	A	A	A		I	A	A
[ ] Process Model	WAS-Process-Model	A	A	A	A		I	A	A
[ ] .NET Environment 3.5	WAS-NET-Environment	A	A	A	A		A	A	A
[ ] Configuration APIs	WAS-Config-APIs	A	A	A	A		I	A	A
[ ] Windows Search Service	Search-Service	R	A	A	A		A	A	I
[ ] Windows Server Backup	Windows-Server-Backup	A	A	A	A	A	I	A	A
[ ] Windows Server Migration Tools	Migration	A	A	A	A		A	A	A
[ ] Windows Standards-Based Storage Management	WindowsStorageManage*	A	A	A	A	A	A	A	A
[ ] Windows System Resource Manager [Deprecated]	WSRM	R	A	A	A		A	A	A
[ ] Windows TIFF IFilter	Windows-TIFF-IFilter	R	A	A	A		A	A	A
[ ] WinRM IIS Extension	WinRM-IIS-Ext	A	A	A	A		A	A	A
[ ] WINS Server	WINS	A	A	A	A		A	A	A
[ ] Wireless LAN Service	Wireless-Networking	R	A	A	A		A	A	A
[ ] WoW64 Support	WoW64-Support	I	I	I	I	I	I	I	I
[ ] XPS Viewer	XPS-Viewer	R	A	A	A		A	A	I

A = Binaries available in installation

D = Binaries deleted from installation

I = Installed by default to this edition

## Features of Windows 8

Feature	Windows 8 Professional	Windows 8 Enterprise x86	Windows 8 Enterprise x64
<input type="checkbox"/> .NET Framework 3.5 (includes .NET 2.0 and 3.0)	A	A	A
<input type="checkbox"/> Windows Communication Foundation HTTP Activation	A	A	A
<input type="checkbox"/> Windows Communication Foundation Non-HTTP Activation	A	A	A
<input type="checkbox"/> .NET Framework 4.5 Advanced Services	I	I	I
<input type="checkbox"/> ASP.NET 4.5	A	A	A
<input type="checkbox"/> WCF Services	I	I	I
<input type="checkbox"/> HTTP Activation	A	A	A
<input type="checkbox"/> Message Queuing (MSMQ) Activation	A	A	A
<input type="checkbox"/> Named Pipe Activation	A	A	A
<input type="checkbox"/> TCP Activation	A	A	A
<input type="checkbox"/> TCP Port Sharing	I	I	I
<input type="checkbox"/> Active Directory Lightweight Directory Services	A	A	A
<input type="checkbox"/> Hyper-V	A	A	A
<input type="checkbox"/> Hyper-V Management Tools	A	A	A
<input type="checkbox"/> Hyper-V GUI Management Tools	A	A	A
<input type="checkbox"/> Hyper-V Module for Windows PowerShell	A	A	A
<input type="checkbox"/> Hyper-V Platform	A		A
<input type="checkbox"/> Internet Explorer 10	I	I	I
<input type="checkbox"/> Internet Information Services	A	A	A
<input type="checkbox"/> FTP Server	A	A	A
<input type="checkbox"/> FTP Extensibility	A	A	A
<input type="checkbox"/> FTP Service	A	A	A
<input type="checkbox"/> Web Management Tools	A	A	A
<input type="checkbox"/> IIS 6 Management Compatibility	A	A	A
<input type="checkbox"/> IIS 6 Metabase and IIS 6 configuration compatibility	A	A	A
<input type="checkbox"/> IIS 6 Management Console	A	A	A
<input type="checkbox"/> IIS 6 Scripting Tools	A	A	A
<input type="checkbox"/> IIS 6 WMI Compatibility	A	A	A
<input type="checkbox"/> IIS Management Console	A	A	A
<input type="checkbox"/> IIS Management Scripts and Tools	A	A	A
<input type="checkbox"/> IIS Management Service	A	A	A

Feature	Windows 8 Professional	Windows 8 Enterprise x86	Windows 8 Enterprise x64
<input type="checkbox"/> Web Server	A	A	A
<input type="checkbox"/> Application Development	A	A	A
<input type="checkbox"/> .NET Extensibility 3.5	A	A	A
<input type="checkbox"/> .NET Extensibility 4.5	A	A	A
<input type="checkbox"/> Application Initialization	A	A	A
<input type="checkbox"/> ASP	A	A	A
<input type="checkbox"/> ASP.NET 3.5	A	A	A
<input type="checkbox"/> ASP.NET 4.5	A	A	A
<input type="checkbox"/> CGI	A	A	A
<input type="checkbox"/> ISAPI Extensions	A	A	A
<input type="checkbox"/> ISAPI Filters	A	A	A
<input type="checkbox"/> Server Side Includes	A	A	A
<input type="checkbox"/> WebSocket Protocol	A	A	A
<input type="checkbox"/> Common HTTP Features	A	A	A
<input type="checkbox"/> Default Document	A	A	A
<input type="checkbox"/> Directory Browsing	A	A	A
<input type="checkbox"/> HTTP Errors	A	A	A
<input type="checkbox"/> HTTP Redirection	A	A	A
<input type="checkbox"/> Static Content	A	A	A
<input type="checkbox"/> WebDAV Publishing	A	A	A
<input type="checkbox"/> Health and Diagnostics	A	A	A
<input type="checkbox"/> Custom Logging	A	A	A
<input type="checkbox"/> HTTP Logging	A	A	A
<input type="checkbox"/> Logging Tools	A	A	A
<input type="checkbox"/> ODBC Logging	A	A	A
<input type="checkbox"/> Request Monitor	A	A	A
<input type="checkbox"/> Tracing	A	A	A
<input type="checkbox"/> Performance	A	A	A
<input type="checkbox"/> Dynamic Content Compression	A	A	A
<input type="checkbox"/> Static Content Compression	A	A	A

Feature	Windows 8 Professional	Windows 8 Enterprise x86	Windows 8 Enterprise x64
<input type="checkbox"/> Security	A	A	A
<input type="checkbox"/> Basic Authentication	A	A	A
<input type="checkbox"/> Centralized SSL Certificate Support	A	A	A
<input type="checkbox"/> Client Certificate Mapping Authentication	A	A	A
<input type="checkbox"/> Digest Authentication	A	A	A
<input type="checkbox"/> IIS Client Certificate Mapping Authentication	A	A	A
<input type="checkbox"/> IP Security	A	A	A
<input type="checkbox"/> Request Filtering	A	A	A
<input type="checkbox"/> URL Authorization	A	A	A
<input type="checkbox"/> Windows Authentication	A	A	A
<input type="checkbox"/> Internet Information Services Hostable Web Core	A	A	A
<input type="checkbox"/> Media Features	I	I	I
<input type="checkbox"/> Windows Media Player	I	I	I
<input type="checkbox"/> Microsoft Message Queue (MSMQ) Server	A	A	A
<input type="checkbox"/> Microsoft Message Queue (MSMQ) Server Core	A	A	A
<input type="checkbox"/> MSMQ Active Directory Domain Services Integration	A	A	A
<input type="checkbox"/> MSMQ HTTP Support	A	A	A
<input type="checkbox"/> MSMQ Triggers	A	A	A
<input type="checkbox"/> Multicasting Support	A	A	A
<input type="checkbox"/> MSMQ DCOM Proxy	A	A	A
<input type="checkbox"/> Network Projection	A	A	A
<input type="checkbox"/> Print and Document Services	I	I	I
<input type="checkbox"/> Internet Printing Client	I	I	I
<input type="checkbox"/> LPD Print Service	A	A	A
<input type="checkbox"/> LPR Port Monitor	A	A	A
<input type="checkbox"/> Scan Management	A	A	A
<input type="checkbox"/> Windows Fax and Scan	I	I	I
<input type="checkbox"/> RAS Connection Manager Administration Kit (CMAK)	A	A	A
<input type="checkbox"/> Remote Differential Compression API Support	I	I	I
<input type="checkbox"/> RIP Listener	A	A	A
<input type="checkbox"/> Services for NFS		A	A
<input type="checkbox"/> Administrative Tools		A	A
<input type="checkbox"/> Client for NFS		A	A
<input type="checkbox"/> Simple Network Management Protocol (SNMP)	A	A	A
<input type="checkbox"/> WMI SNMP Provider	A	A	A

Feature	Windows 8 Professional	Windows 8 Enterprise x86	Windows 8 Enterprise x64
<input type="checkbox"/> Simple TCPIP services (i.e. echo, daytime etc)	A	A	A
<input type="checkbox"/> Subsystem for UNIX-based Applications		A	A
<input type="checkbox"/> Telnet Client	A	A	A
<input type="checkbox"/> Telnet Server	A	A	A
<input type="checkbox"/> TFTP Client	A	A	A
<input type="checkbox"/> Windows Identity Foundation 3.5	A	A	A
<input type="checkbox"/> Windows Location Provider	I	I	I
<input type="checkbox"/> Windows PowerShell 2.0	I	I	I
<input type="checkbox"/> Windows PowerShell 2.0 Engine	I	I	I
<input type="checkbox"/> Windows Process Activation Service	A	A	A
<input type="checkbox"/> .NET Environment	A	A	A
<input type="checkbox"/> Configuration APIs	A	A	A
<input type="checkbox"/> Process Model	A	A	A
<input type="checkbox"/> Windows Search	I	I	I
<input type="checkbox"/> Windows TIFF IFilter	A	A	A
<input type="checkbox"/> XPS Services	I	I	I
<input type="checkbox"/> XPS Viewer	I	I	I

A = Available for installation

I = Installed by default

## Windows 8 Display Languages

Language	Native name	Base language required
Afrikaans	Afrikaans	English (United States) or English (United Kingdom)
Albanian	shqipe	English (United States) or English (United Kingdom)
Amharic	አማርኛ	English (United States) or English (United Kingdom)
Arabic	العربية	Any language
Armenian	Հայերեն	English (United States), English (United Kingdom), or Russian
Assamese	অসমীয়া	English (United States) or English (United Kingdom)
Azerbaijani (Latin)	Azərbaycan	English (United States), English (United Kingdom), or Russian
Bangla (Bangladesh)	বাংলা (বাংলাদেশ)	English (United States) or English (United Kingdom)
Bangla (India)	বাংলা (ভারত)	English (United States) or English (United Kingdom)
Basque	euskara	Spanish, English (United States), English (United Kingdom), or French
Belarusian	беларуская мова	Russian, English (United States) or English (United Kingdom)
Bosnian (Latin)	bosanski	English (United States), Croatian, English (United Kingdom), or Serbian (Latin)
Bulgarian	Български	Any language
Catalan	català	Spanish, English (United States), English (United Kingdom), or French
Central Kurdish (Arabic)	سۆزانی	English (United States), Arabic, or English (United Kingdom)
Cherokee (Cherokee)	ᏣᏵ ᏌᏉᏰᏃᏇᏚᏚ	English (United States) or English (United Kingdom)
Chinese Simplified	中文(简体)	Any language
Chinese Traditional (Hong Kong)	中文(繁體)	Any language
Chinese Traditional (Taiwan)	中文(繁體)	Any language
Croatian	hrvatski	Any language
Czech	čeština	Any language
Danish	dansk	Any language
Dari	دري	English (United States) or English (United Kingdom)
Dutch	Nederlands	Any language
English	English	Any language
Estonian	eesti	Any language
Filipino	Filipino	English (United States) or English (United Kingdom)
Finnish	suomi	Any language
French	français	Any language
Galician	galego	Spanish, English (United States) or English (United Kingdom)
Georgian	ქართული	English (United States), English (United Kingdom), or Russian
German	Deutsch	Any language
Greek	Ελληνικά	Any language
Gujarati	ગુજરાતી	English (United States) or English (United Kingdom)
Hausa (Latin)	Hausa	English (United States), English (United Kingdom), or French
Hebrew	עברית	Any language
Hindi	हिंदी	English (United States) or English (United Kingdom)
Hungarian	magyar	Any language
Icelandic	íslenska	English (United States) or English (United Kingdom)
Igbo	Ndi Igbo	English (United States) or English (United Kingdom)
Indonesian	Bahasa Indonesia	English (United States) or English (United Kingdom)
Irish	Gaeilge	English (United States) or English (United Kingdom)
isiXhosa	isiXhosa	English (United States) or English (United Kingdom)
isiZulu	isiZulu	English (United States) or English (United Kingdom)
Italian	italiano	Any language
Japanese	日本語	Any language
Kannada	ಕನ್ನಡ	English (United States) or English (United Kingdom)
Kazakh	Қазақ	English (United States), English (United Kingdom), or Russian
Khmer	ខ្មែរ	English (United States) or English (United Kingdom)
K'iche'	Qatz'ijob'al	Spanish, English (United States), or English (United Kingdom)
Kinyarwanda	Ikinyarwanda	English (United States) or English (United Kingdom)
KiSwahili	Kiswahili	English (United States) or English (United Kingdom)
Konkani	कोंकणी	English (United States) or English (United Kingdom)
Korean	한국어	Any language
Kyrgyz	Кыргыз	Russian, English (United States), or English (United Kingdom)
Latvian	latviešu	Any language
Lithuanian	lietuvių	Any language
Luxembourgish	Lëtzebuergesch	French, English (United States), English (United Kingdom), or German
Macedonian	македонски јазик	English (United States) or English (United Kingdom)
Malay (Malaysia, Brunei, and Singapore)	Bahasa Melayu	English (United States) or English (United Kingdom)
Malayalam	മലയാളം	English (United States) or English (United Kingdom)
Maltese	Malti	English (United States) or English (United Kingdom)
Maori	Te Reo Māori	English (United States) or English (United Kingdom)
Marathi	मराठी	English (United States) or English (United Kingdom)

Language	Native name	Base language required
Mongolian (Cyrillic)	Монгол хэл	English (United States), English (United Kingdom), or Russian
Nepali	नेपाली	English (United States) or English (United Kingdom)
Norwegian (Bokmål)	norsk (bokmål)	Any language
Norwegian (Nynorsk)	norsk (nynorsk)	Norwegian (Bokmal), English (United States), or English (United Kingdom)
Odia	ଓଡ଼ିଆ	English (United States) or English (United Kingdom)
Persian	فارسی	English (United States) or English (United Kingdom)
Polish	Polski	Any language
Portuguese (Brazil)	Português	Any language
Portuguese (Portugal)	português	Any language
Punjabi	ਪੰਜਾਬੀ	English (United States) or English (United Kingdom)
Punjabi (Arabic)	پنجابی	English (United States) or English (United Kingdom)
Quechua	runasimi	Spanish, English (United States), or English (United Kingdom)
Romanian	română	Any language
Russian	Русский	Any language
Scottish Gaelic	Gàidhlig	English (United States) or English (United Kingdom)
Serbian (Cyrillic, Bosnia and Herzegovina)	српски	English (United States), Croatian, English (United Kingdom) or Serbian (Latin)
Serbian (Cyrillic, Serbia)	српски	Serbian (Latin), English (United States), or English (United Kingdom)
Serbian (Latin)	sрpski	Any language
Sesotho sa Leboa	Sesotho sa Leboa	English (United States) or English (United Kingdom)
Setswana (South Africa and Botswana)	Setswana	English (United States) or English (United Kingdom)
Sindhi (Arabic)	سنڌي	English (United States) or English (United Kingdom)
Sinhala	සිංහල	English (United States) or English (United Kingdom)
Slovak	slovenčina	Any language
Slovenian	slovenski	Any language
Spanish	Español	Any language
Swedish	svenska	Any language
Tajik (Cyrillic)	тоҷикӣ	Russian, English (United States), or English (United Kingdom)
Tamil (India and Sri Lanka)	தமிழ்	English (United States) or English (United Kingdom)
Tatar	Татар	Russian, English (United States), or English (United Kingdom)
Telugu	తెలుగు	English (United States) or English (United Kingdom)
Thai	ไทย	Any language
Tigrinya (Ethiopia)	ትግርኛ	English (United States) or English (United Kingdom)
Turkish	Türkçe	Any language
Turkmen	Türkmençe	Russian, English (United States), or English (United Kingdom)
Ukrainian	українська	Any language
Urdu	اردو	English (United States) or English (United Kingdom)
Uyghur	ئۇيغۇرچە	Chinese (Simplified), English (United States), or English (United Kingdom)
Uzbek (Latin)	O'zbekcha	English (United States), English (United Kingdom), or Russian
Valencian	valencià	Spanish, English (United States), or English (United Kingdom)
Vietnamese	Tiếng Việt	English (United States) or English (United Kingdom)
Welsh	Cymraeg	English (United States) or English (United Kingdom)
Wolof	Wolof	French, English (United States), or English (United Kingdom)
Yoruba	ede Yorùbá	English (United States) or English (United Kingdom)

Any language

= Own installation media with that language



## Role Dependencies with User Interface Requirements in Server 2012

Role	Role Service	Active Directory Federation Services	Application Server	File and Storage Services	Hyper-V	Network Policy and Access Services	Print and Document Services	Web Server (IIS)	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Group Policy Management	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	RPC over HTTP Proxy	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	WoW64 Support	Core User Interface	Minimal User Interface	GUI
Active Directory Certificate Services	Certification Authority Certificate Enrolment Policy Web Service							X		X					(O)				X	X	X		
	Certification Authority Web Enrolment							X		X									X		X	X	
	Network Device Enrollment Service							X													X	X	X
	Online Responder							X							(O)						X	X	X
										X (O)						X		X			X	X	X
																			X	X	X	X	X
																			X	X	X	X	X
Active Directory Federation Services	Federation Service							X	X									X	X	X	X	X	
	Federation Service Proxy							X	X									X	X	X	X	X	
	AD FS 1.1 Claims-aware Agent							X	X									X	X	X	X	X	
	AD FS 1.1 Windows Token-based Agent							X	X									X	X	X	X	X	
Active Directory Lightweight Directory Services								X						X			X			X	X	X	
Active Directory Rights Management Services	Active Directory Rights Management Server							X	X					(O)				X	X		X	X	X
	Identity Federation Support	X						X	X									X	X	X	X	X	
Application Server	.NET Framework 4.5								X									X	X		X	X	
	COM+ Network Access		X						X									X	X		X	X	
	Distributed Transactions		X						X									X	X		X	X	
	WS-Atomic Transactions		X						X									X	X		X	X	
	Incoming Network Transactions		X						X									X	X		X	X	
	Outgoing Network Transactions		X						X									X	X		X	X	
	TCP Port Sharing		X						X									X	X		X	X	
	Web Server (IIS) Support		X					X	X									X	X		X	X	
	Application Process Activation Service Support								X									X	X		X	X	
	HTTP Activation		X					X	X									X	X	X	X	X	
	Message Queuing Activation		X					X	X		X							X	X	X	X	X	
	Named Pipes Activation		X						X									X	X	X	X	X	
	TCP Activation		X						X									X	X	X	X	X	

Role	Role Service	Active Directory Federation Services	Application Server	File and Storage Services	Hyper-V	Network Policy and Access Services	Print and Document Services	Web Server (IIS)	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Group Policy Management	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	RPC over HTTP Proxy	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	Wow64 Support	Core User Interface	Minimal User Interface	GUI
DHCP Server															(O)						X	X	X
DNS Server															(O)						X	X	X
Fax Server						X			X								X		X		X	X	X
File and Storage Services	File Server																				X	X	X
	BranchCache for Network Files		X																		X	X	X
	Data Deduplication		X																		X	X	X
	DFS NameSpaces		X												(O)						X	X	X
	DFS Replication		X												(O)						X	X	X
	File Server Resource Manager		X						X						(O)						X	X	X
	File Server VSS Agent Service		X																		X	X	X
	iSCSI Target Server		X																		X	X	X
	iSCSI Target Storage Provider		X																		X	X	X
Server for NFS		X												(O)						X	X	X	
Hyper-V														(O)						X	X	X	
Network Policy and Access Services	Network Policy Server								X						(O)		X	X			X	X	X
	Health Registration Authority				X	X			X						(O)		X	X			X	X	X
	Host Credential Authorization Protocol				X	X			X						(O)		X	X			X	X	X
Print and Document Services	Print Server														(O)						X	X	X
	Distributed Scan Server								X						(O)		X	X			X	X	X
	Internet Printing LDP Service					X	X		X						(O)		X	X			X	X	X
Remote Access						X		X	(O)				X	(O)	X	X				X	X	X	
Remote Desktop Services	Remote Desktop Connection Broker															X					X	X	X
	Remote Desktop Gateway				X	X			X						X	X	X				X	X	X
	Remote Desktop Licensing																				X	X	X
	Remote Desktop Session Host								X	X							X	X			X	X	X
	Remote Desktop Virtualization Host			X											(O)						X	X	X
	Remote Desktop Web Access						X		X								X	X			X	X	X
	Volume Activation Services														(O)						X	X	X
Web Server (IIS)	.NET Extensibility 3.5						X	X	X												X	X	X
	.NET Extensibility 4.5						X		X												X	X	X
	Application Initialization																				X	X	X
ASP						X														X	X	X	

Role	Role Service	Active Directory Federation Services	Application Server	File and Storage Services	Hyper-V	Network Policy and Access Services	Print and Document Services	Web Server (IIS)	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Group Policy Management	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	RPC over HTTP Proxy	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	WoW64 Support	Core User Interface	Minimal User Interface	GUI	
Web Server (IIS)	ASP.NET 3.5							X	X	X											X	X	X	
	ASP.NET 4.5							X		X											X	X	X	
	Basic Authentication																				X	X	X	
	Centralized SSL																				X	X	X	
	Certificate Support																				X	X	X	
	CGI																				X	X	X	
	Client Certificate Mapping																				X	X	X	
	Autjentication																				X	X	X	
	Custom Logging																				X	X	X	
	Default Document																				X	X	X	
	Digest Authentication																				X	X	X	
	Directory Browsing																				X	X	X	
	Dynamic Content Compression																				X	X	X	
	FTP Extensibility								X												X	X	X	
	FTP Service																				X	X	X	
	HTTP Errors																				X	X	X	
	HTTP Logging																				X	X	X	
	HTTP Redirection																				X	X	X	
	IIS 6 Management Console								X		X								X	X		X	X	
	IIS 6 Metabase Compatibility																				X	X	X	
	IIS 6 Scripting Tools								X															
	IIS 6 WMI Compatibility								X															
	IIS Client Certificate Mapping Authentication																					X	X	X
	IIS Hostable Web Core																					X	X	X
	IIS Management Console										X								X	X		X	X	
	IIS Management Scripts and Tools																					X	X	X
	IP and Domain Restrictions																					X	X	X
	ISAPI Extensions																					X	X	X
	ISAPI Filters																					X	X	X
	Logging Tools																					X	X	X
	Management Service										X													
	ODBC Logging																					X	X	X
	Request Filtering																					X	X	X
	Request Monitor																					X	X	X
	Server Side Includes																					X	X	X
	Static Content																					X	X	X
	Static Content Compression																					X	X	X

Role	Role Service	Active Directory Federation Services	Application Server	File and Storage Services	Hyper-V	Network Policy and Access Services	Print and Document Services	Web Server (IIS)	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Group Policy Management	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	RPC over HTTP Proxy	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	Wow64 Support	Core User Interface	Minimal User Interface	GUI
Web Server (IIS)	Tracing																				X	X	X
	URL Authorization																				X	X	X
	WebDAV Publishing							X													X	X	X
	WebSocket Protocol																				X	X	X
Windows Deployment Services	Windows Authentication																				X	X	X
	Deployment Server								X						(O)		X		X			X	X
Windows Server Update Services	Transport Server								X						(O)		X		X			X	X
	WSUS Service							X	X						X	X	X		X		X	X	X
Windows Server Update Services	WID Database						X		X						X	X	X		X		X	X	X
	Database						X		X						X	X	X		X		X	X	X

X = Needed

(O) = Optional

## Feature Dependencies with User Interface Requirements in Server 2012

Feature		Web Server (IIS)	Windows Deployment Services	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Enhanced Storage	Group Policy Management	Ink and Handwriting Services	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	WoW64 Support	Core User Interface	Minimal User Interface	GUI
1. Level	2.Level																		
.NET Framework 3.5 Features	.NET Framework 3.5 (includes .NET 2.0 and 3.0)			X													X	X	X
	HTTP Activation	X		X	X									X			X	X	X
	Non-HTTP Activation			X	X									X			X	X	X
.NET Framework 4.5 Features	.NET Framework 4.5				X												X	X	X
	ASP.NET 4.5				X												X	X	X
	HTTP Activation	X			X									X			X	X	X
	Message Queuing (MSMQ) Activation				X					X				X			X	X	X
	Named Pipe Activation				X									X			X	X	X
	TCP Activation				X									X			X	X	X
	TCP Port Sharing				X												X	X	X
Background Intelligent Transfer Service (BITS)	Compact Server																X	X	X
	IIS Server Extension	X			X									X		X	X	X	X
BitLocker Drive Encryption						X											X	X	X
BitLocker Network Unlock			X		X							(O)		X		X	X	X	X
BranchCache																	X	X	X
Client for NFS																	X	X	X
Data Center Bridging																	X	X	X
Enhanced Storage						X											X	X	X
Failover Clustering												(O)					X	X	X
Group Policy Management							X										X	X	X
Ink and Handwriting Services					X			X						X		X	X	X	X
Internet Printing Client					X									X		X	X	X	X
IP Address Management (IPAM) Server					X		X					X	X	X	X	X	X	X	X
iSNS Server Service																	X	X	X
LPR Port Monitor					X									X		X	X	X	X
Management OData IIS Extension		X			X											X	X	X	X
Media Foundation									X								X	X	X
	Message Queuing Server									X							X	X	X
	Directory Service Integration									X							X	X	X
Message Queuing	HTTP Support	X								X							X	X	X
	Message Queuing Triggers									X							X	X	X
	Multicasting Support									X							X	X	X
	Routing Service									X							X	X	X
	Message Queuing DCOM Proxy									X							X	X	X
Multipath I/O																	X	X	X
Network Load Balancing												(O)					X	X	X
Peer Name Resolution Protocol																	X	X	X
Quality Windows Audio Video Experience																	X	X	X
RAS Connection Manager Administration KIT (CMAK)					X						X			X		X		X	X
Remote Assistance																	X	X	X
Remote Differential Compression					X									X		X	X	X	X
	Active Directory Administrative Center				X							X		X		X	X	X	X
	Active Directory module for Windows PowerShell				X							X		X		X	X	X	X
	Active Directory Rights Management Services Tools				X							X		X		X	X	X	X
	AD DS Snap-Ins and Command-Line Tools										X						X	X	X
	AD LDS Snap-Ins and Command-Line Tools										X						X	X	X
	API and PowerShell cmdlets (WSUS)				X						X						X	X	X
	BitLocker Drive Encryption Tools				X						X		X	X		X	X	X	X
Remote Server Administration Tools	BitLocker Recovery Password Viewer				X						X		X	X		X	X	X	X
	BITS Server Extensions Tools	X			X						X		X	X		X	X	X	X
	Certification Authority Management Tools				X						X		X	X		X	X	X	X
	DFS Management Tools				X						X		X	X		X	X	X	X
	DHCP Server Tools				X						X		X	X		X	X	X	X
	DNS Server Tools										X						X	X	X
	Failover Cluster Automation Server										X						X	X	X
	Failover Cluster Command Interface										X						X	X	X
	Failover Cluster Management Tools				X						X		X	X		X	X	X	X
	Failover Cluster module for Windows PowerShell										X						X	X	X

Feature		Web Server (IIS)	Windows Deployment Services	.NET Framework 3.5 Features	.NET Framework 4.5 Features	Enhanced Storage	Group Policy Management	Ink and Handwriting Services	Media Foundation	Message Queuing	RAS Connection Manager Administration Kit (CMAK)	Remote Server Administration Tools	Windows Internal Database	Windows PowerShell	Windows Process Activation Service	WoW64 Support	Core User Interface	Minimal User Interface	GUI
1. Level	2.Level																		
Remote Server Administration Tools	Fax Server Tools				X							X		X	X				X
	File Server Resource Manager Tools				X							X		X	X			X	X
	Hyper-V GUI Management Tools				X							X		X	X			X	X
	Hyper-V Module for Windows PowerShell											X					X	X	X
	IP Address Management (IPAM) Client				X	X						X		X	X			X	X
	Network Load Balancing Tools				X							X		X	X			X	X
	Network Policy and Access Services Tools				X							X		X	X			X	X
	Online Responder Tools				X							X		X	X			X	X
	Print and Document Services Tools											X						X	X
	Remote Access GUI and Command-Line Tools				X	X					X		X	X	X				X
	Remote Access module for Windows PowerShell							X				X						X	X
	Remote Desktop Gateway Tools				X							X		X	X			X	X
	Remote Desktop Licensing Diagnoser Tools				X							X		X	X			X	X
	Remote Desktop Licensing Tools				X							X		X	X			X	X
	Server for NIS Tools				X							X		X	X			X	X
	Services for Network File System Management Tools				X							X		X	X			X	X
	Share and Storage Management Tools				X							X		X	X			X	X
	SMTP Server Tools	X			X							X		X	X			X	X
	SNMP Tools				X							X		X	X			X	X
	User Interface Management Console (WSUS)				X							X		X	X			X	X
	Volume Activation Tools				X							X		X	X			X	X
	Windows Deployment Services Tools				X							X		X	X			X	X
	Windows System Resource Manager RSAT				X							X		X	X			X	X
	WINS Server Tools				X							X		X	X			X	X
	RPC over HTTP Proxy		X		X									X	X			X	X
	Simple TCP/IP Services				X									X	X			X	X
	SMTP Server		X		X							X		X	X			X	X
	SNMP Service	SNMP WMI Provider										(O)						X	X
Subsystem for UNIX-based Applications																	X	X	
Telnet Client																	X	X	
Telnet Server					X								X	X			X	X	
TFTP Client					X								X	X			X	X	
User Interfaces and Infrastructure	Graphical Management Tools and Infrastructure				X								X	X			X	X	
	Desktop Experience				X	X	X						X	X			X	X	
	Server Graphical Shell				X								X	X			X	X	
Windows Biometric Framework				X								X	X				X	X	
Windows Feedback Forwarder																	X	X	
Windows Identity Foundation 3.5																	X	X	
Windows Internal Database													X				X	X	
Windows PowerShell	Windows PowerShell 3.0				X									X			X	X	
	Windows PowerShell 2.0 Engine				X	X								X			X	X	
	Windows PowerShell ISE				X									X	X		X	X	
	Windows PowerShell Web Access	X			X									X			X	X	
Windows Process Activation Service	Process Model													X			X	X	
	.NET Environment 3.5 Configuration APIs				X	X								X			X	X	
Windows Search Service					X								X	X			X	X	
Windows Server Backup																	X	X	
Windows Server Migration Tools																	X	X	
Windows Standards-Based Storage Management																	X	X	
Windows System Resource Manager					X						(O)	X	X	X			X	X	
Windows TIFF IFilter					X								X	X			X	X	
WinRM IIS Extension		X															X	X	
WINS Server											(O)						X	X	
Wireless LAN Service					X								X	X			X	X	
WoW64 Support														X	X		X	X	
XPS Viewer					X								X	X			X	X	

X = Needed

(O) = Optional

### Format Differences between English (United States) and Finnish (Finland)

		English (United States)	Finnish (Finland)
<b>Numbers</b>	<b>Decimal symbol</b>	. [dot]	, [comma]
	<b>Digit grouping symbol</b>	, [comma]	[space]
	<b>List separator</b>	, [comma]	; [semicolon]
	<b>Measurement system</b>	U.S.	Metric
<b>Currency</b>	<b>Currency symbol</b>	\$	€
	<b>Positive currency format</b>	€1.1	1.1 €
	<b>Negative currency format</b>	(€1.1)	-1.1 €
	<b>Decimal symbol</b>	. [dot]	, [comma]
	<b>Digital grouping symbol</b>	, [comma]	[space]
<b>Time</b>	<b>Short time</b>	h:mm tt	H:mm
	<b>Long time</b>	h:mm:ss tt	H:mm:ss
	<b>AM symbol</b>	AM	[null]
	<b>PM symbol</b>	PM	[null]
<b>Date</b>	<b>Short date</b>	M/d/yyyy	d.M.yyyy
	<b>Long date</b>	dddd, MMMM d, yyyy	d. MMMM'ta 'yyyy

### Format Differences between SI Decimal and JEDEC Binary Prefixes

Name	Symbol	SI decimal prefixes		JEDEC binary prefixes	
Bit	bit	1 bit	1 bit	1 bit	1 bit
Byte	B	1 B	8 bit	1 B	8 bit
Kilobyte	kB	$10^3 \text{ B} = 1000 \text{ B}$	1 000 B	$2^{10} \text{ B} = 1024 \text{ B}$	1 024 B
Megabyte	MB	$10^6 \text{ B} = 1000^2 \text{ B}$	1 000 kB	$2^{20} \text{ B} = 1024^2 \text{ B}$	1 024 kB
Gigabyte	GB	$10^9 \text{ B} = 1000^3 \text{ B}$	1 000 MB	$2^{30} \text{ B} = 1024^3 \text{ B}$	1 024 MB
Terabyte	TB	$10^{12} \text{ B} = 1000^4 \text{ B}$	1 000 GB	$2^{40} \text{ B} = 1024^4 \text{ B}$	1 024 GB

There is also a third standard for this in the world, it is IEC standard. That standard uses different prefixes but is otherwise the same with the JEDEC standard. It uses kibibit (Kibit), mebibit (Mibit), gibibit (Gibit) and tebibit (Tibit) prefixes. For example in commercials and in daily use these SI decimal and JEDEC binary prefixes are mixed.

For example: 2 TB hard drive is also 2048 GB. Making two 1000 GB partitions to this 2 TB hard drive leaves 48 GB free unused area. When hard disk capacity needs to share many partitions right numbers and units gives required result.

Nowadays maybe the most important target to understand differences between the bits per second (bit/s) and the bytes per second (B/s) is the data transfer speeds.

For example:

How much is 1 Gbit/s?

1:	$(1 \text{ Gbit/s}) * 1024$	=	1 024 Mbit/s
2:	$(1024 \text{ Mbit/s}) * 1024$	=	1 048 576 kbit/s
3:	$(1048576 \text{ kbit/s}) * 1024$	=	1 073 741 824 bit/s
4:	$(1073741824 \text{ bit/s}) / 8$	=	134 217 728 B/s
5:	$(134217728 \text{ B/s}) / 1024$	=	131 072 kB/s
6:	$(131072 \text{ kB/s}) / 1024$	=	128 MB/s
7:	$(128 \text{ MB/s}) / 1024$	=	0,125 GB/s

(Formal "bit/s", less formal "b/s" or "bps")

SI, Le Système international d'unités

JEDEC, Joint Electron Devices Engineering Council

IEC, International Electrotechnical Commission's standard



## Installed Updates to the Environment

Microsoft Windows Server 2012 Standard installation status on May 1, 2013

KB Number	Description
KB2729462	MS12-074: Description of the security update for the .NET Framework 3.5 on Windows 8, Windows RT, and Windows Server 2012: November 13, 2012
KB2736693	MS13-007: Description of the security update for the .NET Framework 3.5 on Windows 8, Windows RT, and Windows Server 2012: January 8, 2013
KB2737084	MS12-074: Description of the security update for the .NET Framework 4.5 on Windows 8, Windows RT, and Windows Server 2012: November 13, 2012
KB2742614	MS13-004: Description of the security update for the .NET Framework 4.5 on Windows 8, Windows RT, and Windows Server 2012: January 8, 2013
KB2742616	MS13-004: Description of the security update for the .NET Framework 3.5 on Windows 8 and Windows Server 2012: January 8, 2013
KB2750149	An update is available for the .NET Framework 4.5 in Windows 8, Windows RT and Windows Server 2012
KB2751352	An update is available to correct tile logo images of files on the All Apps View
KB2753842	MS12-078: Description of the security update for the Windows OpenType Compact Font Format (CFF) driver: December 11, 2012
KB2756872	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update
KB2756923	MS13-004: Description of the security update for the .NET Framework 3.5 on Windows 8 and Windows Server 2012: January 8, 2013
KB2757638	MS13-002: Description of the security update for XML Core Services 3.0 and 6.0: January 8, 2013
KB2758246	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2761094	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update

KB2764870	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update
KB2765809	MS12-083: Vulnerability in IP-HTTPS component could allow security feature bypass: December 11, 2012
KB2769034	WinRE is not enabled after you run the OOBE wizard in Windows 8, Windows RT, or Windows Server 2012
KB2769165	An update is available for certain Microsoft files that contain an incorrect digital signature in Windows 8 and Windows Server 2012
KB2769166	An update is available to update the digital signature on the files that are produced by Microsoft in Windows 8 and Windows Server 2012
KB2770660	MS12-082: Vulnerability in DirectPlay could allow remote code execution: December 11, 2012
KB2770917	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2771431	A servicing stack update is available for Windows 8 and Windows Server 2012
KB2771744	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2771821	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2772930	MS13-032: Description of the security update for Active Directory: April 9, 2013
KB2777166	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2778171	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2778344	MS13-016: Vulnerabilities in Windows kernel-mode driver could allow elevation of privilege: February 12, 2013
KB2779562	December 2012 cumulative time zone update for Windows operating systems
KB2779768	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2780342	Windows 8 and Windows Server 2012 cumulative update: November 2012

KB2780541	Incorrect keyboard layout is used after you refresh Windows 8 or Windows Server 2012
KB2782419	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2783251	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2784160	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2785094	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2785220	MS13-006: Vulnerabilities in Microsoft SSL implementation could allow security feature bypass: January 8, 2013
KB2788350	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2789649	MS13-015: Description of the security update for the .NET Framework 4.5 on Windows 8 and Windows Server 2012: February 12, 2013
KB2789650	MS13-015: Description of the security update for the .NET Framework 3.5 on Windows 8 and Windows Server 2012: February 12, 2013
KB2790655	MS13-018: Vulnerability in TCP/IP could allow denial of service: February 12, 2013
KB2790920	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2792100	MS13-009: Cumulative Security Update for Internet Explorer: February 12, 2013
KB2793210	Compatibility update is available for Windows 8 and Windows Server 2012
KB2794599	Fonts in console programs are too small to read in multilingual versions of Windows RT, Windows 8, and Windows Server 2012
KB2795944	Windows 8 and Windows Server 2012 cumulative update: February 2013
KB2797052	MS13-010: Vulnerability in vector markup language could allow remote code execution: February 12, 2013
KB2799494	MS13-017: Vulnerabilities in Windows kernel could allow elevation of privilege: February 12, 2013

KB2800033	Windows cannot be restored on a Windows RT-based, Windows 8-based or Windows Server 2012-based computer
KB2803676	Windows 8 and Windows Server 2012 cumulative update: February 2013
KB2807986	MS13-027: Vulnerabilities in Windows Kernel-Mode drivers could allow elevation of privilege: March 12, 2013
KB2808735	MS13-036: Description of the security update for the Windows kernel-mode driver (win32k.sys): April 9, 2013
KB2813170	MS13-031: Vulnerabilities in Windows Kernel could allow elevation of privilege: April 9, 2013
KB2817183	MS13-028: Cumulative Security Update for Internet Explorer: April 9, 2013
KB2822241	Windows 8 and Windows Server 2012 cumulative update: April 2013
KB2823516	Windows 8 and Windows Server 2012 cumulative update: April 2013

Descriptions are titles from the Microsoft Support site <http://support.microsoft.com>.  
Example <http://support.microsoft.com/?kbid=2803676>.

## Microsoft Windows 8 Enterprise x64 installation status on May 1, 2013

<b>KB Number</b>	<b>Description</b>
KB2712101	An update that adds Microsoft Camera Codec Pack support to Windows 8 and Windows RT is available
KB2727528	MS12-072: Vulnerabilities in Windows shell could allow remote code execution: November 13, 2012
KB2737084	MS12-074: Description of the security update for the .NET Framework 4.5 on Windows 8, Windows RT, and Windows Server 2012: November 13, 2012
KB2742614	MS13-004: Description of the security update for the .NET Framework 4.5 on Windows 8, Windows RT, and Windows Server 2012: January 8, 2013
KB2750149	An update is available for the .NET Framework 4.5 in Windows 8, Windows RT and Windows Server 2012
KB2751352	An update is available to correct tile logo images of files on the All Apps View
KB2753842	MS12-078: Description of the security update for the Windows OpenType Compact Font Format (CFF) driver: December 11, 2012
KB2756872	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update
KB2757638	MS13-002: Description of the security update for XML Core Services 3.0 and 6.0: January 8, 2013
KB2758246	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2761094	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update
KB2764870	Windows 8 Client and Windows Server 2012 General Availability Cumulative Update
KB2768703	Protected content playback errors on Windows 8 or Windows Server 2012 after you install KB 2756872
KB2769034	WinRE is not enabled after you run the OOBE wizard in Windows 8, Windows RT, or Windows Server 2012

KB2769165	An update is available for certain Microsoft files that contain an incorrect digital signature in Windows 8 and Windows Server 2012
KB2770407	An update is available to improve the program registration process in Windows 8
KB2770660	MS12-082: Vulnerability in DirectPlay could allow remote code execution: December 11, 2012
KB2770917	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2771431	A servicing stack update is available for Windows 8 and Windows Server 2012
KB2771744	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2771821	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2777166	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2777294	Program Compatibility Assistant dialog box appears when you start a desktop app from the "Autoplay" dialog box in Windows 8
KB2778171	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2778344	MS13-016: Vulnerabilities in Windows kernel-mode driver could allow elevation of privilege: February 12, 2013
KB2779562	December 2012 cumulative time zone update for Windows operating systems
KB2779768	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2780342	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2780523	Windows 8 and Windows Server 2012 cumulative update: November 2012
KB2780541	Incorrect keyboard layout is used after you refresh Windows 8 or Windows Server 2012
KB2781197	Anti-malware platform update for Windows Defender is available in Windows 8

KB2782419	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2783251	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2784160	Windows 8 and Windows Server 2012 cumulative update: December 2012
KB2785094	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2785220	MS13-006: Vulnerabilities in Microsoft SSL implementation could allow security feature bypass: January 8, 2013
KB2788350	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2789649	MS13-015: Description of the security update for the .NET Framework 4.5 on Windows 8 and Windows Server 2012: February 12, 2013
KB2790655	MS13-018: Vulnerability in TCP/IP could allow denial of service: February 12, 2013
KB2790907	Compatibility update is available for Windows 8 and Windows Server 2012
KB2790920	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2792009	Windows 8 and Windows Server 2012 cumulative update: January 2013
KB2792100	MS13-009: Cumulative Security Update for Internet Explorer: February 12, 2013
KB2793210	Compatibility update is available for Windows 8 and Windows Server 2012
KB2794599	Fonts in console programs are too small to read in multilingual versions of Windows RT, Windows 8, and Windows Server 2012
KB2795944	Windows 8 and Windows Server 2012 cumulative update: February 2013
KB2797052	MS13-010: Vulnerability in vector markup language could allow remote code execution: February 12, 2013
KB2799494	MS13-017: Vulnerabilities in Windows kernel could allow elevation of privilege: February 12, 2013

KB2800033	Windows cannot be restored on a Windows RT-based, Windows 8-based or Windows Server 2012-based computer
KB2800088	Windows 8 and Windows Server 2012 cumulative update: March 2013
KB2803676	Windows 8 and Windows Server 2012 cumulative update: February 2013
KB2805940	Microsoft Security Advisory: Update for Vulnerabilities in Adobe Flash Player in Internet Explorer 10
KB2807986	MS13-027: Vulnerabilities in Windows Kernel-Mode drivers could allow elevation of privilege: March 12, 2013
KB2808735	MS13-036: Description of the security update for the Windows kernel-mode driver (win32k.sys): April 9, 2013
KB2809289	MS13-021: Cumulative Security Update for Internet Explorer: March 12, 2013
KB2811660	Windows 8 and Windows Server 2012 cumulative update: March 2013
KB2812822	System may restart and not display the "Choose an option" screen in Windows RT, Windows 8, or Windows Server 2012
KB2812829	Windows 8 and Windows Server 2012 cumulative update: March 2013
KB2813170	MS13-031: Vulnerabilities in Windows Kernel could allow elevation of privilege: April 9, 2013
KB2815769	Windows 8 and Windows Server 2012 cumulative update: March 2013
KB2817183	MS13-028: Cumulative Security Update for Internet Explorer: April 9, 2013
KB2819372	Microsoft Security Advisory: Update for vulnerabilities in Adobe Flash Player in Internet Explorer 10
KB2822241	Windows 8 and Windows Server 2012 cumulative update: April 2013
KB2823233	Windows 8 and Windows Server 2012 cumulative update: March 2013
KB2823516	Windows 8 and Windows Server 2012 cumulative update: April 2013
KB2824670	Microsoft Security Advisory: Update for Vulnerabilities in Adobe Flash Player in Internet Explorer 10: March 12, 2013
KB2833510	Microsoft Security Advisory: Update for Vulnerabilities in Adobe Flash Player in Internet Explorer 10: April 9, 2013
KB976002	What is the Browser Choice update? (KB976002)

Descriptions are titles from the Microsoft Support site <http://support.microsoft.com>.

Example <http://support.microsoft.com/?kbid=2819372>.



## Costs of Different Storage Options

Assumptions in the table:

-Prices; 128 GB SSD 130€, 256 GB SSD 210€, 512 GB SSD 460€

1 TB HDD 70€, 2 TB HDD 120€, 3 TB HDD 160€

Additional RAID controller 200€

-Speeds; SSD 450 MB/s, HDD 150 MB/s

-Others; Target speed 900 MB/s and motherboard includes six SATA3 channels

	Disk1	Disk2	Disk3	Disk4	Disk5	Disk6	Controller	Disk7	Disk8	Disk9	Disk10	Disk11	Disk12	RAID	Size	Type	Price
	128 GB	128 GB												0	256 GB	SSD	260€
	128 GB	128 GB	128 GB	128 GB										10	256 GB	SSD	520€
	256GB	256GB												0	512 GB	SSD	420€
	256 GB	256 GB	256 GB	256 GB										10	512 GB	SSD	840€
	512 GB	512 GB												0	1 TB	SSD	920€
	512 GB	512 GB	512 GB	512 GB										10	1 TB	SSD	1840€
	1 TB	1 TB	1 TB	1 TB	1 TB	1 TB								0	6 TB	HDD	420€
	1 TB	1 TB	1 TB	1 TB	1 TB	1 TB	Yes	1 TB	1 TB	1 TB	1 TB	1 TB	1 TB	10	6 TB	HDD	1040€
	2 TB	2 TB	2 TB	2 TB	2 TB	2 TB								0	12 TB	HDD	720€
	2 TB	2 TB	2 TB	2 TB	2 TB	2 TB	Yes	2 TB	2 TB	2 TB	2 TB	2 TB	2 TB	10	12 TB	HDD	1640€
	3 TB	3 TB	3 TB	3 TB	3 TB	3 TB								0	18 TB	HDD	960€
	3 TB	3 TB	3 TB	3 TB	3 TB	3 TB	Yes	3 TB	3 TB	3 TB	3 TB	3 TB	3 TB	10	18 TB	HDD	2120€

**Results:****RAID0**

Storage size 0-256 GB is best to do with two 128 GB SSD disks, price 260€

Storage size 256-512 GB is best to do with two 256 GB SSD disks, price 420€

Storage size 512 GB-6 TB is best to do with six 1 TB HDD disks, price 420€ (Choice for the test environment)

Storage size 6-12 TB is best to do with six 2 TB HDD disks, price 720€

Storage size 12-18 TB is best to do with six 3 TB HDD disks, price 960€

**RAID10**

Storage size 0-256 GB is best to do with four 128 GB SSD disks, price 520€

Storage size 256-512 GB is best to do with four 256 GB SSD disks, price 840€

Storage size 512 GB-6 TB is best to do with twelve 1 TB HDD disks, price 1040€

Storage size 6-12 TB is best to do with twelve 2 TB HDD disks, price 1640€

Storage size 12-18 TB is best to do with twelve 3 TB HDD disks, price 2120€