

Availability (FT & MSCS)

Maximums (FT advice): Disks per VM = 16 FT VMs per host = 4 Minimum hosts per cluster = 3

FW Port	Source	Destination	Prot (ESX port)	Description
8100, 8200	Hosts	ESX/ESXi	UDP (SC)	FT
8100, 8200 (out)	ESX/ESXi	Hosts	TCP/UDP(SC)	FT

FT: uses anti-affinity rules. Requires - HA & host monitoring, host certificate checking (on by default), dedicated logging NIC, compatible CPU, Hardware Virtualization (HVT), thick disks on shared storage, supported guest OS. Not supported - snapshots, storage VMotion, DRS features, hotplugging, MSCS, VCB, SMP, physical RDMs, Paravirtualized VMs, NPV, VMDirectPath, EPT/RV1.

MSCS: Win 2000 SP4, 2003 SP2 & 2008 (Failover Clustering) * 32 & 64bit * only 2 nodes clusters Not supported - DRS/HA on VMs, VMotion, FT, NPV, Round Robin NMP, iSCSI/NFS based disks

	VMDK	Virtual RDM	Physical RDM
Cluster in a box (CIB)	Yes (zeroed)	Yes	No (not supported)
Cluster across boxes (CAB)	No	Yes - not Win2008, not CCR	Yes (recommended)
Physical & VM (n+1)	No	No	Yes
Snapshots	Yes	Yes	Yes
SCSI target software	No	No	Yes

- Configure all RDMs before configuring VM's network settings, or initialising LUNs within windows.
- Add all RDMs to a 2nd SCSI controller i.e. SCSI(Lx). Set sharing to Physical or Virtual as required.
- SCSI bus sharing - CIB = Virtual / CAB or N+1 = Physical

Links: <http://kb.vmware.com/kb/101061> - Understanding FT
<http://kb.vmware.com/kb/1008027> - CPU & guest OS that support FT

Networking

Maximums (per host): 1GB VMNICS = 2 - 32 dependent on HW (e1000/e=32) 10GB VMNICS = 4 PCI VMDirectPath devices=8 vSS switches=248 VEM switches=1 vSwitch ports (vSS/vDS)=4,096 Service Console ports = 16 VMotion and IP storage (VMkernel) port group = 1

Maximums (per vCenter): vDS switches = 16 vDS port groups = 512 vDS switch ports = 6,000

Maximums (per switch): Hosts (per vDS) = 64 vSS port groups = 512 vSS switch ports = 4,088

Terminology: VMNICS - logical name for physical server NICs vNICS - virtual NICs assigned to VMs vSS - virtual Standard Switch vDS - virtual Distributed Switch vPort - port group on a vDS vDvUplink - uplink VMNICS on a vDS Network VMotion - tracking of VM's network state on a vDS

Common networking commands (-h switch for options or man page for detailed description):

```
List VMNICS: $ sudo /usr/sbin/esxconfig-nics -l
List vSwitches & Port Groups: $ sudo /usr/sbin/esxconfig-vswitch -l
List Service Console ports: $ sudo /usr/sbin/esxconfig-vswif -l
List VMkernel ports: $ sudo /usr/sbin/esxconfig-vmknic -l
List VMkernel Default Gateway: $ sudo /usr/sbin/esxconfig-route
```

Common networking configuration files: Name resolution order: `/etc/nsswitch.conf`
Local host file: `/etc/hosts` DNS servers: `/etc/resolv.conf` DG: `/etc/sysconfig/network`

Ethernet tagging: - EST (External Switch Tagging) - Default. No trunking required. 1-1 relationship from VMNICS to physical switch ports. Each VMNIC can only see 1 subnet. VLAN ID of 0 or blank.

- VST (Virtual Switch Tagging) - Commonly used, VMNICS connected to a vSwitch can span several VLANs. Each Port Group has a VLAN ID of 1-4094. Set the VLAN ID to blank to use Native VLAN.
- VGT (Virtual Guest Tagging) - Rarely used. Install 802.1Q trunking driver software in the VMs, the vSwitch preserves the tags given by the VMs. VLAN ID of 4095 on vSS, VLAN policy on vDS. Avoid using a VLAN ID of 1, as this is the native Cisco VLAN ID.

vSS & vDS options (options can also be overridden on individual Port Groups):

General - Number of ports - by default 56 for vSS, 64 for vDS, 128 when created on Service Console. (not a Port Group option) • Network label & VLAN ID - only on Port Groups not vSwitches.

Security - Promiscuous mode (default Reject) - only listens to traffic destined for its MAC address.
- MAC Address Changes (default Accept) - accepts inbound frames when VM changes MAC address.
- Forged Transmits (default Accept) - won't drop outbound frames if source MAC address is different.

Traffic Shaping - Status (default Disabled) Average Bandwidth (default 102400 Kbps) Peak Bandwidth (default 102400 Kbps) Burst size (default 102400 KB) - shapes out on vSS, in/out on vDS.

NIC Teaming - Load Balancing (spreads outbound traffic from vNICS across VMNICS) - Originating port ID (default) uses VMNIC based on where traffic entered - ip hash based on source & destination IP address of each packet (when physical switch ports are etherchannel) - Source MAC hash based on source MAC address - Use explicit failover order. Incoming traffic is load balanced by physical switch.

- Network Failover Detection Link status only (default) detects cable pulls & switch power failures, not misconfigurations. Beacon Probing (don't use with IP-hash load balancing).
- Notify Switches - No or Yes (default) updates lookup tables. Disable for MS NLB in unicast mode.
- Failback - No or Yes (default) VMNIC will return after recovering from a failure.
- Failover order Active - Standby - Unused. Don't use standby uplinks with IP-hash load balancing.

VLAN (vDS only) - VLAN - set ID. Trunk range - restrict IDs on trunked links. PVLAN - see below.

Miscellaneous (vDS only) - Port blocking - selected or unselected (default) block all ports.

dvPort options: - Port Binding Static when initially connected Dynamic when connected/power-on Ephemeral no binding - Traffic shaping Ingress into vSwitch Egress out of vSwitch - Allow live port moving - Config reset at disconnect - Host can assign port if vCenter is down - Name format

PVLAN (Private VLAN): extension to VLAN standard, adds further segmentation. Not encapsulated. Primary PVLAN - Original VLAN divided into smaller groups. Secondary PVLAN - exists only within primary, has specific VLAN ID. Secondary types: Promiscuous - connect with VMs in primary. Community - connect to themselves & VMs on promiscuous Isolated - connect with VMs on promiscuous TSO (TCP Segmentation Offload): enabled by default on VMkernel ports, allows very large frames (up to 64KB), even with smaller MTU. To enable on VMs, they need enhanced vmxnet3.

Jumbo frames up to 9kB. Must be enabled for each vSwitch. VMs need enhanced vmxnet3 to use it.

NetQueue enabled by default, allows certain VMNICS to spread processing across multiple CPUs.

Configure networking (for vSS): (1) add a vSwitch `esxconfig-vswitch -a (2)` add a port group to the vSwitch `esxconfig-vswitch -A (3)` set the port group's VLAN ID `esxconfig-vswitch -p -v (4)` add the VMNIC to the vSwitch `esxconfig-vswitch -l`

- VM connections: set the VM's NIC to use the port group.
- Service Console: create interface & add it to the port group `esxconfig-vswif -a -p -i -n`, set the DG in `/etc/sysconfig/network`, then restart networking `service network restart`.
- VMkernel ports: add the port `esxconfig-vmknic -a -i -n` & set the VMkernel DG `esxconfig-route`. VMotion should be enabled in vCenter if required.

Links: <http://kb.vmware.com/kb/1010812> - Configure IPv6
<http://vmware.com/files/pdf/vsphere-network-ds-migration-configuration-wp.pdf> - vDS whitepaper
<http://kb.vmware.com/kb/1000258> - Configure networking from Service Console command line

Storage

Maximums (per host): Volumes = 256 Paths = 1024 NAS datastores = 8 (64 with adv settings) FC - HBAs = 8 (HBA ports = 16) targets per HBA = 256 paths to each LUN = 32 iSCSI HW - HBAs = 4 targets per HBA = 64 Dynamic (61 Static) paths to each LUN = 8 iSCSI SW - NICS = 8 targets = 256 paths to each LUN = 8

Maximums (per volume): VMs = 256 Hosts = 64 (DRS limit, 2048 for linked clones) VMFS = 64TB (less 64KB) NFS = 16TB File size (1/2/4/8MB blocks) = 256GB/512GB/1TB/2TB RDMs = 2TB (less 512B) Extents = 32 Extent size = 2TB (less 512B)

FW Port	Source	Destination	Prot (ESX port)	Description
2049	NFS server	ESX/ESXi	TCP (VMK)	NFS Client
2049	ESX/ESXi	NFS server	TCP (VMK)	NFS Client
3260	ESX/ESXi	iSCSI server	UDP (SC+VMK)	iSCSI Client

Common storage commands (-h switch for options, or man page for detailed description):

```
List all storage devices: $ sudo /usr/sbin/esxconfig-scsidevs -c
List LUNs, paths & multipathing plugins: $ sudo /usr/sbin/esxconfig-mpath -l
List all VMware SATPs: $ sudo /usr/sbin/esxcli nmp satp list
List claim rules: $ sudo /usr/sbin/esxcli corestorage claimrule list
List datastores, dev names to VMFS: $ sudo /usr/sbin/esxconfig-scsidevs -m
List snapshot volumes: $ sudo /usr/sbin/esxconfig-volume -l
Test VMkernel connectivity: $ /usr/sbin/vmknping
Manage HW iSCSI (Qlogic) settings: $ sudo /usr/sbin/esxconfig-hwiscsi -l
Manage SW iSCSI settings: $ sudo /usr/sbin/esxconfig-swiscsi -q
List iSCSI LUNs: $ sudo /usr/sbin/vmkniscsi-tool -l -l adapter
Rescan iSCSI LUNs: $ sudo /usr/sbin/esxconfig-rescan adapter
List the NFS exports from the VMkernel: $ sudo /usr/sbin/esxconfig-nas -l
```

	FC	iSCSI	NAS
VMotion, DRS, HA, FT, VCB, SRM & Thin VMDKs	Yes	Yes	Yes
VMFS volumes, RDMs & VMware's NMP	Yes	Yes	No
Boot ESX host	Yes	Yes	(HW initiator) No
VM MSCS clustering	Yes	No	No

Zoning: at the switch. **LUN masking:** done at the SP or server.

Active-active: access to the LUNs simultaneously through all ports, without performance degradation.

Active-passive: one port actively providing access, other as backup. Path thrashing can occur.

NPV (N-Port ID Virtualization): FC HBA port assigns dedicated virtual port (WWPN) to VM (RDM)

LUN addressing FC: `Runtime Name` `vmkernel:CH:TH:L#` - adapter:channel:target:LUN
iSCSI: `IQN iqn.year-mo.reverse_domain_name:string or EUI.eui.string`

iSCSI discovery methods: Static - can manually add/remove items, only with hardware initiators. Dynamic - uses "SendTargets", target responds with list. Removed targets return after HBA rescan/resend CHAP: HW iSCSI 1-way CHAP, initiator level. SW iSCSI 1-way & mutual CHAP, initiator or target VMkernel port is required to use iSCSI or NFS storage. (S.C. port not required for iSCSI anymore)

MPP (MultiPathing Plugins): claim rules in `/etc/vmware/esx.conf` specify MPP to use for each path.

Claim rules: indicate which MPP, native or 3rd party, manages a given physical path.

NMP (Native MPP): SATPs (Storage Array Type Plugins) - handles failovers. • PSPs (Path Selection Plugins) - handles load-balancing. **NMP policies:** - default for active/active, uses preferred path when available. MRU (Most Recently Used) - default for active/passive (& iSCSI), first working path found at boot. RR (Round Robin) - safe for all arrays, rotates through paths (not MSCS LUNs).

Disk,MaxLUN: reduce number of LUNs scanned. `Disk.MaskLUN: convert to claim rule format.`

VMFS volumes: Large-less LUNs to create, less manage, flexible resizing & snapshots. Small-less contention (locking), less wasted space, different RAID, more flexible multipathing & disk shares.

TPGS (Target Port Group Support): storage shows path performances, so hosts can determine best path.

ALUA (Asymmetric Logical Unit access): finds/manages multiple paths for failover & load balancing.

Links: <http://kb.vmware.com/kb/1009553> - Local connectivity to storage
<http://media.netapp.com/documents/tr-3749.pdf> - Storage best practices whitepaper (NetApp)
<http://media.netapp.com/documents/tr-3747.pdf> - File System alignment whitepaper (NetApp)
<http://kb.vmware.com/kb/1011387> - ESX 4.x handling of LUNs detected as snapshot

Resources

Maximums (per DRS cluster): Hosts = 32 VMs (powered on) = 1280 (limit of 256 per host)

Maximums (per Resource Pool): Children = 1024 Tree depth = 12 (10 when in a DRS cluster)

Maximums (other): Datacenters per host = 100 RPs per host = 4096 RPs per cluster = 512

Datacenters mark organisational & VMotion boundaries. **Clusters** gather host CPU & memory resources. **Resource Pools** apply policies to clusters. A DRS cluster is also implicitly a resource pool.

Resource pools: • Shares - low, medium & high (1,2,4) • Reservations - MHz(CPU)/MB(RAM) • Limits - MHz/MB • Expandable reservation - yes (can draw from parent's pool) - no (can draw from own pool). List the resource group settings: `$ sudo /usr/sbin/esxconfig-resgrp -l`

Shares only apply during contention. Shares are relative to siblings. Reservations guarantee a minimum, are only checked when a VM is powered on. Limits are an upper bound, never exceeded; manage user expectations but can waste idle resources. Expandable reservations do not automatically hunt upwards, define if reservations are considered by admission control. Child pools actively reserve resources from parent even if VMs are powered off. Hierarchical resource pools require DRS enabled.

DRS: priority levels 1-5 (1 the highest). **DRS cluster settings:** • Manual / Partial (Initial VM placement) • Fully Automated (Initial VM placement & Dynamic balancing). **Current Host Load Standard Deviation:** load imbalance. Lower than Target value unless recommendations are unapplied.

"Grafted from" pools created when adding a host to a DRS cluster & keeping the host's resource pool hierarchy. **Maintenance mode** only clears VMs off host if DRS cluster is fully automated.

Affinity Rules keep VMs together or apart in a DRS cluster. Anti-affinity rule limited to 2. Rule conflicts - older wins, newer rule disabled. Anti-affinity wins over affinity. Disabled rules ignored.

Current host load standard deviation: DRS load imbalance. **Current < Target** unless advice unapplied

DRS: uses IPMI, ILO or WOL (in that order). DRS & DPM thresholds are independent. Verify host's DPM **Last Time Exited Standby:** DPM level - Off, Manual (makes recommendations) & Automatic. Hosts reclaim memory from VMs by: • Balloon driver (vmemctl) force guest to use native algorithms (guest swap) • VM Swap files (if vmemctl not available/responsive) • Sharing memory across VMs

Links: <http://kb.vmware.com/kb/1005764> - Enhanced VMotion (EVC) FAQ
<http://kb.vmware.com/kb/1003212> - EVC CPU compatibility
<http://www.yellow-bricks.com/hrs-deepdive/> - DRS Deep Dive

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ESX Hosts

Maximums (per host): vCPUs = 512 vCPUs per physical core = 25 Logical procs (incl HT) = 64 RAM = 1TB Service Console RAM = 800MB (min=300MB) VMs = 320 (HA can limit)

FW Port	Source	Destination	Prot (ESX port)	Description
22	SSH client	ESX	TCP (SC)	SSH server
80	ESX/ESXi	DNS server(s)	UDP (SC)	DNS requests
82 (out)	Clients	ESX/ESXi	TCP (SC)	HTTP access
123 (out)	ESX/ESXi	NTP source	UDP (SC)	NTP (time) client
427	Hosts, Client	ESX/ESXi	UDP (SC)	CIM SLP client/server
427 (out)	ESX/ESXi	Hosts	UDP (SC)	CIM SLP client/server
443	Hosts, Clients, VC	ESX/ESXi	TCP (SC)	HTTPS access
902	Hosts, Clients, VC	ESX/ESXi	TCP (SC)	Auth, migrate, provision
902 (out)	ESX/ESXi	Hosts, VC	UDP (SC)	Auth, migrate, provision
903	Clients	ESX/ESXi	TCP (SC)	VM Console
5900-5964	?	ESX/ESXi	TCP (SC)	RFB for mgt tools (VNC)
5900-5964 (out)	Hosts	?	TCP (SC)	RFB for mgt tools (VNC)
5989	Clients	ESX/ESXi	TCP (SC)	CIM server over HTTPS
5989 (out)	ESX/ESXi	Hosts	TCP (SC)	CIM server over HTTPS
8000	Hosts	ESX/ESXi	TCP (VMK)	VMotion requests
8000 (out)	ESX/ESXi	Hosts	TCP (VMK)	VMotion requests

Possible extras: 21(FTP), 22(SSH), 53(DNS), 88/389/464(AD), 161/162(SNMP), 445(SMB), 5988(CIM)

Logs: Service Console Availability & VMkernel Messages, Alerts, Availability: `/var/log/vmkernel`
ESX service log: `/var/log/vmware/hostlog` Syslog: `/var/log/messages`
VMkernel warnings: `/var/log/vmkernelwarning` VMkernel events: `/var/log/vmksuppmary`
VC agent: `/var/log/vmware/vpx/vpxa.log` Patching: `/var/log/vmware/esxupdate.log`

Common ESX host commands (-h switch for options or man page for detailed description):

```
List status of all services: $ sudo /sbin/service --status-all
List the service runlevels: $ chkconfig -l
Restart a service: $ sudo /sbin/service service_name restart (start, stop, status available)
Common services: - mgmt-vmware (hostd) - vmware-vpxa (vCenter agent) - vmware-vmkauthd (authentication) - network (vsfwif changes) - vmware-webAccess (Web Access)
```

Show build number: `$ vmware -v`
Check the filesystem usage: `$ sudo vdf -hP`
List diagnostic partitions: `$ sudo /usr/sbin/esxconfig-dumppart -l`
Show description of VMkernel error: `$ vmkerrcode error_code_number`
Export detailed config file: `$ sudo esxconfig-info > /tmp/esxconfig-info.txt`
Gather debugging report: `$ sudo /usr/sbin/vm-support -w /tmp`
Configure authentication settings: `$ sudo /usr/sbin/esxconfig-auth -l`
Lists drivers loaded at startup: `$ sudo /usr/sbin/esxconfig-module -l`
Set advanced options: `$ sudo /usr/sbin/esxconfig-option $value (-g to get)`
Update bootstrapping settings: `$ sudo /usr/sbin/esxconfig-boot (treat with caution)`
Initialization routines (resets things): `$ sudo /usr/sbin/esxconfig-init (treat with caution)`

Internal firewall commands (ptables on Service Console):

```
Show all firewall settings: $ sudo /usr/sbin/esxconfig-firewall -q
List the firewall named services: $ sudo /usr/sbin/esxconfig-firewall -l
Enable a service: $ sudo /usr/sbin/esxconfig-firewall -e service_name (-d to disable)
To open a port: $ sudo /usr/sbin/esxconfig-firewall -o port,protocol,direction,name
```

Security Levels: High - in/out blocked, Medium - in blocked, out open. Low - in/out open. By default all traffic blocked in & out, except 22, 123, 427, 443, 902, 5989, 5988, pings, DHCP & DNS.

Master config file: `/etc/vmware/esx.conf` Certificate files: hostd regenerates new files if not present. Certificate public key `/etc/vmware/ssl/ru1.crt` Certificate private key `/etc/vmware/ssl/ru1.key`
Set certificate location `/etc/vmware/hostd/proxy.xml` SSL settings `/etc/vmware/hostd/config.xml`

PAM (Pluggable Authentication Modules) configuration: `/etc/pam.d/vmware-authd`
Default authentication method is `etc/passwd`. vpxuser is for vCenter Server permissions.

Passwords: ESX uses `pam_cracklib.so` plug-in by default. No restrictions on root password. Defaults for non-root users: password length = 3, minimum password length = 9, shorter passwords with 4 Characters Classes mixed (upper, lower, digits & other) M - CC = E. `pam_passwdqc.so` provides more options.

User Password Aging: enabled by default, set to never expire (max days) & change anytime (min days = 0, warning = 7) • Change host settings: `esxconfig-auth` • Change user settings: `chage`

NUMA (Non-Uniform Memory Access): controls VM memory distribution across host memory. Only use NUMA if CPU affinity is set. HT: can help better utilize idle resources.

VMware MIBs: uses embedded SNMP agent (disabled by default). Enable: `vicfg-smnp`
`syslogd`: to configure • ESX - edit `/etc/syslog.conf` • ESXi - use client or `vicfg-syslog`

Links: <http://kb.vmware.com/kb/653> - Collecting diagnostic information for ESX Servers
<http://kb.vmware.com/kb/1005184> - Decoding Machine Check Exception output after purple screen
<http://kb.vmware.com/kb/1012514> - Determining detailed build number information for ESX hosts
<http://kb.vmware.com/kb/1000258> - Video: Configure Service Console networking from CLI
<http://kb.vmware.com/kb/1991/1992> - VMotion compatibility for Intel / AMD processors
http://www.vmware.com/pdf/Perf_Best_Practices_vSphere4.0.pdf - Performance best practices
<http://communities.vmware.com/docs/DOC-9279> - Interpreting esxop Statistics

ESXi hosts

HW requirements: 64bit x86 CPUs, 2GB RAM, SATA, SAS or SCSI disks. No ESXi WebAccess. ESXi Installable starts in eval mode (60 days). If no DHCP at install, link local IP used 169.254.x.x/16.

ESXi Installable Partitions: 4GB VFAT scratch for system swap (not required, but stores vswp), 110MB diagnostic for core dumps, VMFS3 on free space.

Not supported: - ESXi Installable & Embedded on same host • Booting multiple servers from 1 image

Direct Console: - Configuring host defaults - Set up administrative access - Troubleshooting

Restarting Mgt agents effects: `/etc/init.d` processes: hostd (mgmt-vmware), ntpd (time), sfcbd (CIM broker), slpd (discover/advertise services), wsman (share mgt info via SOAP), vobd (error reporting) & AAM (HA agent) if installed. To isolate ESXi host from DRS/HA cluster disable mgt network.

Management Network Test: pings DG, primary DNS nameserver, secondary DNS, resolves hostname.

Lockdown mode: prevents remote access by root account, but not other accounts. Disabled by default. `vicfg-cfgbackup` • Backup host configuration: `-s` • Restore: `-l` (-f if different build number)

Repair mode: on ESXi Installable CD overrides all configuration data. VMFS is preserved if VMFS3 is original location on boot disk (or beyond 900MB partition), or another disk.

Tech Support Mode: • login to console • Alt+F1 • **unsupported** • enter root password
Return to console: `# exit` • Alt+F2 <http://kb.vmware.com/kb/1003677> - Tech Support Mode KB

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Restarting Mgt agents effects: `/etc/init.d` processes: hostd (mgmt-vmware), ntpd (time), sfcbd (CIM broker), slpd (discover/advertise services), wsman (share mgt info via SOAP), vobd (error reporting) & AAM (HA agent) if installed. To isolate ESXi host from DRS/HA cluster disable mgt network.

Management Network Test: pings DG, primary DNS nameserver, secondary DNS, resolves hostname.

Lockdown mode: prevents remote access by root account, but not other accounts. Disabled by default. `vicfg-cfgbackup` • Backup host configuration: `-s` • Restore: `-l` (-f if different build number)

Repair mode: on ESXi Installable CD overrides all configuration data. VMFS is preserved if VMFS3 is original location on boot disk (or beyond 900MB partition), or another disk.

Tech Support Mode: • login to console • Alt+F1 • **unsupported** • enter root password
Return to console: `# exit` • Alt+F2 <http://kb.vmware.com/kb/1003677> - Tech Support Mode KB

ESXi hosts

HW requirements: 64bit x86 CPUs, 2GB RAM, SATA, SAS or SCSI disks. No ESXi WebAccess. ESXi Installable starts in eval mode (60 days). If no DHCP at install, link local IP used 169.254.x.x/16.

ESXi Installable Partitions: 4GB VFAT scratch for system swap (not required, but stores vswp), 110MB diagnostic for core dumps, VMFS3 on free space.

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Direct Console: - Configuring host defaults - Set up administrative access - Troubleshooting

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