COPYRIGHT
Copyright © 2010 - 2018 Turbonomic, Inc. All rights reserved

END-USER LICENSE AGREEMENT
Table of Contents

Target Configuration ........................................ 1
    Adding and Removing Target Virtual Management Servers 3
    Adding Targets .......................................... 3
    Editing and Removing Targets .......................... 3

Hypervisor Targets ......................................... 4
    IBM PowerVM ........................................... 8
    Hyper-V ............................................. 11
    Creating A Service User Account ...................... 16
    Red Hat Enterprise Virtualization (RHEV-M) .......... 17
    vCenter Server ....................................... 20
    Creating A Service User Account In vCenter ...... 24
    XenServer ............................................. 25

Cloud Management Targets ................................. 29
    Private Cloud ......................................... 33
    CloudStack ............................................. 35
    OpenStack ........................................... 38
    vCloud Director ....................................... 43
    Virtual Machine Manager ............................. 47
    Public Cloud ......................................... 53
    Amazon Web Services ................................ 54
    IBM SoftLayer ....................................... 57
    Microsoft Azure ..................................... 60

Storage Targets ........................................... 64
    Dell Compellent ..................................... 66
    EMC ScaleIO ......................................... 69
    EMC VMAX ........................................... 71
    EMC VNX ............................................. 73
    EMC VPLEX .......................................... 77
    EMC XtremIO ......................................... 78
    HPE 3PAR ............................................. 80
    HDS ................................................... 84
    NetApp ................................................ 86
    Restricted Service Accounts In NetApp .......... 90
    Pure Storage .......................................... 92

Guest OS Process Targets ................................ 95
    AppDynamics ......................................... 97
    Docker Containers .................................. 100
    SNMP .................................................. 102
    Enabling SNMP ...................................... 104
    WMI ................................................... 105
    Enabling WMI ....................................... 107
Application Server Targets 109
  JBoss 113
  Apache Tomcat 116
  JVM Application 120
  Oracle WebLogic 123
  IBM WebSphere 127

Database Server Targets 131
  MySQL 133
    Enabling User Permissions on MySQL Server 135
  Oracle 136
    Creating a Service User Account in Oracle 139
    SQL Server 139

Windows® Application Targets 143

Network Flow Targets 146
  Arista 148
  Cisco APIC 149
  Tetration 150
  NetFlow 152
  sFlow 153

Application Container Targets 156
  Setting Up Application Containers Managed By Kubernetes 157

PaaS Targets 159
  Cloud Foundry 162
  Pivotal Operations Manager 165

Fabric Targets 169
  Cisco UCS Manager 171
  Cisco UCS Central 174
  HPE OneView 177

Hyperconverged Targets 181
  Cisco HyperFlex 183
  Nutanix 186
    Enabling Standalone (Acropolis) Operating Mode In Nutanix 190

UCS Director 191
Load Balancer Targets 195

Turbonomic Targets for Aggregation 199

Appendix — Target Configuration 201

- Enabling Management via DCOM 201
- Secure Setup of WSMan 202
- Enabling Windows Remote Management 203
  - Enabling WinRM Via Global Policy Objects 204
  - Enabling WinRM Via PowerShell 205
- Port Configuration 206
- Cisco Unified Computing System 208
Target Configuration

A target is a service that performs management in your virtual environment. Turbonomic uses targets to monitor workload and to execute actions in your environment. Target Configuration specifies the ports Turbonomic uses to connect with these services. You must install Turbonomic on a network that has access to the specific services you want to set up as targets.

For each target, Turbonomic communicates with the service via the management protocol that it exposes — The REST API, SMI-S, XML, or some other management transport. Turbonomic uses this communication to discover the managed entities, monitor resource utilization, and execute actions.

You can assign instances of the following technologies as Turbonomic targets:

- **Application Servers**
  - IBM WebSphere Application Server 8.5+
  - Oracle WebLogic 12c
  - JBoss Application Server 6.3+
  - Apache Tomcat 7.x, 8.x, and 8.5.x
  - JVM 6.0+

- **Cloud Managers**
  - CloudStack 4.3 — 4.9
  - Microsoft System Center 2012 Virtual Machine Manager and System Center 2012 R2 Virtual Machine Manager
  - VMware vCloud Director 5.x — 8.2
  - OpenStack Havana — Newton
  - Amazon AWS
  - Microsoft Azure
  - IBM SoftLayer

- **Database Servers**
  - Oracle 11g R2 and 12c
  - MySQL all 5.6 and 5.7 releases

- **Fabric Managers**
  - Cisco UCS 3.1+
  - Cisco UCS Central
  - HPE OneView 3.00.04+
- Guest OS Processes
  - AppDynamics 4.1+
  - Docker API 1.20+
- Hyperconverged
  - Nutanix Community Edition
  - Hyperflex 2.5, 2.6
- Hypervisors
  - Citrix XenServer 5.6.x and 6.x
  - IBM PowerVM 8.3+
  - Microsoft Hyper-V 2008 R2, Hyper-V 2012, and Hyper-V 2012 R2
  - RHEV-M (RedHat Enterprise Virtualization Manager) versions 3.x
  - VMware vCenter 4.1 — 6.0 running with ESX 3.x, 4.x, 5.x, and 6.x
- Load Balancers
  - Citrix NetScaler NS10.5
- Microsoft Applications
  - Microsoft Exchange 2012
- Network Flow Collectors
  - NetFlow/sFlow: NFDUMP — Turbonomic provides an OVA download with NFDUMP preconfigured for NetFlow and sFlow collection
  - Arista Command eAPI
  - Cisco API
  - Cisco Tetration 2.2.1.31
- Orchestrator Targets
  - UCS Director 6.0 — 6.5
- PaaS Targets
  - CloudFoundry Pivotal / Stackato
  - OpenShift 3.3+
  - Mesos 1.0+
- Storage Managers
  - NetApp (Cmode/7mode) using ONTAP 8.0+
  - EMC VMAX using SMI-S 8.1+
  - EMC VNX (Celera) using VNX Control Station
  - EMC VNX (Clarrion) using SMI-S 4.6.x
  - EMC VPLEX Local Architecture with 1:1 mapping of virtual volumes and LUNs
  - EMC XtremIO XMS 4.0+
  - Pure Storage F-series and M-series arrays
  - HP 3PAR InForm OS 3.2.2+, 3PAR SMI-S, 3PAR WSAPI
  - Dell Compellent Enterprise Manager 2014-2016R3 using Dell Compellent SMI-S
  - HDS (Embedded) with VSP, HUS VM, G600, G800, G1000
  - HDS (Shared) with HUS110, HUS 130, HUS 150
  - HDS Tuning Manager 9.x
- Turbonomic Targets
  To configure an aggregated deployment of Turbonomic, you can assign Turbonomic servers as targets. The versions of target instances must match the version of the aggregating instance.
Adding and Removing Target Virtual Management Servers

The target services your Turbonomic installation will manage appear in the Target Configuration list. You can add, remove, and edit entries in this list. Note that the target service’s account must be configured with privileges that support the Turbonomic activities you want to perform. For example, the following list shows how vCenter privileges correspond to activities Turbonomic can perform:

- **Read Only** — Enables Turbonomic monitoring and simulation (what-if scenarios) only
- **vCenter Administrator** — Enables Turbonomic monitoring, simulation (what-if scenarios), and automation functions
- **Enable Datastore Browse** — Enabling this property for the account gives Turbonomic the privileges it needs to enable its storage management functionality

Adding Targets

To add a target service, click the **Target Configuration** button, provide the requested information, and click **Apply** to validate those targets and start a new discovery.

Typical information you provide includes:

- **Target Type** — Choose among the supported VM Management technologies (Hypervisor, Cloud Management, Load Balancer, etc.)
  
  After you choose the technology, then choose the specific target type for that technology. For example, for Hypervisor technology, the types you can choose include vCenter, RHEV, Hyper-V, and XenServer.
- **Hostname or IP address** — The address of the target service you want to add
- **User Name** — A valid account username for the target service
- **Password** — A password for the target service account

Editing andRemoving Targets

To edit a target entry, select it in the list and then click **Edit**. The **Target Configuration Form** opens, where you can make your settings.

To remove a target, select the entry in the list and then click **Delete**.
Hypervisor Targets

A hypervisor is a service that creates and runs virtual machines (VMs), providing the VMs compute and storage resources. When you connect Turbonomic to hypervisor targets in your environment, Turbonomic controls your environment, assuring application performance while also utilizing resources as efficiently as possible.

One of the first steps in any Turbonomic deployment is to connect to the hypervisors within your environment. Once connected, Turbonomic discovers the VMs, the physical machines that host the VMs, the datastores that provide storage resources to the physical machines, and the virtual datastores that provide storage resources to the VMs.

Supply Chain

Each hypervisor requires a physical machine (host) and one or more datastores to provide compute and storage resources. Virtual machines (VMs) run on those physical resources, and the VMs in turn provide resources to applications.

At the bottom of the supply chain, physical machines consume resources from data centers.

If your environment includes SAN technologies such as disk arrays, then the storage consumes resources from that underlying technology. If you add these storage targets, then Turbonomic extends the supply chain analysis into the components that make up the disk array. For more information, see Storage Targets on page 64.
Adding and Removing Target Virtual Management Servers

Actions

Turbonomic recommends actions for the hypervisor supply chain as follows.

**NOTE:** This is a general list of actions for entities discovered for hypervisors. Detailed actions per target are described in each target section.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Storage</td>
<td>• Start Storage</td>
</tr>
<tr>
<td></td>
<td>• Provision Storage</td>
</tr>
<tr>
<td></td>
<td>• Suspend Storage</td>
</tr>
<tr>
<td></td>
<td>• Move (only with Storage Targets configured)</td>
</tr>
<tr>
<td></td>
<td>• Resize (only with Storage Targets configured)</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
</tbody>
</table>
• Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Physical Machine**

• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**Storage**

• Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)

• Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second

• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

**Datacenter**

*NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.*

• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
• Balloon
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

Provider Virtual Datacenter
• Memory (Mem)
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
• Storage
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

Consumer Virtual Datacenter
• Memory (Mem)
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
• Storage
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)
IBM PowerVM

Turbonomic connects with IBM PowerVM servers through the IBM Hardware Management Console (HMC) to manage logical partitions (LPARs), Processor Pools, virtual I/O servers (VIOS), and the associated network and storage.

The components of IBM PowerVM map to entities in the Turbonomic supply chain as follows:

<table>
<thead>
<tr>
<th>PowerVM Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>Physical Machine</td>
</tr>
<tr>
<td>Node</td>
<td>N/A — A source of compute resources contained within the frame, but not described in the Turbonomic user interface as a separate entity</td>
</tr>
<tr>
<td>LPAR or VIOS</td>
<td>Virtual Machine</td>
</tr>
<tr>
<td>Fabric</td>
<td>Storage</td>
</tr>
</tbody>
</table>

Prerequisites

- IBM Hardware Management Console (HMC) 8.3 or higher with the Performance and Capacity Monitoring API and data collection enabled.
- A service account Turbonomic can use to connect to your HMC. To generate actions, the account must have HMC Viewer permission and access to the HMC Capacity and Performance Monitoring API. To automate actions the account must have HMC Root permissions.

**NOTE:** To discover utilization (Mem, CPU, etc.) on HMC frames, the account’s user permissions must include the List Utilization Data permission for each frame.

- To accurately monitor LPAR memory, and to recommend actions based on LPAR memory utilization:
  - Each LPAR must use an AIX operating system
  - Each LPAR must have SNMP enabled

When you specify an HMC target, you specify an SNMP port and a community name — The values you provide for the target should match the SNMP configuration on the LPARs that the HMC manages.

If you do not enable SNMP connections to a given LPAR, then Turbonomic successfully manages that LPAR but it cannot read memory utilization from the LPAR. Without SNMP to an LPAR running AIX, Turbonomic gets memory consumption values from the Hardware Management Console. HMC memory values are not based on actual utilization in the LPAR.

Adding PowerVM Targets

To add PowerVM targets, select the Hypervisors > IBM PowerVM option on the Target Configuration page and provide the following information:

- **Address**
  - The name or IP address of the Hardware Management Console.
- **Username/Password**
  - Credentials for the service account Turbonomic can use to connect to the HMC.
After discovering your target, Turbonomic creates a group named AIX-vioses-auto to contain discovered VMs. Under some circumstances, the PowerVM configuration does not provide the information Turbonomic needs to create this group. To fix this issue, see the following IBM workaround: http://www-01.ibm.com/support/docview.wss?uid=isg3T1024482;.

**Resizing Down Virtual I/O Servers**

If you do not want to receive "Resize down" recommendations for your virtual I/O servers, you can disable this on the Policy tab as follows:

1. **In the Policy Management Tab, select Automation Policy.**
2. **For policy type, select Virtual Machine**
3. **For scope, add the group AIX-vioses-auto.**
4. **For Action Automation, select Resize down and Disabled.**
5. **Click Save and Apply.**

**Supported Actions**

Turbonomic supports the following actions for IBM PowerVM entities:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>Move, Resize Down, Resize Up</td>
<td>Start, Suspend, Terminate, Provision, Reconfigure</td>
</tr>
<tr>
<td>Physical Machine</td>
<td></td>
<td>Start, Suspend, Terminate, Provision</td>
</tr>
</tbody>
</table>

**Monitored Resources**

Turbonomic monitors the following resources for the hypervisor supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem) The utilization of the VMem allocated to the hosting VM Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU) The utilization of the VCPU allocated to the hosting VM Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
• Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB)
• Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS
• Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Physical Machine
• Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
• CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
• IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
• Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
• Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
• Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
• CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

Storage
• Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
• Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
• Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second
• Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)
NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)
  The utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the PM’s CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The utilization of the PM’s IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The utilization of data through the PM’s network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The utilization of the PM’s swap space
  Measured in Kilobytes (KB)
- Balloon
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

Hyper-V

If you have a small number of Hyper-V hosts in your environment, you can add them individually as Turbonomic targets. Also, if you have deployed the Hyper-V hosts in a clustered domain (for example as a failover cluster), you can specify one Hyper-V host as a target and Turbonomic automatically add the other members of that cluster.

Note that for large Hyper-V environments, it’s typical to manage the hosts via System Center Virtual Machine Manager (VMM). You can specify the VMM server as a target and Turbonomic will use it to discover and manage its child Hyper-V hosts. If you use VMM, you should not add individual Hyper-V hosts as targets. For information about adding VMM targets, see Virtual Machine Manager on page 47.

NOTE: Even if you manage Hyper-V using a VMM target, you must still configure remote management on each Hyper-V server. This Hyper-V topic includes instructions to configure remote management — see “Enabling Windows Remote Management” in the User Guide.

For accurate SMB storage calculations, Turbonomic requires a VMM target.
Prerequisites

- Create a service account that Turbonomic can use to connect to your Hyper-V servers. See Creating A Service User Account on page 16.
- Configure remote management on each Hyper-V server. Refer to the relevant section below:
  - Turbonomic 5.4 or higher: See "Enabling Windows Remote Management" in the User Guide.
  - Turbonomic 5.3 or below: See Enabling Management via DCOM on page 201.

Adding Hyper-V Targets

Once you’ve enabled remote management, you can add your Hyper-V hosts as targets. To add Hyper-V targets, select the Hypervisors > Hyper-V option on the Target Configuration page and provide the following information:

- **Address**
  The FQDN of the Hyper-V host. If you’re using the “Discover Host Cluster” below to add an entire cluster, enter the name of any one of the Hyper-V hosts in the cluster.
  Note that you can enter an IP address for the host, but you must first configure an SPN on the host. Turbonomic recommends that you use the FQDN in this field.
- **Port number**
  The port number for the remote management connection. The default HTTP port is 5985; the default HTTPS port is 5986.
- **Secure connection**
  Select this option to use a secure connection (HTTPS). Make sure the required certificate is configured for use on the host.
- **Full domain name**
  The full domain name of the cluster to which the host belongs.
- **Discover Host Cluster**
  Turbonomic discovers and adds all Hyper-V hosts in the named cluster if this option is checked. Note that each server must be configured to allow remote management. You may find it helpful to configure WinRM using a GPO so new servers are configured automatically (see Enabling WinRM Via Global Policy Objects on page 204).
- **Username**
  The username of a service account Turbonomic can use to connect to the Hyper-V host. If you checked "Discover Host Cluster” in the field above, use an account that is valid for all Hyper-V hosts in that cluster.
  **For Turbonomic 5.3 or below:** The account must also be one of the server’s WBEM Scripting Locator owners (see Enabling Management via DCOM on page 201).
- **Password**
  Password for account used.

**NOTE:** If your Hyper-V hosts are running in a Nutanix environment, you must understand pinning a Nutanix Controller VM. For more information, see Controller VM Pinning on page 188.
Turbonomic offers the capability to adjust certain properties of the probe. In general, this tweaking will not be necessary. If adjustment is needed, the file can be found in the `/srv/tomcat/webapps/vmturbo/probe-jars/{probe}/resources` folder. This target has the following properties:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxEnvelopeSize</td>
<td>Maximum size of SOAP response envelope</td>
</tr>
<tr>
<td>timeout</td>
<td>Determines the timeout in milliseconds for both initial connection and discovery, and maximum period between data packets</td>
</tr>
<tr>
<td>conversionObjectsBatchSize</td>
<td>Maximum amount of internal objects that should be converted into EntityDTO in one batch</td>
</tr>
<tr>
<td>queriesThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool even if idle timeout is exceeded. This number should be lower or equal to queriesThreadPoolMaximumSize</td>
</tr>
<tr>
<td>queriesThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool</td>
</tr>
<tr>
<td>queriesThreadPoolIdleTimeout</td>
<td>Time in seconds before a thread will time out if number of active threads are above queriesThreadPoolCoreSize</td>
</tr>
<tr>
<td>hostThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool responsible for simultaneous discovery of host instances. This number should be lower or equal to hostThreadPoolMaximumSize</td>
</tr>
<tr>
<td>hostThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool responsible for simultaneous discovery of host instances</td>
</tr>
<tr>
<td>hostThreadPoolIdleTimeout</td>
<td>Time in seconds before a thread will time out if number of active threads are above hostThreadPoolCoreSize</td>
</tr>
<tr>
<td>clusterThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool for handling requests to Hyper-V targets. This number should be lower or equal to clusterThreadPoolMaximumSize</td>
</tr>
<tr>
<td>clusterThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool responsible for handling requests to Hyper-V hosts</td>
</tr>
</tbody>
</table>
Hypervisor Targets

### clusterThreadPoolIdleTimeout
Time in seconds before a thread will time out if the number of active threads are above clusterThreadPoolCoreSize.

### hypervCommonThreadPoolCoreSize
Number of threads that will remain in the thread pool responsible for miscellaneous SDK tasks.

### hypervCommonThreadPoolMaximumSize
Maximum number of threads that will be used by the thread pool responsible for miscellaneous SDK tasks. This number should be lower or equal to hypervCommonThreadPoolMaximumSize.

### hypervCommonThreadPoolIdleTimeout
Time in seconds before a thread will time out if the number of active threads are above hypervCommonThreadPoolCoreSize.

### actionStepCheckSucceededTimeout
Time in milliseconds to wait before triggering the next step in an action chain.

### actionStepCheckAmount
Number of times to poll for an action is complete before failure.

### actionStepCheckTimeout
Time in milliseconds between action checks.

### requestsPerHost
Maximum number of simultaneous requests per host.

---

**NOTE:** To improve the performance of discovery in large environments (25+ Hosts), increase the following settings:

- queriesThreadPoolMaximumSize
- hostThreadPoolMaximumSize
- clusterThreadPoolMaximumSize

This increases the number of threads that the probe uses to discover your environment. As you increase the number of threads, you may need to increase the amount of memory allocated to Turbonomic.

### Supported Actions

For each discovered entity within the hypervisor supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>Start, Move, Suspend, Storage Move, Resize Down, Resize Up</td>
<td>Terminate, Provision, Reconfigure</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>Start, Suspend</td>
<td>Terminate, Provision</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>
## Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| VirtualMachine  | • Virtual Memory (VMem)  
The utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
The utilization of the virtual storage capacity allocated for the VM  
Measured in Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The utilization of IOPS allocated for the VStorage on the VM  
Measured in IOPS  
• Latency  
The utilization of latency allocated for the VStorage on the VM  
Measured in milliseconds (ms) |
| Physical Machine| • Memory (Mem)  
The utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB)  
• CPU  
The utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz)  
• IO  
The utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s)  
• Net  
The utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s)  
• Swap  
The utilization of the PM's swap space  
Measured in Kilobytes (KB) |
| Storage         | • Storage Amount  
The utilization of the datastore's capacity  
Measured in Megabytes (MB)  
• Storage Provisioned  
The utilization of the datastore's capacity, including overprovisioning.  
Measured in Megabytes (MB)  
• Storage Access Operations Per Second (IOPS)  
The summation of the read and write access operations per second on the datastore  
Measured in Operations per second |
Hypervisor Targets

- Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

**Datacenter**

**NOTE:** For datacenter entities, *Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.*

- Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- Balloon
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

### Creating A Service User Account

The service account Turbonomic uses to connect to a Hyper-V host must be an Active Directory domain account. The account must have full access to the cluster. To create such an account, execute the following command at a PowerShell prompt:

```
Grant-ClusterAccess <domain>\<service_account> -Full
```

Additionally, the service account must have specific local access rights on each host. The easiest way to grant Operations Manager the access it requires is to add the domain account to the **Local Administrators** group on each Hyper-V server.

Some enterprises require that the service account does not grant full administrator rights. In that case, you can create a restricted service account on every Hyper-V host:

1. **Add the service account to each of the following local groups:**
   - WinRMRMoteWMIUsers__ (or Remote Management Users)
   - Hyper-V Administrators
   - Performance Monitor Users
NOTE: These groups are standard Windows Server 2012 security groups. If you are using an earlier version of Windows Server and do not see these groups, contact Turbonomic Support for assistance.

2. Grant permissions to the service account.
   In the WMI Management console, grant the Enable Account and Remote Enable advanced security permissions to the service account:
   • Open the WMI Management console (wmimgmt).
   • Right-click WMI Control (Local) and choose Properties.
   • Go to the Security tab and then click Security to display the Security for Root dialog.
   • Click Advanced, select the service account, and click Edit.
   • Confirm that This namespace and subnamespace is selected.
   • Select Enable Account and Remote Enable and click OK.

3. Configure the WinRM security descriptor to allow access by the service account:
   • At a PowerShell prompt, execute winrm configSDDL default.
   • In the "Permissions for Default" dialog box, grant the service account Read and Execute access.

Red Hat Enterprise Virtualization (RHEV-M)

Red Hat Enterprise Virtualization Manager (RHEV-M) provides centralized management of Red Hat hypervisors. To manage Red Hat hypervisors, you specify a RHEV-M instance as a target.

Prerequisites

- A service account Turbonomic can use to connect to the RHEV-M server. The account must have administrator privileges on RHEV-M.

Adding RHEV-M Targets

To add RHEV-M targets, select the Hypervisors > RHEV-M option on the Target Configuration page and provide the following information:

- Address
  The name or IP address of the RHEV-M console. Turbonomic defaults to port 443. If your RHEV-M uses a port other than 443, append the port number to the address. For example, RHEV-M 3.0 uses port 8443 — You would specify the following address:<RHEV-M_IP_ADDRESS>:8443.

- Username/Password
  Credentials for the service account Turbonomic can use to connect to RHEV-M. If you’re connecting using an account that is not the internal admin account, specify <domain>\<username> for the username.
Supported Actions

For each discovered entity within the hypervisor supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

**NOTE:** Turbonomic will not discover VMs that are powered off during initial discovery of this target. As those VMs are powered back on, Turbonomic will discover them normally.

### Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>Start, Move, Suspend, Storage Move, Resize Down, Resize Up</td>
<td>Terminate, Provision, Reconfigure</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>Start, Suspend</td>
<td>Terminate, Provision</td>
</tr>
<tr>
<td>Datastore (&quot;Storage&quot;)</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

**Entity Type**

**Commodity**

**Virtual Machine**

- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Physical Machine**

- Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
• Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

Storage
• Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)
• Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)
• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second
• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

Datacenter
  **NOTE:** For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.
• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
• Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

Provider Virtual Datacenter

• Memory (Mem)
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

• Storage
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

Consumer Virtual Datacenter

• Memory (Mem)
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

• Storage
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

vCenter Server

VMware vCenter Server provides a centralized management platform for VMware hypervisors. To manage your
VMware environment with Turbonomic, you specify a vCenter Server instance as a target. Turbonomic discovers the
associated infrastructure and performs intelligent workload management.

Prerequisites

• A service user account Turbonomic can use to connect to your vCenter and execute actions (see Creating A
  Service User Account In vCenter on page 24).
General Considerations Before Target Addition

- **Linked vCenters:**
  For linked vCenters, you must add each vCenter separately. Turbonomic communicates with each vCenter through a separate API endpoint, but aggregates the data from those vCenters and makes cross-vCenter actions possible.

- **Shared Datastores:**
  If you add more than one vCenter target that manages the same datastore, you may see conflicts in the metadata Turbonomic maintains for each vCenter. For example, datastore browsing may display a conflict between active and wasted files, or each vCenter may define the same datastore as a member of a different storage cluster. Turbonomic recommends that you do not add multiple vCenter targets that manage the same datastore.

- **Restricting Turbonomic Access to Specific Clusters:**
  When you add a vCenter target, Turbonomic discovers all of the connected entities that are visible based on the account you’re using to connect to the vCenter. If there are clusters or other entities you want to exclude, you can do this by setting the role for the Turbonomic account to No access in the vSphere management client.

Adding vCenter Targets

To add vCenter targets, select the **Hypervisors > vCenter** option on the Target Configuration page and provide the following information:

- **Address**
  The name or IP address of the vCenter server.

- **Username/Password**
  Credentials for the service account Turbonomic can use to connect to the vCenter Server. Include the domain if required (\<domain\>\<username\>).

NOTE: If your VMware hypervisors are running in a Nutanix environment, you must understand pinning a Nutanix Controller VM. For more information, see Controller VM Pinning on page 188.

vCenter Post-Addition Imports

In addition to discovering entities managed by the hypervisor, Turbonomic also imports a wide range of vSphere settings, such as Host DRS rules, annotations, Resource Pools, and DRS HA settings (See “Other Information Imported From vCenter” in the User Guide).

NOTE: *Turbonomic does not import Storage DRS settings.*

VMware vSphere 6.0 introduced the ability to move VMs between vCenters. If you enabled this feature in your VMware environment, you can configure Turbonomic to include cross vCenter vMotions in its recommendations.

To configure Operations Manager to support cross vCenter vMotion recommendations, you must create a Workload Placement Segment that merges the clusters on the different vCenters. To create a merge segment:

1. **In the Policy Management Tab, select Placement Policy.**
2. **For policy type, select Merge.**
3. **For consumer type, select DataCenter, and click Select Clusters.**
4. **Choose the clusters that make up the two vCenters, and click Select.**
5. Click Save Policy.

**NOTE:** Since Turbonomic can only execute vMotions between clusters that use the same switch type (VSS or VDS), make sure any clusters you merge use the same switch type. Although Turbonomic will not initiate VSS → VDS vMotions, vSphere may do so. If this happens, Turbononomic displays a compliance violation notification.

## Supported Actions

For each discovered entity within the hypervisor supply chain, Operations Manager can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>Start, Move, Suspend, Storage Move,</td>
<td>Terminate, Provision, Reconfigure</td>
</tr>
<tr>
<td></td>
<td>Resize Down, Resize Up</td>
<td></td>
</tr>
<tr>
<td>Physical Machine</td>
<td>Start, Suspend</td>
<td>Terminate, Provision</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

## Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

**Entity Type**

**VirtualMachine**

- **Commodity**
  - Virtual Memory (VMem)
    - The utilization of the VMem allocated to the hosting VM
    - Measured in Kilobytes (KB)
  - Virtual CPU (VCPU)
    - The utilization of the VCPU allocated to the hosting VM
    - Measured in Megahertz (MHz)
  - Virtual Storage (VStorage)
    - The utilization of the virtual storage capacity allocated for the VM
    - Measured in Kilobytes (KB)
  - Storage Access Operations Per Second (IOPS)
    - The utilization of IOPS allocated for the VStorage on the VM
    - Measured in IOPS
  - Latency
    - The utilization of latency allocated for the VStorage on the VM
    - Measured in milliseconds (ms)

**Physical Machine**

- **Commodity**
  - Memory (Mem)
    - The utilization of the PM’s memory reserved or in use
    - Measured in Kilobytes (KB)
  - CPU
    - The utilization of the PM’s CPU reserved or in use
    - Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**Storage**

- **Storage Amount**
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)

- **Storage Provisioned**
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)

- **Storage Access Operations Per Second (IOPS)**
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second

- **Latency**
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

**Datacenter**

*NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.*

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
Hypervisor Targets

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

---

Creating A Service User Account In vCenter

The service account you use must have specific permissions on the vCenter. The easiest way to grant Turbonomic the access it requires is to grant full administrator rights.

Some enterprises require that the service account does not grant full administrator rights. In that case, you can create a restricted service account that grants the following permissions to enable the required Turbonomic activities:

<table>
<thead>
<tr>
<th>Turbonomic Activity</th>
<th>Required Privileges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Read-only for all entity types</td>
</tr>
<tr>
<td>Recommend Actions</td>
<td>Read-only for all entity types</td>
</tr>
<tr>
<td>Wasted Storage Reporting</td>
<td>Datastore &gt; Browse Datastore</td>
</tr>
</tbody>
</table>
**XenServer**

XenServer is a virtualization platform that provides centralized management of virtual resources. The XenServer environment configures hosts as resource pools with shared storage. A resource pool always has at least one physical node that serves as the resource pool master. The master exposes an administration interface, and forwards commands to other members of the pool. Turbonomic connects to a pool through the resource pool master — you specify the resource pool master as a target.

**Prerequisites**

- A service account Turbonomic can use to connect to the XenServer host that serves as a resource pool master. In addition, this account must have administrator privileges on all hosts in the resource pool.
- For full integration, XenServer 6.1 or higher with the Performance Monitoring Enhancements Pack is required. Earlier versions of the API do not provide Turbonomic with storage IOPS and latency information.
- All hosts in the environment must have their clocks synchronized via NTP. Turbonomic is unable to collect utilization data from XenServer hosts if they are not time synchronized.

<table>
<thead>
<tr>
<th>Turbonomic Activity</th>
<th>Required Privileges</th>
</tr>
</thead>
</table>
| Execute VM Move (vMotion)                | Resource > Migrate  
Resource > Query Vmotion  
Resource > Modify Resource Pool  
Resource > Assign VM to Resource Pool     |
| Execute VM Storage Move (svMotion)       | Datastore > Allocate Space  
Datastore > Browse Datastore  
Datastore > Configure Datastore  
Datastore > Move Datastore  
Datastore > Remove File  
Datastore > Update Virtual Machine Files  
Datastore Cluster > Configure a Datastore Cluster  
Resource > Assign VM to Resource Pool  
Resource > Migrate  
Resource > Relocate  
Resource > Modify Resource Pool  
Resource > Move Resource Pool  
Resource > Query VMotion  
Virtual Machine > Configuration > Change Resource  
Virtual Machine > Configuration > Swap File Placement  |
| Execute VM Resize                        | Virtual Machine > Configuration > Change CPU Count  
Virtual Machine > Configuration > Change Resources  
Virtual Machine > Configuration > Memory  
Virtual Machine > Interaction > Reset  
Virtual Machine > Interaction > Power Off  
Virtual Machine > Interaction > Power On  |
| Discover tags                            | Global > Global tags  
In addition, you must open ports 10443 and 7443 on the target server  |
Adding XenServer Targets

To add XenServer targets, select the **Hypervisors > XenServer** option on the Target Configuration page and provide the following information:

- **Address**
  The name or IP address of the Resource Pool Master.

- **Username/Password**
  Credentials for the service account Turbonomic can use to connect to the Resource Pool Master.

Supported Actions

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>Start, Move, Suspend, Resize Down, Resize Up</td>
<td>Terminate, Provision, Storage Move, Reconfigure</td>
</tr>
<tr>
<td>Physical Machine</td>
<td></td>
<td>Start, Suspend, Terminate, Provision</td>
</tr>
<tr>
<td>Datastore (&quot;Storage&quot;)</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

**Entity Type** | **Commodity**
---|---
Virtual Machine | • Virtual Memory (VMem)
                  The utilization of the VMem allocated to the hosting VM
                  Measured in Kilobytes (KB)
• Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
• Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
• Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
• Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Physical Machine | • Memory (Mem)
                  The utilization of the PM's memory reserved or in use
                  Measured in Kilobytes (KB)
• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

Storage

• Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)

• Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second

• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

Datacenter

  NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)
Cloud Management Targets

Cloud-based datacenters support scalability, resource pooling, multi-tenancy, and self-service management of virtual resources. Turbonomic supports the following cloud technologies:

- **Private cloud**
  - Apache CloudStack
  - Microsoft Virtual Machine Manager (VMM)
  - OpenStack Cloud Operating System
  - VMware vCenter Server

- **Public cloud**
  - Amazon Web Services (AWS)
  - IBM SoftLayer
  - Microsoft Azure

- **Hybrid clouds**
  A combination of private and public clouds — Turbonomic can burst workload out to the public cloud to accommodate peaks in demand. For more information about this configuration, see "Hybrid Cloud Configuration" in the User Guide.

Turbonomic can manage private and public clouds, ensuring that applications running on the cloud have enough resources to assure performance. For example, if applications on private cloud need more resources, Turbonomic can recommend that the self-service customer add more virtual resources. Or if necessary, Turbonomic can provision more physical machines to increase the pool of resources available to all the self-service customers.

Cloud infrastructures declare resource pools to serve business needs for multi-tenancy, authorized visibility into the infrastructure, and regional distribution of resources. These pools manage resources such as compute, storage, memory, and network bandwidth in ways that support the cloud’s business requirements. Turbonomic discovers and manages these resource pools in relation to the whole datacenter. This enables Turbonomic to:

- Display cloud resources within each pool
- Analyze workload distribution across the entire datacenter
- Control the distribution of workload at each level of the cloud infrastructure
Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

NOTE: This is a general list of actions for entities discovered for cloud targets. You can see how actions differ per technology in each section that describes adding a specific type of cloud target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

NOTE: This is a general list of commodities for entities discovered for application servers. You can see how actions differ per technology in each section that describes adding a specific type of application server target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
Physical Machine

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

Datacenter

**NOTE:** For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
Cloud Management Targets

- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**
- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**
- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

**Zone**
- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)
Private Cloud

A private cloud manages resources in pools to support multi-tenancy and self-service provisioning of virtual workloads. Turbonomic manages these resource pools in real time as demand fluctuates. This includes demand across resource pools, virtual datacenters (VDCs), and tenants.

On the private cloud, you can use Turbonomic to:

- Set up charge-back and show-back for private cloud or service-provider scenarios
- For service-providers, set up scoped views to limit exposure to the customer base
- Plan hardware requirements — the planning scenarios takes cloud architectures into account

Supply Chain

For private clouds, Turbonomic discovers resource partitions that are managed by the cloud manager, as well as the workload running on these partitions (the VMs and applications) and, where applicable, the supply that hosts workload (the physical machines and storage). Turbonomic represents these partitions as the following types of Virtual Datacenters (VDCs):

- Provider VDC
  A collection of physical resources (PMs and datastores) within a private cloud. The cloud administrator has access to these resources, and defines the datacenter members. Administrators allocate Provider VDCs to manage resources that will be allocated to external customers through one or more Consumer VDCs.
• **Consumer VDC**
  A collection of resources that are available for customers to perform self-service management of workload through the cloud. It is an environment customers can use to store, deploy, and operate virtual systems. Consumer VDCs use the resources supplied by a Provider VDC.

  **NOTE:** Different targets use different names to refer to Virtual Datacenters. In the Turbonomic supply chain, these entities are all represented by Consumer and Provider VDCs, as follows:

<table>
<thead>
<tr>
<th>Turbonomic</th>
<th>vCloud Director</th>
<th>vCenter Server</th>
<th>VMM</th>
<th>CloudStack</th>
<th>OpenStack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer VDC</td>
<td>Organization VDC</td>
<td>Resource Pool (Child)</td>
<td>Tenant or TenantQuota</td>
<td>Accounts</td>
<td>Tenant</td>
</tr>
<tr>
<td>Provider VDC</td>
<td>Provider VDC</td>
<td>Resource Pool (Root)</td>
<td>Cloud</td>
<td>Pod</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Actions

Turbonomic recommends actions for private cloud infrastructures as follows:

**Entity Type** | **Action**
---|---
Provider Virtual Datacenters | Turbonomic does not recommend actions to perform on a Provider VDC. Instead, it recommends actions to perform on the devices running in the datacenter.

Consumer Virtual Datacenters | • Resize Consumer vDC
| • Provision Consumer vDC

### Monitored Resources

Turbonomic monitors the following private cloud infrastructure resources:

**Entity Type** | **Commodity**
---|---
Provider Virtual Datacenter | • Memory (Mem) The utilization of the Datacenter's memory reserved or in use Measured in Kilobytes (KB)
| • CPU The utilization of the Datacenter's CPU reserved or in use Measured in Megahertz (MHz)
| • Storage The utilization of the storage attached to the Provider vDC Measured in Kilobytes (KB)

Consumer Virtual Datacenter | • Memory (Mem) The utilization of the Datacenter's memory reserved or in use Measured in Kilobytes (KB)
• CPU
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

• Storage
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

CloudStack

Apache CloudStack deploys and manages VMs and storage on a multi-tenancy infrastructure. Turbonomic supports CloudStack servers as targets, in an environment where CloudStack manages the hypervisors that you have specified as Turbonomic targets. For information about hypervisor targets, see Hypervisor Targets on page 4.

**NOTE:** After setting a CloudStack server as a target, you must then set the hypervisors that server will manage as targets. If you want Turbonomic to manage CloudStack without specifying the hypervisor targets as well, please contact technical support.

Adding CloudStack Targets

To add CloudStack targets, select the Cloud Management > CloudStack option on the Target Configuration page, and provide the following information:

• Host Name or IP Address
  Name or IP of the CloudStack Management Server, or the primary server in a Management Server Cluster.
  Turbonomic assumes port 443 by default. If your system communicates over a different port, specify that port in the address field.
  For example: 10.10.123.45:444

• Username and Password
  The credentials must be for a Root Administrator user on the Management Server. In addition, this user must have a generated pair of API and Secret keys for the CloudStack API. Turbonomic uses the credentials you provide here to log into the CloudStack server and discover the user’s key values.

Other Information Imported from CloudStack

CloudStack supports Affinity Groups to express rules about VM placement — Currently CloudStack supports anti-affinity rules. Turbonomic discovers these Affinity Groups and imports them as Workload Placement Policies (see "Importing Workload Placement Policies" in the User Guide). Imported rules are enabled by default, but you can disable specific rules if you want.
Actions

Turbonomic recommends the following actions for Cloudstack targets:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbononic monitors the following resources for Cloudstack targets:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>• Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's memory reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's CPU reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• IO</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's IO adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
</tbody>
</table>
• **Net**
The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• **Swap**
The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• **Balloon**
The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• **CPU Ready**
The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**Datacenter**

*NOTE: For datacenter entities, Turbonomic does not monitor resources directly from
the datacenter, but from the physical machines in the datacenter.*

• **Memory (Mem)**
The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

• **CPU**
The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• **IO**
The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

• **Net**
The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• **Swap**
The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• **Balloon**
The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• **CPU Ready**
The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**

• **Memory (Mem)**
The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

• **CPU**
The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
Cloud Management Targets

- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

**DPod**

- **Memory (Mem)**
  The utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)

- **Flow**
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

**OpenStack**

To manage your OpenStack® environment, Turbonomic connects to the Keystone identity service endpoint. Through this connection, Turbonomic discovers the other services it needs to control your OpenStack environment. If it discovers the necessary services, then it considers the OpenStack target to be validated.

Turbonomic has been tested with hypervisors running Openstack on Red Hat Enterprise Linux and Red Hat RDO.

**Prerequisites**

Turbonomic supports OpenStack version Icehouse or later.

You must have the following services installed and enabled, and Turbonomic must have access to each service at its administrative endpoint:

- **Keystone** — Identity service, to support discovery of OpenStack tenants
- **Nova** — Host and manage cloud computing systems (hypervisors)
- **Cinder** — Manage block storage (Cinder volumes)
- **Ceilometer** — Collect and persist data on the utilization of physical and virtual resources (telemetry)
• Gnocchi (Optional) — Collect and persist data on the utilization of physical and virtual resources via a metrics and resources database. Turbonomic recommends using Gnocchi in addition to ceilometer for more consistent metric collection.

To verify that these services are enabled, Open the Horizon dashboard to the Admin/System page, or execute the following command at the OpenStack command line:

[root@openstack ~(keystone_admin)]# keystone service-list

You should see each of the required services in the list.

### Adding OpenStack Targets

To add OpenStack targets, select **Cloud Management > OpenStack** on the Target Configuration page, and provide the following information:

- **Hostname or IP Address**
  Provide the public URL of the Keystone service. The default port is 5000 — Do not provide a port if you want to use the default. For the default port, validation assumes a standard HTTP connection. If you provide a port value (for a port other than 5000), validation assumes a secure HTTPS connection unless you specify the protocol. For example, `10.10.123.45:5001` will use HTTPS, while `http://10.10.123.45:5775` will use HTTP.

- **Username**
  The account must have an administrator role on the specified tenant. This account must be authenticated by OpenStack.

- **Password**
  The password for the administrator account.

- **Tenant Name**
  The organizational structure within the Compute service that you want to manage. In a basic OpenStack installation this tenant is usually named `admin`.

### Enabling Reservations

When you add a valid OpenStack target, Turbonomic can perform its analysis, recommend actions, and perform actions to assure performance and efficiency in your environment. To support these actions, you do not need to perform other configuration.

Turbonomic also includes reservations — deployment capabilities that can act as workload orchestration, or be integrated into an existing orchestration system (see the Deploy View in the Turbonomic user interface). These capabilities include:

• Calculate optimal placement for new workload
• Reserve resources for proposed workload, and include the reservations in real-time and planning analysis

An OpenStack user can use the Turbonomic placement proposals to deploy workload to the optimal locations.

To enable these capabilities, you must install the Turbonomic Nova Scheduler plugin that matches your version of OpenStack. Turbonomic delivers the following versions of this plugin on the Turbonomic Github repository:

• Icehouse

• Juno
Cloud Management Targets

- Kilo
- Mitaka / Newton

To fetch the scheduler plugin you want, execute the following commands on the Nova controller (substituting the url to the version of scheduler plugin that you want):

cd /usr/lib/python2.6/site-packages/nova/scheduler/
curl -O <URL TO CORRECT VERSION OF vmt_scheduler.py>

After you execute these commands to add the plugin to your controller, add the following entries to the file, /etc/nova/nova.conf under the [DEFAULT] section, where you provide the IP address of your Turbonomic server, and credentials for a Turbonomic user account that has administrator privileges:

```
scheduler_driver = nova.scheduler.vmt_scheduler.VMTScheduler
vmturbo_rest_uri = <VMTurbo_IPAddress>
vmturbo_username = <VMTurbo_UserName>
vmturbo_password = <VMTurbo_Password>
```

After you restart the Nova scheduler, it can use the plugin to communicate with your Turbonomic instance.

### Collecting Physical Machine Metrics

To collect full metrics from physical machines in your environment and display them in Turbonomic, the following actions must be taken:

- /etc/ceilometer/pipeline.yaml must be modified to match the following snippets:

```
- name: meter_snmp
  interval: 600
  resources:
  - [Compute Node FQDN]
  - [Compute Node FQDN]
  - [Compute Node FQDN]

  meters:
  - "hardware.cpu*"
  - "hardware.memory.used"
  - "hardware.disk.size.used"

  sinks:
  - meter_sink
  - name: meter_snmp_rate
    interval: 600
    resources:
    - [Compute Node FQDN]
    - [Compute Node FQDN]
    - [Compute Node FQDN]

    meters:
    - "hardware.network*"
    - "hardware.system_stats*"

    sinks:
    - snmp_sink
  - name: snmp_sink
    transformers:
    - name: "rate_of_change"
```
parameters:
source:
map_from:
name:
"hardware\.(system_stats.io|network)\.(incoming|outgoing)\.(blocks|bytes)"
unit: "(blocks|B)"
target:
map_to:
name: "hardware.\1.\2.\3.rate"
unit: "\1/s"
type: "gauge"
publishers:
- notifier://

- After modifying this file, you will need to create a `snmpd.conf` file. For information about creating this file, contact Technical Support.

The following Green Circle article includes instructions for this procedure: OpenStack Compute Node Changes to Enable PM Metric Collection.

After these modifications are made, OpenStack will collect all available metrics for physical machines.

**Actions**

Turbonomic recommends actions for the cloud target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

**Monitored Resources**

Turbonomic monitors the following resources for the cloud target supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
• Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB)

• Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS

• Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

**Physical Machine**

• Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)

• CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)

• IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)

• Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)

• Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)

• Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)

• CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

**Datacenter**

*NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.*

• Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)

• CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)

• IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)

• Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
• **Swap**
  The utilization of the PM’s swap space
  Measured in Kilobytes (KB)

• **Balloon**
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**

• **Memory (Mem)**
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

• **CPU**
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

• **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

• **Memory (Mem)**
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

• **CPU**
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

• **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

**vCloud Director**

A vCloud Director environment has one or more vCloud Director servers (sometimes called cells) to build a multi-tenant private cloud by pooling resources managed by vCenter Servers. For typical installations, each vCloud Director cell manages one vCenter Server instance.

A Provider Virtual Datacenter combines the compute and memory resources from a single vCenter Server with the storage available to that vCenter Server into a single pool of resources to provide to an organization, and an Organization Virtual Datacenter uses the resources in a Provider Virtual Datacenter to present virtual compute and storage to the user.

In addition, Turbonomic will:

• Import Elastic VDC settings and represent them as Provider VDCs where appropriate
• Create Merge Cluster policies for clusters added to the same Provider VDC automatically
• Discover VM metadata defined in vCloud Director as entity tags that may be used for grouping within Turbonomic.
Prerequisites

- vCloud Director account with System Administrator role
- vCenter service account with privileges to execute Turbonomic actions. For information about service accounts on vCenter Server, see Creating A Service User Account In vCenter on page 24

Adding vCloud Director Targets

**NOTE:** If any of the vCenter Servers that are connected to vCloud Director are already added as targets in Turbonomic, they must be deleted prior to adding vCloud Director.

A vCloud Director target must specify the address and user of a vCloud Director server and also a service account on the associated vCenter Server instance.

If the credentials for the vCenter Server service account are not valid, then the target will fail to validate in Turbonomic.

To add vCloud Director targets, select the **Cloud Management > vCloud Director** option on the Target Configuration page, and provide the following information:

- **Address**
  Host name or IP address of the vCloud Director Server.

- **Username**
  The username for an account on the vCloud Director server that has a System Administrator role.

- **Password**
  The password for the System Administrator account.

- **VC User Name**
  The username for a service account on the vCenter Servers that are managed by this vCloud Director.

- **VC Password**
  The password for the service account on the vCenter Server.

After successfully adding your target, it may take up to two market cycles (typically 20 minutes) for Turbonomic to display all relationships between vCloud Director entities.

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtual Machines</strong></td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td><strong>Physical Machines</strong></td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td><strong>Consumer Virtual Datacenters</strong></td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>
## Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

### Entity Type

#### VirtualMachine
- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

#### Physical Machine
- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)
**Datacenter**

**NOTE:** For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)
Virtual Machine Manager

In a VMM environment, the VMM management server processes commands and controls communications with the Hyper-V hosts. To manage VMM, you set the management server as a target. Turbonomic communicates with that target, and also with the Hyper-V hosts that the VMM server manages. For this reason, if you add a VMM target, you should not also add individual Hyper-V hosts as targets. You must grant Turbonomic access to the VMM management server, and also to all the associated Hyper-V machines.

Prerequisites

- Configure remote management on the VMM management Hyper-V server. Refer to the relevant section below:
  - Turbonomic 5.4 or higher: See "Enabling Windows Remote Management" in the User Guide
  - Turbonomic 5.3 or below: See Enabling Management via DCOM on page 201
- Apply necessary hot fixes on the VMM host
  For example, if you are running VMM Server on a Windows Server version earlier than Windows Server 2012 R2, you must apply the hotfix referenced in the Microsoft Knowledge Base article #2842230 (http://support.microsoft.com/kb/2842230).
- Apply time synchronization
  The VM that hosts Turbonomic must be synchronized with each target VMM management server. The Turbonomic Installation Guide includes instructions for synchronizing the clock on the Turbonomic server.
- PowerShell execution must be enabled on the VMM management server.
- Configure port access
  WinRM uses ports 5985 and 5986 for standard and secure communications, respectively. The firewall on your VMM server must open these ports.
- Preexisting Hyper-V Targets
  If any of the hosts that make up the VMM target were added separately as Hyper-V targets (and you do not plan to exclude these hosts), these targets must be deleted. Failure to do so will create duplicate entities in the market, which will negatively impact Turbonomic performance.

Adding VMM Targets

Turbonomic uses the address and credentials you provide to discover the VMM target. From the VMM target, Turbonomic gets the list of managed Hyper-V instances. It then uses that list to discover each Hyper-V instance. The Hyper-V credentials you provide must be valid for all of these machines.

Turbonomic will also import your Availability Sets, representing them as placement policies for the affected infrastructure.

To add VMM targets, select the Cloud Management > VMM option on the Target Configuration page, and provide the following information:
- The IP address or host name of the VMM management server
- Which port to use for the WSMan connection
  For a standard connection (HTTP) use 5985. For a secure connection (HTTPS) use 5986.
- Enable or disable a secure connection
  If you enable a secure connection, then you must configure a certificate, and you must configure Turbonomic to communicate over HTTPS. For more information, see Secure Setup of WSMan on page 202.

Note that setting a secure connection for VMM does not also set secure connections for the underlying Hyper-V hosts. Any communications between Turbonomic and VMM will be secure. To configure secure connections to the underlying Hyper-V hosts, you must specify secure connections on each one.
Cloud Management Targets

- Full domain name for the user account
  This domain name identifies the user account for Active Directory authentication.
- Login credentials for the Hyper-V servers that are managed by the VMM target (Optional)
  Turbonomic must log into the Hyper-V servers that the VMM server manages. If you leave the Hyper-V credentials blank, then it will use the same credentials that VMM uses. If you provide Hyper-V credentials, then it will use that service account to log into every Hyper-V managed by the VMM.
  Note that the service account Turbonomic uses to log into a Hyper-V host must satisfy certain requirements. For more information, see Creating A Service User Account on page 16.
- Hosts in the VMM target that you would like to exclude from Turbonomic.
  Turbonomic will not discover or manage any hosts you enter in this field. These hosts do not participate in the market, and Turbonomic does not generate actions that involve these hosts. Enter multiple hosts in a comma-separated list. This field accepts both host names, and FQDNs (Fully Qualified Domain Names), and allows the use of the wildcard characters * and ?.

Microsoft VMM and Hyper-V VLANs

Windows Server Hyper-V provides support for VLANs on host and VM partitions. If your Hyper-V environment makes use of this VLAN support, then your VM moves must be sensitive to which hosts provide networking access to your defined VM networks. If a VM is a member of a given VM network, then any move of that VM must be to a host that has access to the same network.

For Hyper-V targets in a VMM environment, the Cloud Control Module is aware of the VM networks, and ensures that a move is to a host that provides connectivity over the given VM network. For example, if Host 1 and 2 provide connectivity to VM Network A, and Host 3 and 4 provide connectivity to VM Network B, Turbonomic will never recommend a VM with access to Network A, residing on Host 1, to move to Host 3. That would render the VM unable to communicate on Network A.

Configuring SMB 3.0 File Shares Discovery

With VMM, Turbonomic can discover SMB 3.0 shares as datastores, assuming these shares have been properly added to your VMM service center. When you add shares to your VMM environment, be sure to:

- Use the Fully Qualified Domain Name of the file server
  As you the associated file server to your VMM environment (via the Add Storage Devices Wizard), be sure to specify the FQDN of the file server on the Specify Discovery Scope page of the wizard. Do not use the file server’s IP address.
- Ensure that file server names are unique
  Do not specify file servers with the same name, even if they belong to different domains. Turbonomic requires the file server names to be unique.

For information about setting up SMB 3.0 shares, please refer to your Microsoft documentation. For example, see “How to Assign SMB 3.0 File Shares to Hyper-V Hosts and Clusters in VMM”.

48
VMM SDK Probe Properties

Turbonomic offers the capability to adjust certain properties of the probe. In general, this tweaking will not be necessary. If adjustment is needed, the file can be found in the `/srv/tomcat/webapps/vmturbo/probe-jars/{probe}/resources` folder. This target has the following properties:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>maxEnvelopeSize</code></td>
<td>Maximum size of SOAP response envelope</td>
</tr>
<tr>
<td><code>timeout</code></td>
<td>Determines the timeout in milliseconds for both initial connection and discovery, and maximum period between data packets</td>
</tr>
<tr>
<td><code>executorThreadPoolSize</code></td>
<td>Size of the thread pool for Discovery process</td>
</tr>
<tr>
<td><code>hypervExecutorThreadPoolSize</code></td>
<td>Size of the thread pool for host discovery within the VMM target. One thread per cluster, and one per standalone host</td>
</tr>
<tr>
<td><code>vmmExecutorThreadPoolSize</code></td>
<td>Size of the thread pool used to execute VMM commands in parallel</td>
</tr>
<tr>
<td><code>connectorFactoryThreadPoolSize</code></td>
<td>Size of the thread pool used to create connection instances</td>
</tr>
<tr>
<td><code>vmmRequestChunkSize</code></td>
<td>Number of VMM commands issued in one chunk</td>
</tr>
<tr>
<td><code>shellRequestPollerInterval</code></td>
<td>Time in milliseconds to poll for completion of PowerShell commands</td>
</tr>
<tr>
<td><code>shellRequestTimeout</code></td>
<td>Time in milliseconds to retrieve result of PowerShell commands</td>
</tr>
<tr>
<td><code>conversionObjectsBatchSize</code></td>
<td>Maximum amount of internal objects that should be converted into EntityDTO in one batch</td>
</tr>
<tr>
<td><code>queriesThreadPoolCoreSize</code></td>
<td>Number of threads that will remain in the thread pool even if idle timeout is exceeded. This number should be lower or equal to <code>queriesThreadPoolMaximumSize</code></td>
</tr>
<tr>
<td><code>queriesThreadPoolMaximumSize</code></td>
<td>Maximum number of threads that will be used by the thread pool</td>
</tr>
<tr>
<td><code>queriesThreadPoolIdleTimeout</code></td>
<td>Time in seconds before a thread will time out if number of active threads are above <code>queriesThreadPoolCoreSize</code></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>hostThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool responsible for simultaneous discovery of host instances. This number should be lower or equal to hostThreadPoolMaximumSize</td>
</tr>
<tr>
<td>hostThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool responsible for simultaneous discovery of host instances</td>
</tr>
<tr>
<td>hostThreadPoolIdleTimeout</td>
<td>Time in seconds before a thread will time out if number of active threads are above hostThreadPoolCoreSize</td>
</tr>
<tr>
<td>clusterThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool for handling requests to Hyper-V targets. This number should be lower or equal to clusterThreadPoolMaximumSize</td>
</tr>
<tr>
<td>clusterThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool responsible for handling requests to Hyper-V hosts</td>
</tr>
<tr>
<td>clusterThreadPoolIdleTimeout</td>
<td>Time in seconds before a thread will time out if number of active threads are above clusterThreadPoolCoreSize</td>
</tr>
<tr>
<td>hypervCommonThreadPoolCoreSize</td>
<td>Number of threads that will remain in the thread pool responsible for miscellaneous SDK tasks</td>
</tr>
<tr>
<td>hypervCommonThreadPoolMaximumSize</td>
<td>Maximum number of threads that will be used by the thread pool responsible for miscellaneous SDK tasks. This number should be lower or equal to hypervCommonThreadPoolMaximumSize</td>
</tr>
<tr>
<td>hypervCommonThreadPoolIdleTimeout</td>
<td>Time in seconds before a thread will time out if number of active threads are above hypervCommonThreadPoolCoreSize</td>
</tr>
<tr>
<td>actionStepCheckSucceededTimeout</td>
<td>Time in milliseconds to wait before triggering the next step in an action chain</td>
</tr>
<tr>
<td>actionStepCheckAmount</td>
<td>Number of times to poll for an action is complete before failure</td>
</tr>
<tr>
<td>actionStepCheckTimeout</td>
<td>Time in milliseconds between action checks</td>
</tr>
<tr>
<td>requestsPerHost</td>
<td>Maximum number of simultaneous requests per host</td>
</tr>
</tbody>
</table>
Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>• Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM’s memory reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM’s CPU reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• IO</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM’s IO adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
</tbody>
</table>
Cloud Management Targets

- Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- CPU Ready
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**Datacenter**

*NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.*

- Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

- CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

- IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- Balloon
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- CPU Ready
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**

- Memory (Mem)
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- CPU
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
Public Cloud

Using the Cloud Naive Edition of Turbonomic, public cloud provides compute, storage, and other resources on demand. You can run all of your infrastructure on a public cloud, or you can set up a hybrid environment where you burst workload to the public cloud as needed. Turbonomic can analyze the performance of applications running on the public cloud, and provision more instances as demand requires. For a hybrid environment, Turbonomic can provision copies of your application VMs on the public cloud to satisfy spikes in demand, and as demand falls off it can suspend those VMs if they’re no longer needed.

On the public cloud, you can use Turbonomic to:

- Extend resource allocation across hybrid clouds
- Locate the most efficient workload placement within the hybrid environment, while assuring performance
- Perform elastic load balancing for application groups deployed to the public cloud

Cloud-based datacenters support scalability, resource pooling, multi-tenancy, and self-service management of virtual resources. Turbonomic supports the following cloud technologies:

Supply Chain

For public clouds, Turbonomic discovers Regions and Zones, and adds them as Datacenter Entities. Regions and zones divide the public cloud into managed subsets. A region is typically associated with the geographic location of the cloud resources, and a zone is some division within the region. One region contains multiple zones.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td>Start VM on the Zone</td>
</tr>
<tr>
<td></td>
<td>Suspend VM on the Zone</td>
</tr>
</tbody>
</table>
Amazon Web Services

Amazon Web Services (AWS) provides a reliable and scalable infrastructure platform in the cloud. You gain access to this infrastructure through a subscription account. To specify an AWS target, you provide the credentials for that account and Turbonomic discovers the resources available to you through that account.

Adding AWS Targets

For Turbonomic to manage an AWS account, you provide the Access Key credentials that you use to access that account. For information about getting an Access Key for an AWS account, see the Amazon Web Services documentation.

To add AWS targets, select Cloud Management > AWS on the Target Configuration page, and provide the following information:

• Address
  You can leave this blank, or enter any value for identification purposes
• Access Key
  Provide the Access Key for the account you want to manage.
• Secret Access Key
  Provide the Access Key Secret for the account you want to manage.
• IAM Role ARN
  The Amazon Resource Name given to the IAM Role
• Proxy Host
  The IP of your Proxy Host
• Proxy Port
  The port required for the proxy above
• Cost and Usage Report Bucket
  Name of the S3 bucket that contains the AWS Cost and Usage report.
• Cost and Usage Report Region
  Region of the S3 bucket that contains the AWS Cost and Usage report.
• Cost and Usage Report Path
  Path in the S3 bucket to the AWS Cost and Usage report.
• ARN Account ID
  When not empty, Turbonomic will add the AWS target via the ARN. This field is required when using an IAM Role.

**NOTE:** Turbonomic supports logging in to AWS targets via AWS Identity and Access Management (IAM) with IAM Users or IAM Roles. To enable using IAM Roles, you must run the Turbonomic software on an EC2 instance in the AWS cloud, and you must have the Turbonomic instance run as the IAM Role, and connect to the AWS target accounts with the appropriate IAM Role. To perform these actions, please contact Technical Support.

Cost and Usage Report

In order for Turbonomic to display month-to-day spend, you must create a cost and usage report in AWS and store it in an S3 bucket.

For more information, see Displaying AWS Spend In Turbonomic.
Managing Reserved Instances

If you use RIs in your AWS environment, then Turbonomic analysis can calculate which workloads to migrate to cloud RIs, how to reduce your cloud costs by taking advantage of RIs, and it can show you RI coverage, costs, and savings.

To take advantage of this analysis, you must be sure to add all AWS accounts in a billing family to Turbonomic. In addition, you must only add accounts from one billing family. If you do not, then it’s possible that a VM that Turbonomic manages consumes resources from an RI that is not visible from any of the attached AWS targets. If this happens, then the values that Turbonomic shows for RI savings can be incorrect.

IAM Authentication

To connect to an AWS target via IAM, Turbonomic requires an IAM User for authentication. This user must have the following permissions:

**NOTE:** Turbonomic recommends that you set up IAM access via an IAM group that has the necessary permissions. After you create this group, create a user that is a member of it and specify that user for Turbonomic to access your AWS environment. For more information on IAM Groups, see [http://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html](http://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html).

The Turbonomic user account must have the following permissions:

For read access:

Use these permissions to gain insight into your environment, including utilization statistics and costs for workloads and services. Turbonomic can recommend actions, but this account cannot execute them.

- AmazonRDSReadOnlyAccess
- AmazonEC2ReadOnlyAccess
- AmazonS3ReadOnlyAccess

For write access (Action Execution):

Use these permissions to gain insight into your environment, and to automate actions based on Turbonomic analysis.

- AmazonRDSFullAccess
- AmazonEC2FullAccess
- AmazonS3ReadOnlyAccess

Turbonomic also supports logging in to AWS targets via IAM Roles. To enable using Roles, you must run the Turbonomic software on an EC2 instance in the AWS cloud, and you must have the Turbonomic instance run as the IAM Role, and connect to the AWS target accounts with the appropriate IAM Role. To perform these actions, please contact Turbonomic Technical Support.

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

**Entity Type** | **Action**
--- | ---
Virtual Machines (Cloud) | • Resize up to template (based on VMem / VCPU)
 | • Resize down to template (based on VMem / VCPU)
 | • Move Virtual Machine (intra-cloud)
NOTE: This is a destructive move—data / applications are not preserved. This action also requires both a Turbonomic merge policy and the moved VM to be a linux VM with template configuration.

Zone
- Start VM on the Zone
- Suspend VM on the Zone

Monitored Resources
Turbonomic monitors the following resources for the cloud target supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>

Datacenter
NOTE: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)
The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

**Provider Virtual Datacenter**
- **Memory (Mem)**
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**
- **Memory (Mem)**
  The utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

**DPod**
- **Memory (Mem)**
  The utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the DPod’s CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)

- **Flow**
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

**IBM SoftLayer**

IBM SoftLayer is an infrastructure platform for the public cloud. You gain access to this infrastructure through a subscription account. To specify a SoftLayer target, you provide the credentials for that account and Turbonomic discovers the resources available to you through that account.
Adding SoftLayer Targets

To add SoftLayer targets, select **Cloud Management > Softlayer** on the Target Configuration page, and provide the following information:

- **Address**
  You can leave this blank, or enter `control.softlayer.com`
- **Username**
  For this field, provide the user name for the account you want to manage.
- **Password**
  Provide the Authentication Key for the account you want to manage.

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Zone</td>
<td>• Start VM on the Zone</td>
</tr>
<tr>
<td></td>
<td>• Suspend VM on the Zone</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
**Datacenter**

**NOTE:** For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

---

**Provider Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

---

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)
Cloud Management Targets

DPod

- Memory (Mem)
  The utilization of the DPod’s memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the DPod’s CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- Flow
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

Microsoft Azure

Microsoft Azure is Microsoft’s infrastructure platform for the public cloud. You gain access to this infrastructure through a subscription account. To specify an Azure target, you provide the credentials for that account and Turbonomic discovers the resources available to you through that account.

It’s common for Cloud operators to host Web applications in Azure. For tips on configuring Web applications to manage with Turbonomic, see the Green Circle article, “How to create and configure a Web Application in Azure for VMTurbo OpsManager 5.6+”.

Prerequisites

- External access via Client/App ID
- Azure Resource Manager **NOTE**: Turbonomic will not discover Azure Classic virtual machines, as they do not utilize the Azure Resource Manager.

External Access via Client/App ID

The administrator of an Azure account can register a Web App with the account — This gives an external application access to the account’s resources. Turbonomic connects to an Azure target via a Web App registered for that Azure account.

To register a Web App with your account:

- Log into the Azure Management Portal
- Add a Web App to an available Active Directory — The Active Directory will correspond with the Tenant ID that you set for the target.
- From the Application’s page in the Management Portal, go to the Configure page
  This page displays the generated Client App ID and Client Secret Key for this app.

**NOTE**: The person who registers the Web App must record the generated secret key. You can return to the Management Portal to see the Client App ID, but the portal only shows the Secret Key when you register that app.

For more information, refer to your Microsoft Azure documentation.
Adding Azure Targets

To add Azure targets, select **Cloud Management > Azure** on the Target Configuration page, and provide the following information:

- **Address**
  You can leave this blank, or enter `management.core.windows.net`.
  **NOTE:** For targets located in Germany, you must provide an Address entry. It can be any text, so long as it ends with `.de`. For example, `management.core.windows.de`.

- **Subscription ID**
  The ID for your Azure subscription.

- **Tenant ID**
  The ID of the tenant you want to manage in your Azure subscription.

- **Client App ID**
  The Client/App ID of the Web App that gives Turbonomic access to resources in your Azure subscription.

- **Client Secret Key**
  The secret key for the Web App.

### Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines (Cloud)</td>
<td>• Resize up to template (based on VMem / VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Resize down to template (based on VMem / VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine (intra-cloud)</td>
</tr>
</tbody>
</table>

**NOTE:** This is a destructive move—data / applications are not preserved. This action also requires both a Turbonomic merge policy and the moved VM to be a Linux VM with template configuration.

<table>
<thead>
<tr>
<th>Consumer Virtual Datacenters</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td></td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

### Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
• Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

• Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

• Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Datacenter

  **NOTE:** For datacenter entities, Turbonomic does not monitor resources directly from
  the datacenter, but from the physical machines in the datacenter.

• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• Balloon
  The utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Kilobytes (KB)

Provider Virtual Datacenter

• Memory (Mem)
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)

• Storage
  The utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)
**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the Consumer vDC.
  Measured in Kilobytes (KB)

**DPod**

- **Memory (Mem)**
  The utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- **Flow**
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)
Storage Targets

Adding a storage Target enables Turbonomic to connect to your storage subsystem through an SMI-S provider API or through the controller's native API. Turbonomic uses the target's API to access information about each of the underlying disk arrays, and uses this information to set disk performance characteristics according to the type and capacity of storage. This leads to improved workload placement. Similarly, Turbonomic knows the relationships between storage controllers and disk arrays, and about the location of datastores within those arrays. This information also helps optimize workload placement.

The section below describes the storage supply chain. For information on how to add specific storage targets, the resources Turbonomic can monitor for the various supply chain entities, and the actions it can take to optimize the environment, refer to the target configuration instructions for your specific storage type.

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities in turn host Storage entities (datastores).

Entity Mapping

<table>
<thead>
<tr>
<th>Turbonomic Mapping</th>
<th>Dell Compellent</th>
<th>EMC VMAX</th>
<th>EMC VNX</th>
<th>EMC XtremIO</th>
<th>HPE 3Par</th>
<th>NetApp</th>
<th>Nutanix</th>
<th>Pure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Volume</td>
<td>Volume (Regular, Thin, Meta)</td>
<td>LUN, Data Store, Volume</td>
<td>Volume</td>
<td>Virtual Volume</td>
<td>Volume</td>
<td>Container</td>
<td>Volume</td>
</tr>
<tr>
<td>Disk Array</td>
<td>Storage Type</td>
<td>Disk Group or Thin Pool</td>
<td>Raid Group, Storage Pool</td>
<td>XTremIO Cluster</td>
<td>CPG</td>
<td>Aggregate</td>
<td>Storage Pool</td>
<td>Shelf Array</td>
</tr>
<tr>
<td>Storage Controller</td>
<td>Storage Center</td>
<td>VMAX Array</td>
<td>Storage Processor</td>
<td>XTremIO Cluster</td>
<td>Controller</td>
<td>Controller / Filer</td>
<td>Controller VM</td>
<td>Controller</td>
</tr>
</tbody>
</table>
Actions

Turbonomic recommends actions for storage targets as follows.

**NOTE:** This is a general list of actions for storage managed by storage controllers. Specific actions Turbonomic can recommend, and which actions it can automate depends on the actual technology — Not all actions make sense for all types of storage. For example, Turbonomic can automate a datastore move across disk arrays or storage controllers for NetApp in C mode, but not for other storage technologies. For another example, Turbonomic doesn’t recommend an action to provision a datastore on Nutanix because that platform includes datastores with each node — to increase storage capacity you would provision a Nutanix node.

You can see how actions differ per technology in each section that describes adding a specific type of Storage Manager target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Start Storage</td>
</tr>
<tr>
<td></td>
<td>• Provision Storage</td>
</tr>
<tr>
<td></td>
<td>• Suspend Storage</td>
</tr>
<tr>
<td></td>
<td>• Move (only with Storage Targets configured)</td>
</tr>
<tr>
<td></td>
<td>• Resize (only with Storage Targets configured)</td>
</tr>
<tr>
<td>Disk Arrays</td>
<td>• Provision Disk Array</td>
</tr>
<tr>
<td></td>
<td>• Start Disk Array</td>
</tr>
<tr>
<td></td>
<td>• Suspend Disk Array</td>
</tr>
<tr>
<td></td>
<td>• Move Disk Array (for NetApp Cluster-Mode, only)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Datastore</td>
</tr>
<tr>
<td>Storage Controller</td>
<td>• Provision Storage Controller (recommendation only)</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the data-store</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
</tbody>
</table>
Storage Targets

- **Latency**
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

**Disk Array**

- **Storage Amount**
  The utilization of the Disk Array's capacity.
  Measured in Megabytes (MB)
- **Storage Provisioned**
  The utilization of the Disk Array's capacity, including overprovisioning.
  Measured in Megabytes (MB)
- **Storage Access Operations Per Second (IOPS)**
  The summation of the read and write access operations per second on the disk array
  Measured in Operations per second
- **Latency**
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

**Storage Controller**

- **CPU**
  The utilization of the Storage Controller's CPU in use
  Measured in Megahertz (MHz)
- **Storage Amount**
  The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
  Measured in Megabytes (MB)

---

**Dell Compellent**

Turbonomic supports the management of Dell SC Series (Compellent) disk arrays and storage controllers. Turbonomic connects through the Dell Enterprise Manager and performs management as a client of the Enterprise Manager Data Collector.

The Dell Enterprise Manager is a management service that provides administration, management, and monitoring of multiple Storage Centers — Typically installed on a Windows VM.

When you specify a Dell Compellent target, you provide the IP address of the Dell Enterprise Manager. Turbonomic discovers the Compellent infrastructure through the SMI-S component which is typically installed as part of the Enterprise Manager.

**NOTE:** Before adding the Dell Compellent target to Turbonomic, confirm that the Storage Centers you want to manage show up in Dell Enterprise Manager (see “Storage Center Administration” in the Dell Compellent Enterprise Manager Administrator's Guide). The SMI-S user account must be able to access all of the Storage Centers. If you add or remove Storage Centers later, Turbonomic will detect the changes during its next discovery cycle.
Prerequisites

- Dell Enterprise Manager Data Collector Service 6.2 or higher
- Dell Compellent SMI-S Provider
- Storage Centers added to Dell Enterprise Manager

Setting Up the Dell Compellent SMI-S Provider

Your Dell Compellent storage environment must include an enabled Dell Compellent SMI-S Provider. Configure the SMI-S Provider as described in the “SMI-S” section of the Dell Storage Manager Administrator’s Guide. The guide provides detailed steps to:

- Open the required ports on the server hosting the Enterprise Manager Data Collector.
- Enable SMI-S for the Data Collector.
- Add a user for SMI-S.
- If using HTTPS, associate the SSL certificate with the SMI-S Provider.

For more information, customers using a version of the Dell Storage Manager older than DSM 2016 R3 find the following Green Circle article useful: Configuring VMTurbo Operations Manager to discover Dell Compellent Targets

Adding Dell Compellent Targets

To add Dell Compellent targets, select the Storage > Dell Compellent option on the Target Configuration page and provide the following information:

- Address
  The name or IP address of the Dell Enterprise Manager.
  By default, Enterprise Manager provides SMI-S data over port 5988 (HTTP). If your installation uses a different port for SMI-S, include the port number in the Address field.
- Username/Password
  Credentials for the SMI-S user you added when setting up the SMI-S provider.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in the Dell Enterprise Manager to those used in Turbonomic:

<table>
<thead>
<tr>
<th>Dell Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Center</td>
<td>Storage Controller</td>
</tr>
<tr>
<td>Storage Type</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
</tbody>
</table>
Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.

Supported Actions

Turbonomic supports the following actions for Dell Compellent entities:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td></td>
<td>Move, Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision, Resize Up</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount&lt;br&gt;The utilization of the datastore's capacity&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the datastore's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The summation of the read and write access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• Latency&lt;br&gt;The utilization of latency on the datastore&lt;br&gt;Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td>Disk Array</td>
<td>• Storage Amount&lt;br&gt;The utilization of the Disk Array's capacity.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the Disk Array's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The summation of the read and write access operations per second on the disk array&lt;br&gt;Measured in Operations per second</td>
</tr>
</tbody>
</table>
- Latency
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

**Storage Controller**
- CPU
  The utilization of the Storage Controller's CPU in use
  Measured in Megahertz (MHz)
- Storage Amount
  The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
  Measured in Megabytes (MB)

---

**EMC ScaleIO**

EMC ScaleIO is an example of Software-Defined Storage for the datacenter. It creates a Virtual SAN overlaying commodity infrastructure that consists of multiple LAN-connected Servers with locally attached commodity Storage. It presents a standard Block Storage interface to Applications accessing the Virtual SAN.

Turbonomic communicates with the EMC ScaleIO system via the REST API Gateway.

**Prerequisites**
- EMC ScaleIO 2.x
- A service account that Turbonomic can use to connect to the ScaleIO Gateway.

**Adding EMC ScaleIO Targets**

To add EMC ScaleIO targets, select the **Storage > EMC ScaleIO** option on the Target Configuration page and provide the following information:
- Address
  The IP or hostname of the Gateway.
- Username
  The Username for the Gateway service account.
- Password
  The Password for the Gateway service account.
Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in EMC ScaleIO to those used in Turbonomic:

<table>
<thead>
<tr>
<th>EMC ScaleIO Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>Storage Pool</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Protection Domain</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Provision (Cloning)</td>
<td>Resize (Disabled by default)</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Resize Disk Array</td>
</tr>
<tr>
<td>Protection Domain</td>
<td></td>
<td>Provision (Cloning)</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount&lt;br&gt;The utilization of the datastore's capacity&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the datastore's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The summation of the read and write access operations per second on the datastore&lt;br&gt;Measured in Operations per second</td>
</tr>
<tr>
<td>Disk Array</td>
<td>• Storage Amount&lt;br&gt;The utilization of the Disk Array's capacity.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the Disk Array's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)</td>
</tr>
</tbody>
</table>
EMC VMAX

Turbonomic supports management of VMAX2 and 3 Series storage arrays. The VMAX series is a family of enterprise storage arrays designed for SAN environments. Turbonomic connects to VMAX storage systems via an EMC SMI-S provider that has the disk arrays added to it. A single SMI-S provider can communicate with one or more disk arrays. When you specify an SMI-S provider as a target, Turbonomic discovers all the added disk arrays.

Turbonomic will create Storage Groups based on the SLO levels defined in VMAX3 Targets. By default, Storage Move actions will respect these SLO levels based on the configured response time.

Prerequisites

- EMC SMI-S Provider V8.x
- A service account that Turbonomic can use to connect to the EMC SMI-S Provider (typically the default admin account)

Adding VMAX Targets

To add VMAX targets, select the Storage > VMAX option on the Target Configuration page and provide the following information:

- Address
  The IP or hostname of the SMI-S provider. If using HTTPS, you must follow the IP with :PORT.
- Username
  The Username for the SMI-S provider.
- Password
  The Password for the SMI-S provider.
Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in EMC VMAX to those used in Turbonomic:

<table>
<thead>
<tr>
<th>EMC VMAX Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Regular, Thin, Meta)</td>
<td>Storage</td>
</tr>
<tr>
<td>Storage Resource Pool (VMAX3) / Thick Provisioned Pool</td>
<td>Disk Array</td>
</tr>
<tr>
<td>(earlier)</td>
<td></td>
</tr>
<tr>
<td>Storage Group (VMAX3) / Thin Provisioned Pool (earlier)</td>
<td>Logical Pool</td>
</tr>
<tr>
<td>VMAX Array</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Provision (Cloning), Delete</td>
<td>Resize (V-Volumes only)</td>
</tr>
<tr>
<td>Logical Pool</td>
<td></td>
<td>Resize</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

Monitored Resources

When calculating available storage, Turbonomic excludes disks devoted to the VMAX operating system by default. If these disks are assigned to new raid groups or storage pools, the capacity of those disks will then be considered when calculating the capacity of the Storage Controller.

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
</tbody>
</table>
• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

Logical Pool

• Storage Amount
  The utilization of the logical pool's capacity.
  Measured in Megabytes (MB)
• Storage Provisioned
  The utilization of the logical pool's capacity, including overprovisioning.
  Measured in Megabytes (MB)
• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the logical pool.
  Measured in Operations per second
• Latency
  The utilization of latency on the logical pool.
  Measured in milliseconds (ms)

Disk Array

• Storage Amount
  The utilization of the Disk Array's capacity.
  Measured in Megabytes (MB)
• Storage Provisioned
  The utilization of the Disk Array's capacity, including overprovisioning.
  Measured in Megabytes (MB)
• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the disk array
  Measured in Operations per second
• Latency
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

Storage Controller

• Storage Amount
  The utilization of the storage controller's capacity.
  Measured in Megabytes (MB)

EMC VNX

Turbonomic supports management of EMC VNX (not VNXe) file and block level storage systems, as well as unified VNX configurations. The requirements for specifying a VNX target differ, depending on the type of storage system you want to manage:

• File level storage
  Turbonomic connects to the VNX Control Station to discover and collect data from connected storage volumes.
• Block level storage
  Turbonomic uses the EMC SMI-S Provider to discover and collect data from block-level disk arrays and the controllers/storage processors in the VNX environment. A single SMI-S provider can communicate with multiple arrays.

• Unified configuration
  For unified (block and file) implementations, configure one VNX target for block and another VNX target for file.

Prerequisites

• For block level storage or unified configurations: EMC SMI-S Provider 4.6.2 (See below)
• For file level storage, VNX Control Station
• Firewall ports for the SMI-S provider
  On the system that hosts the SMI-S provider you may need to open the following ports:
  - UDP port 427
  - TCP ports 5988 and 5989
• A service account Turbonomic can use to connect to the target:
  - File level storage: An account with administrator privileges on the VNX Control Station (nasadmin).
  - Block level storage: An account with administrator privileges on the SMI-S provider host.

EMC SMI-S Provider Setup Requirements

NOTE: The SMI-S Provider is required for block level storage and unified configurations only. If you are using file level storage only, you do not need the SMI-S Provider.

1. **Download EMC SMI-S Provider 4.6.2 from the EMC Support website.**

2. **Install the SMI-S Provider.**
   Perform installation according to the installation instructions in the EMC SMI-S Provider Release Notes. When installing the provider:
   • In the Providers list, select the “Array Provider” (not the “Host Provider”).
   • If prompted to select which Stordaemon Services to install and start, select “EMC SE SYMAPI Server Daemon.”

3. **Add storage resources to the SMI-S provider.**
   Use the “testsmiprovider” utility to add the disk arrays/pools you want to manage. Find instructions in the “Out-of-band discovery method” section of the EMC SMI-S Provider Release Notes.

The SMI-S Provider communicates over UDP port 427 and TCP ports 5988 and 5989. If a firewall is running on the server hosting the provider, these ports must be open. Also, the SMI-S Provider service must be running at all times.

NOTE: If you are running a Vblock environment or are using the Cisco UCS Converged Fabric, you may be using a Cisco SMI-S provider. Turbonomic requires the EMC SMI-S Provider. Since both providers use the same TCP port, install the EMC provider on its own system.
Adding EMC VNX Targets

To add EMC VNX targets, select the **Storage > EMC VNX** option on the Target Configuration page and provide the following information:

- **Address**
  - **File level storage**: The address of the primary VNX Control Station. You can get this from the EMC Unisphere management console.
  - **Block level storage**: The name or IP address of the server with the EMC SMI-S provider (see the section above for SMI-S Provider Setup Requirements).

- **Username/Password**
  - **File level storage**: Credentials for an administrator user on the primary VNX Control Station.
  - **Block level storage**: The name or IP address of the EMC SMI-S provider (see the section above for SMI-S Provider Setup Requirements).

**NOTE:** For unified configurations, configure one VNX target for block and another VNX target for file.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in EMC VNX to those used in Turbonomic:

<table>
<thead>
<tr>
<th>VNX Name (CLARiiON / Celerra)</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUN, Data Store / Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>Raid Group, Storage Pool / Storage Pool</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Storage Processor / Storage Processor</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

**Supply Chain**

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory **Supply Chain** on page 64.

**Supported Actions**

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td></td>
<td>Move, Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision, Resize Up</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>
Monitored Resources

When calculating available storage, Turbonomic excludes disks devoted to the VNX operating system by default. If these disks are assigned to new raid groups or storage pools, the capacity of those disks will then be considered when calculating the capacity of the Storage Controller.

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td>Disk Array</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the disk array</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency, computed from the latency of each device in the disk array.</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Storage Controller</td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Storage Controller's CPU in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
</tbody>
</table>
EMC VPLEX

Turbonomic supports management of EMC VPLEX virtual storage systems in a local configuration, via the VPLEX API. Currently, Turbonomic does not support Metro or Geo configurations.

VPLEX is used to aggregate and refine data collected between connected Storage and Hypervisor targets. VPLEX supports one-to-one, one-to-many, and many-to-one relationships between virtual volumes and LUNs. Only one-to-one mapping between virtual volume and LUNs is supported by Turbonomic.

Prerequisites

- VPLEX Management Server
- Hypervisor target supported by Turbonomic
- Storage target supported by Turbonomic

**NOTE:** In order for Turbonomic to make use of the information provided by VPLEX, you must also add the hypervisor and storage layered under it as targets.

Adding EMC VPLEX Targets

To add EMC VPLEX targets, select the **Storage > EMC VPLEX** option on the Target Configuration page and provide the following information:

- **Address:**
  The IP or Hostname of the VPLEX Management Server
- **Username:**
  The Username for the VPLEX Management Server
- **Password:**
  The Password for the VPLEX Management Server
- **Port Number:**
  The port number for the remote management connection. The default port number for the VPLEX Management server is 443
- **Secure Connection:**
  Select this option to use a secure connection (HTTPS)

**NOTE:** The default port (443) uses a secure connection.

Supported Actions

For this target, actions are generated and executed via the underlying storage targets. Turbonomic will use the enhanced visibility provided by VPLEX to make more intelligent storage decisions- for example, recommending storage vMotion between pools.
EMC XtremIO

EMC® XtremIO® is a flash-based (SSD) storage solution, designed to push data to applications at higher speeds. The system building blocks are SAN appliances called X-Bricks. A deployment is organized into clusters of X-Bricks, and the clusters are managed by the XtremIO Management Server (XMS).

Turbonomic connects to X-Bricks through the XMS. The XMS presents a unified view of each connected X-Brick cluster, rather than exposing the individual X-Bricks within each cluster. Within Turbonomic, each X-Brick cluster displays as a single storage controller with an associated disk array.

The relationship between Storage entities and individual X-Bricks within the cluster is not exposed through the XMS — Turbonomic cannot make recommendations to move datastores from one X-Brick to another. Additionally, the X-Brick has a fixed form factor — Turbonomic does not recommend resize actions for disk array or storage controller resources.

Turbonomic recognizes XtremIO arrays as flash storage and sets the IOPS capacity on discovered arrays accordingly.

Prerequisites

- A service user account on XMS 4.0 or higher — typically the default xmsadmin account
  Turbonomic uses this account to connect to the XMS and execute commands through the XtremIO API.

Adding XtremIO Targets

For EMC XtremIO targets, select the Storage > EMC XtremIO option on the Target Configuration page and provide the following information:

- Address
  The name or IP address of the XtremIO Management Server (XMS).
- Username/Password
  Credentials for a user account on the XMS.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in XTremIO to those used in Turbonomic:

<table>
<thead>
<tr>
<th>XTremIO Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>XTremIO Cluster</td>
<td>Disk Array</td>
</tr>
<tr>
<td>XTremIO Cluster</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.
Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td></td>
<td>Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monitored Resources

When calculating available storage, Turbonomic excludes disks devoted to the VNX operating system.

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td>Disk Array</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the disk array</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency, computed from the latency of each device in the disk array.</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
**Storage Controller**

- **CPU**
  The utilization of the Storage Controller’s CPU in use
  Measured in Megahertz (MHz)

- **Storage Amount**
  The utilization of the storage controller’s capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
  Measured in Megabytes (MB)

---

**HPE 3PAR**

HPE 3PAR StoreServ systems use controller nodes to manage pools of storage resources and present a single storage system to consumers. Turbonomic communicates with the HPE 3PAR system via both the WSAPI and SMI-S providers that are installed on the 3PAR controller node.

**Prerequisites**

- SMI-S Provider enabled and configured on the controller node.
- WSAPI Provider enabled and configured on the controller node.
- A service account on the controller node that Turbonomic can use to connect to the SMI-S and WSAPI providers.

---

**NOTE:** For discovery and monitoring, Turbonomic requires the `Browse` permission on applicable domains. For action execution, Turbonomic requires the `Edit` permission.

---

**Setting Up the SMI-S Provider**

The HPE 3PAR SMI-S Provider should be installed on the controller node. It is disabled by default — you must ensure it is installed properly and running on the controller node.

To enable the SMI-S provider:

1. **Log into the HPE 3PAR Command Line Interface (CLI).**
   Open a secure shell session (ssh) on the controller node. Default credentials are `3paradm/3pardata`.

2. **Check the current status of the SMI-S provider.**
   In the shell session, execute the command `showcim`.

3. **If the CIM service is not running, start it.**
   Execute the command `startcim` to enable the CIM service and the SMI-S provider.

To stop the SMI-S provider, execute the command `stopcim -f -x`. 
Setting Up the WSAPI Provider

The HPE 3PAR WSAPI Provider should be installed on the controller node.

To enable the WSAPI provider:

1. Log into the HPE 3PAR Command Line Interface (CLI).
   Open a secure shell session (ssh) on the controller node. Default credentials are 3paradm/3pardata.
2. Check the current status of the WSAPI provider.
   In the shell session, execute the command, showwsapi.
3. If the WSAPI service is not running, start it by executing the command startwsapi.
   Execute the command set wsapi -http enable to allow only insecure connections, or set wsapi -https enable to allow only secure connections.

To stop the WSAPI provider, execute the command stopwsapi -f.

Adding HPE 3PAR Targets

To add an HPE 3PAR target, select the Storage > HPE 3Par option on the Target Configuration page and provide the following information:

- **Address**
  The name or IP address of the 3PAR controller node.
  By default, the controller provides SMI-S data over port 5988 (HTTP) or port 5989 (HTTPS). If your installation uses a different port for SMI-S, include the port number in the Address field.

- **Username/Password**
  Credentials for a user account on the controller node.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in HPE 3PAR to those used in Turbonomic:

<table>
<thead>
<tr>
<th>HPE 3PAR Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>CPG</td>
<td>Disk Array</td>
</tr>
<tr>
<td>AO Configuration</td>
<td>Logical Pool</td>
</tr>
<tr>
<td>Controller</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supply Chain

Storage targets (storage controllers) add Storage Controller, Logical Pool and Disk Array entities to the supply chain. Logical Pool and Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.
3Par Adaptive Optimization

Adaptive Optimization (AO) for HPE 3Par enables management of data storage across two or three tiers. AO places storage regions on the appropriate tier in response to periodic analysis that AO performs.

To work with the storage in an AO group, Turbonomic:

- Discovers each Common Provisioning Group (CPG) as a disk array
  In the Turbonomic user interface, these disk arrays do not host storage — They appear empty. Turbonomic will not recommend storage moves between these disk arrays, because such moves would conflict with AO block-level placement.

- Creates a single logical pool that hosts all the datastores in an AO group
  This logical pool represents the AO group, and it includes all the member CPGs. Turbonomic considers this single logical pool when it performs analysis — It can recommend moving storage into or out of the AO group. Also, Turbonomic aggregates resource capacity in this logical pool. For example, the IOPS capacity for the AO logical pool is a combination of IOPS capacity for the constituent CPGs.

You can see the AO logical pool in the Turbonomic user interface. The display name for this logical pool is the name of the AO Configuration.

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Provision, Resize Up/Down, Delete</td>
<td>Move</td>
</tr>
<tr>
<td>Disk Array</td>
<td>Provision, Resize Up/Down, Delete</td>
<td></td>
</tr>
<tr>
<td>Logical Pool</td>
<td>Provision, Resize Up/Down, Delete</td>
<td></td>
</tr>
<tr>
<td>Storage Controller</td>
<td>Provision</td>
<td></td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
</tbody>
</table>
• Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

• Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

• Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)

• Storage Provisioned
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the disk array
Measured in Operations per second

• Latency
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Logical Pool

• Storage Amount
The utilization of the logical pool's capacity.
Measured in Megabytes (MB)

• Storage Provisioned
The utilization of the logical pool's capacity, including overprovisioning.
Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the logical pool.
Measured in Operations per second

• Latency
The utilization of latency on the logical pool.
Measured in milliseconds (ms)

Storage Controller

• CPU
The utilization of the Storage Controller's CPU in use
Measured in Megahertz (MHz)

• Storage Amount
The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
Measured in Megabytes (MB)
HDS

Turbonomic supports management of HDS storage systems, via either the embedded SMI-S, or the shared SMI-S (Not recommended). If using the embedded SMI-S provider, each Storage System must be added to Turbonomic as a separate target.

Prerequisites

- SMI-S Provider
  Turbonomic recommends using the embedded SMI-S provider. Turbonomic also provides the ability to use the shared SMI-S Provider. To use the shared SMI-S provider, please contact Turbonomic support. The Hitachi Command Suite Administrator Guide.

- Tuning Manager
  The Tuning Manager is required for monitoring IOPs and Latency. For assistance in setting up the Tuning Manager, please see The HDS Tuning Manager User Guide.

Adding HDS Targets

To add HDS targets, select the Storage > HDS option on the Target Configuration page and provide the following information:

- SMI-S Address
  The IP or hostname of the SMI-S provider.

- SMI-S Username
  The Username for the SMI-S provider.

- SMI-S Password
  The Password for the SMI-S provider.

- SMI-S Secure connection
  If you are using HTTPS with the SMI-S Provider, select this.

- Shared SMI-S Provider
  If you are using the Shared SMI-S Provider (not recommended), select this.

- TnM Address
  The IP or hostname of the Tuning Manager.

- TnM Username
  The Username for the Tuning Manager.

- TnM Password
  The Password for the Tuning Manager.

- TnM Secure connection
  If you are using HTTPS with the Tuning Manager, select this.
Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in HDS to those used in Turbonomic:

<table>
<thead>
<tr>
<th>HDS Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume, Logical Device (LDEV), V-VOL</td>
<td>Storage</td>
</tr>
<tr>
<td>Parity Group</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Dynamic Provisioning Pool</td>
<td>Logical Pool</td>
</tr>
<tr>
<td>Storage System</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td></td>
<td>Provision, Suspend, Resize (V-Volumes only), Move</td>
</tr>
<tr>
<td>Logical Pool</td>
<td></td>
<td>Provision, Resize, Delete</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore’s capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore’s capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the data-store</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
</tbody>
</table>
Storage Targets

Logical Pool
- Storage Amount
  The utilization of the logical pool's capacity.
  Measured in Megabytes (MB)
- Storage Provisioned
  The utilization of the logical pool's capacity, including overprovisioning.
  Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the logical pool.
  Measured in Operations per second
- Latency
  The utilization of latency on the logical pool.
  Measured in milliseconds (ms)

Disk Array
- Storage Amount
  The utilization of the Disk Array's capacity.
  Measured in Megabytes (MB)
- Storage Provisioned
  The utilization of the Disk Array's capacity, including overprovisioning.
  Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the disk array.
  Measured in Operations per second
- Latency
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

Storage Controller
- CPU
  The utilization of the Storage Controller's CPU in use.
  Measured in Megahertz (MHz)
- Storage Amount
  The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.
  Measured in Megabytes (MB)

NetApp
The Storage Control Module adds support for NetApp filers running the Data ONTAP operating system. NetApp storage controllers are Storage Virtual Machines that manage storage arrays — Vfilers for 7-Mode and Vservers for C-Mode. Turbonomic connects to these storage controllers to support NetApp targets in 7-Mode and Cluster-Mode (C-Mode).
Prerequisites

- Storage Control Module license
- Transport Layer Security (TLS) is enabled
- A service account Turbonomic can use to connect to the NetApp target

Enabling TLS

Starting with version 5.4, by default Turbonomic requires Transport Layer Security (TLS) version 1.2 to establish secure communications with targets. NetApp filers have TLS disabled by default, and the latest version they support is TLSv1. If your NetApp target fails to validate on Turbonomic 5.4 or later, this is probably the cause.

If target validation fails because of TLS support, you might see validation errors with the following strings:

- No appropriate protocol
  To correct this error, ensure that you have enabled the latest version of TLS that your target technology supports. If this does not resolve the issue, please contact Turbonomic Technical Support.

- Certificates does not conform to algorithm constraints
  To correct this error, refer to your NetApp documentation for instructions to generate a certification key with a length of 1024 or greater on your target server. If this does not resolve the issue, please contact Turbonomic Technical Support.

For information about enabling TLS, see the Data ONTAP System Administration Guide for sections on the SSL protocol.

Service User Account — Administrator Role

To discover and fully manage NetApp disk arrays, Turbonomic must have a service account that grants privileges to execute commands through the NetApp filer’s OnTap API (ontapi). In most cases, you can provide a user account with Administrator privileges:

- **NetApp 7-Mode**: Create the administrator account from the NetApp command line — For example:
  ```
  useradmin user add Turbonomic -g Administrators
  ```

- **NetApp C-Mode**: Create the administrator account via the NetApp OnCommand System Manager, or from the NetApp command line — For example:
  ```
  security login create -role admin -username Turbonomic -application ontapi -authmethod password
  ```

If you prefer not to grant full administrator rights, see Restricted Service Accounts In NetApp on page 90
Adding NetApp Targets

To add a NetApp target, select the Storage > NetApp option on the Target Configuration page and provide the following information:

- **Address**
  The name or IP address of the NetApp Storage Controller.

  - **7-Mode**: Enter the storage controller address.
  - **Cluster-Mode (C-Mode)**: Enter the cluster management address.

- **Username/Password**
  Credentials for the NetApp service user account that you have configured for Turbonomic to use.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in NetApp to those used in Turbonomic:

<table>
<thead>
<tr>
<th>NetApp Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>Aggregate</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Controller / Filer</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Move (C-Mode only)</td>
<td>Move (7-Mode), Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Resize Up, Move (C-Mode only), Provision (C-Mode only)</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

Note that for NetApp in C-Mode, Turbonomic can automate moving a datastore to a disk array on the same storage controller, as well as moves to a disk array on a different storage controller.
Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the data-store</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td>Disk Array</td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the disk array</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency, computed from the latency of each device in the disk array</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Storage Controller</td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Storage Controller's CPU in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the storage controller’s capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller</td>
</tr>
</tbody>
</table>
|                  | Measured in Megabytes (MB)
Restricted Service Accounts In NetApp

While Turbonomic prefers a NetApp service account with administrator rights, it is possible to create an account that has limited access, by following the steps outlined below, depending on NetApp mode.

NetApp 7-Mode Restricted Service Account Setup

If you prefer to use a service account that does not have full administrator rights:

1. Log into the NetApp filer from a command shell.
2. Create a role with API privileges.
   
   For example:
   ```bash
   useradmin role add Turbonomic Role <capabilities>
   ```
   
   where `<capabilities>` is a comma-separated list of capabilities assigned to the role. The required capabilities are listed below.

   **Inspection capabilities:**
   - api-aggr-list-info
   - api-disk-list-info
   - api-fcp-node-get-name
   - api-flash-device-list-info
   - api-igroup-list-info
   - api-iscsi-node-get-name
   - api-lun-initiator-list-map-info
   - api-lun-list-info
   - api-net-ifconfig-get
   - api-nfs-exportfs-list-rules-2
   - api-options-list-info
   - api-system-get-info
   - api-system-get-version
   - api-volume-list-info
   - api-snapshot-list-info
   - api-perf-object-get-instances
   - api-perf-object-instance-list-info
   - api-perf-object-counter-list-info
   - api-qtree-list
   - security-api-vfiler
   - api-vfiler-list-info
   - api-volume-options-list-info
   - login-http-admin
   - login-

   Note that the last login capability (login-*) may be necessary for external users.

   **Execution capabilities:**
   - api-volume-create
   - api-volume-size
   - api-volume-offline
   - api-volume-online
   - api-volume-destroy
   - api-aggr-add
3. Create a group and assign the role.
   For example:
   useradmin add Turbonomic Group -r Turbonomic Role

4. Create a user that is a member of the group.
   For example:
   useradmin user add Turbonomic -g Turbonomic Group

5. Enter a password for the new user when prompted.

NetApp C-Mode Restricted Service Account Setup

If you prefer to use a service account that does not have full administrator rights:

1. Log into the NetApp filer from a command shell.

2. Create a role and assign it permission to execute each of the following commands:
   - aggr-get-iter
   - igroup-get-iter
   - cluster-identity-get
   - lun-map-get-iter
   - net-interface-get-iter
   - storage-disk-get-iter
   - system-get-node-info-iter
   - volume-get-iter
   - vserver-get-iter
   - fcp-node-get-name
   - flash-device-get-iter
   - iscsi-node-get-name
   - options-list-info
   - qtree-list-iter
   - system-get-version
   - lun-get-iter
   - snapshot-get-iter
   - perf-object-get-instances
   - volume-get-iter
   - volume-move-get-iter
   - volume-move-start

   For example, to enable volume offline, execute the following:
   security login role create -role Turbonomic Role -access all -cmddirname "volume offline" -vserver <cluster_name>

3. Create a user based on the role you create.

   Give the user access to the ssh and ontapi applications. For example:
   security login create -role Turbonomic Role -username Turbonomic -application ontapi -authmethod password
   security login create -role VMTurboRole -username VMTurbo -application ssh -authmethod password
Pure Storage

Turbonomic supports management of Pure Storage FlashArray systems. Note that one Pure Storage target manages a single Pure Storage FlashArray instance. The storage devices in the array are all flash storage — to analyze IOPS capacity, Turbonomic uses the setting made for SSD Disks in the Policy View.

Because of the improved performance of Pure Storage arrays, Turbonomic intelligently moves more demanding workloads to these datastores. Turbonomic analysis is also able to incorporate Pure Storage de-duplication and compression when recommending actions.

Prerequisites

- A service account Turbonomic can use to connect to the FlashArray
  This account needs privileges to execute commands through the Pure Storage API — Typically the default pureuser administrative account.

Adding Pure Storage Targets

To add a Pure Storage target, select the Storage > Pure Storage option on the Target Configuration page and provide the following information:

- Address
  The name or IP address of the Pure Storage FlashArray.
- Username/Password
  Credentials for the service account Turbonomic can use to connect to the FlashArray.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in Pure to those used in Turbonomic:

<table>
<thead>
<tr>
<th>Pure Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>Shelf Array</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Controller</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.
Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage</strong></td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the datastore's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td><strong>Disk Array</strong></td>
<td>• Storage Amount</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Provisioned</td>
</tr>
<tr>
<td></td>
<td>The utilization of the Disk Array's capacity, including overprovisioning.</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The summation of the read and write access operations per second on the disk array</td>
</tr>
<tr>
<td></td>
<td>Measured in Operations per second</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency, computed from the latency of each device in the disk array.</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>

Pure Storage assigns all the disks managed by a storage controller to a single array, with a fixed form-factor. There are no actions to perform for an array — For example, there is no action to move a disk array from one storage controller to another. Likewise, there are no actions to move or provision volumes because of the fixed form-factor.
Storage Controller

- CPU
  The utilization of the Storage Controller’s CPU in use
  Measured in Megahertz (MHz)

- Storage Amount
  The utilization of the storage controller’s capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
  Measured in Megabytes (MB)
Guest OS Process Targets

This version of Turbonomic supports the following Guest OS Process targets:

- SNMP (Simple Network Management Protocol)
- WMI (Windows Management Instrumentation)
- Docker

**NOTE:** Starting with version 5.8, Turbonomic offers Target Configuration for WMI, SNMP, and Docker targets. This method deprecates discovery via application policies. To avoid duplication of any legacy targets, you must remove them from the Policy view before adding them via Target Configuration.

Do not discover the same targets though both Policy view and Target Configuration. Doing so will cause entity duplication and may adversely affect your environment.

Supply Chain

Guest Process targets add Application entities to the supply chain. You can navigate to each individual application server to see specific details.

Actions

Turbonomic recommends actions for the Guest OS Process supply chain as follows.

**NOTE:** This is a general list of actions for entities discovered for applications. You can see how actions differ per technology in each section that describes adding a specific type of application target.
Guest OS Process Targets

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host.</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the Guest OS Process supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMI/SNMP Application</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
AppDynamics

Turbonomic supports workload management of the application infrastructure monitored by AppDynamics, via adding the AppDynamics instance to Turbonomic as a target.

The Turbonomic integration with AppDynamics provides a full-stack view of your environment, from application to physical hardware. With information obtained from AppDynamics, Turbonomic is able to make recommendations and take actions to both assure performance and drive efficiency with the full knowledge of the demands of each individual application.

In its default configuration, the AppDynamics target will collect up to 1100 AppDynamics nodes within the default collection period when a proxy is used, and up to 5000 nodes when no proxy is required. Larger AppDynamics environments are expected to take longer than one cycle to collect complete data.

Prerequisites

- SaaS or on-prem installation of AppDynamics, version 4.1+
- A valid AppDynamics user account.
  For all types of application instances, the service account must have the `Read Only User` role. For monitoring database instances, this user must also have the `DB Monitoring User` role.

AppDynamics Database Servers

AppDynamics also monitors database servers. In order for your database servers to be correctly stitched to the rest of your environment, you must:

- Enable enhanced metric collection.
  For Hyper-V hosts, you must install Hyper-V Integration Services on the target VM hosting the database. For more information, please refer to the following integration services TechNet article: https://technet.microsoft.com/en-us/library/dn798297(v=ws.11).aspx
  For VMware hosts, you must install VMware Tools on the target VMs.
- Ensure that the database name in AppDynamics is resolvable to an IP address by the Turbonomic instance.
  You may need to make changes to your DNS or the file `/etc/resolv.conf` on the Turbonomic instance.

Entity Comparison

After validating the new target, Turbonomic discovers the connected applications. This table compares terms used in AppDynamics to those used in Turbonomic:

<table>
<thead>
<tr>
<th>AppDynamics</th>
<th>Turbonomic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Application</td>
<td>Business Application</td>
</tr>
<tr>
<td>Node</td>
<td>Application Server / Application</td>
</tr>
<tr>
<td>Database</td>
<td>Database Server</td>
</tr>
</tbody>
</table>
Adding an AppDynamics Target

**NOTE:** It is possible to monitor certain applications or database servers with both AppDynamics and Turbonomic, but this must be avoided as it will cause the entities to appear duplicated in the market.

If an application is monitored by AppDynamics, do not add it as a separate Turbonomic application target.

To add an AppDynamics instance as a target, specify:

- **Hostname or IP Address**
  The hostname or IP Address of the AppDynamics instance.

- **Username@Account**
  Username and account ID with the necessary role(s). The format must be Username@Account.

- **Password**
  Password for the account used to connect to the AppDynamics instance.

- **Port**
  The port used to connect to the AppDynamics instance. By default, this is set to ports 80 (HTTP) and 443 (HTTPS).

- **Secure Connection**
  When checked, Turbonomic will connect via HTTPS. Make sure the required certificate is configured for use on the host.

- **Proxy Host**
  The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- **Proxy Port**
  The port to use with the proxy specified above. By default, this is 8080.

- **Proxy Username**
  The username to use with the proxy specified above.

- **Proxy Password**
  The password to use with the proxy specified above.

Actions

**NOTE:** The exact actions recommended will differ based on application type. For applications that can be added to Turbonomic as an individual target, available actions can be found in the Application Server Targets on page 109.

For other applications and application servers, Turbonomic will make action recommendations based on the resources we are able to monitor. For example, Node.js® applications report CPU usage, so you may see a vCPU resize recommendation in the Turbonomic UI.

Turbonomic recommends actions for the AppDynamics supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application / Application Server</td>
<td>- Resize Heap</td>
</tr>
<tr>
<td></td>
<td>Recommendation only.</td>
</tr>
<tr>
<td></td>
<td>- Resize Thread Pool</td>
</tr>
<tr>
<td></td>
<td>Recommendation only.</td>
</tr>
</tbody>
</table>
- Resize Connection Capacity
  Recommendation only.
- Suspend VM
  Recommendation only.
- Provision VM
  Recommendation only.

**Virtual Machines**
- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

**Monitored Resources**

**NOTE:** The exact resources monitored will differ based on application type. This list includes all resources you may see.

Turbonomic monitors the following resources for the AppDynamics supply chain:

**Entity Type**

**Commodity**

- **Application**
  - Virtual Memory (VMem)
    The utilization of the VMem allocated to the hosting VM
    Measured in Kilobytes (KB)
  - Virtual CPU (VCPU)
    The utilization of the VCPU allocated to the hosting VM
    Measured in Megahertz (MHz)
  - Transactions
    The utilization of the allocated transactions per second for the given virtual application
    Measured in transactions per second
  - Heap
    The utilization of the application server’s heap
    Measured in Kilobytes (KB)
  - Response Time
    The utilization of the server’s allocated response time
    Measured in Milliseconds (ms)
  - Threads
    The utilization of the server’s thread capacity
    Measured in Threads
  - Connection
    The utilization of the connection capacity. Only applicable to database servers
    Measured in Connections
  - Garbage Collection
    The percentage of server uptime spent garbage collecting
    Measured in of uptime (%)
Guest OS Process Targets

**VirtualMachine**

- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)

- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)

- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Docker Containers**

Turbonomic will discover Docker application containers running on VMs in your entire environment, or a portion of your environment, based on scope.

**Prerequisites for Docker Containers**

- Underlying VM host targets added to Turbonomic (for discovery)
- Docker remote API (Docker REST service) v1.20+ enabled/configured on target VMs

**NOTE:** For Hyper-V hosts, you must install Hyper-V Integration Services on the target VMs. For more information, please refer to the following integration services TechNet article:


**Adding Docker Targets**

To add Docker targets, select the **Guest OS Processes > Docker** option on the Target Configuration page and provide the following information:

- **Target ID**
  The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- **Port**
  The Port number Turbonomic will use to connect to the Virtual Machine hosting the application
• Secure Connection
  Turbonomic will use SSL to connect to the target

• Scope
  Turbonomic will search for Docker containers on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular virtual machines. Select this option and choose the scope for discovery.

Supported Actions

For each discovered entity within the container supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docker Container</td>
<td>Resize Container</td>
</tr>
<tr>
<td></td>
<td>Recommend Only</td>
</tr>
</tbody>
</table>

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

Monitored Resources

Turbonomic monitors the following resources for the container supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docker Container</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
• Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB)

• Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS

• Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

SNMP

Turbonomic will discover application and operating system resources using SNMP (Simple Network Management Protocol) on Linux hosts in your entire environment, or a portion of your environment, based on scope.

Prerequisites

• Underlying VM host targets added to Turbonomic (for discovery)
• SNMP service enabled/configured on target VMs

NOTE: For Hyper-V hosts, you must install Hyper-V Integration Services on the target VMs. For more information, please refer to the following integration services TechNet article:


For VMware hosts, you must install VMware Tools on the target VMs.

Adding SNMP Targets

To add SNMP targets, select the Guest OS Processes > SNMP option on the Target Configuration page and provide the following information:

• Target Name
The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

• Scope
Turbonomic will search for SNMP applications using the port entered above on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular virtual machines. Select this option and choose the scope for application discovery.
Turbonomic recommends that a single scope contain no more than 500 virtual machines. Multiple targets should be used for environments exceeding this limit.
• Community
  The SNMP v2c community string Turbonomic will use to connect to the application
• Port number
  The Port number Turbonomic will use to connect to the virtual machines hosting the application
• Full Validation
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.
• Enable SNMP V3
  When checked, Turbonomic will use SNMP V3 to connect to the virtual machines in the selected scope
• SNMPV3 Username/Securityname
  The Username or Securityname that Turbonomic will use to connect to the virtual machines hosting the application
• SNMPV3 Enable Privacy
  When checked, Turbonomic will encrypt using the privacy password to keep the connection private.
• SNMPV3 Authentication Password
  The Authentication Password Turbonomic will use to connect to the virtual machines in the selected scope
• SNMPV3 Privacy Password
  The Privacy Password Turbonomic will use to connect to the virtual machines in the selected scope
• SHA-1 For Authentication
  When checked, Turbonomic will use SHA-1 Authentication to connect to the virtual machines in the selected scope. When unchecked, Turbonomic uses MD5
• AES For Privacy
  When checked, Turbonomic will use AES 128 to connect to the virtual machines in the selected scope. When unchecked, Turbonomic uses DES

**NOTE:** Turbonomic does not support AES 192 or 256 for SNMP targets.

**Supported Actions**

For each discovered entity within the application supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host. For specific application servers, see the individual application entry.</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)  &lt;br&gt; • Move Virtual Machine  &lt;br&gt; • Move Virtual Machine Storage  &lt;br&gt; • Reconfigure Storage  &lt;br&gt; • Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>
Monitored Resources

Turbonomic monitors the following resources for the application supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMI/SNMP Application</td>
<td>- Virtual Memory (VMem) The utilization of the VMem allocated to the hosting VM&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;- Virtual CPU (VCPU) The utilization of the VCPU allocated to the hosting VM&lt;br&gt;Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>- Virtual Memory (VMem) The utilization of the VMem allocated to the hosting VM&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;- Virtual CPU (VCPU) The utilization of the VCPU allocated to the hosting VM&lt;br&gt;Measured in Megahertz (MHz)&lt;br&gt;- Virtual Storage (VStorage) The utilization of the virtual storage capacity allocated for the VM&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;- Storage Access Operations Per Second (IOPS) The utilization of IOPS allocated for the VStorage on the VM&lt;br&gt;Measured in IOPS&lt;br&gt;- Latency The utilization of latency allocated for the VStorage on the VM&lt;br&gt;Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>

Enabling SNMP

Turbonomic requires that SNMP is enabled and configured in order to discover Guest Processes. While these steps will change slightly between OS versions, the general instructions are below:

1. **Obtain and install the SNMP server package for your version of Linux. This is commonly called** `net-snmp` **in most package managers. Also install the** `net-snmp-utils` **package if it is available**

2. **Configure the SNMP daemom by editing** `/etc/snmp/snmpd.conf` **or running** `snmpconf -i` **at the command line in order to verify that:**
   - SNMPv2c is enabled
   - A read-only community name has been set. This community name will be used by Turbonomic to communicate with the VM

   **NOTE:** The community name you select must have at least read-only access to all OIDs in the system.

3. **Configure the daemon to listen on a public interface. Most default installations only listen on** `127.0.0.1`

4. **Start the SNMP daemon process**
Sample snmp.conf Files

Provided below are two sample snmp.conf files that will aid in making the necessary changes.

Long form, VACM:

# First, map the community name "mycommunity1" into a "security name"
# sec.name source community
com2sec notConfigUser default mycommunity1
# Second, map the security name into a group name:
#   groupName securityModel securityName
group  notConfigGroup v2c notConfigUser
# Finally, grant the group read-only access to any OID.
#   group context sec.model sec.level prefix read   write   notif
access  notConfigGroup "" any noauth exact all none none

Short form, older syntax:

rocommunity mycommunity1 default system

Verify SNMP Setup

Verify that your SNMP setup is successful by using the following command from a remote machine, replacing the community string and IP address:

snmpwalk -Os -v 2c -c COMMUNITY_STRING IP_ADDRESS iso.3.6.1.2.1.1.1

If successful, the command will return the kernel version of the machine (similar to the output of `uname -a`)

WMI

Turbonomic will discover application and operating system resources using WMI (Windows Management Instrumentation) in your entire environment, or a portion of your environment, based on scope.

Prerequisites

- Underlying VM host targets added to Turbonomic (for discovery)
- WMI Enabled on target VMs. For assistance in enabling WMI, see Enabling WMI on page 107.

NOTE: For Hyper-V hosts, you must install Hyper-V Integration Services on the target VMs. For more information, please refer to the following integration services TechNet article:


For VMware hosts, you must install VMware Tools on the target VMs.
Adding WMI Targets

To add WMI targets, select the Guest OS Processes > WMI option on the Target Configuration page and provide the following information:

- **Target Name**
  The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- **Username**
  The username Turbonomic will use to connect to the WinRM service on the Virtual Machine hosting the application. This should not include the Active Directory domain.

- **Password**
  The password Turbonomic will use to connect to the WinRM service on the Virtual Machine hosting the application.

- **Scope**
  Turbonomic will search for Windows applications on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular virtual machines. Select this option and choose the scope for application discovery.
  Turbonomic recommends that a single scope contain no more than 500 virtual machines. Multiple targets should be used for environments exceeding this limit.

- **Domain Name**
  The Active Directory domain used by Turbonomic in conjunction with the Username for authentication. Leave blank for local accounts.

- **Full Validation**
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.

Supported Actions

For each discovered entity within the application supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host.</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>

For specific application servers, see the individual application entry.
Monitored Resources

Turbonomic monitors the following resources for the container supply chain:

### Entity Type: WMI/SNMP Application

- **Virtual Memory (VMem)**
  - The utilization of the VMem allocated to the hosting VM
  - Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  - The utilization of the VCPU allocated to the hosting VM
  - Measured in Megahertz (MHz)

### Entity Type: VirtualMachine

- **Virtual Memory (VMem)**
  - The utilization of the VMem allocated to the hosting VM
  - Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  - The utilization of the VCPU allocated to the hosting VM
  - Measured in Megahertz (MHz)
- **Virtual Storage (VStorage)**
  - The utilization of the virtual storage capacity allocated for the VM
  - Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  - The utilization of IOPS allocated for the VStorage on the VM
  - Measured in IOPS
- **Latency**
  - The utilization of latency allocated for the VStorage on the VM
  - Measured in milliseconds (ms)

Enabling WMI

### Enabling Discovery

To enable Turbonomic discovery of Windows-based Guest Processes, you must configure and enable WMI with WinRM, usually by using a group policy for AD Domains.

When local credentials are provided to Turbonomic, NTLM is the authentication mechanism. When domain credentials are provided, either NTLM or Kerberos can be specified.

**NOTE:** If Kerberos is specified, the IP address of the target must be resolvable to a host name using DNS.

While these steps will change slightly between Windows Server versions, the general instructions are:

1. Open an elevated PowerShell prompt on the virtual machine(s) to be discovered as a WMI Target.
2. Enable the WS-Management protocol and set the default configuration for remote management.
   
   ```
   Execute `winrm quickconfig`.
   ```
3. **Enable the WinRM Negotiate authentication scheme.**
   This policy is enabled by default. To enable this policy if it is disabled, execute `winrm set winrm/config/service/auth '{Negotiate="true"}'`.

4. **Set the WinRM AllowUnencrypted property to true if non-SSL connections are preferred.**
   This property must be set on both the server and the client. Note that setting this value to true does not mean that WMI passes sensitive data in an unencrypted form. It will send only the content of the SOAP messages as plain text:
   - Server setting:
     `winrm set winrm/config/service '{AllowUnencrypted="true"}'`
   - Client setting:
     `winrm set winrm/config/client '{AllowUnencrypted="true"}'`

5. **Restart the Remote Registry service.**
   After restarting the Remote Registry service, Turbonomic will discover the WMI targets.

**SSL Connections**

To connect using SSL, then a certificate must be assigned to WinRM, and an SSL listening socket enabled. Turbonomic will accept self-signed certificates. Complete details can be found in the official WinRM documentation.

Some example SSL-related commands:

- List certificates on the system:
  `ls cert://localmachine/my`

- Find Thumbprint for the default certificate:
  `7B56C33F029E7605D5C58E5597D0A077FE1D7F1C CN=winsql-server1.corp.mycorp.com`

- Enable SSL listener:
  `winrm create winrm/config/listener?Address="*"+Transport=HTTPS @(Hostname="winsql-server1.corp.mycorp.com";CertificateThumbprint="7B56C33F029E7605D5C58E5597D0A077FE1D7F1C";Port=5986)`
Application Server Targets

This version of Turbonomic supports the following application servers as targets:

- IBM WebSphere
- Oracle WebLogic
- JBoss
- Apache Tomcat
- Generic JVM

With the exception of Apache Tomcat and Generic JVM, these target types support domains of application servers that are controlled by management servers. For such managed domains you can add the management server as a target, and Turbonomic will discover the managed application servers. You can also add an individual stand-alone application server as a target, or you can add all matching targets within a given scope.

To add any of these servers as a target, you specify:

- The scope containing the VMs hosting the management server
  You can optionally specify a scope that contains a VM hosting an individual application server.
- The port that the target server listens on
- Administrator credentials for the target server instance

Supply Chain

Application Server targets add Application entities to the supply chain. The inventory groups applications by server type — You can navigate to each individual application server to see specific details.
Resource Monitoring

To manage application servers, Turbonomic monitors the resources that affect application performance, as listed in the following table. Note that because WebLogic performs its own tuning of thread pools, Turbonomic does not monitor threads for WebLogic application servers.

<table>
<thead>
<tr>
<th>Monitored Resource</th>
<th>WebSphere</th>
<th>WebLogic</th>
<th>JBoss</th>
<th>Tomcat</th>
<th>JVM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heap</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Garbage Collection Time</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Threads</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Transactions</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Response Time</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>QoS (a measure of application latency)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>VMem (from underlying VM)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>VCPU (from underlying VM)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

In addition to monitoring these resources and recommending associated actions, Turbonomic:

- Monitors garbage collection in the application memory space, and uses that information when recommending actions for heap resizes.
- Discovers JDBC connection pools and through these pools can discover relationships between an application server and a given database server. As a result, Turbonomic sees the JDBC connection pool as a consumer of database connections, and can recommend resize actions for that connection pool.

Application Server Scaling Policy

After you specify an application server target, Turbonomic discovers the resource utilization for that server, and recommends appropriate actions. These actions will follow one of the two following scaling policies:

- Provision
  Scaling by Provision enables horizontal scaling, where the environment adjusts to increased demand by provisioning new application servers.
- Resize
  Scaling by Resize enables vertical scaling, where the environment adjusts to increased demand by resizing the application server, or the VM that hosts the application server.
These scaling policies are mutually exclusive — the affected application servers can scale by Provisioning or by Resizing, but not both. For example, Turbonomic can recommend resize actions, but if you have set the Scaling Policy to Provision, Turbonomic will only recommend Provision and Suspend actions.

You set the Scaling Policy in the Policy view — Turbonomic policies support scope, so you can select specific groups of application servers to set their Scaling Policies as you like. For more information, see "Application Server Actions" in the User Guide.

### Actions

Turbonomic recommends actions for the application supply chain as follows.

---

**NOTE:** This is a general list of actions for entities discovered for applications. See specific actions for each target on that targets page.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
</table>
| **Virtual Applications** | Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application.  
Virtual Applications will only be discovered if there is a load balancer configured. |
| **Applications**     | Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host.  
For specific application servers, see the individual application entry. |
| **Virtual Machines** | • Provision additional resources (VMem, VCPU)  
• Move Virtual Machine  
• Move Virtual Machine Storage  
• Reconfigure Storage  
• Reconfigure Virtual Machine |
Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

**NOTE:** This is a general list of commodities for entities discovered for application servers. You can see how commodities differ per technology in each section that describes adding a specific application server target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Applications | - Transactions  
                     The utilization of the allocated transactions per second for the given virtual application  
                     Measured in transactions per second                                                                 |
|                   | - Virtual Memory (VMem)  
                     The utilization of the VMem allocated to the hosting VM  
                     Measured in Kilobytes (KB)                                                                 |
|                   | - Virtual CPU (VCPU)  
                     The utilization of the VCPU allocated to the hosting VM  
                     Measured in Megahertz (MHz)                                                                 |
|                   | - Transactions  
                     The utilization of the allocated transactions per second for the given virtual application  
                     Measured in transactions per second                                                                 |
|                   | - Heap  
                     The utilization of the application server’s heap  
                     Measured in Kilobytes (KB)                                                                 |
|                   | - Response Time  
                     The utilization of the server’s allocated response time  
                     Measured in Milliseconds (ms)                                                                 |
|                   | - Threads  
                     The utilization of the server’s thread capacity  
                     Measured in Threads                                                                 |
|                   | - Connection  
                     The utilization of the connection capacity. Only applicable to database servers  
                     Measured in Connections                                                                 |
|                   | - Garbage Collection  
                     The percentage of server uptime spent garbage collecting  
                     Measured in of uptime (%)                                                                 |
| VirtualMachine    | - Virtual Memory (VMem)  
                     The utilization of the VMem allocated to the hosting VM  
                     Measured in Kilobytes (KB)                                                                 |
|                   | - Virtual CPU (VCPU)  
                     The utilization of the VCPU allocated to the hosting VM  
                     Measured in Megahertz (MHz)                                                                 |
• Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB)
• Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS
• Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

JBoss

Turbonomic supports connecting to JBoss targets running in these operation modes:

• Managed Domain
A collection of JBoss servers in a domain, with a single Domain Controller process acting as the central management control point. In this case, the VM that hosts the Domain Controller will be the target. You configure a Domain Controller via the domain-controller entry in the host.xml file on the JBoss machine.

• Standalone
A single JBoss server — The VM that hosts the server is the target.

Prerequisites

• The target VM is properly configured as Domain Controller or standalone, depending on the operations mode
• Discovered infrastructure
Turbonomic discovers JBoss servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.
To set the target for a server running on a VM, you must have first discovered the hosting VM through a hypervisor target. To set the target for a server running in a container, you must have configured container discovery for JBoss applications.
  - For information about container targets, see Application Container Targets on page 156
  - For information about hypervisor targets, see Hypervisor Targets on page 4

• To monitor Threads (utilization of thread pool capacity), threads must be configured for the JBoss server
Turbonomic monitors the Threads resource in application servers to track utilization of thread pool capacity. To monitor threads in JBoss, each JBoss server must define a thread pool in its configuration files. To specify thread pools, see your JBoss documentation.

Adding a JBoss Target

You can add an individual JBoss server as a target, or you can add all matching targets within a given scope.
Application Server Targets

To add a server as a target, specify:

- **Address**: The name or IP address of the VM hosting the JBoss server
  If you are adding a Domain Controller, give the IP address of the VM that hosts the Domain Controller. For a standalone JBoss server, give the address of the VM that hosts the JBoss server.

- **Scope (optional)**: A cluster or group of VMs that host JBoss servers or Domain Controllers
  If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a JBoss server over the specified port. Turbonomic adds any JBoss servers it finds as targets.

- **Port Number**: The port that connects to the JBoss server
  The default port for HTTP access is 9990.

- **Username/Password**: Valid administrator credentials for the JBoss server or Domain Controller

**Application Names**

Turbonomic displays discovered JBoss servers in the user interface. These names indicate whether they're standalone or in a managed domain.

The name is divided into three sections:

- IP Address
- Domain Controller name or “STANDALONE”
- The server name

**Actions**

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application.</td>
</tr>
</tbody>
</table>

Virtual Applications will only be discovered if there is a load balancer configured.

<table>
<thead>
<tr>
<th>JBoss</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Resize Heap</strong></td>
</tr>
<tr>
<td></td>
<td>This action can only be executed by Turbonomic when running in a domain controller. Standalone applications will see only a recommendation.</td>
</tr>
<tr>
<td></td>
<td><strong>Resize Thread Pool</strong></td>
</tr>
<tr>
<td></td>
<td>Recommendation only.</td>
</tr>
<tr>
<td></td>
<td><strong>Resize Connection Capacity</strong></td>
</tr>
<tr>
<td></td>
<td>Recommendation only.</td>
</tr>
</tbody>
</table>
• Suspend VM
  This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
• Provision VM
  Recommendation only.

**Virtual Machines**
• Provision additional resources (VMem, VCPU)
• Move Virtual Machine
• Move Virtual Machine Storage
• Reconfigure Storage
• Reconfigure Virtual Machine

**Monitored Resources**

Turbonomic monitors the following resources for the application server supply chain:

**Entity Type**

**Commodity**

**Virtual Applications**
• Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second

**Application**
• Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
• Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
• Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second
• Heap
  The utilization of the application server’s heap
  Measured in Kilobytes (KB)
• Response Time
  The utilization of the server’s allocated response time
  Measured in Milliseconds (ms)
• Threads
  The utilization of the server’s thread capacity
  Measured in Threads
• Connection
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections
• Garbage Collection
  The percentage of server uptime spent garbage collecting
  Measured in of uptime (%)
VirtualMachine

- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Apache Tomcat

Turbonomic supports connecting to individual Tomcat targets. Turbonomic connects to the Tomcat process as a remote client via remote JMX access. Target configuration includes the port used by the JMX/RMI registry.

Prerequisites

- A valid JMX user account for the Tomcat server.
  If Tomcat security is enabled, this must be a Tomcat JMX user with a readonly role.
- Tomcat should run on JDK version 7 or 8
- For VMware environments, VMware Tools must be installed on the VM that hosts the Tomcat server. For Hyper-V environments, Hyper-V Integration Services must be installed.
  This ensures that the VM hosting the Tomcat server can get its IP address.
- Remote JMX access is enabled through a port that is opened to the firewall.
- Discovered infrastructure.
  Turbonomic discovers Tomcat servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.
  To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for Tomcat applications.
    - For information about container targets, see Application Container Targets on page 156
    - For information about hypervisor targets, see Hypervisor Targets on page 4
Configuring JMX Remote Access

Turbonomic monitors and controls the Tomcat server via JMX Remote access. You must configure a JMX Remote port.

Note that to work with a firewall you should also set the RMI Server port — If you don’t set an RMI port, then JMX sets an arbitrary ephemeral port, and you can’t guarantee that the port will be open to your firewall.

There are two ways to set JMX Remote port on Linux platforms:

- **Ports specified as system properties**
  You can set the port via the system property, `com.sun.management.jmxremote.port`. For example:
  ```
  com.sun.management.jmxremote.port=8050
  ```
  A common way to set this property is to declare it in the `CATALINA_OPTS` system variable — You can set this in the `setenv.sh` script. For example:
  ```
  CATALINA_OPTS="$CATALINA_OPTS
  -Dcom.sun.management.jmxremote
  -Dcom.sun.management.jmxremote.port=8050"
  export CATALINA_OPTS
  ```
  Note that this sets the JMX Remote port, but it does not set the RMI Server port — Tomcat startup will specify an ephemeral port for the RMI server.

- **Ports specified in a JMX Remote Lifecycle Listener**
  This listener component fixes the ports used by the JMX/RMI Server. When you configure the listener, you specify both the JMX Remote port and the RMI Server port. This is the preferred method when working with a firewall. For more information, see the Apache Tomcat documentation.

On Windows, the typical installation is with Tomcat as a service. There are two ways to set the JMX Remote port:

- **Via setenv.bat**
  Add the property to the `CATALINA_OPTS` environment variable:
  ```
  set "CATALINA_OPTS=%CATALINA_OPTS% -Dcom.sun.management.jmxremote.port=8050"
  ```

- **Use the Tomcat configuration utility (tomcat7w or tomcat8w)**
  Set the port with the following command:
  ```
  -Dcom.sun.management.jmxremote.port=8050
  ```

To discover the JMX port that is set to an already running Tomcat, you can look in the following locations:

- **For Linux platforms, look in the configuration files** — Either:
  - `setenv.sh` — Assuming you configured the port by adding it to the `CATALINA_OPTS` environment variable
  - `$CATALINA_HOME/conf/server.xml` — Assuming you configured a JMX Remote Lifecycle Listener in this file

- **For Windows platforms, look in:**
  - `setenv.bat` — Assuming you configured the port by adding it to the `CATALINA_OPTS` environment variable
  - The Windows registry — Assuming you installed Tomcat as a Windows service using the Tomcat Configuration utility
Adding a Tomcat Target

You can add an individual Tomcat server as a target, or you can add all matching servers within a given scope.

To add a server as a target, specify:

- **Target Name**
  Name displayed in the Turbonomic UI
- **Username**
  Username of an account with the Admin role
- **Password**
  Password of an account with the Admin role
- **Scope**
  A cluster or group of VMs that host Tomcat servers
  If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a Tomcat server over the specified port. Turbonomic adds any Tomcat servers it finds as targets
- **Port Number**
  The Tomcat remote port
- **Full Validation**
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.

Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application. Virtual Applications will only be discovered if there is a load balancer configured.</td>
</tr>
</tbody>
</table>
| Tomcat          | • Resize Heap
  Recommendation only.
• Resize Thread Pool
  Recommendation only.
• Resize Connection Capacity
  Recommendation only. |
• Suspend VM
  This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
• Provision VM
  Recommendation only.

Virtual Machines
• Provision additional resources (VMem, VCPU)
• Move Virtual Machine
• Move Virtual Machine Storage
• Reconfigure Storage
• Reconfigure Virtual Machine

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Applications | • Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second |
|                   | • Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB) |
|                   | • Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz) |
|                   | • Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second |
|                   | • Heap
  The utilization of the application server’s heap
  Measured in Kilobytes (KB) |
|                   | • Response Time
  The utilization of the server’s allocated response time
  Measured in Milliseconds (ms) |
|                   | • Threads
  The utilization of the server’s thread capacity
  Measured in Threads |
|                   | • Connection
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections |
|                   | • Garbage Collection
  The percentage of server uptime spent garbage collecting
  Measured in of uptime (%) |
VirtualMachine

- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

JVM Application

Turbonomic supports connecting to individual JVM Applications as targets. Turbonomic connects to the JVM process as a remote client via remote JMX access. Target configuration includes the port used by the JMX/RMI registry.

Prerequisites

- A valid JMX user account for the JVM application
  If JMX security is enabled this must be a JMX user with a readonly role
- The application should run on JDK version 7 or 8
- For VMware environments, VMware Tools must be installed on the VM that hosts the application
  This ensures that the VM hosting the application can get the application’s IP address
- Remote JMX access is enabled through a port that is opened to the firewall
- Discovered infrastructure
  Turbonomic discovers JVM applications that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.
  To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for JVM applications.
  - For information about container targets, see Application Container Targets on page 156
  - For information about hypervisor targets, see Hypervisor Targets on page 4
Configuring JMX Remote Access

Turbonomic monitors and controls the JVM application via JMX Remote access. You must configure a JMX Remote port.

Note that to work with a firewall you should also set the RMI Server port — If you don’t set an RMI port, then JMX sets an arbitrary ephemeral port, and you can’t guarantee that the port will be open to your firewall.

To set the JMX Remote port, pass in the port at the command line when you start your application. For example, to set the port to 8090, start your application with the following options:

-Dcom.sun.management.jmxremote -Dcom.sun.management.jmxremote.port=8090

Adding a JVM Target

You can add an individual JVM application as a target, or you can add all matching applications within a given scope.

To add an application as a target, specify:

- **Address**: The name or IP address of the VM hosting the JVM application
- **Scope (optional)**: a Turbonomic group of VMs that host JVM applications
  - If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a JVM application over the specified port. Turbonomic adds any applications it finds as targets.
- **Port Number**: The JMX Remote port
- **Username/Password**: Credentials for a user account with an Admin role
  - The credentials you provide must match the credentials you specify for JMX login configuration when you start up the application.
  - If you disable authentication on the application, then you must still provide arbitrary values for Username and Password. To disable JMX authentication, use the following flags in the command line as you start the application:
    -Dcom.sun.management.jmxremote.authenticate=false
    -Dcom.sun.management.jmxremote.ssl=false

Multiple JVM Targets On Single VM

Note that you can specify targets with different ports, but that run on the same VM (use the same IP address). You can also specify targets via the same scope, but with different ports — This is another way to assign applications running on the same VM to different ports. To do this:

To do this, add the targets in two separate steps. For example, assume you want to add two JVM application targets, and they both run on the VM at 10.10.123.45. One application is on port 123, and the other application is on port 456. To specify these two targets:

- **Specify the first target with the following parameters**:
  - **Scope/Address**: VMs_myCluster.mycorp.com
  - **Port number**: 123
  - **Username**: AppUser
  - **Password**: *********

Then click ADD.
• Specify the second target with the following parameters:
  - Scope/Address: VMs_myCluster.mycorp.com
  - Port number: 456
  - Username: OtherAppUser
  - Password: **********

Then click ADD.

**Actions**

Turbonomic recommends actions for the application supply chain as follows.

**Entity Type** | **Action**
---|---
Virtual Applications | Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application.

Virtual Applications will only be discovered if there is a load balancer configured.

JVM

- Resize Heap
  - Recommendation only.
- Resize Thread Pool
  - Recommendation only.
- Resize Connection Capacity
  - Recommendation only.
- Suspend VM
  - This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
  - Provision VM
  - Recommendation only.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Applications| • Transactions  
The utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
|                     | • Virtual Memory (VMem)  
The utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB) |
|                     | • Virtual CPU (VCPU)  
The utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz) |
|                     | • Virtual Storage (VStorage)  
The utilization of the virtual storage capacity allocated for the VM  
Measured in Kilobytes (KB) |
|                     | • Storage Access Operations Per Second (IOPS)  
The utilization of IOPS allocated for the VStorage on the VM  
Measured in IOPS |
|                     | • Latency  
The utilization of latency allocated for the VStorage on the VM  
Measured in milliseconds (ms) |

Oracle WebLogic

The typical WebLogic deployment is a managed domain with one Administration Server that provides a single point of entry for administration and management of the domain. The domain can include other WebLogic Servers which are the Managed Servers. You set the WebLogic Administration Server as a Turbonomic target.

For a standalone WebLogic deployment, the single server acts as its own Administration Server — You can set the standalone server as a Turbonomic target.

WebLogic deployments can include clusters to distribute workload across multiple WebLogic servers. Turbonomic recommended actions respect the cluster architecture. For example, if you have enabled horizontal scaling for your WebLogic servers, then Turbonomic can recommend provisioning new servers for a given cluster.
Prerequisites

- A service user account.
  To execute actions the service account must have an Admin role. For read-only monitoring and analysis, you can set the target with a more restricted role, but then you will have to execute all recommended actions manually, through the WebLogic interface.
- Weblogic requires both the local and remote ends of the connection be resolvable by DNS. The Turbonomic IP address and all WebLogic server IP addresses must be resolvable by your local DNS server.
- Discovered infrastructure
  Turbonomic discovers WebLogic servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.
  To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for WebLogic applications.
    - For information about container targets, see Application Container Targets on page 156
    - For information about hypervisor targets, see Hypervisor Targets on page 4

Finding the T3 Listen Port

To configure a WebLogic target, you need to know the port that the server listens on for administrative communications. Launch the WebLogic Administration Console:

- Navigate to Domain Structure and display the domain you’re interested in
- Navigate to Environment > Servers and select the Domain Administration Server you’re setting as a target
  The console displays configuration information for the server, including the T3 listen port.

Adding a WebLogic Target

You can add one or more WebLogic targets in a given scope, including both standalone servers and domain managers.

To add a this target, specify:

- Target Name
  Name displayed in the Turbonomic UI
- Username
  Username of an account with the Admin role
- Password
  Password of an account with the Admin role
- Scope
  A cluster or group of VMs that host WebLogic servers
- Port Number
  The WebLogic remote port
- Full Validation
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.
## Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application.</td>
</tr>
</tbody>
</table>

Virtual Applications will only be discovered if there is a load balancer configured.

| WebLogic              | • Resize Heap  
|                       |   This action can only be executed by Turbonomic when running in a domain controller. Standalone applications will see only a recommendation.  
|                       | • Resize Thread Pool  
|                       |   Recommendation only.  
|                       | • Resize Connection Capacity  
|                       |   Recommendation only.  
|                       | • Suspend VM  
|                       |   This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.  
|                       | • Provision VM  
|                       |   Recommendation only.  |

| Virtual Machines       | • Provision additional resources (VMem, VCPU)  
|                       | • Move Virtual Machine  
|                       | • Move Virtual Machine Storage  
|                       | • Reconfigure Storage  
|                       | • Reconfigure Virtual Machine  |

## Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Applications | • Transactions  
|                       |   The utilization of the allocated transactions per second for the given virtual application  
|                       |   Measured in transactions per second  |
Application

- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- **Transactions**
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second
- **Heap**
  The utilization of the application server’s heap
  Measured in Kilobytes (KB)
- **Response Time**
  The utilization of the server’s allocated response time
  Measured in Milliseconds (ms)
- **Threads**
  The utilization of the server’s thread capacity
  Measured in Threads
- **Connection**
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections
- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in of uptime (%)

VirtualMachine

- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)
IBM WebSphere

The typical WebSphere deployment is a cell of WebSphere servers, controlled by a Deployment Manager. A cell makes up a managed domain that incorporates multiple VMS that host managed application servers. The Deployment Manager is a WebSphere instance that provides a single point of entry for the managed domain.

NOTE: When adding a WebSphere Deployment Manager as a target, you must ensure that the name of each WebSphere node is resolvable to an IP address by the Turbonomic instance.

You may need to make changes to your DNS or the file /etc/resolv.conf on the Turbonomic instance to make it aware of the domain names in use in your environment.

To configure the WebSphere installation, you can use the WebSphere Integrated Solutions Console. This is a client that exposes configuration settings including the SOAP port and the PMI settings.

To manage the servers in an installation, WebSphere uses the Performance Monitoring Infrastructure (PMI). Each WebSphere server runs a PMI service that collects performance data from the various application server components. Turbonomic uses PMI for monitoring and control of the WebSphere installation.

Prerequisites

- The PMI service set to monitor at the Basic level or greater
- A service user account
  - To execute actions the service account must have an Administrator role. For read-only monitoring and analysis, you can set the target with a more restricted role (Monitor), but then you will have to execute all recommended actions manually, through the WebSphere interface.
- Discovered infrastructure
  - Turbonomic discovers WebSphere servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.
  - To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for WebSphere applications.
    - For information about hypervisor targets, see Application Container Targets on page 156
    - For information about container targets, see Hypervisor Targets on page 4

Finding the SOAP Connector Address

To configure a WebSphere target, you need to know the port that the server listens on for administrative communications. Launch the WebSphere Administration Console:

- Navigate to System Administration > Deployment Manager
- Under Additional Properties, click Ports
  - The entry for SOAP_CONNECTOR_ADDRESS gives the currently set port number.
Adding a WebSphere Target

You can add an individual WebLogic server as a target, or you can add all matching targets within a given scope.

To add a server as a target, specify:

- **Target Name**
  Name displayed in the Turbonomic UI
- **Username**
  Username of an account with the Admin role
- **Password**
  Password of an account with the Admin role
- **Scope**
  A cluster or group of VMs that host WebSphere servers
- **Port Number**
  The WebSphere remote port
- **Full Validation**
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.

Actions

Turbonomic recommends actions for the application supply chain as follows.

**NOTE:** Executing multiple right-sizing actions for a WebSphere node in quick succession may fail if the affected node is not able to resynchronize after each action. For example, it’s possible that one WebSphere application server can have actions on heap and threads at the same time. In many cases, a WebSphere action is disruptive, and requires a restart of the WebSphere node. In order to prevent successive action failure, Turbonomic recommends not executing multiple actions simultaneously on WebSphere targets.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application. Virtual Applications will only be discovered if there is a load balancer configured.</td>
</tr>
</tbody>
</table>
WebSphere

- Resize Heap
  This action can only be executed by Turbonomic when running in a domain controller. Standalone applications will see only a recommendation.
- Resize Thread Pool
  Recommendation only.
- Resize Connection Capacity
  Recommendation only.
- Suspend VM
  This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
- Provision VM
  Recommendation only.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

**Entity Type**

- **Commodity**

**Virtual Applications**

- Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second

**Application**

- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second
- Heap
  The utilization of the application server’s heap
  Measured in Kilobytes (KB)
- Response Time
  The utilization of the server’s allocated response time
  Measured in Milliseconds (ms)
• **Threads**
  The utilization of the server’s thread capacity
  Measured in Threads

• **Connection**
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections

• **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in of uptime (%)

**VirtualMachine**

• **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)

• **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)

• **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

• **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

• **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)
Database Server Targets

This version of Turbonomic supports the following database servers as targets:

- Oracle
- Microsoft SQL Server
- MySQL

You can add an individual database server as a target, or you can add all matching targets within a given group or scope.

If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a database server over the specified port. Turbonomic adds any database servers it finds as targets.

Supply Chain

Database targets add Database Server entities to the supply chain.

Actions

Turbonomic recommends actions for the database supply chain as follows.

NOTE: This is a general list of actions for entities discovered for databases. You can see how actions differ per technology in each section that describes adding a specific type of database target.
<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• Resize Database Memory</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Transactions</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Connections</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>

## Monitored Resources

Turbonomic monitors the following resources for the database supply chain:

---

**NOTE:** This is a general list of commodities for entities discovered for databases. You can see how actions differ per technology in each section that describes adding a specific type of database target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• <strong>DBMem</strong></td>
</tr>
<tr>
<td></td>
<td>The memory utilized by the database, as a of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM</td>
</tr>
<tr>
<td></td>
<td>• <strong>Transactions</strong></td>
</tr>
<tr>
<td></td>
<td>The utilization of the allocated transactions per second for the given virtual application</td>
</tr>
<tr>
<td></td>
<td>Measured in transactions per second</td>
</tr>
<tr>
<td></td>
<td>• <strong>Response Time</strong></td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s allocated response time</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td></td>
<td>• <strong>Connections</strong></td>
</tr>
<tr>
<td></td>
<td>The utilization of the connection capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Connections</td>
</tr>
<tr>
<td></td>
<td>• <strong>TransactionLog</strong></td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s capacity for storage devoted to transaction logs</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• <strong>Cache Hit Rate</strong></td>
</tr>
<tr>
<td></td>
<td>The percentage of accesses that result in cache hits.</td>
</tr>
<tr>
<td></td>
<td>Measured in a percentage of hits vs total attempts (%)</td>
</tr>
</tbody>
</table>
MySQL

To manage MySQL databases, Turbonomic can connect to one or more database servers within a defined scope. This version of Turbonomic supports all 5.6 and 5.7 releases.

Prerequisites

- User Permissions are enabled on the MySQL Server. See Enabling User Permissions on MySQL Server on page 135

Adding a MySQL Database Target

You can add all matching targets within a given scope.

To add a database server as a target, you specify:

- Target ID
  Name displayed in the Turbonomic UI
- Username
  Username of an account with the Admin role
- Password
  Password of an account with the Admin role
- Scope
  A cluster or group of VMs that host MySQL servers
- Port Number
  The MySQL remote port
- Full Validation
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.
Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• Resize Database Memory</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Transactions</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Connections</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• DBMem</td>
</tr>
<tr>
<td></td>
<td>The memory utilized by the database, as a of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM</td>
</tr>
<tr>
<td></td>
<td>• Transactions</td>
</tr>
<tr>
<td></td>
<td>The utilization of the allocated transactions per second for the given virtual application</td>
</tr>
<tr>
<td></td>
<td>Measured in transactions per second</td>
</tr>
<tr>
<td></td>
<td>• Response Time</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s allocated response time</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td></td>
<td>• Connections</td>
</tr>
<tr>
<td></td>
<td>The utilization of the connection capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Connections</td>
</tr>
<tr>
<td></td>
<td>• TransactionLog</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s capacity for storage devoted to transaction logs</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Cache Hit Rate</td>
</tr>
<tr>
<td></td>
<td>The percentage of accesses that result in cache hits.</td>
</tr>
<tr>
<td></td>
<td>Measured in a percentage of hits vs total attempts (%)</td>
</tr>
</tbody>
</table>
VirtualMachine

- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Enabling User Permissions on MySQL Server

Follow the following steps in order to enable appropriate user permissions on a MySQL Server.

1. **Edit the MySQL server’s configuration file.**
   You must edit the `.conf` file on the MySQL server to grant user permissions. Open a secure shell session on the server and edit the file. Depending on the platform your MySQL is running on, you’ll find the file at different locations:
   - Debian Linux:
     `/etc/mysql/my.cnf`
   - Red Hat Linux (Fedora or Centos):
     `/etc/my.cnf`
   - FreeBSD Linux:
     You must create the file at `/var/db/mysql/my.cnf`
   Open the file in an editor and find the section, `[mysqld]`. Then make the following changes:
   - Comment out the line:
     `skip-networking`
     Commenting out this line enables remote connections over TCP/Is.
   - Add the line
     `bind-address=<MySQL_IP_Address>`
   For example, if your MySQL server has the address, 123.45.66.77, then the section of the `.conf` file should appear as follows:
   ```
   [mysqld]
   user            = mysql
   pid-file        = /var/run/mysqld/mysqld.pid
   socket          = /var/run/mysqld/mysqld.sock
   port            = 3306
   basedir         = /usr
   datadir         = /var/lib/mysql
   tmpdir          = /tmp
   language        = /usr/share/mysql/English
   bind-address    = 123.45.66.77 # skip-networking
   ....
   When you are done, save the `.conf` file.
   ```
2. **Give your Turbonomic server remote access to the database.**

   Execute the following command to log into the MySQL server:
   ```
   $ mysql -u root -p mysql
   ```

   Then execute the following command:
   ```
   Assume a user named USER_NAME with a password PWD_STRING. Then assume that your Turbonomic has an IP address of 10.10.123.45. The following command grants privileges to that Turbonomic, if it connects with the specified user account:
   ```
   GRANT SELECT ON performance_schema.* TO 'USER_NAME'@'10.10.123.45' IDENTIFIED BY 'PWD_STRING';
   ```
   ```
   GRANT PROCESS ON *.* TO 'USER_NAME'@'10.10.123.45' IDENTIFIED BY 'PWD_STRING';
   ```
   ```
   FLUSH PRIVILEGES;
   ```
   When you’re finished, log out of MySQL.

### Oracle

To connect to an Oracle database, you will:

- Add a Dynamic Performance view to the Oracle database
- Configure a service account on the database that Turbonomic can use to log on
- Find the Service Name (SID) and port for the database

This version of Turbonomic supports Oracle versions 11g R2 and 12c

### Prerequisites

- User permissions that grant access to Turbonomic through a specific user account. See *Creating a Service User Account in Oracle* on page 139.
- Dynamic Performance View (V$) must be enabled. See "Adding a Dynamic Performance View", below.
- Access through the firewall to the MySQL database port that you specify for the Turbonomic target connection

### Adding a Dynamic Performance View

In order to collect data from the Oracle database, Turbonomic uses the Dynamic Performance View (referred to as V$). V$ is not enabled by default, and users must run a script to build the tables and views that are necessary to enable V$. In some environments only the DBA has privileges to run this script.

To enable V$:

- Open a secure shell session (ssh) on the database host as a system user or a user with the *sysdba* role
- In the shell session enter the following commands:
  ```
  sqlplus /nolog
  connect /as sysdba
  @?/rdbms/admin/catalog.sql
  ```
Adding an Oracle Database to Turbonomic

You can add an individual database server as a target, or you can add all matching targets within a given scope.

To add a database server as a target, you specify:

- **Address**: The name or IP address of the VM hosting the database server
- **Scope (optional)**: A cluster or group of VMs that host Oracle database servers
  
  If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to an Oracle database server over the specified port. Turbonomic adds any database servers it finds as targets.

- **Port Number**: The port that connects to database SID
  
  You must open the firewall on the database server to allow access through this port. For further information, see "Finding the Service Name (SID) and Port", below.

- **Service**: The SID for the database that you are connecting to

- **Username/Password**: Valid client credentials for the database server
  
  For Turbonomic to execute actions, the account must have administrator privileges. Also, you must have enabled user permissions to this user account, including remote access from the Turbonomic server.

Finding the Service Name (SID) and Port

To specify a target, you must provide the SID and port that you want to connect to. To find the SID for your database:

- Open a secure shell session (ssh) on the database host as a system user or a user with the sysdba role
- In the shell session, enter the command, `lsnrctl status`
  
  Find the line that has the string `PROTOCOL=tcp` and note the port number.

- In the shell session enter the following commands:
  
  ```
  sqlplus /nolog
  connect /as sysdba
  SELECT SYS_CONTEXT('userenv', 'db_name') FROM dual;
  ```

  Note the SID that displays as a result of these commands.

Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• Resize Database Memory</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Transactions</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td></td>
<td>• Resize Connections</td>
</tr>
<tr>
<td></td>
<td>Recommendation only</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
</tbody>
</table>
• Reconfigure Storage
• Reconfigure Virtual Machine

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>• DBMem</td>
</tr>
<tr>
<td></td>
<td>The memory utilized by the database, as a fraction of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM</td>
</tr>
<tr>
<td></td>
<td>• Transactions</td>
</tr>
<tr>
<td></td>
<td>The utilization of the allocated transactions per second for the given virtual application</td>
</tr>
<tr>
<td></td>
<td>Measured in transactions per second</td>
</tr>
<tr>
<td></td>
<td>• Response Time</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s allocated response time</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td></td>
<td>• Connections</td>
</tr>
<tr>
<td></td>
<td>The utilization of the connection capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Connections</td>
</tr>
<tr>
<td></td>
<td>• TransactionLog</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s capacity for storage devoted to transaction logs</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Cache Hit Rate</td>
</tr>
<tr>
<td></td>
<td>The percentage of accesses that result in cache hits.</td>
</tr>
<tr>
<td></td>
<td>Measured in a percentage of hits vs total attempts (%)</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
Creating a Service User Account in Oracle

To collect data from the Oracle database, Turbonomic requires a service account that has privileges to access the V$ Dynamic Performance view. To create this account:

- Open a secure shell session (ssh) on the database host as a system user or a user with the sysdba role
- In the shell session enter the following commands:
  ```
  sqlplus /nolog
  connect /as sysdba
  CREATE USER My_Username IDENTIFIED BY My_Password container=all;
  GRANT CONNECT TO My_Username container=all;
  GRANT sysdba TO My_Username container=all;
  ```
  This creates a user account named My_Username with full privileges to access the V$ Dynamic Performance view.

**NOTE:** The above example uses a fictitious username. To comply with Oracle 12C norms, the username should include a prefix of c##.

Some enterprises don’t allow accounts with sysdba access. Turbonomic recommends using sysdba, according to the Oracle documentation. However, you can work with your Oracle DBA staff to provide read access to the following views, which are the ones that Turbonomic needs:

- V$INSTANCE
- V$LOG
- V$LOGFILE
- V$PARAMETER
- V$PGASTAT
- V$RESOURCE_LIMIT
- V$SGASTAT
- V$SYS_TIME_MODEL
- V$SYSMETRIC
- V$SYSSTAT

**SQL Server**


**NOTE:** SQL Server clusters are not supported by this version of Turbonomic.

**Prerequisites**

- A user account with SQL permissions including Connect SQL and View Server State on the database
- The following services must be running, and set to enabled:
  - Net.Tcp Listener Adapter
  - Net.Tcp Port Sharing Service
- TC/IP is enabled on the port that you set for the Turbonomic specification
Creating a Service User Account

The user account that Turbonomic uses for its service login must include the following:

- The account must exist in the Security folder within the SQL Server Object Explorer, with the following properties:
  - Enable SQL Server Authentication
  - Disable Enforce password policy
- The account's security properties must include:
  - Permission to connect to the database through SQL
  - Permission to view the server state

Adding a SQL Server Database to Turbonomic

You can add an individual database server as a target, or you can add all matching targets within a given scope.

To add a database server as a target, you specify:

- Target ID
  Name displayed in the Turbonomic UI
- Username
  Username for the account. This username must not include the AD domain
- Password
  Password for the account. This username must not include the AD domain
- Scope
  A cluster or group of VMs that host SQL servers
- Port Number
  The SQL remote port
- Domain Name
  The Active Directory domain used by Turbonomic in conjunction with the Username for authentication. Leave blank for local accounts.
- Full Validation
  When selected, Turbonomic will require every VM in the selected scope to be a valid target. If Turbonomic is unable to authenticate a VM in the scope, the target will not validate and data will not be collected.

For additional information about adding SQL Server targets, see the Green Circle article, "How to Target SQL Servers in VMTurbo (5.4 and later)"

Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host. For specific application servers, see the individual application entry.</td>
</tr>
</tbody>
</table>
Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

**Entity Type**  
**Commodity**

**Database Server**

- DBMem  
  The memory utilized by the database, as a portion of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.
- Transactions  
  The utilization of the allocated transactions per second for the given virtual application.
  Measured in transactions per second.
- Response Time  
  The utilization of the server’s allocated response time.
  Measured in Milliseconds (ms).
- Connections  
  The utilization of the connection capacity. Only applicable to database servers.
  Measured in Connections.
- TransactionLog  
  The utilization of the server’s capacity for storage devoted to transaction logs.
  Measured in Kilobytes (KB).
- Cache Hit Rate  
  The percentage of accesses that result in cache hits.
  Measured in a percentage of hits vs total attempts (%).

**VirtualMachine**

- Virtual Memory (VMem)  
  The utilization of the VMem allocated to the hosting VM.
  Measured in Kilobytes (KB).
- Virtual CPU (VCPU)  
  The utilization of the VCPU allocated to the hosting VM.
  Measured in Megahertz (MHz).
- Virtual Storage (VStorage)  
  The utilization of the virtual storage capacity allocated for the VM.
  Measured in Kilobytes (KB).
- Storage Access Operations Per Second (IOPS)  
  The utilization of IOPS allocated for the VStorage on the VM.
  Measured in IOPS.
• Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)
Windows® Application Targets

This version of Turbonomic supports adding Microsoft® Exchange® servers as targets. With the Application Control Module, Turbonomic can monitor the application server resources and recommend actions to scale server capacity horizontally (provision new servers) or vertically (resize existing servers).

You can add an individual Exchange server as a target, or you can add all matching targets within a given scope.

Prerequisites

• Configure remote management on the Exchange server. See "Enabling Windows Remote Management" in the User Guide
• Port access
  WinRM uses ports 5985 and 5986 for standard and secure communications, respectively. The firewall on the your VMM server must open these ports.

Supply Chain

Exchange Server targets add Application entities to the supply chain. The inventory groups applications by server type — You can navigate to each individual application server to see specific details.
Adding Microsoft Exchange Server Targets

Once you’ve enabled remote management, you can add your Exchange servers as targets. To add an Exchange Server target, select the Windows Application > MS Exchange option on the Target Configuration page and provide the following information:

- **Scope**
  A cluster or group of VMs that host Exchange servers
  Turbonomic scans each VM within that group or cluster and tries to connect to an Exchange server over the specified port. Turbonomic adds any servers it finds as targets.

- **Port number**
  The port number for the remote management connection. The default HTTP port is 5985; the default HTTPS port is 5986.

- **Username**
  The domain\username of an Active Directory account that Turbonomic can use to connect to the Exchange server.

- **Password**
  Password for account used.

## Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host. For specific application servers, see the individual application entry.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Virtual Machines</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>
## Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Transactions</td>
</tr>
<tr>
<td></td>
<td>The utilization of the allocated transactions per second for the given virtual application</td>
</tr>
<tr>
<td></td>
<td>Measured in transactions per second</td>
</tr>
<tr>
<td></td>
<td>• Heap</td>
</tr>
<tr>
<td></td>
<td>The utilization of the application server’s heap</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Response Time</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s allocated response time</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td></td>
<td>• Threads</td>
</tr>
<tr>
<td></td>
<td>The utilization of the server’s thread capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Threads</td>
</tr>
<tr>
<td></td>
<td>• Connection</td>
</tr>
<tr>
<td></td>
<td>The utilization of the connection capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Connections</td>
</tr>
<tr>
<td></td>
<td>• Garbage Collection</td>
</tr>
<tr>
<td></td>
<td>The percentage of server uptime spent garbage collecting</td>
</tr>
<tr>
<td></td>
<td>Measured in of uptime (%)</td>
</tr>
<tr>
<td><strong>VirtualMachine</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
Network Flow Targets

With Network Targets, Turbonomic can calculate costs associated with network proximity when managing workload placement. For example, two VMs that show a lot of network traffic between each other should be placed close together. They would see the best network performance if they were placed on the same physical host, and latency would increase as traffic has to hop more switches to pass data between them. With a Network Target added, Turbonomic can include the benefits of localizing network traffic in its analysis.

For network analysis, Turbonomic groups entities into two types of group:

- **VPods**
  Sets of consumers that communicate frequently with each other over the network — for example, VMs that run processes for the same distributed application.

- **DPods**
  Sets of closely connected providers (providers underneath the same switch) — For example a storage controller, its datastores, and the hosts that consume the storage resources. A unified fabric chassis can also make up a DPod, as can the providers under a switch in an Arista network.

In this scheme, DPods provide network flow to VPods, and VPods provide this flow to their constituent consumers. For example, as Turbonomic calculates the placement of a VM on a host or datastore, it considers the cost of the network flow so that VMs can reside closer together if that will lower the overall cost of their placement.

There are four levels of cost for network flow:

- **Zero**
  The consumers use the same provider — For example VMs that reside on the same host. Such consumers have infinite net throughput capacity.

- **Low**
  The consumers reside within the same DPod. Net throughput capacity for these consumers is determined by the capacity of the providers on the DPod.

- **Medium**
  The consumers communicate across DPods (communicate through multiple switches). Throughput capacity is the capacity of the uplink, divided by the number of providers sharing it.

- **High**
  The consumers communicate across the cloud.

Turbonomic takes these costs into account when making workload placement decisions.
License Requirements

- Network targets are available in the Premier Edition of Turbonomic
- To discover DPods via storage controllers, a storage target
- To discover DPods via UCS fabrics, a fabric target

Supply Chain

Network targets add VPod and DPod entities to the Supply Chain.

Actions

Turbonomic recommends actions for the network target supply chain as follows.

**NOTE:** This is a general list of actions for entities discovered for network targets. You can see how actions differ per technology in each section that describes adding a specific type of network target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
</table>
| VPod        | • Move VPod across DPod  
             | • Move VM across VPods |
| DPod        | • Provision new DPod |

Monitored Resources

Turbonomic monitors the following resources for the network supply chain:

**NOTE:** This is a general list of commodities for entities discovered for network targets. You can see how actions differ per technology in each section that describes adding a specific type of network target.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| VPod        | • Memory (Mem)  
             | The utilization of the VPod's memory reserved or in use  
             | Measured in Kilobytes (KB) |
Network Flow Targets

- **CPU**
  The utilization of the VPod's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the VPod
  Measured in Kilobytes (KB)

- **Flow**
  The utilization of the network flow capacity utilized by the VPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

**DPod**

- **Memory (Mem)**
  The utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)

- **Storage**
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)

- **Flow**
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

**Arista**

To monitor an Arista network, choose a single Top-Of-Rack switch from the network you want to monitor and add it as a Turbonomic target. Turbonomic can discover the rest of the network through that single switch. As a result of discovery, Turbonomic builds one DPod per switch.

**note:** An Arista target only discovers DPods from the Arista switches. To include VPods in your network analysis, you must also add flow connectors. For more information, see NetFlow on page 152 or sFlow on page 153.

**Prerequisites**

- The Arista Command eAPI must be enabled for HTTPS communication (see the Arista documentation for details)
- A service account Turbonomic can use to connect to Arista. This account must be able to connect to the Arista eAPI.
Adding Arista Targets to Turbonomic

To add an Arista target, select the Network > Arista option on the Target Configuration page and provide the following information:

- **Address**: The IP address of the top-of-rack switch
- **Username/Password**: The credentials of an account Turbonomic can use to connect to the Arista switch.

**Actions**

Turbonomic recommends actions for the network target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPod</td>
<td>Provision new DPod</td>
</tr>
</tbody>
</table>

**Monitored Resources**

Turbonomic monitors the following resources for the network supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPod</td>
<td>Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the DPod's memory reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td>DPod</td>
<td>CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the DPod's CPU reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td>DPod</td>
<td>Storage</td>
</tr>
<tr>
<td></td>
<td>The utilization of the storage attached to the DPod</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td>DPod</td>
<td>Flow</td>
</tr>
<tr>
<td></td>
<td>The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
</tbody>
</table>

**Cisco APIC**

Turbonomic uses TCAM (Ternary Content-Addressable Memory) table utilization to make network-aware VM placement decisions under top-of-rack APIC (Application Policy Infrastructure Controller) switches in such a way that the tables remain balanced. To monitor a network using Cisco APIC, add it as a Turbonomic target. Turbonomic will discover the TCAM utilization of the underlying infrastructure.
NOTE: Adding a Cisco APIC target will not cause any service entities to appear in the market. Instead, Turbonomic represents TCAM utilization using a commodity that Physical Machines under the APIC sell to the associated VMs.

Prerequisites

- A service account Turbonomic can use to connect to Cisco APIC. Unlike most other targets, this account can be read-only as Turbonomic does not make action recommendations directly through the Cisco APIC.

Adding Cisco APIC Targets to Turbonomic

To add a Cisco APIC target, select the Network > Cisco APIC option on the Target Configuration page and provide the following information:

- **Address:** The IP address of the Cisco APIC.
- **Username/Password:** The credentials of an account Turbonomic can use to connect to the Cisco APIC.

Actions

The commodity that represents TCAM utilization assists in driving actions in the market, in conjunction with other factors such as resource usage, etc.

Tetration

Turbonomic can connect to Cisco Tetration to gather information about east-west traffic between VMs, hosts, and storage. Using this information, Turbonomic can build VPods to manage performance related to network traffic. With these VPods, Turbonomic can reduce network latency through enhanced Flow analysis, and keep VMs close together on the network if they communicate frequently with each other.

To get the most benefit from the information that Tetration provides, you must also add any hypervisor target(s) that correspond to the VMs using Tetration. For example, if the VMs to be monitored are residing in a vCenter environment, add that vCenter as a hypervisor target.

Prerequisites

- A Cisco Tetration data collector
- An API key with the flow_inventory_query permission that Turbonomic can use to connect to the data collector
Adding Tetration Targets to Turbonomic

To add a Tetration target, select the **Network > Tetration** option on the Target Configuration page and provide the following information:

- **Address:** The IP address of the Tetration server
- **Username:** The API key that Turbonomic will use to connect to the Tetration server.
- **Password:** The API secret for the API key Turbonomic will use to connect to the Tetration server.

**Actions**

Turbonomic recommends actions for the network target supply chain as follows:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPod</td>
<td>Move VPod across DPod</td>
</tr>
<tr>
<td></td>
<td>Move VM across VPods</td>
</tr>
</tbody>
</table>

**Monitored Resources**

Turbonomic monitors the following resources for the network supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPod</td>
<td>Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VPod's memory reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VPod's CPU reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
</tr>
<tr>
<td></td>
<td>The utilization of the storage attached to the VPod</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>Flow</td>
</tr>
<tr>
<td></td>
<td>The utilization of the network flow capacity utilized by the VPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
</tbody>
</table>
NetFlow

Turbonomic can connect to NetFlow data collectors to gather information about traffic between VMs, hosts, and storage. Using this information, Turbonomic can build VPods and make recommendations that reduce network latency.

**NOTE:** The NetFlow target builds VPods and includes them in Turbonomic analysis. To get the most benefit from the Network Control Module, you should also build DPods. To do this, you must add targets for Arista networks, storage controllers, or fabrics.

For information about adding these targets, see:
- Arista on page 148
- Storage Targets on page 64
- Fabric Targets on page 169

Prerequisites

- A NetFlow data collector
- A service account Turbonomic can use to connect to the NetFlow data collector
  
The service account Turbonomic uses must have permission to remotely SSH into the data collector and run NFDUMP.

NetFlow Data Collector Requirements

The NetFlow data collector that you use must include NFDUMP tools, and the `nfcapd` service (NetFlow capture daemon) must be running on the NetFlow system.

Turbonomic uses `nfdump` to import the NetFlow data from the collector.

Turbonomic provides a NetFlow data collector OVA with NFDUMP preconfigured.

For more information and to download this OVA, see the Green Circle article: NetFlow and sFlow Monitoring for the Network Control Module.

To verify that the data collector is capturing data, open a secure shell on the collector’s host, log in using the service account that you specify for the Turbonomic target, and execute the following command:

```
nfdump -R /var/netflow
```

vSphere Distributed Switch Requirements

If you are collecting NetFlow data from a vSphere Distributed Switch (vDS):
- The vDS must be configured to point to the NetFlow data collector
- NetFlow Monitoring must be enabled on the distributed port group associated with each vDS

For information about these configuration steps, refer to your vSphere documentation.
Adding NetFlow Targets to Operations Manager

To add a NetFlow target, select the Network > NetFlow option on the Target Configuration page and provide the following information:

- **Address**: The IP address of the Netflow data collector
- **Username/Password**: The credentials of an account Turbonomic can use to connect to the data collector.

**Actions**

Turbonomic recommends actions for the network target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
</table>
| VPod        | • Move VPod across DPod  
             | • Move VM across VPods |

**Monitored Resources**

Turbonomic monitors the following resources for the network supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| VPod        | • Memory (Mem)  
             | The utilization of the VPod's memory reserved or in use  
             | Measured in Kilobytes (KB)  
             | • CPU  
             | The utilization of the VPod's CPU reserved or in use  
             | Measured in Megahertz (MHz)  
             | • Storage  
             | The utilization of the storage attached to the VPod  
             | Measured in Kilobytes (KB)  
             | • Flow  
             | The utilization of the network flow capacity utilized by the VPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization  
             | Measured in Kilobytes per second (KB/s) |

**sFlow**

Turbonomic can connect to SFlow data collectors to gather information about traffic between VMs, hosts, and storage. Using this information, Turbonomic can build VPods and make recommendations that reduce network latency.
Network Flow Targets

NOTE: The sFlow target builds VPods and includes them in Turbonomic analysis. To get the most benefit from the Network Control Module, you should also build DPods. To do this, you must add targets for Arista networks, storage controllers, or fabrics.

For information about adding these targets, see:

- Arista on page 148
- Storage Targets on page 64
- Fabric Targets on page 169

Prerequisites

- An sFlow data collector

You must have an sFlow data collector running on your network. Make sure the sflow-rt service is running. Turbonomic connects to the data collector through its REST API on port 8008. Credentials are not typically required to access the SFlow API. If you require a secure connection, contact Turbonomic Technical Support for assistance.

Turbonomic provides an OVA with a preconfigured sFlow-RT data collector.

For more information and to download this OVA, see the Green Circle article: NetFlow and sFlow Monitoring for the Network Control Module.

Adding sFlow Targets to Operations Manager

To add a NetFlow target, select the Network > sFlow option on the Target Configuration page and provide the following information:

- **Address:** The IP address of the sFlow data collector
- **Username/Password:** The credentials of an account Turbonomic can use to connect to the data collector.

Actions

Turbonomic recommends actions for the network target supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
</table>
| VPod        | • Move VPod across DPod  
             | • Move VM across VPods |
Monitored Resources

Turbonomic monitors the following resources for the network supply chain:

### Entity Type | Commodity
--- | ---
VPod | • Memory (Mem)  
The utilization of the VPod's memory reserved or in use  
Measured in Kilobytes (KB)  
• CPU  
The utilization of the VPod's CPU reserved or in use  
Measured in Megahertz (MHz)  
• Storage  
The utilization of the storage attached to the VPod  
Measured in Kilobytes (KB)  
• Flow  
The utilization of the network flow capacity utilized by the VPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization  
Measured in Kilobytes per second (KB/s)
Application Container Targets

If you are running the Cloud Native Edition of Turbonomic, it will discover application containers in your environment, recommend resize actions, and display discovered containers in the Inventory view. This release of Turbonomic supports Docker containers.

To use this functionality, you must specify a container target. These targets are found under the "Application Server" target type in the Target Configuration section of the Admin tab.

Supply Chain

Turbonomic adds Container objects to the inventory. A container object hosts an application.

Actions

Turbonomic recommends actions for the container supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docker Container</td>
<td>Resize Container</td>
</tr>
<tr>
<td></td>
<td>Recommend Only</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
</tbody>
</table>
Monitored Resources

Turbonomic monitors the following resources for the container supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContainerPod</td>
<td>• VMem</td>
</tr>
<tr>
<td></td>
<td>The of memory capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• VCPU</td>
</tr>
<tr>
<td></td>
<td>The of CPU capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Gigahertz (Ghz)</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>

Setting Up Application Containers Managed By Kubernetes

Turbonomic will discover application containers running across all pods in a Kubernetes cluster.

Prerequisites

- Turbonomic 5.9+ installation
- Running Kubernetes 1.4+ cluster
Adding Kubernetes Targets

In order to add this target, you must create a Kubeturbo configuration file with your Turbonomic credentials and a custom pod definition that will be used by Kubelet to create a mirror pod running the Kubeturbo service.

For more information, please see the Kubeturbo github repository, located at https://github.com/turbonomic/kubeturbo and specifically, the readme located at https://github.com/turbonomic/kubeturbo/blob/master/deploy/general-deploy/README.md.

NOTE: You must install Kubeturbo on each cluster you want Turbonomic to discover.

Supported Actions

For each discovered entity within the container supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kubernetes ContainerPod</td>
<td>• Horizontal Scale Up</td>
</tr>
<tr>
<td></td>
<td>• Horizontal Scale Down</td>
</tr>
<tr>
<td></td>
<td>• Resize VMem</td>
</tr>
<tr>
<td></td>
<td>Recommend Only</td>
</tr>
<tr>
<td></td>
<td>• Resize CPU</td>
</tr>
<tr>
<td></td>
<td>Recommend Only</td>
</tr>
<tr>
<td></td>
<td>• Move Pod across VM</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the container supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContainerPod</td>
<td>• VMem</td>
</tr>
<tr>
<td></td>
<td>The of memory capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
<tr>
<td></td>
<td>• VCPU</td>
</tr>
<tr>
<td></td>
<td>The of CPU capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Gigahertz (Ghz)</td>
</tr>
</tbody>
</table>
PaaS Targets

Platform as a Service (PaaS) is a management model designed to deliver applications over the internet. A PaaS provider delivers hardware and software tools as a service, and customers use the service to build and deploy applications.

Turbonomic then uses the information provided by this target and the rest of your environment to drive appropriate recommendations to assure workload performance.

Turbonomic supports the following PaaS targets:

- Cloud Foundry SDK 2.0+
- Pivotal Operations Manager

Turbonomic has also tested implementations of HPE Stackato and Pivotal Cloud Foundry on vSphere.

Actions

Turbonomic recommends actions for the PaaS supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host. For specific application servers, see the individual application entry.</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
</tbody>
</table>
• Reconfigure Virtual Machine

**Physical Machines**
• Start Physical Machine  
• Provision Physical Machine  
• Suspend Physical Machine

**Storage**
• Start Storage  
• Provision Storage  
• Suspend Storage  
• Move (only with Storage Targets configured)  
• Resize (only with Storage Targets configured)

## Monitored Resources

Turbonomic monitors the following resources for the PaaS supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application (PaaS)</td>
<td></td>
</tr>
</tbody>
</table>
  • Virtual Memory (VMem)  
  The utilization of the VMem allocated to the hosting VM  
  Measured in Kilobytes (KB)  
  
  • Virtual CPU (VCPU)  
  The utilization of the VCPU allocated to the hosting VM  
  Measured in Megahertz (MHz)  
  
  • Transactions  
  The utilization of the allocated transactions per second for the given virtual application  
  Measured in transactions per second  
  
  • Connection  
  The utilization of the connection capacity. Only applicable to database servers  
  Measured in Connections  |
| VirtualMachine      |  
  • Virtual Memory (VMem)  
  The utilization of the VMem allocated to the hosting VM  
  Measured in Kilobytes (KB)  
  
  • Virtual CPU (VCPU)  
  The utilization of the VCPU allocated to the hosting VM  
  Measured in Megahertz (MHz)  
  
  • Virtual Storage (VStorage)  
  The utilization of the virtual storage capacity allocated for the VM  
  Measured in Kilobytes (KB)  
  
  • Storage Access Operations Per Second (IOPS)  
  The utilization of IOPS allocated for the VStorage on the VM  
  Measured in IOPS |
• Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Physical Machine

• Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

• CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

• IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

• Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

• Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

• Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The utilization of the PM's allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

Storage

• Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)

• Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the data-
  store
  Measured in Operations per second

• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)
Cloud Foundry

Turbonomic supports the Cloud Foundry platform. Cloud Foundry is an open source platform that you can deploy to run your workloads on your own computing infrastructure, or deploy on an IaaS service.

Turbonomic uses the information provided by Cloud Foundry to make recommendations that ensure workload performance across your environment.

Prerequisites

- Cloud Foundry SDK 2.0+
- A service account Turbonomic can use to connect to the Cloud Foundry endpoint.

Identifying the Cloud Foundry API Endpoint

To specify a target, you attach to a Cloud Foundry API endpoint. The following steps describe how to identify the endpoint in HPE Stackato:

- Open the Management Console
- Navigate to Admin > Cluster Management
- Find the entry for API Endpoint — That shows the IP address you need for the Turbonomic target

Entity Mapping

<table>
<thead>
<tr>
<th>Turbonomic Mapping</th>
<th>Cloud Foundry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Application</td>
<td>Application</td>
</tr>
<tr>
<td>Application</td>
<td>Application Instance</td>
</tr>
<tr>
<td>Container</td>
<td>Droplet</td>
</tr>
<tr>
<td>Virtual Machine</td>
<td>DEA, Diego Cell</td>
</tr>
<tr>
<td>Virtual Data Center</td>
<td>Organization, Space</td>
</tr>
</tbody>
</table>

Adding Cloud Foundry Targets

To add Cloud Foundry targets, select the PaaS > CloudFoundry option on the Target Configuration page and provide the following information:

- Address:
  The address of the API endpoint.
- Username/Password:
  Credentials for an account on the endpoint with administrator privileges.
• **Proxy Host:**
  If using a proxy, set the address here.
• **Proxy Port:**
  If using a proxy, set the port Turbonomic will use to connect.

## Actions

Turbonomic recommends actions for the PaaS supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CloudFoundry</strong></td>
<td>• Provision (Clone) Application</td>
</tr>
<tr>
<td></td>
<td>• Resize Container Memory</td>
</tr>
<tr>
<td></td>
<td>• Clone Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Resize Virtual Machine</td>
</tr>
<tr>
<td><strong>Physical Machines</strong></td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>• Start Storage</td>
</tr>
<tr>
<td></td>
<td>• Provision Storage</td>
</tr>
<tr>
<td></td>
<td>• Suspend Storage</td>
</tr>
<tr>
<td></td>
<td>• Move (only with Storage Targets configured)</td>
</tr>
<tr>
<td></td>
<td>• Resize (only with Storage Targets configured)</td>
</tr>
</tbody>
</table>

## Monitored Resources

Turbonomic monitors the following resources for the PaaS supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Transactions</td>
</tr>
<tr>
<td></td>
<td>The utilization of the allocated transactions per second for the given virtual application</td>
</tr>
<tr>
<td></td>
<td>Measured in transactions per second</td>
</tr>
<tr>
<td></td>
<td>• Heap</td>
</tr>
<tr>
<td></td>
<td>The utilization of the application server’s heap</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
- **Response Time**
  The utilization of the server’s allocated response time
  Measured in Milliseconds (ms)

- **Threads**
  The utilization of the server’s thread capacity
  Measured in Threads

- **Connection**
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections

- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in of uptime (%)

**VirtualMachine**

- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)

- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)

- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Physical Machine**

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- **Net**
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
Pivotal Operations Manager

Turbonomic supports the Pivotal Cloud Foundry platform. Pivotal Operations Manager is a commercial implementation of the Cloud Foundry open source platform built on BOSH that you can deploy to run your workloads on your own computing infrastructure, or deploy on Pivotal Web Services.

Turbonomic uses the information provided by Pivotal to make recommendations that ensure workload performance across your environment, including the support of cluster auto-scaling.

Prerequisites

- Pivotal Operations Manager running Cloud Foundry SDK 2.0+
- A service account Turbonomic can use to connect to the Pivotal Operations Manager.

Entity Mapping

<table>
<thead>
<tr>
<th>Turbonomic Mapping</th>
<th>Cloud Foundry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Application</td>
<td>Application</td>
</tr>
<tr>
<td>Application</td>
<td>Application Instance</td>
</tr>
<tr>
<td>Container</td>
<td>Droplet</td>
</tr>
<tr>
<td>Virtual Machine</td>
<td>DEA, Diego Cell</td>
</tr>
<tr>
<td>Virtual Data Center</td>
<td>Organization, Space</td>
</tr>
</tbody>
</table>
Adding Pivotal Operations Manager Targets

To add Pivotal Operations Manager targets, select the PaaS > Pivotal Ops Manager option on the Target Configuration page and provide the following information:

- **Address:** The address of the API endpoint.
- **Username/Password:** Credentials for an account on the endpoint with administrator privileges.
- **Client ID:** If required by your Pivotal installation, set the client ID here.
- **Client Secret:** If a client ID is specified, enter the associated secret key here.
- **Proxy Host:** If using a proxy, set the address here.
- **Proxy Port:** If using a proxy, set the port Turbonomic will use to connect.

**Actions**

Turbonomic recommends actions for the PaaS supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CloudFoundry</td>
<td>Provision (Clone) Application</td>
</tr>
<tr>
<td></td>
<td>Resize Container Memory</td>
</tr>
<tr>
<td></td>
<td>Clone Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>Resize Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>Suspend Physical Machine</td>
</tr>
<tr>
<td>Storage</td>
<td>Start Storage</td>
</tr>
<tr>
<td></td>
<td>Provision Storage</td>
</tr>
<tr>
<td></td>
<td>Suspend Storage</td>
</tr>
<tr>
<td></td>
<td>Move (only with Storage Targets configured)</td>
</tr>
<tr>
<td></td>
<td>Resize (only with Storage Targets configured)</td>
</tr>
</tbody>
</table>

**Monitored Resources**

Turbonomic monitors the following resources for the PaaS supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Data Center (Cloud Foundry)</td>
<td>Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the Organization / Space</td>
</tr>
<tr>
<td></td>
<td>Measured in Megabytes (MB)</td>
</tr>
</tbody>
</table>
Application
- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Transactions
  The utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second

VirtualMachine
- Virtual Memory (VMem)
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Virtual Storage (VStorage)
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

Physical Machine
- Memory (Mem)
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)
- Balloon
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
• CPU Ready
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

Storage

• Storage Amount
  The utilization of the datastore’s capacity
  Measured in Megabytes (MB)

• Storage Provisioned
  The utilization of the datastore’s capacity, including overprovisioning.
  Measured in Megabytes (MB)

• Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second

• Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)
Fabric Targets

A fabric target is a service that unites compute, network and storage access into a cohesive system. When you connect Turbonomic to fabric targets, it monitors the performance and resource consumption of your fabric interconnects, IO modules, chassis, and Blade Servers to assure application performance while also utilizing resources as efficiently as possible.

Once connected, Turbonomic discovers the blades that host the VMs, the chassis and datastores that provide resources to the blades, the IO modules and fabric interconnects that provide network resources, and the virtual datastores that provide storage resources to the VMs.

As part of this process, Turbonomic will stitch information from the fabric target and the associated hypervisor targets together, to provide deeper insight into the state of the hardware, and information related to the applications and VM’s running on the hypervisor-stitched blades.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect, Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines (blade servers) — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network, and also hosts the UCS Manager for UCS Targets. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

Supported Fabric Targets

Turbonomic supports the following fabric targets:

- Cisco UCS
- Cisco UCS Central
- HPE Oneview
## Monitored Resources

Turbonomic monitors the following resources for the fabric supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| VirtualMachine    | • Virtual Memory (VMem)  
The utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
The utilization of the virtual storage capacity allocated for the VM  
Measured in Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The utilization of IOPS allocated for the VStorage on the VM  
Measured in IOPS  
• Latency  
The utilization of latency allocated for the VStorage on the VM  
Measured in milliseconds (ms) |
| Blade             | • Net  
The utilization of data through the Blade's network adapters  
Measured in Kilobytes per second (KB/s)  
• Treated as a Physical Machine of the underlying Hypervisor (see below)  
CPU, Mem, etc. |
| Physical Machine  | • Memory (Mem)  
The utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB)  
• CPU  
The utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz)  
• IO  
The utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s)  
• Net  
The utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s)  
• Swap  
The utilization of the PM's swap space  
Measured in Kilobytes (KB)  
• Balloon  
The utilization of shared memory among VMs running on the host. ESX-only  
Measured in Kilobytes (KB) |
- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**I/O Module**
- **NetThroughput**
  Rate of message delivery over a port
  Measured in Megabits per second (Mb/s)

**Fabric Interconnect**
- **NetThroughput**
  Rate of message delivery over a port
  Measured in Mb/s
- **PortChannel**
  Amalgamation of ports with a shared net throughput and utilization
  Measured in Mb/s

---

**Cisco UCS Manager**

The Cisco Unified Computing System (UCS) Manager is a management solution that participates in server, fabric, and storage provisioning, device discovery, inventory, configuration, diagnostics, monitoring, fault detection, auditing, and statistics collection.

UCS integrates all of these resources in a scalable multi-chassis platform to converge administration onto a single point. Managing these various entities on a network fabric with Turbonomic enables automation at the hardware level, including automated provisioning of hosts.

---

**Prerequisites**

- A service account Turbonomic can use to connect to UCS Manager

---

**Adding UCS Targets**

To add a UCS target, select the **Fabric** category and choose one of the UCS Fabric options to match the version of UCS you want to manage. Then provide the following information:

- **Address**: The IP address of the UCS Manager
  This gives access to the Fabric Manager that resides on the interconnect.
  Turbonomic connects to the UCS Manager via the HTTPS protocol by default. In order to force the HTTP protocol, the Address must be entered in one of two ways. For example, an IP of 8.8.8.8 must be entered as http://8.8.8.8 or by using a specific HTTP port, such as 8.8.8.8:80.

- **Username/Password**: The credentials of the account Turbonomic will use to connect to UCS Manager.
  specify the IP address and credentials for UCS Manager. Turbonomic discovers the fabric interfaces associated with that manager.
NOTE: When providing a username, if the account is managed in Active Directory you must include the domain in case-sensitive spelling. For example, MyDomain\john is not the same as mydomain\john. For local user accounts, just provide the username.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect (Switch), Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network, and also hosts the UCS Manager. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

Actions

Turbonomic recommends actions for the various entities of the UCS Fabric Network as follows:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Chassis</td>
<td>• Provision New Chassis</td>
</tr>
<tr>
<td>Fabric Interconnect</td>
<td>• Add Port to Port Channel</td>
</tr>
<tr>
<td></td>
<td>• Remove Port from Port Channel</td>
</tr>
<tr>
<td>DPod</td>
<td>• Provision new DPod</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following commodities of the UCS target:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
• Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB)

• Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS

• Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Physical Machine

• Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)

• CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)

• IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)

• Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)

• Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)

• Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)

• CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

Chassis

• Space
Representation of the physical number of Rack-Mounts available
Measured in Rack-slots

• Power
Electricity being consumed by the Chassis
Measured in Watts (W)

• Temperature
Temperature of the internals of the Chassis
Measured in degrees Celsius (C)

I/O Module

• NetThroughput
Rate of message delivery over a port
Measured in Megabits per second (Mb/s)
Fabric Interconnect

- NetThroughput
  Rate of message delivery over a port
  Measured in Mb/s
- PortChannel
  Amalgamation of ports with a shared net throughput and utilization
  Measured in Mb/s

DPod

- Memory (Mem)
  The utilization of the DPod’s memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The utilization of the DPod’s CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- Flow
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)

Cisco UCS Central

Cisco UCS Central aggregates multiple Cisco Unified Computing System targets onto a single point of management. Managing compute resources on a network fabric of this magnitude enables automation at the hardware level, including automated provisioning of hosts on any of the underlying UCS Manager instances.

Turbonomic does not discover entities through the UCS Central target. Instead, all entities are identified from the UCS Manager instances associated to the UCS Central Software, and discovered through the UCS Managers.

Prerequisites

- A service account Turbonomic can use to connect to UCS Central Software

**NOTE:** You must ensure that the username and password for the UCS Central service account are identical to those of the underlying UCS Manager instances. Turbonomic will not have visibility into any UCS Manager instances for which the credentials are not identical.

Adding UCS Central Targets

To add a UCS Central target, select the Fabric category and choose UCS Central. Then provide the following information:
• **Address:** The IP address of the Virtual Machine running the UCS Central OVA. This gives access to the UCS Central Software that resides on the Virtual Machine. Turbonomic uses the HTTPS protocol by default. In order to force the HTTP protocol, the address must be entered in one of two ways. For example, an IP of 8.8.8.8 must be entered as http://8.8.8.8 or by using a specific HTTP port, such as 8.8.8.8:80.

• **Username/Password:** The credentials of the account Turbonomic will use to connect to UCS Central. The credentials must be identical on UCS Central and each connected UCS Manager instance for Turbonomic to discover the instances.

**NOTE:** When providing a username, if the account is managed in Active Directory you must include the domain in case-sensitive spelling. For example, `MyDomain\john` is not the same as `mydomain\john`. For local user accounts, just provide the username.

After you add a UCS Central target, Turbonomic will discover all the associated UCS Manager targets that are part of the UCS Central instance.

### Supply Chain

Fabric targets add IO Module, Fabric Interconnect (Switch), Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network, and also hosts the UCS Manager. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

### Actions

Turbonomic recommends actions for the various UCS Manager instances of the UCS Central Fabric Network as follows:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
</table>
| Fabric Interconnect | • Add Port to Port Channel  
                   | Overutilization of Ports in Port Channel  
                   | • Remove Port from Port Channel  
                   | Underutilization of Ports in Port Channel  
                   | • Add Port  
                   | Overutilization of Ports not in Port Channels  |
| Blade             | • Provision Blade  
                   | Overutilization of currently available Blades  
                   | Available powered-down Blade without associated host profile  
                   | • Start Blade  
                   | Overutilization of currently available blades  
                   | Available powered-down Blade with associated host profile  
                   | • Suspend Blade  
                   | Underutilization of currently available Blades  |
**NOTE:** Turbonomic will also recommend adding a port to the I/O Module via an "Add Port to Port Channel" recommendation from the Fabric Interconnect, with the Port Channel name of "fex" (Fabric EXtender). Turbonomic will never resize down the I/O module Port Channel.

## Monitored Resources

Turbonomic monitors the following commodities of each underlying UCS Manager instance:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Blade</td>
<td>• Net</td>
</tr>
<tr>
<td></td>
<td>The utilization of data through the Blade's network adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
<tr>
<td></td>
<td>• Treated as a Physical Machine of the underlying Hypervisor (see below)</td>
</tr>
<tr>
<td></td>
<td>CPU, Mem, etc.</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>• Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's memory reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's CPU reserved or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• IO</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's IO adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
<tr>
<td></td>
<td>• Net</td>
</tr>
<tr>
<td></td>
<td>The utilization of data through the PM's network adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
<tr>
<td></td>
<td>• Swap</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's swap space</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**Chassis**
- **Space**
  Representation of the physical number of Rack-Mounts available
  Measured in Rack-slots
- **Power**
  Electricity being consumed by the Chassis
  Measured in Watts (W)
- **Temperature**
  Temperature of the internals of the Chassis
  Measured in degrees Celsius (C)

**I/O Module**
- **NetThroughput**
  Rate of message delivery over a port
  Measured in Megabits per second (Mb/s)

**Fabric Interconnect**
- **NetThroughput**
  Rate of message delivery over a port
  Measured in Mb/s
- **PortChannel**
  Amalgamation of ports with a shared net throughput and utilization
  Measured in Mb/s

---

**HPE OneView**

HPE OneView is a management solution that streamlines provisioning and lifecycle management across compute, storage, and fabric. Through a unified API, infrastructure can be configured, monitored, updated, and repurposed.

HPE OneView integrates all of these resources in a scalable multi-enclosure platform to converge administration onto a single point. Managing these various entities on a network fabric with Turbonomic enables automation at the hardware level, including automated provisioning of hosts.

**Prerequisites**

- A service account Turbonomic can use to connect to HPE OneView.
- HPE OneView 2.0 and compatible hardware.
Adding HPE OneView Targets

To add a HPE OneView as a target, select the Fabric category and choose the HPE OneView radio button. Then provide the following information:

- **Address**: The IP address of the HPE OneView target
  This gives access to the Fabric Manager that resides on the VM.
  Turbonomic uses the HTTPS protocol by default. In order to force the HTTP protocol, the Address must be entered in one of two ways. For example, an IP of 8.8.8.8 must be entered as http://8.8.8.8 or by using a specific HTTP port, such as 8.8.8.8:80.

- **Username/Password**: The credentials of the account Turbonomic will use to connect to the HPE OneView target.
  specify the IP address and credentials for HPE OneView. Turbonomic discovers the fabric interfaces associated with that instance.

**NOTE**: When providing a username, if the account is managed in Active Directory you must include the domain in case-sensitive spelling. For example, MyDomain\john is not the same as mydomain\john. For local user accounts, just provide the username.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect (Switch), Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

**NOTE**: For HPE OneView targets, the "Fabric Interconnect" entity exists as a false "Switch", and only as a pass-through for network resources. Unlike other fabric targets, such as UCS, there is no physical hardware that serves this function.

Actions

Turbonomic recommends actions for the various entities of the HPE OneView Fabric Network as follows:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines</td>
<td>• Provision additional resources (VMem, VCPU)</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine</td>
</tr>
<tr>
<td></td>
<td>• Move Virtual Machine Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Storage</td>
</tr>
<tr>
<td></td>
<td>• Reconfigure Virtual Machine</td>
</tr>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Provision Physical Machine</td>
</tr>
<tr>
<td></td>
<td>• Suspend Physical Machine</td>
</tr>
<tr>
<td>Fabric Interconnect</td>
<td>• Add Port to Port Channel</td>
</tr>
<tr>
<td></td>
<td>• Remove Port from Port Channel</td>
</tr>
<tr>
<td></td>
<td>• Add Port</td>
</tr>
<tr>
<td>DPod</td>
<td>• Provision new DPod</td>
</tr>
</tbody>
</table>
# Monitored Resources

Turbonomic monitors the following commodities of the HPE OneView target:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to</td>
</tr>
<tr>
<td></td>
<td>the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VCPU allocated to</td>
</tr>
<tr>
<td></td>
<td>the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Virtual Storage (VStorage)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the virtual storage</td>
</tr>
<tr>
<td></td>
<td>capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The utilization of IOPS allocated for the</td>
</tr>
<tr>
<td></td>
<td>VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The utilization of latency allocated for</td>
</tr>
<tr>
<td></td>
<td>the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>• Memory (Mem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's memory reserved</td>
</tr>
<tr>
<td></td>
<td>or in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's CPU reserved or</td>
</tr>
<tr>
<td></td>
<td>in use</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• IO</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's IO adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
<tr>
<td></td>
<td>• Net</td>
</tr>
<tr>
<td></td>
<td>The utilization of data through the PM's</td>
</tr>
<tr>
<td></td>
<td>network adapters</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes per second (KB/s)</td>
</tr>
<tr>
<td></td>
<td>• Swap</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's swap space</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Balloon</td>
</tr>
<tr>
<td></td>
<td>The utilization of shared memory among VMs</td>
</tr>
<tr>
<td></td>
<td>running on the host. ESX-only</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPU Ready</td>
</tr>
<tr>
<td></td>
<td>The utilization of the PM's allocated</td>
</tr>
<tr>
<td></td>
<td>ready queue capacity (measured in Kbytes)</td>
</tr>
<tr>
<td></td>
<td>that is in use, for 1, 2, and 4 CPU ready</td>
</tr>
<tr>
<td></td>
<td>queues. ESX-only</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</td>
</tr>
</tbody>
</table>
Storage

- Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)

- Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second

- Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

I/O Module

- NetThroughput
  Rate of message delivery over a port
  Measured in Megabits per second (Mb/s)

Fabric Interconnect

- NetThroughput
  Rate of message delivery over a port
  Measured in Mb/s

- PortChannel
  Amalgamation of ports with a shared net throughput and utilization
  Measured in Mb/s

DPod

- Memory (Mem)
  The utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)

- CPU
  The utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)

- Storage
  The utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)

- Flow
  The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization
  Measured in Kilobytes per second (KB/s)
A hyperconverged target is a service that unites compute, network and storage access into a cohesive system. When you connect Turbonomic to hyperconverged targets, it monitors the performance and resource consumption of your stitched infrastructure, enhancing the data used to assure application performance while also utilizing resources as efficiently as possible.

As part of this process, Turbonomic will stitch information from the hyperconverged target and the associated hypervisor and fabric targets together, to provide deeper insight into the state of the hardware, and information related to the applications and workload running in your environment.

**Supported Hyperconverged Targets**

Turbonomic supports the following hyperconverged targets:

- Cisco HyperFlex
- Nutanix

**Monitored Resources**

Turbonomic monitors the following resources for the hyperconverged supply chain, once stitched to your hypervisor and other associated targets:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualMachine</td>
<td>Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The utilization of the VMem allocated to the hosting VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)

- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Blade**

- **Net**
  The utilization of data through the Blade's network adapters
  Measured in Kilobytes per second (KB/s)

- **Treated as a Physical Machine of the underlying Hypervisor (see below)**
  CPU, Mem, etc.

**Physical Machine**

- **Memory (Mem)**
  The utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

- **CPU**
  The utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)

- **IO**
  The utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)

- **Net**
  The utilization of data through the PM’s network adapters
  Measured in Kilobytes per second (KB/s)

- **Swap**
  The utilization of the PM's swap space
  Measured in Kilobytes (KB)

- **Balloon**
  The utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The utilization of the PM’s allocated ready queue capacity (measured in Kbytes)
  that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
  Measured in Megahertz (MHz)

**I/O Module**

- **NetThroughput**
  Rate of message delivery over a port
  Measured in Megabits per second (Mb/s)
Fabric Interconnect

- NetThroughput
  Rate of message delivery over a port
  Measured in Mb/s
- PortChannel
  Amalgamation of ports with a shared net throughput and utilization
  Measured in Mb/s

Storage

- Storage Amount
  The utilization of the datastore's capacity
  Measured in Megabytes (MB)
- Storage Provisioned
  The utilization of the datastore's capacity, including overprovisioning.
  Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the datastore
  Measured in Operations per second
- Latency
  The utilization of latency on the datastore
  Measured in Milliseconds (ms)

Disk Array

- Storage Amount
  The utilization of the Disk Array's capacity.
  Measured in Megabytes (MB)
- Storage Provisioned
  The utilization of the Disk Array's capacity, including overprovisioning.
  Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
  The summation of the read and write access operations per second on the disk array
  Measured in Operations per second
- Latency
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

Cisco HyperFlex

Cisco HyperFlex provides a hyperconverged platform that combines the networking and compute power of UCS with the storage capabilities of the HyperFlex HX Data Platform.

With the additional and refined storage information provided by HyperFlex, Turbonomic narrows the Desired State and recommends actions using the joint compute and storage information, gaining valuable insight into the interconnected nature of your environment.
For Turbonomic to make the most informed decisions, you must also add the compute nodes and any associated hypervisors. HyperFlex environments typically include:

- **Converged (HX) Nodes**
  A combination of the cluster’s storage devices into a single multi-tiered, object-based datastore.

- **Compute Nodes**
  Cisco B or C series servers that make up the compute resources of the cluster, and are typically managed by a hypervisor.

- **Controller VMs**
  Each HyperFlex node includes a Controller VM that intercepts and handles all the I/O from associated virtual machines. Turbonomic will not recommend actions for these VMs.

### Prerequisites

- A service account on the controller VM that Turbonomic can use to connect to the HyperFlex environment

### Adding HyperFlex Targets

To add a HyperFlex target, select the **Hyperconverged > HyperFlex** option on the Target Configuration page and provide the following information:

- **Address**
  The name or IP address of the HyperFlex controller VM
- **Username/Password**
  Credentials for a user account Turbonomic will use to connect to the controller VM
- **Port Number**
  Port Number Turbonomic will use to connect to the controller VM
- **Secure Connection**
  When checked, Turbonomic will use HTTPS to connect to the HyperFlex target

### Supply Chain

HyperFlex targets add Disk Array entities to the supply chain, and receive more granular information from the compute resources in your environment.
### Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in HyperFlex to those used in Turbonomic:

<table>
<thead>
<tr>
<th>HyperFlex Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>Storage</td>
</tr>
<tr>
<td>HX Cluster</td>
<td>Disk Array</td>
</tr>
</tbody>
</table>

### Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td></td>
<td>Move, Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Provision, Resize Up</td>
</tr>
</tbody>
</table>

**NOTE:** For this target, Turbonomic discovers the HX Cluster as a Disk Array. When you see a provision action on this entity, you should determine which of the following is most relevant, based on your environment:

- Add disks to converged nodes
- Add a new converged node
- Add a new HX Cluster

### Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount&lt;br&gt;The utilization of the datastore's capacity&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the datastore's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The summation of the read and write access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• Latency&lt;br&gt;The utilization of latency on the datastore&lt;br&gt;Measured in Milliseconds (ms)</td>
</tr>
</tbody>
</table>
Hyperconverged Targets

Disk Array

- **Storage Amount**
  The utilization of the Disk Array's capacity.
  Measured in Megabytes (MB)

- **Storage Provisioned**
  The utilization of the Disk Array's capacity, including overprovisioning.
  Measured in Megabytes (MB)

- **Storage Access Operations Per Second (IOPS)**
  The summation of the read and write access operations per second on the disk array.
  Measured in Operations per second

- **Latency**
  The utilization of latency, computed from the latency of each device in the disk array.
  Measured in milliseconds (ms)

Nutanix

Nutanix products provide hyperconverged platforms that include VM hosting and a distributed storage fabric. The platform presents storage in two tiers — Local HDD storage and server-attached flash (hot storage).

Nutanix environments include:

- **One or more Nutanix appliances**
  An appliance contains up to four server nodes.

- **Nutanix nodes**
  Servers that expose compute and storage resources. Each node provides local HDD and hot storage. Nodes combine to form a unified cluster that pools resources.

- **Controller VMs**
  Each node includes a Controller VM that manages the node’s resources within the cluster pool. To minimize storage latency, the Controller VM keeps the most frequently accessed data in the hot storage.

Turbonomic supports management of Nutanix fabrics, where the supply chain treats a Nutanix Storage Pool as a disk array. Turbonomic recognizes Nutanix storage tiers when calculating placement of VMs and VStorage. In addition, Turbonomic can recommend actions to scale flash capacity up or down by adding more hosts to the cluster, or more flash drives to the hosts.

To specify a Nutanix target, provide the Cluster External IP address. This is a logical IP address that always connects to one of the active Controller VMs in the cluster. In this way, you can specify a Nutanix target without having to specify an explicit Controller VM.

**NOTE:** The Controller VM must remain pinned to its host machine — You must not move the Controller VM to a different host. If the Nutanix cluster uses the Nutanix Acropolis OS to manage VMs, Turbonomic automatically pins the Controller VMs. However, if you use vCenter Server or Hyper-V to manage VMs on the hosts, you must configure a group to pin the Controller VMs. For more information, see “Pinning Nutanix Controller VMs in Generic Hypervisor Mode” in the User Guide.
Prerequisites

- A service account with administrator rights on the Nutanix target

Finding the Cluster External IP Address

To set a Nutanix target, provide the Cluster External IP address for the given Nutanix cluster.

The Cluster External IP address is a logical IP that resolves to the cluster's Prism Leader. If the Prism Leader fails, then the Cluster External IP address will resolve to the newly elected Prism Leader.

To find this IP address, open the Web Console (the Prism Element) on the cluster and navigate to the Cluster Details view. In this view you can see the Cluster External IP address. If there is no IP address specified, you can specify the address at this time. For more information, see the Nutanix documentation.

Operating Modes

A Nutanix node is a server that hosts VMs — In this sense the node functions as a hypervisor. A cluster of nodes can host VMs using the following Hypervisor technologies:

- Nutanix Acropolis
  The native Nutanix host platform, which combines software-defined storage with built-in virtualization.
- VMware ESXi
- Microsoft Hyper-V

Turbonomic divides Nutanix cluster management into two modes:

- Standalone Mode (Acropolis)
  In this mode you:
    - Enable standalone mode and restart the Turbonomic server
    - Specify the Nutanix Cluster External IP address as the target address — This adds the cluster as a Turbonomic target to manage both VM and storage resources

- Generic Hypervisor Mode (ESXi or Hyper-V)
  In this mode you:
    - Add each Hyper-V host or vCenter as a hypervisor target — This enables VM workload control for the respective hypervisor technologies
    - Specify the Nutanix Cluster External IP address as the target address — This adds the cluster as a Storage Controller target to enable Turbonomic storage control

NOTE: These operating modes are mutually exclusive for a Nutanix cluster. You cannot mix operating modes in the same cluster.

Enabling Standalone (Acropolis) Operating Mode

By default, Turbonomic supports the Generic Hypervisor operating mode. To enable management of Acropolis VMs, you must modify the Turbonomic targets configuration file and then restart the Turbonomic server, as outlined in Enabling Standalone (Acropolis) Operating Mode In Nutanix on page 190.
Controller VM Pinning

Each Nutanix node hosts a Controller VM that runs the Nutanix software and manages I/O for the hypervisor and all VMs running on the host. Each Controller VM must remain on its host node — The Controller VM must be pinned to that host, and must not be moved to any other host.

For more information about how to pin the Controller VM, see "Pinning Nutanix Controller VMs in Generic Hypervisor Mode" in the User Guide.

Adding Nutanix Targets

NOTE: This describes how to add a Nutanix cluster to Turbonomic as a target. The steps are the same no matter which operating mode you use (Standalone or Generic Hypervisor). Before you add the cluster as a target, you should know which operating mode you intend. If you want Standalone mode, then you will have to enable that operating mode after adding the cluster. If you want Generic Hypervisor mode, then you will have to add the hypervisors as targets after you have added the Nutanix cluster as a target. For more information, see Hypervisor Targets on page 4.

To add Nutanix targets, select the Storage > Nutanix option on the Target Configuration page and provide the following information:

- Address
  The Cluster External IP address for the Nutanix cluster.
- Username/Password
  Credentials for an account on the Nutanix cluster.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in Nutanix to those used in Turbonomic:

<table>
<thead>
<tr>
<th>Nutanix Name</th>
<th>Turbonomic Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container</td>
<td>Storage</td>
</tr>
<tr>
<td>Storage Pool</td>
<td>Disk Array</td>
</tr>
<tr>
<td>Controller VM</td>
<td>Storage Controller</td>
</tr>
</tbody>
</table>

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory Supply Chain on page 64.
Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Can Be Automated</th>
<th>Recommendations only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datastore (&quot;Storage&quot;)</td>
<td></td>
<td>Provision, Resize Up</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>• Storage Amount&lt;br&gt;The utilization of the datastore's capacity&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Provisioned&lt;br&gt;The utilization of the datastore's capacity, including overprovisioning.&lt;br&gt;Measured in Megabytes (MB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The summation of the read and write access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• Latency&lt;br&gt;The utilization of latency on the datastore&lt;br&gt;Measured in Milliseconds (ms)&lt;br&gt;</td>
</tr>
</tbody>
</table>
| Disk Array    | • Storage Amount<br>The utilization of the Disk Array's capacity.<br>Measured in Megabytes (MB)<br>• Storage Provisioned<br>The utilization of the Disk Array's capacity, including overprovisioning.<br>Measured in Megabytes (MB)<br>• Storage Access Operations Per Second (IOPS)<br>The summation of the read and write access operations per second on the disk array<br>Measured in Operations per second<br>• Latency<br>The utilization of latency, computed from the latency of each device in the disk array.<br>Measured in milliseconds (ms)
Hyperconverged Targets

**Storage Controller**

- **CPU**
  The utilization of the Storage Controller’s CPU in use
  Measured in Megahertz (MHz)

- **Storage Amount**
  The utilization of the storage controller’s capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller
  Measured in Megabytes (MB)

---

**Enabling Standalone (Acropolis) Operating Mode In Nutanix**

**NOTE:** Standalone and Generic modes are mutually exclusive for a Nutanix cluster. You cannot mix operating modes in the same cluster.

To enable Acropolis management for a cluster:

1. **Add the Nutanix cluster as a target.**
   Add the cluster as a target using the Cluster External IP address. Be sure you have added the target, and that Turbonomic has validated the target. Keep a note of the IP address you used.

2. **Open a secure session on the Turbonomic server.**
   ```
   ssh root@<server_ip_address>
   ```
   The default password is `vmturbo`.

3. **Navigate to the configuration directory.**
   Change directory to `/srv/tomcat/data/config`.

4. **Back up the config file.**
   Create a backup of `disc.config.topology`.

5. **Locate the target entry for the cluster you added.**
   Open `disc.config.topology` in a text editor.
   In this file, search the `<targets>` section for the `nutanix:NutanixTarget` entry that has the IP address you supplied for the Nutanix cluster.
   For example, assume you added a Nutanix cluster with the IP address, `10.10.64.88`. Then you would search for the following entry in the config file:
   ```
   <targets xsi:type="nutanix:NutanixTarget" uuid="_pRSdsFheEeWgpfmffIwmXw"
   name="VMTTarget_10.10.64.88" displayName="10.10.64.88" nameOrAddress="10.10.64.88"
   timeout="30000" template="_2kieMIMcEeCC5PhGzd6dJj" ... </targets>
   ```

6. **Modify the entry’s TEMPLATE attribute.**
   Note the template attribute. In the example above, the value is `_2kieMIMcEeCC5PhGzd6dJj`.
   Change the last character in the `template` attribute from `j` to `i`. Following the example, the config file entry would now be:
   ```
   <targets xsi:type="nutanix:NutanixTarget" uuid="_pRSdsFheEeWgpfmffIwmXw"
   name="VMTTarget_10.10.64.88" displayName="10.10.64.88" nameOrAddress="10.10.64.88"
   timeout="30000" template="_2kieMIMcEeCC5PhGzd6dJi" ... </targets>
   ```

7. **Save your changes to the configuration file.**

8. **Restart Turbonomic.**
UCS Director

Turbonomic supports dynamic execution of UCS Director workflows, enabling provisioning, resizing and decommissioning of entities in a UCS environment.

Prerequisites

- UCS Director 5.0+
- UCS Director user account with administrator permissions
- UCS Director Workflow Configuration (see below)

**NOTE:** If UCS Director is managing other services which are also Turbonomic targets (for example, NetApp or vCenter), these targets must be added using the same convention (Hostname or IP) in both UCS Director and Turbonomic.

Adding UCS Director Targets

To add UCS Director targets, select the **Orchestration > UCS Director** option on the Target Configuration page and provide the following information:

- Address
  IP of the UCS Director Instance
- Username
  Username for the UCS Director Instance
- Password
  Password for the UCS Director Instance
- Port Number
  Port Number used to access the UCS Director Instance
Binding A UCS Director Workflow to a Turbonomic Action Execution Policy

NOTE: Orchestrator workflows can only be associated to action execution in the HTML5 UI.

To add a UCS Director workflow, perform the following steps:
1. Navigate to Settings > Policies, and select the Automation Policy button.
2. Select the entity that the workflow affects, bringing you to the policy configuration page.
3. Under Action Orchestration, select the action that the workflow affects.
4. In the Run In dropbox that appears after the action is selected, choose UCS Director.
5. Click Link Workflow and select the applicable workflow.
6. Click Save and Apply. The workflow is now activated.

Supported Workflows

To execute each workflow, Turbonomic will provide a set number of pre-defined parameters to Turbonomic as outlined below. Your workflow must be designed to accept the parameters mentioned below for Turbonomic integration to succeed. No parameters may be omitted, or integration will fail.

Workflow discovery will occur once per day. To discover new workflows sooner, you must manually rediscover the UCS Director target.

NOTE: For example workflows that leverage these parameters, please see the following Cisco documentation: https://communities.cisco.com/docs/DOC-75351.

- Host Provision

NOTE: The intent behind this workflow is to provide a user with the information they need to enable a new UCS Server and to configure a hypervisor on that server.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD</td>
<td>The name of the Pod</td>
<td>Default Pod</td>
</tr>
<tr>
<td>SERVER_FILER</td>
<td>The UCSM IP/FQDN of the host</td>
<td>ucsmanager.domain.com</td>
</tr>
<tr>
<td>SERVER</td>
<td>The stitched IP/FQDN of the host</td>
<td>vcenter1.domain.com</td>
</tr>
<tr>
<td>REFERENCE_HOST</td>
<td>The name of the reference host</td>
<td>hypervisor.domain.com</td>
</tr>
<tr>
<td>HOST_PROFILE</td>
<td>The name of the host profile</td>
<td>vcenter1@HostProfileName</td>
</tr>
<tr>
<td>SERVICE_PROFILE_TEMPLATE_ID</td>
<td>The ID of the service profile template</td>
<td>ucspe;org-root;org-root/ls-sp1_template</td>
</tr>
<tr>
<td>SERVICE_PROFILE_ORGANIZATION</td>
<td>The name of the service profile organization</td>
<td>org-root</td>
</tr>
</tbody>
</table>
### Host Suspend

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV_ACCOUNT</td>
<td>The account name of the hypervisor target</td>
<td>vcenter1</td>
</tr>
<tr>
<td>REFERENCE_SERVER</td>
<td>The name of the UCS Manager reference server</td>
<td>sys/chassis-1/blade-1</td>
</tr>
<tr>
<td>UCSM_ACCOUNT</td>
<td>The name of the UCS Manager account</td>
<td>ucsmanager</td>
</tr>
<tr>
<td>DATACENTER</td>
<td>The name of the datacenter for the new host</td>
<td>DataCenter1</td>
</tr>
<tr>
<td>CLUSTER</td>
<td>The name of the cluster for the new host</td>
<td>Cluster-1</td>
</tr>
</tbody>
</table>

### Storage Resize

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD</td>
<td>The name of the Pod</td>
<td>Default Pod</td>
</tr>
<tr>
<td>SERVER_FILER</td>
<td>The UCSM IP/FQDN of the storage</td>
<td>netapp-cluster1.domain.com</td>
</tr>
<tr>
<td>SERVER</td>
<td>The stitched IP/FQDN of the hypervisor</td>
<td>vcenter1.domain.com</td>
</tr>
<tr>
<td>HOST</td>
<td>The host name to suspend</td>
<td>hypervisor.domain.com</td>
</tr>
<tr>
<td>HV_ACCOUNT</td>
<td>The account name of the hypervisor target</td>
<td>vcenter1</td>
</tr>
<tr>
<td>SC_DATASTORE</td>
<td>The name of the datastore in the Storage Controller</td>
<td>ESXvol1</td>
</tr>
<tr>
<td>SC_ACCOUNT</td>
<td>The account name of the storage controller target</td>
<td>netapp-cluster1</td>
</tr>
<tr>
<td>HV_DATASTORE</td>
<td>The names of the datastores in the Hypervisor</td>
<td>NETAPP8.3-VOL1</td>
</tr>
<tr>
<td>HV_ACCOUNTS</td>
<td>The account names of the Hypervisor targets</td>
<td>vcenter1</td>
</tr>
<tr>
<td>SIZE</td>
<td>The target size of the storage in GB</td>
<td>3.75</td>
</tr>
<tr>
<td>HOSTS</td>
<td>The hosts that the datastore is exposed to</td>
<td>hypervisor1.domain.com, hypervisor2.domain.com, hypervisor3.domain.com</td>
</tr>
<tr>
<td>LUN_NAME</td>
<td>The LUN to resize on the Storage Target</td>
<td>NETAPP8.3-LUN1</td>
</tr>
</tbody>
</table>

### Storage Delete

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD</td>
<td>The name of the Pod</td>
<td>Default Pod</td>
</tr>
<tr>
<td>SERVER_FILER</td>
<td>The UCSM IP/FQDN of the storage</td>
<td>netapp-cluster1.domain.com</td>
</tr>
<tr>
<td>SERVER</td>
<td>The stitched IP/FQDN of the hypervisor</td>
<td>vcenter1.domain.com</td>
</tr>
</tbody>
</table>

---

**Parameter**

**Description**

**Sample Output**
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC_DATASTORE</td>
<td>The name of the datastore in the Storage Controller</td>
<td>ESXvol1</td>
</tr>
<tr>
<td>SC_ACCOUNT</td>
<td>The account name of the storage controller target</td>
<td>netapp-cluster1</td>
</tr>
<tr>
<td>HV_DATASTORE</td>
<td>The names of the datastores in the Hypervisor</td>
<td>NETAPP8.3-VOL1</td>
</tr>
<tr>
<td>HV_ACCOUNTS</td>
<td>The account names of the Hypervisor targets</td>
<td>vcenter1</td>
</tr>
<tr>
<td>HOSTS</td>
<td>The hosts that the datastore is exposed to</td>
<td>hypervisor1.domain.com, hypervisor2.domain.com, hypervisor3.domain.com</td>
</tr>
<tr>
<td>LUN_NAME</td>
<td>The LUN to resize on the Storage Target</td>
<td>NETAPP8.3-LUN1</td>
</tr>
</tbody>
</table>

### Storage Provision

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Sample Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD</td>
<td>The name of the Pod</td>
<td>Default Pod</td>
</tr>
<tr>
<td>SERVER_FILER</td>
<td>The UCSM IP/FQDN of the storage</td>
<td>netapp-cluster1.domain.com</td>
</tr>
<tr>
<td>SERVER</td>
<td>The stitched IP/FQDN of the hypervisor</td>
<td>vcenter1.domain.com</td>
</tr>
<tr>
<td>SC_REFERENCE_DATASTORE</td>
<td>The name of the reference datastore in the Storage Controller</td>
<td>ESXvol1</td>
</tr>
<tr>
<td>SC_ACCOUNT</td>
<td>The account name of the storage controller target</td>
<td>netapp-cluster1</td>
</tr>
<tr>
<td>DATASSTORE_PROVIDER</td>
<td>The provider (DiskArray / LogicalPool) of the new datastore</td>
<td>netapp-cluster1:aggr1</td>
</tr>
<tr>
<td>HOSTS</td>
<td>The hosts that the datastore is exposed to</td>
<td>hypervisor1.domain.com, hypervisor2.domain.com, hypervisor3.domain.com</td>
</tr>
<tr>
<td>HV_ACCOUNTS</td>
<td>The account names of the Hypervisor targets</td>
<td>vcenter1</td>
</tr>
<tr>
<td>SIZE</td>
<td>The target size of the storage in GB</td>
<td>3.75</td>
</tr>
<tr>
<td>LUN_NAME</td>
<td>The LUN to resize on the Storage Target</td>
<td>NETAPP8.3-LUN1</td>
</tr>
</tbody>
</table>
Load Balancer Targets

A load balancer is a network appliance that provides Level 4 load balancing of requests to application services. Level 4 load balancing routes traffic according to business rules so that servers with the least load or fastest response times will receive requests from the load balancer.

Turbonomic supports Citrix NetScaler load balancers. When you add these targets, Turbonomic can discover the associated virtual applications.

Turbonomic recommends actions on the VMs that host the underlying applications. If the VM hosts an application with a signature that is associated with a virtual application, then provisioning the new VM will automatically bind the underlying application to the virtual application. In this way, Turbonomic can control the underlying resources that support the load balancer’s demand.

Supply Chain

A load balancer target adds virtual applications to the supply chain. Turbonomic discovers the virtual applications (sometimes called virtual servers) that are managed by that load balancer. The virtual application is a proxy for multiple instances of actual applications. When a client requests application services, it requests them through the virtual application. The load balancer distributes the requests to balance the workload on the underlying applications that provide transactions to the virtual application.

Configuring Load Balancer Discovery

After you add a load balancer as a target, you must configure Turbonomic to discover the virtual applications that load balancer manages.
The steps to do this are:

1. **Specify discovery for the applications the load balancer will manage**
   The load balancer manages workload across instances of running applications in your environment. Turbonomic must be configured to discover and manage these running applications before it can recognize that they are managed by the load balancer. For example, to specify discovery of a specific application, you define its application signature and then provide credentials for the protocol (WMI, SNMP, or JMX) that Turbonomic can use to access the VMs that host the application. For more information, see "Application Discovery" in the User Guide.

2. **Assign application signatures to specific virtual applications**
   Turbonomic discovers the virtual applications that the load balancer uses to manage applications. After you have specified signatures and discovery for the applications you want the load balancer to manage, you can then assign those application signatures to specific virtual applications. For more information, see "Load Balancer Discovery" in the User Guide.

   For example, assume the load balancer uses virtual applications named *web* and *sql* to manage web servers and SQL databases. Also assume that you have defined an application signature named *IIS* for IIS Web Server applications, and another signature named *SQL* for Microsoft SQL Server applications. In that case, you need to map the IIS signature to the *web* virtual application, and SQL to the *sql* virtual application (as explained in the Load Balancer Discovery section). Now Turbonomic can discover these applications and represent them as the running components within the load balancer.

### Adding Citrix NetScaler Targets

To add NetScaler targets, select the **Load Balancers > NetScaler** option on the Target Configuration page and provide the following information:

- **Address**: The IP address of the primary NetScaler load balancer server
  Turbonomic discovers the service types that are assigned to that load balancer. These service types appear in the Turbonomic supply chain as virtual applications. To enable discovery of virtual applications, you must configure load balancer discovery.

- **Username/Password**: The credentials of an account Operations Manager can use to connect to the load balancer.

### Actions

Turbonomic recommends actions for the Load Balancer supply chain as follows.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Turbonomic does not recommend actions to perform on the virtual application itself, but it does recommend actions to perform on the VMs that host bound applications. For example, assume a virtual application that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new VM to run another instance of the database application, and bind it to the virtual application. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it from the virtual application. Virtual Applications will only be discovered if there is a load balancer configured.</td>
</tr>
</tbody>
</table>
Applications
Without discovered Guest OS Processes or Application Servers, Turbonomic doesn’t perform actions on applications. Instead, it performs resize actions on the host VMs. If host utilization is high enough on the physical machine running the application VM, Turbonomic may also recommend provisioning a new host.

For specific application servers, see the individual application entry.

Virtual Machines
- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

Monitored Resources
Turbonomic monitors the following resources for the Load Balancer supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Applications | - Transactions
                  | The utilization of the allocated transactions per second for the given virtual application
                  | Measured in transactions per second                                          |
| Application    | - Virtual Memory (VMem)
                  | The utilization of the VMem allocated to the hosting VM
                  | Measured in Kilobytes (KB)                                                      |
|                | - Virtual CPU (VCPU)
                  | The utilization of the VCPU allocated to the hosting VM
                  | Measured in Megahertz (MHz)                                                     |
|                | - Transactions
                  | The utilization of the allocated transactions per second for the given virtual application
                  | Measured in transactions per second                                             |
|                | - Heap
                  | The utilization of the application server’s heap
                  | Measured in Kilobytes (KB)                                                      |
|                | - Response Time
                  | The utilization of the server’s allocated response time
                  | Measured in Milliseconds (ms)                                                   |
|                | - Threads
                  | The utilization of the server’s thread capacity
                  | Measured in Threads                                                            |
- **Connection**
  The utilization of the connection capacity. Only applicable to database servers
  Measured in Connections

- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in % of uptime

**VirtualMachine**

- **Virtual Memory (VMem)**
  The utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)

- **Virtual CPU (VCPU)**
  The utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)

- **Virtual Storage (VStorage)**
  The utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

- **Latency**
  The utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)
Turbonomic Targets for Aggregation

For large virtual environments, you can use more than one Turbonomic instance to manage your workload. By aggregating multiple instances in this way, you can view the entire environment through a single GUI. One special installation of Turbonomic serves as the aggregating instance to display the combined data of each underlying target instance. For more information about Turbonomic aggregation, see "AggregatedInstTurbonomic allations" in the User Guide.

License Requirements

All Editions of Turbonomic support aggregated deployments.

Prerequisites

The Turbonomic instance that aggregates other Turbonomic servers cannot have any other targets — It can only manage other instances of Turbonomic.

Adding Turbonomic Targets

To add an aggregated instance of Turbonomic, select the Turbonomic Appliance option on the Target Configuration page and provide the following information:

**NOTE:** All the targets of an aggregating instance must be target instances of Turbonomic. You cannot use an aggregating instance to manage other types of targets.
• Address
  The name or IP address of the Turbonomic server.

• Username/Password
  Credentials for the administrator account on the Turbonomic server.

• Appliance ID
  An ID string that you can use to identify this particular Turbonomic server.
  The Server ID appears in the aggregating user interface when the user needs to access an underlying server. For example, assume you’re logged into an aggregating server and want to run a plan. When you display the Plan view, you will see the underlying target servers, listed by their Server IDs.
Appendix — Target Configuration

This appendix contains topics that are related to configuring Turbonomic targets.

Enabling Management via DCOM

**NOTE:** This section applies to Operations Manager 5.3 or below only. If you are using Operations Manager 5.4 or higher, see Enabling Windows Remote Management on page 203.

To enable management via DCOM, the account you use to connect to each Hyper-V target must be one of the server's "WBEM Scripting Locator" owners. To enable access, edit the server’s WBEM Scripting Locator registry keys as described below to add the account and grant full control.

1. Open regedit as Administrator.
2. Locate the following registry key:
   ```
   HKEY_CLASSES_ROOT\CLSID\{76A64158-CB41-11D1-8B02-00600806D9B6}
   ```
3. Right-click the key and choose Permissions.
4. Click Advanced and then click the Owner tab.
5. In the Owners list, add the user you want to allow to connect to the machine.
6. Click OK.
7. Highlight the user and grant Full Control.
8. Search for the following registry key:
   ```
   HKLM\Software\Classes\Wow6432Node\CLSID\{76A64158-CB41-11D1-8B02-00600806D9B6}
   ```
9. If the key exists, repeat the previous steps to grant full control for this key also.

**NOTE:** The user created or modified here must also be the user whose credentials are given for target addition in the Username and Password fields of "Adding Hyper-V Targets" in the User Guide.
Configuring your Firewall for DCOM

Your firewall must be configured to enable communication over DCOM from Operations Manager to the Hyper-V server. DCOM uses port 135 to make the initial connection, but port 445 must also be open.

After the initial connection, DCOM switches to a random non-privileged port for ongoing communication. Most firewalls detect this switch and enable communication via the new port automatically. However, Microsoft's own default firewall setup does not support automatic port switching. If you're using the default Microsoft firewall, you have two options:

- Configure each Hyper-V target to use a static port for DCOM. For steps to do this, see https://msdn.microsoft.com/en-us/library/windows/desktop/bb219447(v=vs.85).aspx. After configuring the static port on each Hyper-V server, open the port on your firewall to allow communication from Operations Manager to your Hyper-V servers.

- Configure the firewall to enable port switching using the following command:
  ```bash
  netsh advfirewall firewall add rule name = Turbonomic dir = in protocol = tcp action = allow localport = rpc remoteip = <IP address of Turbonomic appliance> profile = DOMAIN
  ```

If you encounter problems, the following article provides troubleshooting guidance: http://blogs.technet.com/b/ask-perf/archive/2007/06/22/basic-wmi-testing.aspx.

Secure Setup of WSMan

Turbonomic provides a secure option for Hyper-V/VMM Targets which requires that WSMan be set up securely. Use PowerShell to generate a self-signed certificate, and create an HTTPS WinRM listener.

**NOTE:** For clustered Hyper-V targets, you do not need to create a listener on each host. Only create a listener on the host that is being added to the "Address" field in the Target Configuration.

To enable secure WSMan on your Hyper-V host:

1. **Generate a self-signed certificate using the following command:**
   ```powershell
   New-SelfSignedCertificate -CertstoreLocation Cert:\LocalMachine\My -DnsName "myhost.example.org"
   ```

2. **Find the thumbprint for the certificate for the host:**
   ```powershell
   Get-childItem cert:\LocalMachine\My
   ```

3. **Create an HTTPS WinRM listener for the host with the thumbprint you've found:**
   ```powershell
   winrm create winrm/config/Listener?Address=*+Transport=HTTPS '@{Hostname="myhost.example.org"; CertificateThumbprint="THUMBPRINT_YOU_FOUND"}';
   ```

4. **Verify the presence of configured listeners:**
   ```powershell
   Get-WSManInstance -ResourceURI winrm/config/listener -Enumerate
   ```
Enabling Windows Remote Management

NOTE: This topic covers the setup of WinRM for a single host. For enabling WinRM on multiple hosts, see the following topics:

- Enabling WinRM Via Global Policy Objects on page 204
- Enabling WinRM Via PowerShell on page 205

Turbonomic communicates with your Hyper-V servers using Web Services Management (WS-Management), which is implemented on Microsoft platforms using Windows Remote Management (WinRM). The following steps show how to enable WinRM on a single host, using the command line.

1. **Ensure Windows Firewall is running on the host.**
   For you to configure WinRM successfully, Windows Firewall must be running on the host. For more information, see the Microsoft Knowledge Base article #2004640 (http://support.microsoft.com/kb/2004640).

2. **Set up an SPN for the host machine.**
   The machine must have an SPN of the form, protocol/host_address. For example, WSMAN/10.99.9.2.
   To get a list of SPNs for the machine, execute the following in the command window:
   ```bash
   setspn -l <vmm-server-name>
   ```
   If there is no valid SPN in the list, create one by running the command:
   ```bash
   setspn -A protocol/host-address:port where port is optional
   ```
   For example, `setspn -A WSMAN/10.99.9.2:VMM-02`

3. **Set up the Windows Remote Management (WinRM) service to run on startup.**
   Run the `quickconfig` utility to set up the WinRM service. The `quickconfig` utility:
   - Configures the WinRM service to auto-start
   - Configures basic authentication and disables unencrypted traffic
   - Creates a firewall exception for the current user profile
   - Configures a listener for HTTP and HTTPS on any IP address
   - Enables remote shell access
   To run `quickconfig`, log into a command window as Administrator on the host machine. Then execute the following commands:
   ```bash
   winrm quickconfig
   ```
   Enter `y` to accept the `quickconfig` changes

4. **Set permissions on the host machine.**
   Execute the following commands in the command window to modify the settings made by `quickconfig`:
   - To set the memory capacity for remote shells:
     ```bash
     winrm set winrm/config/winrs @{MaxMemoryPerShellMB="1024"}
     ```
   - To set up an unsecured HTTP connection:
     ```bash
     winrm set winrm/config/service @{AllowUnencrypted="true"}
     winrm set winrm/config/service/Auth @{Basic="true"}
     ```
Enabling WinRM Via Global Policy Objects

You can configure WinRM for all of your Hyper-V targets by creating and linking a Global Policy Object (GPO) within the Hyper-V domain and applying the GPO to all servers.

Follow the steps below to enable Windows Remote Management (WinRM) for your Hyper-V targets.

For additional information, you can also see the Green Circle article, Application Discovery: GPO for necessary Registry Changes

1. On the AD domain controller, open the Group Policy Management Console (GPMC). If the GPMC is not installed, see https://technet.microsoft.com/en-us/library/cc725932.aspx.

2. Create a new Global Policy Object:
   a) In the GPMC tree, right-click Group Policy Objects within the domain containing your Hyper-V servers.
   b) Choose Create a GPO in this domain, and link it here.
   c) Enter a name for the new GPO and click OK.

3. Specify the computers that need access:
   a) Select the new GPO from the tree.
   b) On the Scope tab, under Security Filtering, specify the computer or group of computers you want to grant access. Make sure you include all of your Hyper-V targets.

4. Right-click the new GPO and choose Edit to open the Group Policy Management Editor.

5. Configure the WinRM Service:
   b) Double-click each of following settings and configure as specified:

   | Allow automatic configuration of listeners ("Allow remote server management through WinRM" on older versions of Windows Server): | Enabled IPv4 filter: *
   |---|---|
   | Allow Basic authentication: | Enabled
   | Allow unencrypted traffic: | Enabled

6. Configure the WinRM service to run automatically:
   a) In the Group Policy Management Editor, expand Computer Configuration > Preferences > Control Panel Settings.
   b) Under Control Panel Settings, right-click Services and choose New > Service.
   c) In the New Service Properties window, configure the following settings:

   | Startup: | Automatic
   |---|---|
   | Service name: | WinRM
   | Service option: | Service start
7. **Enable Windows Remote Shell:**
   a) In the Group Policy Management Editor, select Computer Configuration > Policies > Administrative Templates > Windows Components > Windows Remote Shell.
   b) Double-click the following setting and configure as specified:

<table>
<thead>
<tr>
<th>Allow Remote Shell Access</th>
<th>Enabled</th>
</tr>
</thead>
</table>

8. **Add a Windows Firewall exception:**
   a) In the Group Policy Management Editor, open Computer Configuration > Windows Settings > Security Settings > Windows Firewall > Windows Firewall.
   b) Under Windows Firewall, right-click Inbound Rules and choose New > Rule.
   c) In the New Inbound Rule Wizard, select Predefined: Windows Remote Management and Allow the connection.

The new group policy will be applied during the next policy process update. To apply the new policy immediately, execute the following command at a Powershell prompt:

```
gpupdate /force
```

### Enabling WinRM Via PowerShell

Using PsExec, you can run quickconfig on all your Hyper-V servers and change the default settings remotely. PsExec is a component of PsTools, which you can download from [https://technet.microsoft.com/en-us/sysinternals/bb897553.aspx](https://technet.microsoft.com/en-us/sysinternals/bb897553.aspx).

1. **Create a text file containing the Hyper-V host names,** for example:

   ```
   hp-vx485
   hp-vx486
   ```

2. **Since Turbonomic requires changes to the default quickconfig settings,** create a batch file containing the following command:

   ```
   @echo off Powershell.exe Set-WSManQuickConfig -Force Powershell.exe Set-Item WSMAN:\localhost\Shell\MaxMemoryPerShellMB 1024
   ```

   **NOTE:** If you are connecting via HTTP, you must include the following command:

   ```
   Powershell.exe Set-Item WSMAN:\localhost\Service\AllowUnencrypted -Value $True
   ```

3. **Use PsExec to enable WinRM on the remote servers:**

   ```
   .\PsExec.exe @<hosts_file_path> -u <username> -p <password> -c <batch_file_path>
   ```

   **NOTE:** If you get an error message when executing this command, add the `-h` option (`.\PsExec.exe -h`).
# Port Configuration

To support communication with different target technologies, Turbonomic requires open access to the following ports:

<table>
<thead>
<tr>
<th>Target</th>
<th>Port(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcenter (Monitoring)</td>
<td>80, 443</td>
</tr>
<tr>
<td>Vcenter (Tags)</td>
<td>443, 10443</td>
</tr>
<tr>
<td>Hyper-V</td>
<td>5985, 5986</td>
</tr>
<tr>
<td>RHEV</td>
<td>80, 443</td>
</tr>
<tr>
<td>XenCenter</td>
<td>80, 443</td>
</tr>
<tr>
<td>Vcloud Director</td>
<td>80, 443</td>
</tr>
<tr>
<td>CloudStack</td>
<td>80, 443</td>
</tr>
<tr>
<td>OpenStack</td>
<td>5000, 8774, 8776, 8777</td>
</tr>
<tr>
<td>VMM</td>
<td>5985, 5986</td>
</tr>
<tr>
<td>CloudFoundry</td>
<td>80, 443</td>
</tr>
<tr>
<td>VMAX</td>
<td>5988, 5989</td>
</tr>
<tr>
<td>Dell Compellent</td>
<td>5988, 5989</td>
</tr>
<tr>
<td>Nutanix</td>
<td>9440</td>
</tr>
<tr>
<td>XtremIO</td>
<td>80, 443</td>
</tr>
<tr>
<td>Pure</td>
<td>80, 443</td>
</tr>
<tr>
<td>HPE 3PAR</td>
<td>5988, 5989, 8080</td>
</tr>
<tr>
<td>Application</td>
<td>Ports</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td>NetApp</td>
<td>80, 443</td>
</tr>
<tr>
<td>NetScaler</td>
<td>80, 443</td>
</tr>
<tr>
<td>Cisco UCS</td>
<td>80, 443</td>
</tr>
<tr>
<td>sFlow</td>
<td>80, 443</td>
</tr>
<tr>
<td>Netflow</td>
<td>80, 443</td>
</tr>
<tr>
<td>Arista</td>
<td>80, 443</td>
</tr>
<tr>
<td>WebSphere</td>
<td>8880</td>
</tr>
<tr>
<td>Weblogic</td>
<td>7001</td>
</tr>
<tr>
<td>Exchange</td>
<td>5985, 5986</td>
</tr>
<tr>
<td>Tomcat</td>
<td>1009</td>
</tr>
<tr>
<td>JBOSS</td>
<td>9990</td>
</tr>
<tr>
<td>Oracle</td>
<td>1521</td>
</tr>
<tr>
<td>SQL Server</td>
<td>1433</td>
</tr>
<tr>
<td>MySQL</td>
<td>3306</td>
</tr>
</tbody>
</table>
Cisco Unified Computing System

UCS Blade Provisioning

When managing a UCS fabric target, Turbonomic can provision any blade servers that are installed in a chassis but not currently in operation. If the workload demands more physical compute resources, Turbonomic can automatically direct UCS to provision a blade, or it can recommend that you provision a blade and you can execute the action from the To Do list. To enable this capability, you must perform two basic steps:

- Configure the way UCS and vCenter Server manage information as blades are provisioned
  To enable Turbonomic to perform automatic provisioning of UCS blades, you must configure UCS to work with vCenter Server as they both manage resources such as server pools, policies, and Service Profile Templates. This ensures that as Turbonomic directs the UCS Manager to provision a new blade, vCenter Server will recognize that the new physical host is available. Once vCenter Server can recognize the new blade, Turbonomic can direct vCenter Server to move workloads onto the server.
  Turbonomic provisions new blades based on the service profiles of operating blades. To enable this, the configuration must include Service Profile Templates, and the operating blades must be bound to these templates. For information about configuration that enables automated provisioning of blades, see the Cisco Communities post, “UCS PowerTool and VMware PowerCLI automated management of Auto-deploy” at the following location: https://communities.cisco.com/community/technology/datacenter/ucs_management/cisco_ucs_developed_integrations/blog/2013/09/16/ucs-powertool-and-vmware-powercli-automated-management-of-auto-deploy
  This post includes a video that shows “a joint PowerShell integration utilizing both Cisco UCS PowerTool and VMware PowerCLI.” You can also download the scripts from this post and modify them as necessary for your deployment.

- Set the Host Provision action to Automate or Manual for the blade servers. By default, Turbonomic sets the Host Provision action to Recommend.
  For any hosts other than blade servers managed by UCS, Turbonomic cannot provision hosts automatically or manually. Instead, it recommends that you provision a host, and you then install the physical machine and wire it to the network.
  In a UCS deployment you can have blade servers installed in the chassis and ready to provision. In that case, Turbonomic can direct UCS to provision a new blade to meet workload demands. For these servers, you can set the Host Provision action to Automated or Manual.

**NOTE:** It’s important that you only set Automated or Manual host provisioning to UCS blades. If you set Host Provision to Automated for other types of hosts, Turbonomic will attempt to perform the action and fail. As a result, you might never see the recommendation to provision a new host of that type.

Turbonomic groups blade servers by chassis. To restrict Automated or Manual settings to blade servers, use this group. You can set the action mode for all blade servers in your environment, or you can set the mode differently for individual chassis.