END-USER LICENSE AGREEMENT

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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:

- **Hypervisors**
  - Citrix XenServer 5.6.x and 6.x
  - IBM PowerVM
  - 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 — 6.5 running with ESX 3.x, 4.x, 5.x, and 6.x

- **Private Cloud Managers**
  - CloudStack 4.0 — 4.6
  - Microsoft System Center 2012 Virtual Machine Manager and System Center 2012 R2 Virtual Machine Manager
  - VMware vCloud Director 1.0 — 5.1
  - OpenStack havana, Icehouse, juno, and kilo

- **Public Cloud Services**
  - Amazon AWS
  - Microsoft Azure
  - IBM SoftLayer

- **Application Servers**
  - IBM WebSphere Application Server, version 8.0.0.9 or greater
  - Oracle WebLogic versions 11g or 12c
  - JBoss Application Server 7.0 and later — JBoss Deployment Manager using jboss-eap-6.3
  - Apache Tomcat, versions 7.x and 8.0.x
  - JVM Application
• Database Servers
  - Microsoft SQL Server 2008 R2, 2012, and 2014
  - Oracle 11g R2 and 12c
  - MySQL 5.5.26 and higher, and all 5.6 releases
• Microsoft Applications
  - Microsoft Exchange
• Load Balancers
  - Citrix NetScaler
• Storage Managers
  - NetApp Storage Systems running Data ONTAP version 8 or later
  - EMC VMAX
  - EMC VNX Series Storage Systems (for version details, see the EMC VNX Support KB article)
  - EMC XtremIO
  - Pure Storage FlashArray
  - HP 3PAR StoreServ
  - Nutanix
  - Dell Compellent
• Fabric Managers
  - Cisco UCS 2.0 and higher
  - Cisco UCS Central
  - HPE OneView
• Network Flow Collectors
  - NetFlow/sFlow: NFDUMP — Turbonomic provides an OVA download with NFDUMP preconfigured for NetFlow and sFlow collection
  - Arista EOS+
  - Cisco APIC
• 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 and Removing Target Virtual Management Servers

Adding Targets

To add a target service, click the Add button ( ), provide the requested information, then add the target to the list of pending targets. When you have configured the pending targets you want, click Apply to validate those targets, set them to Turbonomic, and start a new run of 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

![Target Configuration](image)

Choose the target type

Provide credentials

Add the settings to the list of pending targets. You can select an item in this list to edit or delete it.

Add the pending targets to Operations Manager, or cancel the operation.
Editing and Removing 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.

License Requirements

Hypervisor targets are supported by the Workload Edition of Turbonomic.
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 70.

To understand how Turbonomic depicts the supply chain, consider the example below. It shows a virtual machine (test2_CO) within the Inventory tree. The "VC" designation indicates that the VM is running in a vCenter datacenter.

By expanding the VM node of the tree, you can see the supply chain entities the VM consumes resources from ("Consumes") and the entities it provides resources to ("Hosts"). In this example, the resource providers are a physical machine (hp-esx45) and a datastore (ESXDC7DS2), and the resource consumer is one or more applications (labeled as GuestLoad prior to application discovery).
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 percentage 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 percentage 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 percentage utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
- Storage Access Operations Per Second (IOPS)
  The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

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

**Physical Machine**

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

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

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

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

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

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

- CPU Ready
  The percentage 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
  The percentage utilization of the datastore's capacity
  Measured in Kilobytes (KB)

- Storage Access Operations Per Second (IOPS)
  The percentage utilization of the storage access operations per second on the
  datastore
  Measured in Operations per second

- Latency
  The percentage utilization of latency on the datastore
  Measured in Milliseconds (ms)
Adding and Removing Target Virtual Management Servers

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

**Datacenter**

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

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The percentage utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage 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), 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.
• **SNMP Port**
  An SNMP port common to the LPARs managed by the target HMC.

• **SNMP Community**
  The SNMP community common to the LPARs managed by the target HMC.

### 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:

- In the Policy Editor, select **Action > VM**
- In the Scope pane, expand **Folders** and select **AIX-vioses-auto**
- For the **Resize down** action in the Action Mode Settings table, enable **Override** and change the value to **Disabled**
- Click **Apply Settings Change**

For more information about Policies, see the Turbonomic Users Guide.

### 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>
</table>
| VirtualMachine    | • Virtual Memory (VMem)  
The percentage utilization of the VMem allocated to the hosting VM  
  Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The percentage utilization of the VCPU allocated to the hosting VM  
  Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
The percentage utilization of the virtual storage capacity allocated for the VM  
  Measured in Kilobytes (KB) |
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS

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

**Physical Machine**

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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**
  The percentage utilization of the datastore's capacity
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

- **Latency**
  The percentage 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 percentage utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the PM’s CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The percentage utilization of the PM’s IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The percentage utilization of data through the PM’s network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The percentage utilization of the PM’s swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The percentage utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The percentage 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 48.

**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 Creating A Service User Account on page 17.
Prerequisites

- Create a service account that Turbonomic can use to connect to your Hyper-V servers. See "Creating a Service User Account in Hyper-V" in the Turbonomic User Guide
- Configure remote management on each Hyper-V server. Refer to the relevant section below:
  - **Turbonomic 5.4 or higher**: See Creating A Service User Account on page 17
  - **Turbonomic 5.3 or below**: See Enabling Management via DCOM on page 200

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 host name of the Hyper-V host. If you’re using the “Full Domain Option” below, 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 host name in this field.

- **Port number**
  - **For Turbonomic 5.4 or higher**: The port number for the remote management connection. The default HTTP port is 5985; the default HTTPS port is 5986.

- **Secure connection**
  - **For Turbonomic 5.4 or higher**: Select this option to use a secure connection (HTTPS). Make sure the required certificate is configured for use on the host.

- **Full domain name (optional)**
  If you enter the name of a Hyper-V cluster, Turbonomic discovers and adds all Hyper-V hosts in the named cluster. In addition, Turbonomic monitors your environment and adds a new target whenever it discovers a new Hyper-V host in the cluster. Note that each new 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 203).

- **Username**
  - **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 200).

- **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 94.
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 percentage utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The percentage utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
The percentage utilization of the virtual storage capacity allocated for the VM  
Measured in Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The percentage utilization of IOPS allocated for the VStorage on the VM  
Measured in IOPS  
• Latency  
The percentage utilization of latency allocated for the VStorage on the VM  
Measured in milliseconds (ms) |
| Physical Machine| • Memory (Mem)  
The percentage utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB)  
• CPU  
The percentage utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz)  
• IO  
The percentage utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s)  
• Net  
The percentage utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s) |
• Swap  
The percentage utilization of the PM's swap space  
Measured in Kilobytes (KB)

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

• CPU Ready  
The percentage 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  
The percentage utilization of the datastore's capacity  
Measured in Kilobytes (KB)

• Storage Access Operations Per Second (IOPS)  
The percentage utilization of the storage access operations per second on the datastore  
Measured in Operations per second

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

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

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

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

• Swap  
The percentage utilization of the PM's swap space  
Measured in Kilobytes (KB)
• **Balloon**  
The percentage utilization of shared of memory among VMs running on the host. ESX-only  
Measured in Kilobytes (KB)  
• **CPU Ready**  
The percentage 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:**
   - WinRMRemoteWMIUsers (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.

<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>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

#### VirtualMachine

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

#### Physical Machine

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

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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 percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

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

- **Storage**
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)
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 25).

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 94.

vCenter Post-Addition Imports

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

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:

- On the Policy > Workload Placement page, click the Add Segment button.
- In the Segment Editor window, select the Merge option and add the vCenter clusters to merge.
  
  For more information about Policies, see the Turbonomic Users Guide.

**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, Turbonomic 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:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual Machine   | • Virtual Memory (VMem)  
                    | The percentage utilization of the VMem allocated to the hosting VM        |
|                   | Measured in Kilobytes (KB)                                              |
|                   | • Virtual CPU (VCPU)  
                    | The percentage utilization of the VCPU allocated to the hosting VM        |
|                   | Measured in Megahertz (MHz)                                             |
|                   | • Virtual Storage (VStorage)   
                    | The percentage utilization of the virtual storage capacity allocated for the VM |
|                   | Measured in Kilobytes (KB)                                              |
|                   | • Storage Access Operations Per Second (IOPS)  
                    | The percentage utilization of IOPS allocated for the VStorage on the VM   |
|                   | Measured in IOPS                                                       |
|                   | • Latency  
                    | The percentage utilization of latency allocated for the VStorage on the VM|
|                   | Measured in milliseconds (ms)                                           |
| Physical Machine  | • Memory (Mem)  
                    | The percentage utilization of the PM’s memory reserved or in use          |
|                   | Measured in Kilobytes (KB)                                              |
|                   | • CPU  
                    | The percentage utilization of the PM’s CPU reserved or in use             |
|                   | Measured in Megahertz (MHz)                                             |
|                   | • IO  
                    | The percentage utilization of the PM’s IO adapters                       |
|                   | Measured in Kilobytes per second (KB/s)                                 |
|                   | • Net  
                    | The percentage utilization of data through the PM’s network adapters     |
|                   | Measured in Kilobytes per second (KB/s)                                 |
|                   | • Swap  
                    | The percentage utilization of the PM’s swap space                        |
|                   | Measured in Kilobytes (KB)                                              |
|                   | • Balloon  
                    | The percentage utilization of shared memory among VMs running on the host.|
|                   | ESX-only                                                                |
|                   | Measured in Kilobytes (KB)                                              |
|                   | • CPU Ready  
                    | The percentage 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)                                             |
Hypervisor Targets

Storage

- Storage
  The percentage utilization of the datastore's capacity
  Measured in Kilobytes (KB)
- Storage Access Operations Per Second (IOPS)
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second
- Latency
  The percentage 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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The percentage utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The percentage utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The percentage utilization of the PM's swap space
  Measured in Kilobytes (KB)
- Balloon
  The percentage utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- CPU Ready
  The percentage 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 percentage utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)
Consumer Virtual Datacenter

- Memory (Mem)
  The percentage utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The percentage 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>
<tr>
<td>Execute VM Move (vMotion)</td>
<td>Resource &gt; Migrate</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Query Vmotion</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Modify Resource Pool</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Assign VM to Resource Pool</td>
</tr>
<tr>
<td>Execute VM Storage Move (svMotion)</td>
<td>Datastore &gt; Allocate Space</td>
</tr>
<tr>
<td></td>
<td>Datastore &gt; Browse Datastore</td>
</tr>
<tr>
<td></td>
<td>Datastore &gt; Configure Datastore</td>
</tr>
<tr>
<td></td>
<td>Datastore &gt; Move Datastore</td>
</tr>
<tr>
<td></td>
<td>Datastore &gt; Remove File</td>
</tr>
<tr>
<td></td>
<td>Datastore &gt; Update Virtual Machine Files</td>
</tr>
<tr>
<td></td>
<td>Datastore Cluster &gt; Configure a Datastore Cluster</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Assign VM to Resource Pool</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Migrate</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Relocate</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Modify Resource Pool</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Move Resource Pool</td>
</tr>
<tr>
<td></td>
<td>Resource &gt; Query VMotion</td>
</tr>
<tr>
<td></td>
<td>Virtual Machine &gt; Configuration &gt; Change Resource</td>
</tr>
<tr>
<td></td>
<td>Virtual Machine &gt; Configuration &gt; Swap File Placement</td>
</tr>
<tr>
<td><strong>NOTE</strong>: Datastore Cluster permissions only apply to vSphere 5.x</td>
<td></td>
</tr>
</tbody>
</table>

Target Configuration Guide 25
Hypervisor Targets

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.

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:

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

Hypervisor Targets

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

- **CPU Ready**
  The percentage 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**
  The percentage utilization of the datastore’s capacity
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

- **Latency**
  The percentage 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 percentage utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

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

- **CPU Ready**
  The percentage 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.

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

License Requirements

Private Cloud Targets are supported by the Workload Edition of Turbonomic.

Public and Hybrid Cloud targets are supported by the Cloud Native Edition of Turbonomic.
Supply Chain

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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of the PM's swap space</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
Cloud Management Targets

- Balloon
  The percentage utilization of shared memory among VMs running on the host.
  ESX-only
  Measured in Kilobytes (KB)
- CPU Ready
  The percentage 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 percentage utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the PM’s CPU reserved or in use
  Measured in Megahertz (MHz)
- IO
  The percentage utilization of the PM’s IO adapters
  Measured in Kilobytes per second (KB/s)
- Net
  The percentage utilization of data through the PM’s network adapters
  Measured in Kilobytes per second (KB/s)
- Swap
  The percentage utilization of the PM’s swap space
  Measured in Kilobytes (KB)
- Balloon
  The percentage utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- CPU Ready
  The percentage 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 percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)
**Consumer Virtual Datacenter**

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

**Zone (Cloud Native)**

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

**Region (Cloud Native)**

- **Memory (Mem)**  
The percentage utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB)
- **CPU**  
The percentage utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz)
- **IO**  
The percentage utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s)
- **Net**  
The percentage utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s)
Cloud Management Targets

- **Swap**
  The percentage utilization of the PM’s swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The percentage utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The percentage 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

License Requirements

The Workload Edition of Turbonomic supports all private cloud targets.

**NOTE:** For public and hybrid cloud targets, the Cloud Native Edition of Turbonomic is required.

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><strong>Consumer VDC</strong></td>
<td>Organization VDC</td>
<td>Resource Pool (Child)</td>
<td>Tenant or TenantQuota</td>
<td>Accounts</td>
<td>Tenant</td>
</tr>
<tr>
<td><strong>Provider VDC</strong></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**  
  **Provider Virtual Datacenters**
  
- **Action**  
  Turbonomic does not recommend actions to perform on a Provider VDC. Instead, it recommends actions to perform on the devices running in the datacenter.

- **Entity Type**  
  **Consumer Virtual Datacenters**
  
- **Action**  
  - Resize Consumer vDC
  - Provision Consumer vDC
Monitored Resources

Turbonomic monitors the following private cloud infrastructure resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Provider Virtual Datacenter | • Memory (Mem)
  The percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The percentage utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
• Storage
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB) |
| Consumer Virtual Datacenter | • Memory (Mem)
  The percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
• CPU
  The percentage utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
• Storage
  The percentage 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 5.

**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 Turbonomic User Guide). Imported rules are enabled by default, but you can disable specific rules if you want.

The example below shows the selection of one imported Affinity Group. The display includes a description of the selected policy, and an option to enable or disable the policy.

<table>
<thead>
<tr>
<th>Segment name: SEG-CLOUDSTACK-ANTIAFFINITY-VM-GROUP-CLOUDSTACK-10.10.150.233/ROOT/admin/3 (Imported)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM of group VM-GROUP-CLOUDSTACK-10.10.150.233/ROOT/admin/3 (Imported) must run on host of group: PM-GROUP-CLOUDSTACK-10.10.150.233/ROOT/admin/3 (Imported)</td>
</tr>
<tr>
<td><strong>Enable</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category:</th>
<th>Workload Placement Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Management</td>
<td></td>
</tr>
<tr>
<td>Workload Placement</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>Discovery</td>
<td></td>
</tr>
<tr>
<td>Infrastructure Cost</td>
<td></td>
</tr>
<tr>
<td>Cluster Capacity</td>
<td></td>
</tr>
<tr>
<td>Templates</td>
<td></td>
</tr>
<tr>
<td>Email / Trap Notification</td>
<td></td>
</tr>
<tr>
<td>Retention</td>
<td></td>
</tr>
<tr>
<td>General Settings</td>
<td></td>
</tr>
</tbody>
</table>
## 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 Datacen-</td>
<td>• Resize Consumer vDC</td>
</tr>
<tr>
<td>ters</td>
<td>• Provision Consumer vDC</td>
</tr>
</tbody>
</table>

## Monitored Resources

Turbonomic monitors the following resources for Cloudstack targets:

<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 percentage 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 percentage 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 percentage utilization of the virtual storage capacity allocated for</td>
</tr>
<tr>
<td></td>
<td>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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

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

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

• CPU Ready
  The percentage 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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

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

• CPU Ready
  The percentage 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

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

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

DPod
- Memory (Mem)
  The percentage utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)
- CPU
  The percentage utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)
- Storage
  The percentage utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- Flow
  The percentage 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)

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.

  For example, `10.10.123.45:5001`

- **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**
  

- **Kilo**
  

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.

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

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

**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 percentage utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the PM’s CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The percentage utilization of the PM’s IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The percentage utilization of data through the PM’s network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The percentage utilization of the PM’s swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The percentage utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The percentage 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 percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

- **Memory (Mem)**
  The percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the Datacenter’s CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage 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.

An Organization Virtual Datacenter uses the resources in a Provider Virtual Datacenter to present virtual compute and storage to the user.

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 25

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 (optional)
  If you provide a value, the username for a service account on the vCenter Server that is managed by this vCloud Director.

  If you do not provide a value, Turbonomic will obtain the username from the vCloud Director server. Even if you do not provide a VC User Name value, you still must provide a VC Password.

- VC Password
  The password for the service account on the vCenter Server.
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)&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>
<tr>
<td>Physical Machines</td>
<td>• Start Physical Machine&lt;br&gt;• Provision Physical Machine&lt;br&gt;• Suspend Physical Machine</td>
</tr>
<tr>
<td>Consumer Virtual Datacenters</td>
<td>• Resize Consumer vDC&lt;br&gt;• 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)&lt;br&gt;The percentage utilization of the VMem allocated to the hosting VM&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• Virtual CPU (VCPU)&lt;br&gt;The percentage utilization of the VCPU allocated to the hosting VM&lt;br&gt;Measured in Megahertz (MHz)&lt;br&gt;• Virtual Storage (VStorage)&lt;br&gt;The percentage 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)&lt;br&gt;The percentage utilization of IOPS allocated for the VStorage on the VM&lt;br&gt;Measured in IOPS&lt;br&gt;• Latency&lt;br&gt;The percentage utilization of latency allocated for the VStorage on the VM&lt;br&gt;Measured in milliseconds (ms)</td>
</tr>
<tr>
<td>Physical Machine</td>
<td>• Memory (Mem)&lt;br&gt;The percentage utilization of the PM's memory reserved or in use&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• CPU&lt;br&gt;The percentage utilization of the PM's CPU reserved or in use&lt;br&gt;Measured in Megahertz (MHz)&lt;br&gt;• IO&lt;br&gt;The percentage utilization of the PM's IO adapters&lt;br&gt;Measured in Kilobytes per second (KB/s)</td>
</tr>
</tbody>
</table>
Private Cloud

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

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

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

- **CPU Ready**
  The percentage 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 percentage utilization of the PM’s memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

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

- **CPU Ready**
  The percentage 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

Provider Virtual Datacenter

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

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

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

Consumer Virtual Datacenter

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

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

- **Storage**
  The percentage 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 Creating A Service User Account on page 17
  - **Turbonomic 5.3 or below**: See Enabling Management via DCOM on page 200

- 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).

- **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.**

- **Port access**
  WinRM uses ports 5985 and 5986 for standard and secure communications, respectively. The firewall on your VMM server must open these ports.
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. The Hyper-V credentials you provide must be valid for all of these machines.

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.

  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.

- 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 in Hyper-V" in the Turbonomic User Guide.

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 provides 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 add the 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”.

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 percentage 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 percentage 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 percentage utilization of the virtual storage capacity allocated for the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
- Storage Access Operations Per Second (IOPS)
  The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- Latency
  The percentage utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Physical Machine**

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

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

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

• **CPU Ready**
  The percentage 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 percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

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

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

**Consumer Virtual Datacenter**

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

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

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

**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:

**License Requirements**

Public and hybrid cloud targets are supported by the Cloud Native Edition of Turbonomic.

For hybrid cloud management, Turbonomic strongly recommends that you use the Application Server targets along with your hybrid cloud targets. In addition, this will enable you to take advantage of NetScaler Global Server load balancing.

**Supply Chain**

For public clouds, Turbonomic discovers Regions and Zones. 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.

Turbonomic adds regions and zones as Datacenter entities. For example, this example shows:

- **Two regions** — `ap-northeast` and `ap-southeast`
- **Two zones in the ap-southeast region** — `ap-southeast-1` and `ap-southeast-2`
### Cloud Management Targets

#### Entity Type

<table>
<thead>
<tr>
<th>Zone (Cloud Native)</th>
<th>Action</th>
</tr>
</thead>
</table>
|                     | • Start VM on the Zone  
|                     | • Suspend VM on the Zone |

#### Monitored Resources

Turbonomic monitors the following public cloud infrastructure resources:

#### Entity Type

<table>
<thead>
<tr>
<th>Zone (Cloud Native)</th>
<th>Commodity</th>
</tr>
</thead>
</table>
|                     | • Memory (Mem)  
The percentage utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB) |
|                     | • CPU  
The percentage utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz) |
|                     | • IO  
The percentage utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s) |
|                     | • Net  
The percentage utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s) |
|                     | • Swap  
The percentage utilization of the PM's swap space  
Measured in Kilobytes (KB) |
- **Balloon**
  The percentage utilization of shared memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)

- **CPU Ready**
  The percentage 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)

**Region (Cloud Native)**

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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)

---

**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 `aws.amazon.com`.

- **Username**
  Provide the **Access Key** for the account you want to manage.

- **Password**
  Provide the **Access Key Secret** 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>Commodity</th>
</tr>
</thead>
</table>
| Virtual Machines       | • Virtual Memory (VMem)  
  The percentage utilization of the VMem allocated to the hosting VM  
  Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
  The percentage utilization of the VCPU allocated to the hosting VM  
  Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
  The percentage utilization of the virtual storage capacity allocated for the VM  
  Measured in Kilobytes (KB) |
| Physical Machines      | • Resize Consumer vDC  
• Provision Consumer vDC |
| Consumer Virtual Datacenters | • Start VM on the Zone  
• Suspend VM on the Zone |
| Zone (Cloud Native)    | • Start Physical Machine  
• Provision Physical Machine  
• Suspend Physical Machine |

**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>
</table>
| VirtualMachine   | • Virtual Memory (VMem)  
  The percentage utilization of the VMem allocated to the hosting VM  
  Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
  The percentage utilization of the VCPU allocated to the hosting VM  
  Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
  The percentage utilization of the virtual storage capacity allocated for the VM  
  Measured in Kilobytes (KB) |
Public Cloud

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

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

**Physical Machine**

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

• **CPU Ready**
  The percentage 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 percentage utilization of the Datacenter’s memory reserved or in use
  Measured in Kilobytes (KB)

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

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

**Consumer Virtual Datacenter**

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

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

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

**DPod**

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

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

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

• **Flow**
  The percentage 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)
Zone (Cloud Native)

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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)

Region (Cloud Native)

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

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

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

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

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

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

- **CPU Ready**
  The percentage 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)
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>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>
<tr>
<td>Zone (Cloud Native)</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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of shared memory among VMs running on the host.</td>
</tr>
<tr>
<td></td>
<td>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 percentage utilization of the PM’s allocated ready queue capacity</td>
</tr>
<tr>
<td></td>
<td>(measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (MHz)</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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The percentage utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The percentage utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The percentage utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The percentage utilization of shared of memory among VMs running on the host. ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The percentage 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 percentage utilization of the Datacenter's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the Datacenter's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage utilization of the storage attached to the Provider vDC.
  Measured in Kilobytes (KB)

**Consumer Virtual Datacenter**

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

- **Memory (Mem)**
  The percentage utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- **Flow**
  The percentage 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)

Zone (Cloud Native)

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

Region (Cloud Native)

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

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

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

• CPU Ready
  The percentage 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)

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

• Configured management certificate
• External access via Client/App ID

Configuring a Management Certificate

For Turbonomic to manage a subscription, you must:
• Upload a Management Certificate (a thumbprint) to your subscription’s certificate store
• Install and register the certificate the Turbonomic server

The Management Certificate grants Turbonomic access to the subscription so it can discover and manage the subscription entities.

For information about creating and uploading a Management Certificate for Azure, see the Microsoft documentation.

For information about installing the certificate on the Turbonomic server, see these Green Circle articles:
• “Manually Configure a Management Certificate for an Azure Target”.
• “Use Automation to Configure a Management Certificate for an Azure Target”.

Microsoft Azure
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:

**NOTE:** For information about how to get these credentials, see the Green Circle article, “How to get the required Azure credentials to add an Azure Target to VMTurbo OpsManager 5.6+”

- Address
  You can leave this blank, or enter management.core.windows.net
- 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</td>
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<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 percentage 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 percentage 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 percentage 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>
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<td></td>
<td>Measured in IOPS</td>
</tr>
<tr>
<td></td>
<td>• Latency</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)

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

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

- **CPU Ready**
  The percentage 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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

- **CPU Ready**
  The percentage 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)

**Provider Virtual Datacenter**

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

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

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

**Consumer Virtual Datacenter**

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

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

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

**DPod**

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

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

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

- **Flow**
  The percentage 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)

**Zone (Cloud Native)**

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

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

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

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

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

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

- CPU Ready
  The percentage 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)

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

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

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

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

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

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

- CPU Ready
  The percentage 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 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.

License Requirements

Storage targets are supported by all Editions of Turbonomic.
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>HP 3Par</th>
<th>NetApp</th>
<th>Nutanix</th>
<th>Pure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Volume</td>
<td>Volume</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</td>
<td>Controller</td>
<td>Controller</td>
</tr>
</tbody>
</table>

Target Configuration Guide 71
**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&lt;br&gt;• Provision Storage&lt;br&gt;• Suspend Storage&lt;br&gt;• Move (only with Storage Targets configured)&lt;br&gt;• Resize (only with Storage Targets configured)</td>
</tr>
<tr>
<td>Disk Arrays</td>
<td>• Provision Disk Array&lt;br&gt;• Start Disk Array&lt;br&gt;• Suspend Disk Array&lt;br&gt;• Move Disk Array (for NetApp Cluster-Mode, only)&lt;br&gt;• Move Virtual Machine&lt;br&gt;• 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&lt;br&gt; The percentage utilization of the datastore's capacity&lt;br&gt; Measured in Kilobytes (KB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt; The percentage utilization of the storage access operations per second on the datastore&lt;br&gt; Measured in Operations per second&lt;br&gt;• Latency&lt;br&gt; The percentage utilization of latency on the datastore&lt;br&gt; Measured in Milliseconds (ms)</td>
</tr>
</tbody>
</table>
Disk Array

- **Storage**
  The percentage utilization of the datastore’s capacity.
  Measured in Kilobytes (KB)

- **Storage Provisioned**
  The percentage utilization of the storage access operations per second on the datastore.
  Measured in Operations per second

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore.
  Measured in Operations per second

- **Latency**
  The percentage utilization of latency on the datastore.
  Measured in milliseconds (ms)

Storage Controller

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

- **Storage**
  The percentage 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 Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the storage controller.
  Measured in Operations per second

- **Latency**
  The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage.
  Measured in milliseconds (ms)

### 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 Compellent Enterprise 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, some customers find the following Green Circle article useful: Configuring VMWare 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) 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 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 71.

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&lt;br&gt;The percentage utilization of the datastore's capacity&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• Storage Access Operations Per Second (IOPS)&lt;br&gt;The percentage utilization of the storage access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• Latency&lt;br&gt;The percentage utilization of latency on the datastore&lt;br&gt;  Measured in Milliseconds (ms)&lt;br&gt;</td>
</tr>
</tbody>
</table>
Storage Controller

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

- **Storage**
  The percentage 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 Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the storage controller
  Measured in Operations per second

- **Latency**
  The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage
  Measured in milliseconds (ms)

**EMC VMAX**

Turbonomic supports management of EMC (Symmetrix) VMAX 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.

**Prerequisites**

- **EMC SMI-S Provider 8.1**
- A service account that Turbonomic can use to connect to the EMC SMI-S Provider (typically the default admin account)

**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 VMAX Targets

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

- **Address**
  The name or IP address and port for the SMI-S provider. For example `10.10.123.45:5989`.
  By default, Enterprise Manager provides SMI-S data over port 5988 (HTTP) or port 5989 (HTTPS).

- **Username/Password**
  Credentials for the service user account on the SMI-S provider.

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>Disk Group or Thin Pool</td>
<td>Disk Array</td>
</tr>
<tr>
<td>VMAX Array</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 enti-
tries in turn host Storage entities (datastores). For a visual representation, see the introductory **Supply Chain** on
page 71.
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>Provision*</td>
<td>Move</td>
</tr>
<tr>
<td>Disk Array</td>
<td></td>
<td>Resize Up, Provision</td>
</tr>
<tr>
<td>Storage Controller</td>
<td></td>
<td>Provision</td>
</tr>
</tbody>
</table>

* Turbonomic can provision a new datastore automatically, but the change is not visible to the connected hypervisor or its VMs until you update the hypervisor with information concerning this new datastore through its API or management console.

Monitored Resources

Turbonomic monitors the following storage resources:

**Entity Type** | **Commodity**
--- | ---
**Storage** | - Storage  
  The percentage utilization of the datastore's capacity  
  Measured in Kilobytes (KB)  
- Storage Access Operations Per Second (IOPS)  
  The percentage utilization of the storage access operations per second on the datastore  
  Measured in Operations per second  
- Latency  
  The percentage utilization of latency on the datastore  
  Measured in Milliseconds (ms)

Disk Array | - Storage  
  The percentage utilization of the datastore's capacity.  
  Measured in Kilobytes (KB)  
- Storage Provisioned  
  The percentage utilization of the storage access operations per second on the datastore  
  Measured in Operations per second  
- Storage Access Operations Per Second (IOPS)  
  The percentage utilization of the storage access operations per second on the datastore  
  Measured in Operations per second  
- Latency  
  The percentage utilization of latency on the datastore  
  Measured in milliseconds (ms)
Storage Controller

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

- **Storage**
  The percentage 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 Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the storage controller
  Measured in Operations per second

- **Latency**
  The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage
  Measured in milliseconds (ms)

---

**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
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:
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 71.

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 The percentage utilization of the datastore's capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>- Storage Access Operations Per Second (IOPS) The percentage utilization</td>
</tr>
<tr>
<td></td>
<td>of the storage 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 The percentage utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
</tbody>
</table>
## Storage Targets

### Disk Array
- **Storage**
  The percentage utilization of the datastore’s capacity.
  Measured in Kilobytes (KB)
- **Storage Provisioned**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second
- **Latency**
  The percentage utilization of latency on the datastore
  Measured in milliseconds (ms)

### Storage Controller
- **CPU**
  The percentage utilization of the Storage Controller's CPU in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage 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 Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the storage controller
  Measured in Operations per second
- **Latency**
  The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage
  Measured in milliseconds (ms)

## 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 \texttt{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 \textit{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 \texttt{Supply Chain} on page 71.

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></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.

Turbonomic monitors the following storage resources:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| **Storage**   | • Storage  
The percentage utilization of the datastore's capacity  
Measured in Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The percentage utilization of the storage access operations per second on the datastore  
Measured in Operations per second  
• Latency  
The percentage utilization of latency on the datastore  
Measured in Milliseconds (ms) |
| **Disk Array**| • Storage  
The percentage utilization of the datastore's capacity.  
Measured in Kilobytes (KB)  
• Storage Provisioned  
The percentage utilization of the storage access operations per second on the datastore  
Measured in Operations per second  
• Storage Access Operations Per Second (IOPS)  
The percentage utilization of the storage access operations per second on the datastore  
Measured in Operations per second  
• Latency  
The percentage utilization of latency on the datastore  
Measured in milliseconds (ms) |
| **Storage Controller** | • CPU  
The percentage utilization of the Storage Controller's CPU in use  
Measured in Megahertz (MHz)  
• Storage  
The percentage 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 Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The percentage utilization of the storage access operations per second on the storage controller  
Measured in Operations per second  
• Latency  
The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage  
Measured in milliseconds (ms) |
**HP 3PAR**

HP 3PAR StoreServ systems use controller nodes to manage pools of storage resources and present a single storage system to consumers. Turbonomic communicates with the HP 3PAR system via an SMI-S provider that is installed on the 3PAR controller node.

**Prerequisites**

- SMI-S 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 provider

**Setting Up the SMI-S Provider**

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

To enable the SMI-S provider:

1. **Log into the HP 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`.

**Adding HP 3PAR Targets**

To add an HP 3PAR target, select the **Storage > HP 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 HP 3PAR to those used in Turbonomic:

<table>
<thead>
<tr>
<th>HP 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>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 71.

3Par Adaptive Optimization

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

You can see the AO disk array in the Turbonomic user interface. The display name for this disk array:

- Begins with the string AO_DiskArray
- Includes the names of the discovered disk arrays (CPGs), separated by underscores

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>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>
</table>
| **Storage**        | • Storage
The percentage utilization of the datastore's capacity
Measured in Kilobytes (KB)
• Storage Access Operations Per Second (IOPS)
The percentage utilization of the storage access operations per second on the datastore
Measured in Operations per second
• Latency
The percentage utilization of latency on the datastore
Measured in Milliseconds (ms) |
| **Disk Array**     | • Storage
The percentage utilization of the datastore's capacity.
Measured in Kilobytes (KB)
• Storage Provisioned
The percentage utilization of the storage access operations per second on the datastore
Measured in Operations per second
• Storage Access Operations Per Second (IOPS)
The percentage utilization of the storage access operations per second on the datastore
Measured in Operations per second
• Latency
The percentage utilization of latency on the datastore
Measured in milliseconds (ms) |
| **Storage Controller** | • CPU
The percentage utilization of the Storage Controller's CPU in use
Measured in Megahertz (MHz)
• Storage
The percentage 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 Kilobytes (KB)
• Storage Access Operations Per Second (IOPS)
The percentage utilization of the storage access operations per second on the storage controller
Measured in Operations per second
• Latency
The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage
Measured in milliseconds (ms) |
**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:
  ```bash
  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:
  ```bash
  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 91
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 71.

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><strong>Storage</strong></td>
<td>• <strong>Storage</strong>&lt;br&gt;The percentage utilization of the datastore's capacity&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• <strong>Storage Access Operations Per Second (IOPS)</strong>&lt;br&gt;The percentage utilization of the storage access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• <strong>Latency</strong>&lt;br&gt;The percentage utilization of latency on the datastore&lt;br&gt;Measured in Milliseconds (ms)</td>
</tr>
<tr>
<td><strong>Disk Array</strong></td>
<td>• <strong>Storage</strong>&lt;br&gt;The percentage utilization of the datastore's capacity.&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• <strong>Storage Provisioned</strong>&lt;br&gt;The percentage utilization of the storage access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• <strong>Storage Access Operations Per Second (IOPS)</strong>&lt;br&gt;The percentage utilization of the storage access operations per second on the datastore&lt;br&gt;Measured in Operations per second&lt;br&gt;• <strong>Latency</strong>&lt;br&gt;The percentage utilization of latency on the datastore&lt;br&gt;Measured in milliseconds (ms)</td>
</tr>
<tr>
<td><strong>Storage Controller</strong></td>
<td>• <strong>CPU</strong>&lt;br&gt;The percentage utilization of the Storage Controller's CPU in use&lt;br&gt;Measured in Megahertz (MHz)&lt;br&gt;• <strong>Storage</strong>&lt;br&gt;The percentage 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&lt;br&gt;Measured in Kilobytes (KB)&lt;br&gt;• <strong>Storage Access Operations Per Second (IOPS)</strong>&lt;br&gt;The percentage utilization of the storage access operations per second on the storage controller&lt;br&gt;Measured in Operations per second&lt;br&gt;• <strong>Latency</strong>&lt;br&gt;The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage&lt;br&gt;Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
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:
   ```
   useradmin role add TurbonomicRole <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-map-list-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`
Storage Targets

- api-aggr-create
- api-aggr-offline
- api-aggr-online
- api-aggr-destroy

3. Create a group and assign the role.
   For example:
   useradmin add TurbonomicGroup -r TurbonomicRole

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

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:
   - volume offline
   - volume unmount
   - volume move
   - volume delete
   For example, to enable volume offline, execute the following:
   security login role create -role TurbonomicRole -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 TurbonomicRole -username Turbonomic -application ontapi -authmethod password
   security login create -role VMTurboRole -username VMTurbo -application ssh -authmethod password

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 on page 97.

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)**
  - 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)**
  - 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 97.

### 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 on page 97.

### 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 5.
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 71.

**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><strong>Storage</strong></td>
<td>• Storage</td>
</tr>
<tr>
<td></td>
<td>The percentage utilization of the datastore's capacity</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 percentage utilization of the storage 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 percentage 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</td>
</tr>
<tr>
<td></td>
<td>The percentage utilization of the datastore's capacity</td>
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<td>Measured in Kilobytes (KB)</td>
</tr>
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</tr>
<tr>
<td></td>
<td>• Storage Access Operations Per Second (IOPS)</td>
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<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
<tr>
<td><strong>Storage Controller</strong></td>
<td>• CPU</td>
</tr>
<tr>
<td></td>
<td>The percentage 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</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 Kilobytes (KB)</td>
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<tr>
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<td>• Latency</td>
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<td></td>
<td>The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
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:
   ```xml
   <targets xsi:type="nutanix:NutanixTarget" uuid="_pRSdsFheEeWgpffIwmXw"
    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:
      ```xml
      <targets xsi:type="nutanix:NutanixTarget" uuid="_pRSdsFheEeWgpffIwmXw"
       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.

Pinning Nutanix Controller VMs in Generic Hypervisor Mode

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 a cluster in Standalone mode (running Acropolis hypervisors), Turbonomic recognizes the Controller VMs, and never recommends move actions for them.
For a cluster in Generic Hypervisor mode (using vCenter or Hyper-V hypervisors), you must use Turbonomic policies to pin the Controller VMs to their respective nodes. To do this, you will create a dynamic group of Nutanix Controller VMs, and then disable move actions for all members of this group.

To pin the Controller VMs:

1. **Create a group of Controller VMs.**
   
   In Turbonomic you can create dynamic groups based on VM name — All VMs with matching names automatically belong to the group. Nutanix uses the following naming convention for Control VMs: `NTNX-<SerialNumber>-A-CVM`, where `<SerialNumber>` is the serial number of the Controller VM.
   
   - **Create a new group**
     
     In Turbonomic go to the *Policy > Group Management* view and create a new group that groups VM entities by criteria.
     
     - **Add a filter to match the VM names**
       
       Add a filter that matches names by the regular expression, `NTNX.*CVM`. This regular expression will match the Nutanix Controller VMs.
   
   The group specification should be similar to the following:

   **Nutanix Controller VMs: Group Configuration**

   ![Group Configuration](image)

   Be sure to save the group. All the Nutanix Controller VMs will automatically become members of this group.

2. **Disable moves for all VMs in this group.**
   
   - **In Turbonomic go to the Policy > Action > VM view**
     
     - **Set the scope to the group you made**
       
       In the *Scope* column, expand *My Groups* and select the group you just made.
     
     - **Disable moves for this group**
       
       In the *Parameter* column under *Action Mode Settings*, set the value to **Disabled**. This will override the global action mode.
     
     - **Save the action mode settings**
       
       Be sure to click **Apply Settings Change**.
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 71.

### 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>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>

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.

### 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</td>
</tr>
<tr>
<td></td>
<td>The percentage utilization of the datastore’s capacity</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 percentage utilization of the storage 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 percentage utilization of latency on the datastore</td>
</tr>
<tr>
<td></td>
<td>Measured in Milliseconds (ms)</td>
</tr>
</tbody>
</table>
Disk Array

- **Storage**
  The percentage utilization of the datastore's capacity.
  Measured in Kilobytes (KB)

- **Storage Provisioned**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

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

Storage Controller

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

- **Storage**
  The percentage 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 Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the storage controller
  Measured in Operations per second

- **Latency**
  The percentage utilization of latency on the storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage
  Measured in milliseconds (ms)
APM Targets

This version of Turbonomic supports the following APM (Application Performance Management) targets:

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

License Requirements

The Workload Edition of Turbonomic supports all APM targets.
Supply Chain

APM targets add Application entities to the supply chain. You can navigate to each individual application server to see specific details. This example shows four APM-discovered applications in the inventory (The host VM is in the brackets).

- MSSQL [apmWmiSDKTest2]
- LSASS [apmWmiSDKTest]
- LSASS [apmWmiSDKTest2]
- LSASS [apmWmiSDKTest1]
## Actions

Turbonomic recommends actions for the APM 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.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>With the Workload Edition, 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. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see &quot;ApplicationPriority&quot; in the Turbonomic User Guide. For application servers, Turbonomic can execute resize actions on heap and threads.</td>
</tr>
</tbody>
</table>
| Virtual Machines | • Provision additional resources (VMem, VCPU)  
• Move Virtual Machine  
• Move Virtual Machine Storage  
• Reconfigure Storage  
• Reconfigure Virtual Machine                                                                                                                                                                                                 |
SNMP Applications

Turbonomic will discover SNMP (Simple Network Management Protocol) Applications in your entire environment, or a portion of your environment, based on scope.

Prerequisites

- Workload Edition of Turbonomic
- 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:

Adding SNMP Targets

To add SNMP targets, select the Application Server > APM SNMP SDK 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.

- **Community**
  The community string Turbonomic will use to connect to the application

- **Port number**
  The Port number Turbonomic will use to connect to the Virtual Machine hosting the application

- **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 physical machines. Select this option and choose the scope for application discovery.

SNMP 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-mediation/probe-jars/{probe}/resources folder.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>connectorTimeoutMillis</td>
<td>Maximum time to wait for a response from a single request</td>
</tr>
<tr>
<td>snmpConnectorRetries</td>
<td>Number of attempts the SNMP connector will make to connect</td>
</tr>
</tbody>
</table>

Supported Actions

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

**Entity Type**

**Applications**

With the Workload Edition, 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.

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.
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 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 percentage 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 percentage 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>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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>• IO</td>
</tr>
<tr>
<td></td>
<td>The percentage 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>• NetThroughput</td>
</tr>
<tr>
<td></td>
<td>Rate of message delivery over a port</td>
</tr>
<tr>
<td></td>
<td>Measured in Mb/s</td>
</tr>
<tr>
<td>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>
WMI Applications

Turbonomic will discover WMI (Windows Management Instrumentation) Applications in your entire environment, or a portion of your environment, based on scope.

Prerequisites

- Workload Edition of Turbonomic
- Underlying VM host targets added to Turbonomic (for discovery)
- WMI Enabled on target VMs. For assistance in enabling WMI, see "Enabling WMI" in the Turbonomic User Guide.

**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 WMI Targets

To add WMI targets, select the Application Server > APM WMI SDK 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.

- Username
  The username Turbonomic will use to connect to the Virtual Machine hosting the application

- Password
  The password Turbonomic will use to connect to the Virtual Machine hosting the application

- Scope
  Turbonomic will search for WMI applications on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular physical machines. Select this option and choose the scope for application discovery.
WMI 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-mediation/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>connectorTimeoutMillis</td>
<td>Maximum time to wait for a response from a single request</td>
</tr>
<tr>
<td>slaCapacity</td>
<td>Capacity for the SLA commodity</td>
</tr>
<tr>
<td>transactionCapacity</td>
<td>Capacity for the Transaction commodity</td>
</tr>
</tbody>
</table>

Supported Actions

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

**Entity Type**  
**Applications**

With the Workload Edition, 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.

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.

**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><strong>WMI/SNMP Application</strong></td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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>• Storage Access Operations Per Second (IOPS)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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>• IO</td>
</tr>
<tr>
<td></td>
<td>The percentage 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>• NetThroughput</td>
</tr>
<tr>
<td></td>
<td>Rate of message delivery over a port</td>
</tr>
<tr>
<td></td>
<td>Measured in Mb/s</td>
</tr>
</tbody>
</table>

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

Turbonomic requires that WMI is enabled and configured in order to discover Windows-based APM targets. While these steps will change slightly between Windows Server versions, the general instructions are below:

1. **Enable WMI by navigating to** Computer Management > Services and Applications > WMI Control.
2. **Enable the following services, and set them to start automatically:** Remote Registry, Windows Management Instrumentation, and Windows Remote Management.
3. **Allow Jinterop access through the firewall.**
4. **Execute Regedit and search for the following:** 76a64158-cb41-11d1-8b02-00600806d9b6.
5. **Change the owner and permissions on each occurrence found by this search to give the user ownership and full control.**
6. **Restart the Remote Registry service.**

After restarting the Remote Registry service, the WMI targets will be available for discovery.
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 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 IP address of the VM hosting the management server
  You can optionally specify the IP address of an individual application server.
- The port that the target server listens on
- Administrator credentials for the target server instance

License Requirements

The Application Edition of Turbonomic supports all Application Server targets.
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. This example shows three WebSphere applications in the inventory.

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>
</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 Turbonomic User Guide.
Turbonomic recommends actions for the application 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.

### Entity Type: Virtual Applications

**Action**

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

With the Workload Edition, 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.

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.

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 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>Virtual Applications</td>
<td>• Transactions  &lt;br&gt;The percentage utilization of the allocated transactions per second for the given virtual application  &lt;br&gt;Measured in transactions per second</td>
</tr>
<tr>
<td>Application</td>
<td>• Virtual Memory (VMem)  &lt;br&gt;The percentage utilization of the VMem allocated to the hosting VM  &lt;br&gt;Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Virtual CPU (VCPU)  &lt;br&gt;The percentage utilization of the VCPU allocated to the hosting VM  &lt;br&gt;Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>• Transactions  &lt;br&gt;The percentage utilization of the allocated transactions per second for the given virtual application  &lt;br&gt;Measured in transactions per second</td>
</tr>
</tbody>
</table>
- **Heap**
  The percentage utilization of the application server’s heap
  Measured in Kilobytes (KB)

- **Response Time**
  The percentage utilization of the server’s allocated response time
  Measured in Milliseconds (ms)

- **Threads**
  The percentage utilization of the server’s thread capacity
  Measured in Threads

- **DBMem**
  The percentage utilization of the database’s memory capacity. Only applicable
to database servers
  Measured in Kilobytes (KB)

- **Connection**
  The percentage utilization of the connection capacity. Only applicable to data-
  base servers
  Measured in Connections

- **TransactionLog**
  The percentage utilization of the server’s capacity for storage devoted to trans-
  action logs
  Measured in Kilobytes (KB)

- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

- **Latency**
  The percentage 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 169
  - For information about hypervisor targets, see Hypervisor Targets on page 5

• 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.

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

This image shows examples of standalone JBoss servers, and servers that are in a managed domain with a Domain Controller named master.
## 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>
<tr>
<td>Applications</td>
<td>With the Workload Edition, 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. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see &quot;ApplicationPriority&quot; in the Turbonomic User Guide. For application servers, Turbonomic can execute resize actions on heap and threads.</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:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
</table>
| Virtual
Applications | • Transactions                                |
|                 | The percentage utilization of the allocated transactions per second for the given virtual application |
|                 | Measured in transactions per second            |
|                 | • Virtual Memory (VMem)                       |
|                 | The percentage utilization of the VMem allocated to the hosting VM |
|                 | Measured in Kilobytes (KB)                     |
|                 | • Virtual CPU (VCPU)                           |
|                 | The percentage utilization of the VCPU allocated to the hosting VM |
|                 | Measured in Megahertz (MHz)                    |
|                 | • Transactions                                |
|                 | The percentage utilization of the allocated transactions per second for the given virtual application |
|                 | Measured in transactions per second            |
|                 | • Heap                                         |
|                 | The percentage utilization of the application server’s heap |
|                 | Measured in Kilobytes (KB)                     |
|                 | • Response Time                                |
|                 | The percentage utilization of the server’s allocated response time |
|                 | Measured in Milliseconds (ms)                  |
|                 | • Threads                                      |
|                 | The percentage utilization of the server’s thread capacity |
|                 | Measured in Threads                            |
|                 | • DBMem                                        |
|                 | The percentage utilization of the database’s memory capacity. Only applicable to database servers |
|                 | Measured in Kilobytes (KB)                     |
|                 | • Connection                                   |
|                 | The percentage utilization of the connection capacity. Only applicable to database servers |
|                 | Measured in Connections                        |
|                 | • TransactionLog                               |
|                 | The percentage utilization of the server’s capacity for storage devoted to transaction logs |
|                 | Measured in Kilobytes (KB)                     |
|                 | • Garbage Collection                            |
|                 | The percentage of server uptime spent garbage collecting |
|                 | Measured in percentage of uptime (%)           |
### VirtualMachine

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

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

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

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

- **Latency**
  The percentage 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 service user account on 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
  This ensures that the VM hosting the Tomcat 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 169
- For information about hypervisor targets, see Hypervisor Targets on page 5
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:

- **Address**: The name or IP address of the VM hosting the Tomcat server
- **Scope (optional)**: a Turbonomic 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 JMX Remote port
- **Username/Password**: Credentials for a user account with an Admin role

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><strong>Virtual Applications</strong></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.

| Applications       | With the Workload Edition, 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. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide. For application servers, Turbonomic can execute resize actions on heap and threads. |


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

- **Transaction Log**
  The percentage utilization of the server’s capacity for storage devoted to transaction logs
  Measured in Kilobytes (KB)
- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

- **Virtual Memory (VMem)**
  The percentage utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
  The percentage utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- **Virtual Storage (VStorage)**
  The percentage utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- **Latency**
  The percentage 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 user account on 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 169
- For information about hypervisor targets, see [Hypervisor Targets](#) on page 5
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: 10.10.123.45
  - Port number: 123
  - Username: AppUser
  - Password: **********

  Then click **ADD** to create an entry in the Pending Targets list.
• Specify the second target with the following parameters:
  - **Scope/Address**: 10.10.123.45
  - **Port number**: 456
  - **Username**: AppUser
  - **Password**: ********

Then click **ADD** to create an entry in the Pending Targets list.

• Click **Apply** to add these pending targets to Turbonomic and begin validation and discovery

## Actions

Turbonomic recommends actions for the application supply chain as follows.

### Entity Type

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Action</th>
</tr>
</thead>
<tbody>
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<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>
<tr>
<td>Applications</td>
<td>With the Workload Edition, 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>
</tbody>
</table>
| Virtual Machines    | - Provision additional resources (VMem, VCPU)
  - Move Virtual Machine
  - Move Virtual Machine Storage
  - Reconfigure Storage
  - Reconfigure Virtual Machine

Virtual Applications will only be discovered if there is a load balancer configured.
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 percentage utilization of the allocated transactions per second for the given virtual application
Measured in transactions per second |
|                     | • Transactions
The percentage utilization of the allocated transactions per second for the given virtual application
Measured in transactions per second |
| JVM Application     | • Heap
The percentage utilization of the application server’s heap
Measured in Kilobytes (KB) |
|                     | • Garbage Collection
The percentage of server uptime spent garbage collecting
Measured in percentage of uptime (%) |
| VirtualMachine      | • Virtual Memory (VMem)
The percentage utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB) |
|                     | • Virtual CPU (VCPU)
The percentage utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz) |
|                     | • Virtual Storage (VStorage)
The percentage utilization of the virtual storage capacity allocated for the VM
Measured in Kilobytes (KB) |
|                     | • Storage Access Operations Per Second (IOPS)
The percentage utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS |
|                     | • Latency
The percentage 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 with an Admin role
  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.

- 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 169
    - For information about hypervisor targets, see Hypervisor Targets on page 5

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 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:

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

- **Port Number**: The T3 listen port that’s configured on the WebLogic server
  The default port for HTTP access is 9990.

- **Username/Password**: Credentials for a wluser account with an Admin role
## Actions

Turbonomic recommends actions for the application supply chain as follows.

<table>
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<th>Action</th>
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<td></td>
<td>Virtual Applications will only be discovered if there is a load balancer configured.</td>
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<tr>
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</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>
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</table>
## Monitored Resources

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

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

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

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 with an Administrator role
  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.
Application Server Targets

- 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 169
  - For information about container targets, see Hypervisor Targets on page 5

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:

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

- **Port Number:** The server’s SOAP_CONNECTOR_ADDRESS port number
- **Username/Password:** Credentials for a wsuser account with an Admin role

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>
Applications

With the Workload Edition, 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.

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.

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 percentage utilization of the allocated transactions per second for the given virtual application
| Measured in transactions per second

Application

- Virtual Memory (VMem)
| The percentage utilization of the VMem allocated to the hosting VM
| Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
| The percentage utilization of the VCPU allocated to the hosting VM
| Measured in Megahertz (MHz)
- Transactions
| The percentage utilization of the allocated transactions per second for the given virtual application
| Measured in transactions per second
- Heap
| The percentage utilization of the application server’s heap
| Measured in Kilobytes (KB)
• **Response Time**
The percentage utilization of the server’s allocated response time
Measured in Milliseconds (ms)

• **Threads**
The percentage utilization of the server’s thread capacity
Measured in Threads

• **DBMem**
The percentage utilization of the database’s memory capacity. Only applicable to database servers
Measured in Kilobytes (KB)

• **Connection**
The percentage utilization of the connection capacity. Only applicable to database servers
Measured in Connections

• **TransactionLog**
The percentage utilization of the server’s capacity for storage devoted to transaction logs
Measured in Kilobytes (KB)

• **Garbage Collection**
The percentage of server uptime spent garbage collecting
Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

• **Latency**
The percentage 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 11g R2 and 12c
- Microsoft SQL Server 2008 R2, 2012, and 2014
- MySQL 5.5.26 and higher, and all 5.6 releases

You can add an individual database server as a target, or you can add all matching targets within a given group or cluster.

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.

License Requirements

The Application Edition of Turbonomic supports all Database Server targets.
Supply Chain

Database targets add Application entities to the supply chain. The inventory groups applications by database type — You can navigate to each individual database to see specific details. This example shows four Microsoft Sql Server databases.

Actions

Turbonomic recommends actions for the application 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.
**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.

Database Applications | With the Workload Edition, Turbonomic doesn’t perform actions on applications. Instead, it performs actions on the host VMs. If utilization is high enough on an application, Turbonomic can create a new copy of the host VM. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to suspend or terminate the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see “ApplicationPriority” in the Turbonomic User Guide.

For database servers, Turbonomic can recommend actions on database memory, connections, and the transaction log.

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 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>
</table>
| Virtual Applications | • Transactions  
The percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
|                      | • DBMem                                         
The memory utilized by the database, as a percentage 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 |
|                      | • Virtual Memory (VMem)                       
The percentage utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB) |
|                      | • Virtual CPU (VCPU)                           
The percentage utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz) |
|                      | • Transactions  
The percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
|                      | • Heap                                          
The percentage utilization of the application server’s heap  
Measured in Kilobytes (KB) |
|                      | • Response Time                                
The percentage utilization of the server’s allocated response time  
Measured in Milliseconds (ms) |
|                      | • Threads                                       
The percentage utilization of the server’s thread capacity  
Measured in Threads |
|                      | • DBMem                                        
The percentage utilization of the database’s memory capacity. Only applicable to database servers  
Measured in Kilobytes (KB) |
| Database Applications| • Connection                                    
The percentage utilization of the connection capacity. Only applicable to database servers  
Measured in Connections |
• **TransactionLog**
  The percentage utilization of the server’s capacity for storage devoted to transaction logs
  Measured in Kilobytes (KB)

• **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

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

---

### MySQL

To manage a MySQL databases, Turbonomic can connect:

• To an individual database server
• To all the database servers within a group or cluster

This version of Turbonomic supports MySQL 5.5.26 and higher, and all 5.6 releases.

### Prerequisites

• Target is properly configured as Domain Controller or standalone, depending on the operations mode
• User Permissions are enabled on the MySQL Server. See Enabling User Permissions on MySQL Server on page 144
Adding a MySQL Database Target

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 MySQL servers
  If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a MySQL database server over the specified port. Turbonomic adds any database servers it finds as targets.

- **Port Number**: The port that connects to the MySQL browser
  You must open the firewall on the MySQL server to allow access through this port.

- **Username/Password**: Valid client credentials for the database service
  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.

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>

| Database Applications | With the Workload Edition, Turbonomic doesn’t perform actions on applications. Instead, it performs actions on the host VMs. If utilization is high enough on an application, Turbonomic can create a new copy of the host VM. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to suspend or terminate the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide. For database servers, Turbonomic can recommend actions on database memory, connections, and the transaction log |
**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 percentage utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second |
|                    | • DBMem
  The memory utilized by the database, as a percentage 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
|                    | • Virtual Memory (VMem)
  The percentage utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB) |
|                    | • Virtual CPU (VCPUs)
  The percentage utilization of the VCPUs allocated to the hosting VM
  Measured in Megahertz (MHz) |
| Database Applications | • Transactions
  The percentage utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second |
|                    | • Heap
  The percentage utilization of the application server’s heap
  Measured in Kilobytes (KB) |
|                    | • Response Time
  The percentage utilization of the server’s allocated response time
  Measured in Milliseconds (ms) |
|                    | • Threads
  The percentage utilization of the server’s thread capacity
  Measured in Threads |
|                    | • DBMem
  The percentage utilization of the database’s memory capacity. Only applicable to database servers
  Measured in Kilobytes (KB) |
Database Server Targets

- **Connection**
The percentage utilization of the connection capacity. Only applicable to database servers
  Measured in Connections
- **TransactionLog**
The percentage utilization of the server’s capacity for storage devoted to transaction logs
  Measured in Kilobytes (KB)
- **Garbage Collection**
The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

**VirtualMachine**

- **Virtual Memory (VMem)**
The percentage utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
The percentage utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- **Virtual Storage (VStorage)**
The percentage utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- **Latency**
The percentage 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 `.cnf` 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 ALL PRIVILEGES ON *.* TO 'USER_NAME'@'10.10.123.45' IDENTIFIED BY 'PWD_STRING'
WITH GRANT OPTION;
```

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 149.
- Dynamic Performance View \( (\text{V}$\) 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 \( \text{V}$\)). \( \text{V}$\) is not enabled by default, and users must run a script to build the tables and views that are necessary to enable \( \text{V}$\). In some environments only the DBA has privileges to run this script.

To enable \( \text{V}$\):

- Open a secure shell session (ssh) on the database host as a system user or a user with the \text{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>Virtual Applications</td>
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</tr>
<tr>
<td>Database Applications</td>
<td>With the Workload Edition, Turbonomic doesn’t perform actions on applications. Instead, it performs actions on the host VMs. If utilization is high enough on an application, Turbonomic can create a new copy of the host VM. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to suspend or terminate the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see &quot;ApplicationPriority&quot; in the Turbonomic User Guide. For database servers, Turbonomic can recommend actions on database memory, connections, and the transaction log</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:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Applications</td>
<td>Transactions</td>
</tr>
<tr>
<td></td>
<td>The percentage 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>Database Applications</td>
<td>DBMem</td>
</tr>
<tr>
<td></td>
<td>The memory utilized by the database, as a percentage 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>Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of the server’s thread capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Threads</td>
</tr>
<tr>
<td></td>
<td>DBMem</td>
</tr>
<tr>
<td></td>
<td>The percentage utilization of the database’s memory capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
• **Connection**  
The percentage utilization of the connection capacity. Only applicable to database servers  
Measured in Connections

• **TransactionLog**  
The percentage utilization of the server’s capacity for storage devoted to transaction logs  
Measured in Kilobytes (KB)

• **Garbage Collection**  
The percentage of server uptime spent garbage collecting  
Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

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

### 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$PAGSTAT
- V$RESOURCE_LIMIT
- V$SGASTAT
- V$SYS_TIME_MODEL
- V$SYSSMETERIC
- V$SYSSTAT

**SQL Server**

When connecting to a SQL Server database, you provide a “service” name. This is the name of the actual database, so the target is the database itself, and not a service on the database.

This version of Turbonomic supports Microsoft SQL Server 2008 R2, 2012, and 2014.

**Prerequisites**

- A user account with SQL permissions 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:

- **Address**: The name or IP address of the VM hosting the database server
- **Scope (optional)**: A cluster or group of VMs that host SQL Server databases
  If you set target scope, Turbonomic scans each VM within that group or cluster and tries to connect to a SQL Server database server over the specified port. Turbonomic adds any database servers it finds as targets.
- **Port Number**: The port this database uses to communicate over TCP/IP
  The default port for SQL Server is 1443. You must enable TCP/IP over the port you specify here, and open the firewall on the database server to allow access through it.
- **Full Domain Name**: Optional — For accounts that use LADP authentication, the Windows domain for the user account
- **Username/Password**: Valid client credentials for an account
  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.

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><strong>Virtual Apps</strong></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>
<tr>
<td><strong>Applications</strong></td>
<td>With the Workload Edition, 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>
</tbody>
</table>

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.
By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.

**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 percentage utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second

**Database Applications**
- DBMem
  The memory utilized by the database, as a percentage 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
- Virtual Memory (VMem)
  The percentage utilization of the VMem allocated to the hosting VM
  Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
  The percentage utilization of the VCPU allocated to the hosting VM
  Measured in Megahertz (MHz)
- Transactions
  The percentage utilization of the allocated transactions per second for the given virtual application
  Measured in transactions per second
- Heap
  The percentage utilization of the application server’s heap
  Measured in Kilobytes (KB)
- Response Time
  The percentage utilization of the server’s allocated response time
  Measured in Milliseconds (ms)
• Threads
  The percentage utilization of the server’s thread capacity
  Measured in Threads

• DBMem
  The percentage utilization of the database’s memory capacity. Only applicable to database servers
  Measured in Kilobytes (KB)

• Connection
  The percentage utilization of the connection capacity. Only applicable to database servers
  Measured in Connections

• TransactionLog
  The percentage utilization of the server’s capacity for storage devoted to transaction logs
  Measured in Kilobytes (KB)

• Garbage Collection
  The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

• Latency
  The percentage 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.

License Requirements

Windows Application Targets require the Application Edition of Turbonomic.

Prerequisites

- Configure remote management on the Exchange server. Refer to the relevant section below:
  - **Turbonomic 5.4 or higher**: See Creating A Service User Account on page 17
  - **Turbonomic 5.3 or below**: See Enabling Management via DCOM on page 200
- **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.
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.

### 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 Turbonomic User Guide.
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:

- **Host**
  The host name of the Exchange server.

  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 host name in this field.

- **Scope (optional)**
  A cluster or group of VMs that host Exchange servers

  If you set target scope, 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**
  *For Turbonomic 5.4 or higher:* 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.

  **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 200).

• 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><strong>Virtual Applications</strong></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>
<tr>
<td><strong>Applications</strong></td>
<td>With the Workload Edition, 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. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see &quot;ApplicationPriority&quot; in the Turbonomic User Guide. For application servers, Turbonomic can execute resize actions on heap and threads.</td>
</tr>
<tr>
<td><strong>Virtual Machines</strong></td>
<td>• Provision additional resources (VMem, VCPU) • Move Virtual Machine • Move Virtual Machine Storage • Reconfigure Storage • 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>
</table>
| Virtual Applications | • Transactions  
The percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
|                   | • Virtual Memory (VMem)  
The percentage utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB) |
|                   | • Virtual CPU (VCPU)  
The percentage utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz) |
|                   | • Transactions  
The percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
|                   | • Heap  
The percentage utilization of the application server’s heap  
Measured in Kilobytes (KB) |
|                   | • Response Time  
The percentage utilization of the server’s allocated response time  
Measured in Milliseconds (ms) |
|                   | • Threads  
The percentage utilization of the server’s thread capacity  
Measured in Threads |
|                   | • DBMem  
The percentage utilization of the database’s memory capacity. Only applicable to database servers  
Measured in Kilobytes (KB) |
|                   | • Connection  
The percentage utilization of the connection capacity. Only applicable to database servers  
Measured in Connections |
|                   | • TransactionLog  
The percentage utilization of the server’s capacity for storage devoted to transaction logs  
Measured in Kilobytes (KB) |
|                   | • Garbage Collection  
The percentage of server uptime spent garbage collecting  
Measured in percentage of uptime (%) |
VirtualMachine

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

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

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

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

- **Latency**
  The percentage utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)
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 Application Edition of Turbonomic
- To discover DPods via storage controllers, a storage target
- To discover DPods via UCS fabrics, a fabric target

Supply Chain

The Application Edition adds VPod and DPod entities to the Supply Chain.

- VPods (3)
  - VPod-0
  - VPod-1
  - VPod-2
- DPods (1)
  - DPod-CLAR+APM00134700308+Array
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 percentage utilization of the VPod's memory reserved or in use  
               - Measured in Kilobytes (KB)  
               • CPU  
               - The percentage utilization of the VPod's CPU reserved or in use  
               - Measured in Megahertz (MHz)  
               • Storage  
               - The percentage utilization of the storage attached to the VPod  
               - Measured in Kilobytes (KB)  
               • Flow  
               - The percentage 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 percentage utilization of the DPod's memory reserved or in use  
               - Measured in Kilobytes (KB)  
               • CPU  
               - The percentage utilization of the DPod's CPU reserved or in use  
               - Measured in Megahertz (MHz) |
- **Storage**
  The percentage utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)

- **Flow**
  The percentage 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 164 or sFlow on page 166.

---

**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.

**Entity Type** | **Action**
--- | ---
DPod | - Provision new DPod
Monitored Resources

Turbonomic monitors the following resources for the network supply chain:

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Commodity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPod</td>
<td>Memory (Mem)</td>
<td>The percentage utilization of the DPod's memory reserved or in use Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>CPU</td>
<td>The percentage utilization of the DPod's CPU reserved or in use Measured in Megahertz (MHz)</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
<td>The percentage utilization of the storage attached to the DPod Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>Flow</td>
<td>The percentage 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)</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 163
- **Storage Targets** on page 70
- "Adding Fabric Targets" in the Turbonomic User Guide

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>
<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:

**Entity Type** | **Commodity**
---|---
VPod | - Memory (Mem)
      | The percentage utilization of the VPod's memory reserved or in use
      | Measured in Kilobytes (KB)
      - CPU
      | The percentage utilization of the VPod's CPU reserved or in use
      | Measured in Megahertz (MHz)
      - Storage
      | The percentage utilization of the storage attached to the VPod
      | Measured in Kilobytes (KB)
      - Flow
      | The percentage 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.

**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 163
- Storage Targets on page 70
- "Adding Fabric Targets" in the Turbonomic User Guide

**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>
<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 percentage 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 percentage 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 percentage 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 percentage 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>

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.
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.

License Requirements

The Cloud Native Edition of Turbonomic.
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>Container</td>
<td>None</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>Containers</td>
<td>• MemAllocation</td>
</tr>
<tr>
<td></td>
<td>The percentage of memory capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPUAllocation</td>
</tr>
<tr>
<td></td>
<td>The percentage of CPU capacity the container utilizes</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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of latency allocated for the VStorage on the VM</td>
</tr>
<tr>
<td></td>
<td>Measured in milliseconds (ms)</td>
</tr>
</tbody>
</table>

Docker Containers

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

Prerequisites

- Cloud Native Edition of Turbonomic
- Underlying VM host targets added to Turbonomic (for discovery)
- Docker remote API (Docker REST 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:

Adding Docker Targets

To add Docker targets, select the Application Server > APM Docker SDK 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 number**
  Within a group, each VM should expose Docker through the same port. If you want to expose different container groups through different ports, then scoping should take that level of grouping into account.

- **Scope**
  Turbonomic will search for Docker containers 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 physical machines. Select this option and choose the scope for Docker 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>Container</td>
<td>None</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>Containers</td>
<td>• MemAllocation</td>
</tr>
<tr>
<td></td>
<td>The percentage of memory capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• CPUAllocation</td>
</tr>
<tr>
<td></td>
<td>The percentage of CPU capacity the container utilizes</td>
</tr>
<tr>
<td></td>
<td>Measured in Megahertz (Mhz)</td>
</tr>
</tbody>
</table>
Docker Application

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

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

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

VirtualMachine

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

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

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

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

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

Platform as a Service (PaaS) is a management model 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 supports the CloudFoundry platform. For targets, you can specify PaaS implementations that use the CloudFoundry SDK v.2. Turbonomic has tested implementations of HP Stackato, but Turbonomic should support other implementations on v.2, such as Pivotal.

License Requirements

The Cloud Native Edition of Turbonomic.

Identifying the CloudFoundry API Endpoint

To specify a target, you attach to a CloudFoundry API endpoint. The following steps describe how to identify the endpoint in HP 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
Adding CloudFoundry Targets

To add CloudFoundry 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.

### 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>With the Workload Edition, 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. When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM. By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see &quot;ApplicationPriority&quot; in the Turbonomic User Guide. For application servers, Turbonomic can execute resize actions on heap and threads.</td>
</tr>
</tbody>
</table>
| Virtual Machines| - Provision additional resources (VMem, VCPU)  
- Move Virtual Machine  
- Move Virtual Machine Storage  
- Reconfigure Storage  
- 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</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of the server’s thread capacity</td>
</tr>
<tr>
<td></td>
<td>Measured in Threads</td>
</tr>
<tr>
<td></td>
<td>• DBMem</td>
</tr>
<tr>
<td></td>
<td>The percentage utilization of the database’s memory capacity. Only applicable to database servers</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
<tr>
<td></td>
<td>• Connection</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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>• Garbage Collection</td>
</tr>
<tr>
<td></td>
<td>The percentage of server uptime spent garbage collecting</td>
</tr>
<tr>
<td></td>
<td>Measured in percentage of uptime (%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VirtualMachine</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage utilization of the virtual storage capacity allocated for the VM
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of IOPS allocated for the VStorage on the VM
  Measured in IOPS
- **Latency**
  The percentage utilization of latency allocated for the VStorage on the VM
  Measured in milliseconds (ms)

**Physical Machine**

- **Memory (Mem)**
  The percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the PM's CPU reserved or in use
  Measured in Megahertz (MHz)
- **IO**
  The percentage utilization of the PM's IO adapters
  Measured in Kilobytes per second (KB/s)
- **Net**
  The percentage utilization of data through the PM's network adapters
  Measured in Kilobytes per second (KB/s)
- **Swap**
  The percentage utilization of the PM's swap space
  Measured in Kilobytes (KB)
- **Balloon**
  The percentage utilization of shared memory among VMs running on the host.
  ESX-only
  Measured in Kilobytes (KB)
- **CPU Ready**
  The percentage 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**
  The percentage utilization of the datastore's capacity
  Measured in Kilobytes (KB)
- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second
- **Latency**
  The percentage 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 VMs running on the hypervisor-stitched blades.

License Requirements

Fabric targets are supported by all Editions of Turbonomic.
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. 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
- HP Oneview
Fabric Targets

Monitored Resources

Turbonomic monitors the following resources for the fabric 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of the PM's swap space</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
• **Balloon**
  The percentage utilization of shared memory among VMs running on the host.
  ESX-only
  Measured in Kilobytes (KB)

• **CPU Ready**
  The percentage 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 an account Operations Manager can 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

![Supply Chain Diagram]

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 HPE OneView. 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>
</tbody>
</table>
Physical Machines
- Start Physical Machine
- Provision Physical Machine
- Suspend Physical Machine

Fabric Interconnect
- Add Port to Port Channel
- Remove Port from Port Channel
- Add Port

DPod
- Provision new DPod

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>VirtualMachine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage 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 percentage utilization of the PM's swap space</td>
</tr>
<tr>
<td></td>
<td>Measured in Kilobytes (KB)</td>
</tr>
</tbody>
</table>
Fabric Targets

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

**DPod**

- **Memory (Mem)**
  The percentage utilization of the DPod's memory reserved or in use
  Measured in Kilobytes (KB)
- **CPU**
  The percentage utilization of the DPod's CPU reserved or in use
  Measured in Megahertz (MHz)
- **Storage**
  The percentage utilization of the storage attached to the DPod
  Measured in Kilobytes (KB)
- **Flow**
  The percentage 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

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 an account Turbonomic can use to connect to UCS Central Software. Specify the IP address and credentials for UCS Central Software. Turbonomic discovers the UCS Managers associated with the instance of UCS Central.

**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 HPE OneView. 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>
</table>
| VirtualMachine| • Virtual Memory (VMem)  
The percentage utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The percentage utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz)  
• Virtual Storage (VStorage)  
The percentage utilization of the virtual storage capacity allocated for the VM  
Measured in Kilobytes (KB)  
• Storage Access Operations Per Second (IOPS)  
The percentage utilization of IOPS allocated for the VStorage on the VM  
Measured in IOPS  
• Latency  
The percentage utilization of latency allocated for the VStorage on the VM  
Measured in milliseconds (ms) |
| Blade         | • Net  
The percentage 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 percentage utilization of the PM's memory reserved or in use  
Measured in Kilobytes (KB)  
• CPU  
The percentage utilization of the PM's CPU reserved or in use  
Measured in Megahertz (MHz)  
• IO  
The percentage utilization of the PM's IO adapters  
Measured in Kilobytes per second (KB/s)  
• Net  
The percentage utilization of data through the PM's network adapters  
Measured in Kilobytes per second (KB/s)  
• Swap  
The percentage utilization of the PM's swap space  
Measured in Kilobytes (KB) |
• Balloon
  The percentage utilization of shared memory among VMs running on the host.
  ESX-only
  Measured in Kilobytes (KB)

• CPU Ready
  The percentage 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

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.

HP 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.

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.

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.

Operations Manager 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 an account Operations Manager can 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, and also hosts the HPE OneView. 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 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>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>Virtual Machine</td>
<td>• Virtual Memory (VMem)</td>
</tr>
<tr>
<td></td>
<td>The percentage 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 percentage 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 percentage utilization of the virtual storage capacity allocated for</td>
</tr>
<tr>
<td></td>
<td>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 percentage 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 percentage 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 percentage utilization of the PM's memory reserved or in use
  Measured in Kilobytes (KB)

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

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

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

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

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

- **CPU Ready**
  The percentage 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**
  The percentage utilization of the datastore's capacity
  Measured in Kilobytes (KB)

- **Storage Access Operations Per Second (IOPS)**
  The percentage utilization of the storage access operations per second on the datastore
  Measured in Operations per second

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

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

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

- Flow
  The percentage 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)
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.

If you have installed the Application Edition of Turbonomic, you can add load balancers as targets. 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.

License Requirements

The Application Edition of Turbonomic supports Load Balancer targets.
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 Turbonomic 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 Turbonomic 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>

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

With the Workload Edition, 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.

When an application is idle, it loses budget. Ultimately, if the budget falls enough, Turbonomic will recommend to resize down the host VM.

By default applications have a priority of Mission Critical. This gives applications unlimited budget so the host VMs will never be suspended. You can override this priority for select applications. For more information, see "ApplicationPriority" in the Turbonomic User Guide.

For application servers, Turbonomic can execute resize actions on heap and threads.

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 percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second |
| Application      | • Virtual Memory (VMem)  
The percentage utilization of the VMem allocated to the hosting VM  
Measured in Kilobytes (KB)  
• Virtual CPU (VCPU)  
The percentage utilization of the VCPU allocated to the hosting VM  
Measured in Megahertz (MHz)  
• Transactions  
The percentage utilization of the allocated transactions per second for the given virtual application  
Measured in transactions per second  
• Heap  
The percentage utilization of the application server’s heap  
Measured in Kilobytes (KB) |
- **Response Time**
  The percentage utilization of the server’s allocated response time
  Measured in Milliseconds (ms)

- **Threads**
  The percentage utilization of the server’s thread capacity
  Measured in Threads

- **DBMem**
  The percentage utilization of the database’s memory capacity. Only applicable to database servers
  Measured in Kilobytes (KB)

- **Connection**
  The percentage utilization of the connection capacity. Only applicable to database servers
  Measured in Connections

- **TransactionLog**
  The percentage utilization of the server’s capacity for storage devoted to transaction logs
  Measured in Kilobytes (KB)

- **Garbage Collection**
  The percentage of server uptime spent garbage collecting
  Measured in percentage of uptime (%)

**VirtualMachine**

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

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

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

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

- **Latency**
  The percentage 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 "Aggregated Turbonomic Installations" in the Turbonomic 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 202.

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 on page 14
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:
  ```
  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/askperf/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:**
   ```
   New-SelfSignedCertificate -CertstoreLocation Cert:\LocalMachine\My -DnsName "myhost.example.org"
   ```

2. **Find the thumbprint for the certificate for the host:**
   ```
   Get-childItem cert:\LocalMachine\My
   ```

3. **Create an HTTPS WinRM listener for the host with the thumbprint you've found:**
   ```
   winrm create winrm/config/Listener?Address=*+Transport=HTTPS '@{Hostname="myhost.example.org"; CertificateThumbprint="THUMBPRINT_YOU_FOUND"}'
   ```

4. **Verify the presence of configured listeners:**
   ```
   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 203
- Enabling WinRM Via PowerShell on page 204

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 a Service Principal Name (SPN) for the host machine.**
   
   The machine must have a 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:
   
   ```
   setspn -l my-vmm-server-name
   ```
   
   If there is no valid SPN in the list, create one by running the command:
   
   ```
   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:
   
   ```
   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:
     ```
     winrm set winrm/config/winrs @{MaxMemoryPerShellMB="1024"}
     ```
   - To set up an unsecured HTTP connection:
     ```
     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:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allow automatic configuration of listeners (&quot;Allow remote server management through WinRM&quot; on older versions of Windows Server):</td>
<td>Enabled IPv4 filter: *</td>
</tr>
<tr>
<td>Allow Basic authentication:</td>
<td>Enabled</td>
</tr>
<tr>
<td>Allow unencrypted traffic:</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Startup</td>
<td>Automatic</td>
</tr>
<tr>
<td>Service name:</td>
<td>WinRM</td>
</tr>
<tr>
<td>Service option:</td>
<td>Service start</td>
</tr>
</tbody>
</table>
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:

   | Allow Remote Shell Access: | Enabled |
   |

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`).
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
- Set the Host Provision action to Automate or Manual for the blade servers. By default, Turbonomic sets the Host Provision action to Recommend.

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:


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.

The following image shows how to set Host Provisioning to Automated for all blade servers in the environment.