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What's New

This release of Turbonomic includes the following new features:

- **Single Sign On (SSO) Support**
  You can now configure your Turbonomic installation to delegate authentication to a remote Identity Provider (IdP) that you have set up for your enterprise. This support uses SAML 2.0 to redirect login from the Turbonomic user interface to the IdP, and then to use the authentication tokens the IdP returns.
  Turbonomic still applies the user roles you have configured to grant privileges to the user. For more information, see “Single Sign-On Authentication” in the *Installation Guide*, and see *Configuring a Group for SSO Authentication* on page 283.

- **Enhanced Container Support**
  For Kubernetes environments, this release adds support for configurations that declare node taints as a way to control Kubernetes scheduling, and the pods that use tolerations. Turbonomic recommends actions that respect these scheduling constraints.

- **Discovered Groups and Scope**
  Turbonomic discovers groups that you can use to set the scope of a session, policy, plan, or chart. This release introduces the following discovered groups:
    - **Azure Resource Groups**
      In the context of Azure Resource Manager, a resource group is a container that holds related resources for an Azure solution. Turbonomic discovers the workloads that are in resource groups, and presents them as groups you can use to set scope. On the Search page, select *Resource Groups*. In the Optimize Cloud plan, you can set the plan scope to one or more resource groups.
    - **Accounts and Services**
      Turbonomic now presents each AWS account and Azure subscription as a group that you can use to set scope. On the Search page, select *Accounts*. From the Top Accounts chart, if you click and account or subscription name, that also sets the session scope to that account. In the Optimize Cloud plan, you can set the scope to one or more accounts.

- **Public Cloud Enhancements**
  This release includes the following workload management improvements for the cloud:
    - **Improved Actions for Cloud Elasticity**
      Analysis settings for VMs now include *Aggressiveness* and *Max Observation Period*. These settings help Turbonomic recommend more relevant actions, to better exploit the elasticity of the cloud. Instead of using the absolute peak value when considering VCPU or VMEM utilization, Turbonomic uses a percentile that...
you set as **Aggressiveness**. With **Max Observation Period**, you specify how much historical data to use when calculating the percentile.

With these settings, Turbonomic evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, where a lower percentile gives more aggressive resize actions. Recommendations better match the real-world utilization of your workloads, and the resulting actions should give you a more efficient, cost effective deployment. For more information, see “Aggressiveness” in the Target Configuration Guide.

- **Cloud Template Compatibility**

  In Azure environments, the VM size for a template series includes a Maximum Data Disks (MDD) limit. For example, in the B-series the Standard_B1s MDD limit is 2, while for Standard_B2s the MDD limit is 4. Turbonomic recognizes these limits, and will not recommend moving an instance to a template that cannot support the current disk requirements. For example, Turbonomic will not move a Standard_B2s instance to a Standard_B1s template.

  In AWS environments, a VM can use Elastic Block Stores (EBS) or Instance Storage. If the VM’s root storage is EBS, then Turbonomic will recommend a VM move. However, because Instance Storage is ephemeral and a move would lose the stored data, Turbonomic does not recommend moving a VM that has Instance Storage as its root storage.

  In AWS some templates require workloads to be configured in specific ways before they can move to those templates. If Turbonomic recommends moving a workload that is not suitably configured onto one of these templates, then it sets the action to Recommend Only, and describes the reason. Turbonomic will not automate the move, even if you have set the action mode for that scope to **Automated**. You can execute the move manually, after you have properly configured the instance.

  The template requirements that Turbonomic recognizes are:
  * Enhanced Network Adapters
  * Linux AMI Virtualization Type
  * 64-bit vs 32-bit
  * NVMe Block

  For more information, see **AWS Template Requirements** on page 60.

- **Reserved Instance (RI) Purchase**

  For AWS environments that use **Instance Size Flexible** rules, Turbonomic can recommend that you buy multiple RIs of smaller instance types to cover specific workload needs.

  Turbonomic tracks RI Coverage — The ratio of total workloads to RI utilization. By default, Turbonomic analysis drives toward 100% RI coverage. With this release, you can override this to set the coverage you desire. See **RI Purchase Profile** on page 200.

  This release introduces a new Recommended RI Purchases chart that gives a breakdown of the RI templates that Turbonomic recommends for you to purchase. You can zoom in for details such as how the RI purchases map to workloads, cost, or where they will be placed. RI purchase recommendations include your total savings, and the estimated time to break even on the purchase investment.

- **AWS Billing Families**

  Turbonomic now discovers AWS accounts that are consolidated into billing families. The Target Configuration user interface shows these families, including the master account and its various member accounts. For RI purchases, different accounts in a billing family can share the same RI resources. At the same time, accounts in other billing families cannot use those RIs. For more information, see **AWS Billing Family Recognition** on page 191.

- **Cloud Discounts**

  Cloud service providers can offer discounts for workloads and services. With this release, you can specify a discount for an AWS billing family, or for an Azure subscription. You can also drill down into the discount to set discount overrides for specific services or template families. See **Cloud Discounts** on page 203.
• Cloud Planning Enhancements

For this release we have improved the Cloud Cost Comparison table so you can more easily see the changes, savings, and investments the plan recommends for your environment. The plans also include the new Recommended RI Purchases chart. In addition, we introduced the following improvements for planning on the cloud:

- Migrate to Cloud Plan

  On the cloud, VM templates usually include an OS platform to run processes on the VM. As you plan to migrate workloads to the cloud, you can specify the OS you prefer to run. You can keep the same OS that the original workload has, or you can choose to map the workload to a different OS. The plan can include the license costs for those OS platforms, or you can exclude the costs and treat the platforms as Bring Your Own License (BYOL). For more information, see OS Migration Profile on page 202.

  Migrate to Cloud plans support RI pricing in Azure environments.

  In accordance with Microsoft guidance on default storage, planning a migration to Azure environments defaults to using Azure Premium Storage for the migrated workloads.

- Optimize Cloud Plan

  When setting the scope of the plan, you can now scope to:
  * Azure Resource Groups
  * Azure Subscriptions
  * AWS Accounts

  When planning for AWS environments, you can specify the RI Coverage that you desire. This is a way to fine tune the RI Buy recommendations that the plan generates.

  When you configure the plan, you can enable or disable RI Purchasing with the following settings:
  * Purchase RI and Optimize Workloads
  * Only Optimize Workloads
  * Only Purchase RI

• Online Documentation

  This release introduces an Online Help version of the User Guide and the Target Configuration Guide. To open the help, click the (?) icon at the bottom-left of the Navigation Bar, then choose Turbonomic Online Help.
Introducing Turbonomic

Thank you for choosing the Turbonomic platform, the premier solution for intelligent workload management of cloud and virtual environments. Turbonomic maintains your environment within the desired state — operating conditions that achieve the following conflicting goals at the same time:

- Assured application performance
  Prevent bottlenecks, provision physical resources, upsize VMs, prioritize workload.
- Efficient use of resources
  Consolidate workload, downsize VMs, prevent VM sprawl and dormant VMs.

Turbonomic is a server application running on VM that you install on your network. You then assign Virtual Management services running on your network to be Turbonomic targets. Turbonomic discovers the devices each target manages, and then performs analysis, anticipates risks to performance or efficiency, and recommends actions you can take to avoid problems before they occur.

How Turbonomic Works

To keep your infrastructure in the desired state, Turbonomic performs Intelligent Workload Management. This is an ongoing process that solves the problem of assuring application performance while simultaneously achieving the most efficient use of resources that is possible.

This is not a simple problem to solve. Intelligent Workload Management has to consider many different resources, numerous control points for each device, and how devices and resources are used in relation to each other. As you add devices to your infrastructure, the factors for each decision increase exponentially. On top of that, the environment is constantly changing — to stay in the desired state, you are constantly trying to hit a moving target.

To perform Intelligent Workload Management, Turbonomic models the environment as a market made up of buyers and sellers. These buyers and sellers make up a supply chain that represents tiers of devices in your inventory.

See the Supply Chain of Entities on page 39 for a visual layout of the buyer and seller relationships.
Turbonomic uses *Virtual Currency* to give a budget to buyers and assign cost to resources. This virtual currency assigns value across all tiers of your environment, making it possible to compare the cost of application transactions with the cost of space on a disk or physical space in a data center.

The price that a seller charges for a resource changes according to the seller’s supply. As demand increases, prices increase. As prices change, buyers and sellers react. Buyers are free to look for other sellers that offer a better price, and sellers can duplicate themselves (open new storefronts) to meet increasing demand. Turbonomic uses its *Economic Scheduling Engine* to analyze the market and make these decisions. The effect is an invisible hand that dynamically guides your IT infrastructure to the optimal use of resources.

To get the most out of Turbonomic, you should understand how it models your environment, the kind of analysis it performs, and the desired state it works to achieve.

## The Desired State

![Diagram showing the desired state with a curve for delay and utilization](image)

The goal of Intelligent Workload Management is to assure performance while maintaining efficient use of resources. When performance and efficiency are both maintained, you are in the desired state. You can measure performance as a function of delay, where zero delay gives the ideal QoS for a given service. Efficient use of resources is a function of utilization where 100% utilization of a resource is the ideal for the most efficient utilization.

If you plot delay and utilization, the result is a curve that shows a correlation between utilization and delay. Up to a point, as you increase utilization, the increase in delay is slight. There comes a point on the curve where a slight increase in utilization results in an unacceptable increase in delay. On the other hand, there is a point in the curve where a reduction in utilization doesn’t yield a meaningful increase in QoS. The desired state lies within these points on the curve.

You could set a threshold to post an alert whenever the upper limit is crossed. In that case, you would never react to a problem until delay has already become unacceptable. To avoid that late reaction you could set the threshold to post an alert before the upper limit is crossed. In that case, you guarantee QoS at the cost of over-provisioning — you increase operating costs and never achieve efficient utilization.

Instead of responding *after a* threshold is crossed, Turbonomic analyzes the operating conditions and constantly recommends actions to keep the entire environment within the desired state. If you execute these actions (or let Turbonomic execute them for you), the environment will maintain operating conditions that assure performance for your customers, while ensuring the lowest possible cost thanks to efficient utilization of your resources.
The Market and Virtual Currency

To perform Intelligent Workload Management, Turbonomic models the environment as a market, and uses market analysis to manage resource supply and demand. For example, bottlenecks form when local workload demand exceeds the local capacity — in other words, when demand exceeds supply. By modeling the environment as a market, Turbonomic can use economic solutions to efficiently redistribute the demand or increase the supply.

Turbonomic uses two sets of abstraction to model the environment:

- Modeling the physical and virtual IT stack as a service supply chain
  The supply chain models devices in your environment as managed entities. These include applications, VMs, host machines (physical machines, or PMs), storage, and data centers. Every entity is a buyer, a seller, or both. A host machine buys physical space, power, and cooling from a data center. The physical machine sells host resources such as CPU cycles and memory to VMs. In turn, VMs buy host services, and then sell their resources (VMem and VCPU) to applications.
  See the Supply Chain of Entities on page 39 for a visual layout of the buyer and seller relationships.

- Using virtual currency to represent delay or QoS degradation, and to manage the supply and demand of services along the modeled supply chain
  The system uses virtual currency to value these buy/sell transactions. Each managed entity has a running budget — the entity adds to its budget by providing resources to consumers, and the entity draws from its budget to pay for the resources it consumes. The price of a resource is driven by its utilization — the more demand for a resource, the higher its price.

These abstractions open the whole spectrum of the environment to a single mode of analysis — market analysis. Resources and services can be priced to reflect changes in supply and demand, and pricing can drive resource allocation decisions. For example, a bottleneck (excess demand over supply) results in rising prices for the given resource. Applications competing for the same resource can lower their costs by shifting their workloads to other resource suppliers. As a result, utilization for that resource evens out across the environment and the bottleneck is resolved.

The Economic Scheduling Engine

Turbonomic tracks price for resources in terms of the Utilization Index (UI). The higher this index for a resource, the more heavily the resource is utilized, the greater the delay for consumers of that resource, and the greater the risk to your QoS. Turbonomic constantly works to keep the UI within acceptable bounds.
You can think of UI as the cost for a resource — Turbonomic works to keep the cost at a competitive level. This is not simply a matter of responding to threshold conditions. Turbonomic analyzes the full range of buyer/seller relationships, and each buyer constantly seeks out the most economical transaction that is available.

This last point is crucial to understanding Turbonomic. The virtual environment is dynamic, with constant changes to workload that correspond with the varying requests your customers make of your applications and services. By examining each buyer/seller relationship, the Economic Scheduling Engine arrives at the optimal workload distribution for the current state of the environment. In this way, Turbonomic constantly drives your environment toward the desired state.

For example, assume a single PM that hosts one VM with a critical application, and also hosts two VMs with non-critical applications. Consider these similar situations:

- The critical application has increased use, and the non-critical applications are dormant
  In this case, Turbonomic can suspend the two unused VMs (reduce VM sprawl) and devote more host resources to the critical application.

- The critical application has increased use, and both non-critical applications see increased use
  In this case, Turbonomic can move the non-critical VMs to another host and devote more host resources to the critical application.

This is a very simple case, but it illustrates the value of constant analysis of all the relationships. For the critical application, the results are the same. But for the environment as a whole, the results arrive at different, economical solutions, that are best for the actual conditions. The Economic Scheduling Engine considers all the entities and resources in your environment, and analyzes them to constantly tend toward the desired state.

NOTE: The default Turbonomic configuration is ready to use in many environments. However, you can fine-tune the configuration to address special services and resources in your environment. Turbonomic provides a full range of policies that you can set to control how the software manages specific groups of entities. Before you make such policy settings, you should understand default Turbonomic operation. For more information about policies, see Setting Up Business Rules on page 193.

The Turbonomic Supply Chain

Turbonomic models your environment as a market of buyers and sellers. It discovers different types of entities in your environment via the targets you have configured for your installation. Discovery maps these entities to the supply chain so Turbonomic can monitor them and manage the workloads they support. For example, for a hypervisor target Turbonomic discovers VMs, the PMs and datastores that provide resources to the VMs, and the applications that use VM resources. The entities in your environment form a chain of supply and demand where some entities provide resources while others consume the supplied resources.

For information about specific members of the supply chain, see Supply Chain of Entities on page 39.

Supply Chain Terminology

Turbonomic introduces specific terms to express IT resources and utilization in terms of supply and demand. These terms are largely intuitive, but you should understand how they relate to the issues and activities that are common for IT management.
Introducing Turbonomic

**Turbonomic Host Requirements**

Turbonomic runs on hosts that meet the following minimum requirements:

<table>
<thead>
<tr>
<th>Supported Hypervisor Technology</th>
<th>Storage Requirements</th>
<th>Memory</th>
<th>CPUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware: vCenter versions 5.1, 5.5, 6.0, and 6.5</td>
<td>1 TB or greater</td>
<td>16GB</td>
<td>4 vCPUs</td>
</tr>
<tr>
<td>Citrix: XenServer versions 5.6.x and 6.x</td>
<td><strong>NOTE:</strong> Can be thin provisioned depending on the storage requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsoft: Hyper-V as bundled with Windows 2016, 2008 R2, Hyper-V Server 2012, or Hyper-V Server 2012 R2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Hat Enterprise Virtualization: RHEV versions 4.x and 3.x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OpenStack: Icehouse or greater</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutanix AHV: All Acropolis versions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Term:** Commodity

The basic building block of Turbonomic supply and demand. All the resources that Turbonomic monitors are commodities. For example, the CPU capacity or memory that a physical machine can provide are commodities. Turbonomic can also represent clusters and segments as commodities. When the user interface shows commodities, it’s showing the resources a service provides. When the interface shows commodities bought, it’s showing what that service consumes.

**Term:** Composed Of

The resources or commodities that make up the given service. For example, in the user interface you might see that a certain VM is composed of commodities such as one or more physical CPUs, an Ethernet interface, and physical memory. Contrast Composed Of with Consumes, where consumption refers to the commodities the VM has bought. Also contrast Composed Of with the commodities a service offers for sale. A physical machine might include four CPUs in its composition, but it offers CPU Cycles as a single commodity.

**Term:** Consumes

The services and commodities a service has bought. A service consumes other commodities. For example, a VM consumes the commodities offered by a physical machine, and an application consumes commodities from one or more VMs. In the user interface you can explore the services that provide the commodities the current service consumes.

**Term:** Entity

A buyer or seller in the market. For example, a VM or a datastore is an entity.

**Term:** Environment

The totality of data center, network, physical machine, storage, VM, and application resources that you are monitoring.

**Term:** Inventory

The list of all entities in your environment.

**Term:** Utilization Index

A measure of the risk to Quality of Service (QoS) that a consumer will experience. The higher the UI on a provider, the more risk to QoS for any consumer of that provider’s services. For example, a physical machine provides host services to one or more VMs. The higher the UI on the provider, the more likely that the VMs will experience QoS degradation. In most cases, for optimal operation the UI on a provider should not go into double digits.
Turbonomic Targets

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

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

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

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

- **Fabric Managers**
  - Cisco UCS 3.1+
  - Cisco UCS Central
  - HPE OneView 3.00.04+

- **Guest OS Processes**
  - AppDynamics 4.1+
  - Docker API 1.20+

- **Hyperconverged**
  - Nutanix Community Edition
  - Hyperflex 2.5, 2.6

- **Hypervisors**
  - Citrix XenServer 5.6.x and 6.x
  - IBM PowerVM 8.3+
  - Microsoft Hyper-V 2008 R2, Hyper-V 2012, and Hyper-V 2012 R2
  - RHEV-M (RedHat Enterprise Virtualization Manager) versions 3.x
  - VMware vCenter 4.1 — 6.0 running with ESX 3.x, 4.x, 5.x, and 6.x

- **Load Balancers**
  - Citrix NetScaler NS10.5

- **Microsoft Applications**
  - Microsoft Exchange 2012

- **Network Flow Collectors**
  - NetFlow/sFlow: NFDUMP — Turbonomic provides an OVA download with NFDUMP preconfigured for NetFlow and sFlow collection
  - Arista Command eAPI
  - Cisco APIC
  - Cisco Tetration 2.2.1.31
• Orchestrator Targets
  - UCS Director 6.0 — 6.5
• PaaS Targets
  - CloudFoundry Pivotal / Stackato
  - OpenShift 3.3+
  - Mesos 1.0+
• Storage Managers
  - NetApp (Cmode/7mode) using ONTAP 8.0+
  - EMC VMAX using SMI-S 8.1+
  - EMC VNX (Celera) using VNX Control Station
  - EMC VNX (Clarrion) using SMI-S 4.6.x
  - EMC VPLEX Local Architecture with 1:1 mapping of virtual volumes and LUNs
  - EMC XtremIO XMS 4.0+
  - Pure Storage F-series and M-series arrays
  - HP 3PAR InForm OS 3.2.2+, 3PAR SMI-S, 3PAR WSAPI
  - Dell Compellent Enterprise Manager 2014-2016R3 using Dell Compellent SMI-S
  - HDS (Embedded) with VSP, HUS VM, G600, G800, G1000
  - HDS (Shared) with HUS110, HUS 130, HUS 150
  - HDS Tuning Manager 9.x
• Turbonomic Targets (Classic UI Only)
  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.

The following sections describe these targets. For information about assigning targets to Turbonomic, see the Target Configuration Guide.

**Hypervisors**

Turbonomic can use a range of VM managers as targets. For general discussion, this document refers to the various supported VM managers as hypervisors.

Turbonomic supports the following hypervisor targets:

• Citrix XenServer
• Microsoft Hyper-V
• Red Hat RHEV-M
• VMware vCenter

Turbonomic uses hypervisor targets to access information about the managed VMs, hosts, and datastores, and also to execute commands such as provisioning, resizing, or reconfiguring entities in the environment. Through the hypervisor, Turbonomic can perform system monitoring, report on wasted storage, recommend actions, execute moves for VMs and VM storage, and execute VM reconfiguration (change CPU count, memory, etc.).

The entities Turbonomic discovers through hypervisor targets include:

• VMs
• Physical machines that host VMs
• Datastores that support the VMs
• Datacenters
Cloud Managers

Cloud Managers provide a layer of control to deliver virtual infrastructures that can be deployed automatically, or in a self-service offering to customers. They define and manage virtual datacenters (VDCs) — provider VDCs to manage the physical and virtual resources that support the cloud offering, and consumer VDCs that present limited resources to customers.

Turbonomic supports the following cloud manager targets:

- Apache CloudStack
- Microsoft Virtual Machine Manager (VMM)
- VMware vCloud Director
- OpenStack Cloud Operating System

Turbonomic has visibility into the full VDC chain, from the resources provided by the underlying hosts and physical datastores, through the resources consumed by a provider VDC, to the resources consumed by VMs hosted on a consumer VDC.

You can create special Turbonomic user accounts for consumer VDC customers. Such an account has a limited scope, and the user cannot see any of the resources outside of that scope. In this way, you can offer Turbonomic to cloud customers without exposing any proprietary infrastructure data to them. For more information, see Managing User Accounts on page 275.

The entities Turbonomic discovers through cloud manager targets include:

- Consumer VDCs
  Virtual resources that are available to customers.
- Provider VDCs
  Physical resources that provide the infrastructure to support Consumer VDCs.

**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>

Application Servers

An application server operates in the middle tier of a multi-tier application environment. It provides reliability and scalability, and it ensures high performance in the middle tier. Many application servers support some form of clustering, where one application server is a master, or Domain Manager, to multiple slave application servers. This can enable load balancing, and failover availability.

Turbonomic supports the following application server targets:

- IBM WebSphere Application Server
- Oracle WebLogic
Introducing Turbonomic

- JBoss
- Apache Tomcat

The target can be a specific application server, or it can be a Domain Manager that manages a cluster of application servers. Turbonomic manages the resources used by application servers, including heap, threads, transactions, and response time in the server process, and VMem and VCPU in the VM that hosts the application server.

Database Servers

A database server hosts processing for the database component of a client/server or multi-tier application. Turbonomic attaches as a client to the database server’s listener.

Turbonomic supports the following database server targets:
- Microsoft SQL Server 2008 R2, 2012, and 2014
- Oracle 11g R2 and 12c

Load Balancers

A load balancer is deployed in front of multiple application servers, and distributes client requests in a way that achieves the best utilization of application resources. Client requests come in to virtual applications (in NetScaler, virtual servers), and the load balancer passes the requests to the bound underlying applications according to its criteria.

Turbonomic supports the following load balancer targets:
- Citrix NetScaler

Turbonomic discovers the virtual applications that are configured for a load balancer. It can also discover applications running in your environment and automatically bind them to the correct virtual application. Turbonomic can then monitor the health of those bound applications and decide whether to provision or decommission application instances. As it provisions new instances, it automatically binds them to the correct virtual application.

The entities Turbonomic discovers through load balancer targets include:
- Virtual Applications
- Applications

Storage Managers

Storage managers provide management and distribution of data storage across disk arrays. Storage managers can support thin provisioning, deduplication, and HA architectures. Turbonomic monitors resource utilization across the storage system to optimize placement and provisioning of volumes and disk arrays, as well as management of storage controller resources.

Turbonomic supports the following storage manager targets:
- NetApp Storage Systems running Data ONTAP version 8 or later
  The actions Turbonomic can recommend and perform are different for systems running in 7-Mode or Cluster-Mode.
- EMC VNX Series Storage Systems — for version details, see the EMC VNX Support KB article.
The entities Turbonomic discovers through storage manager targets include:

- Storage Controllers (NetApp controllers/filers, VNX processors)
- Disk Arrays (aggregates, clustered aggregates, storage pools, RAID groups)
- Datastores (volumes or LUNs)

Fabric Managers

Fabric managers provide a point of control for fabrics that unify compute, network, storage, and virtual resources within a single system.

Turbonomic supports the following fabric manager targets:

- Cisco UCS Fabric Manager

The entities Turbonomic discovers through fabric managers targets include:

- UCS Domains
- Chassis
- Fabric Interconnects
- IO Modules

Turbonomic Servers as Targets

In large virtual environments, you can use more than one Turbonomic instance to manage your workload. To manage the full environment through a single client user interface, you add these Turbonomic instances as targets to a master instance of Turbonomic. This creates an aggregated installation of Turbonomic. For more information, see the Target Configuration Guide.

NOTE: To set up and use an Aggregated Turbonomic deployment, you must be running the Classic User Interface. To display the classic user interface, click **SWITCH TO CLASSIC UI** at the bottom left of the Turbonomic user interface.

Turbonomic Actions

Turbonomic does more than track problems in your environment. Before problems occur, Turbonomic identifies actions you can take to avoid the problems. You can perform these actions manually, direct Turbonomic to perform the actions on command, or direct Turbonomic to perform actions automatically as they arise. You can set different action modes (whether to automate or not) globally or for specific groups or clusters within your environment (see **Action Modes** on page 226).

Turbonomic performs the following general types of actions:

- Placement — Place a consumer on a specific provider (place a VM on a Host)
- Configuration — Correct a misconfiguration
Introducing Turbonomic

• Scaling — Resize allocation of resources, based on profitability:
  - Resize up, shown as a required investment
  - Resize down, shown as savings
• Start — Start a new instance to add capacity to the environment, shown as a required investment
• Stop — Suspend an instance to increase efficient use of resources, shown as savings
• Buy RI — For workloads that are good RI candidates, purchase RI capacity to move your environment toward the RI Coverage that you desire.

Placement

Placement actions determine the best provider for a consumer. These include initial placement for a new entity, and move actions that change a consumer to use a different provider. For example, moving a VM assigns the VM to be hosted on a different PM. Moving a VM’s storage means the VM will use a different datastore. Turbonomic can move the following:

• VMs
• Containers
• Container Pods (for Kubernetes)
• DPods and VPods
• Storage

Effective CPU Capacity

CPU processor speed is not necessarily an effective indicator of CPU capacity. For example, processor architecture can make a slower CPU have a greater effective capacity. Newer models of machines can often have fewer cores or less clock speed, but still have a higher effective capacity.

When placing VMs on hosts in the on-prem environment, Turbonomic discovers the effective CPU capacity of your hosts. This increases the accuracy of placement calculations so that newer, more efficient hosts will show a greater effective capacity than less efficient hosts that might have larger or faster processors.

To discover the effective capacity, Turbonomic uses the CINT2006 benchmark data from spec.org. This benchmark data maps to effective capacity settings that Turbonomic uses to make placement calculations.

You can see a catalog of these benchmark data and choose from listed processors when you edit Host templates. For more information, see Selecting CPUs from the Catalog on page 266.

Shared-Nothing Migration Actions

If you have enabled storage moves and VM moves, Turbonomic can perform shared-nothing migrations, which move the VM and the stored VM files simultaneously. For example, assume a VM on a host also uses local storage on that host. In that case, Turbonomic can move that VM and move its data to a different host in a single action.

Shared-nothing migrations are available for any environments that support automation of both VM moves and storage moves. In addition, you must have the action modes for VM and storage moves set to Manual or Automated. If you meet these criteria, then all VM moves will take advantage of this feature.

If you want to limit the effect of shared-nothing migration in a VMware environment, you can use the Lock VMs to Datastores setting in the Policies view. This will ensure that specific VMs stay within a specified storage cluster.
Currently, the following targets support Shared-Nothing Migrations:

- vSphere, versions 5.1 or greater
- VMM for Hyper-V 2012 or later

**Cross-vCenter vMotion**

VMware vSphere 6.0 introduces functionality that enables migration of virtual machines between different vCenter Server instances. Turbonomic supports this capability — it considers cross-vCenter locations when calculating placement, and can recommend or execute moves to different vCenter servers.

**Moves on the Public Cloud**

On the public cloud you do not place workloads on physical hosts. In the Turbonomic Supply Chain, the Host nodes represent availability zones. Turbonomic can recommend moving a workload to a different zone, if such a move can reduce your cloud cost. These moves recognize constraints such as template and RI availability on the given zones.

In AWS environments, a VM can use Elastic Block Stores (EBS) or Instance Storage. If the VM's root storage is EBS, then Turbonomic will recommend a VM move. However, because Instance Storage is ephemeral and a move would lose the stored data, Turbonomic does not recommend moving a VM that has Instance Storage as its root storage.

In AWS environments, if a VM is running within a billing family, then Turbonomic only recommends moving that VM to other regions within that billing family.

**Configuration**

These are configure, reconfigure, and resize actions. Configure actions can add necessary network access, or reconfigure storage. Resize actions allocate more or less resource capacity on an entity, which can include adding or subtracting VCPUs or VMem on a VM, adding or subtracting capacity on a datastore, and adding or subtracting volumes in a disk array. Turbonomic can reconfigure the following:

- Application Servers (only with Resize scaling policy)
- VMs
- Containers
- Storage
- Disk Arrays
- Virtual Datacenters

**Scaling**

Scaling actions update capacity in your environment. For vertical scaling, Turbonomic increases or decreases the capacity of resources on existing entities. For horizontal scaling it provisions new. For example, provisioning a PM adds more compute capacity that is available to host VMs. Provisioning a VM adds capacity to run applications. Turbonomic can provision the following:

- Application Servers (only with Provision scaling policy)
- Containers
Introducing Turbonomic

- VMs
- PMs
- Storage
- Storage Controllers (only for planning scenarios)
- Disk Arrays

Under certain circumstances, Turbonomic can also recommend that you provision a virtual datacenter.

Scaling on the Public Cloud

On the cloud, scaling actions move the VM to a different template. These can include:

- Moving a VM to a template with different capacity
- Moving an on-demand workload to an RI template
- Moving a workload from one RI template to another

For these actions the action list shows the current cost for the source workload, and also the projected cost given the change. To show the current cost, Turbonomic uses the actual costs for that workload. However, to show the projected cost it uses an estimate based on average utilization for the VM, for the costs of the given template.

Note that such a move can result in placing the VM on a larger RI template (one that has a greater NFU value), even though the VM does not need that capacity and there are other smaller templates available. In the public cloud, the cost of usage takes precedence over the resource capacity of the template, assuming the template fully satisfies workload demand.

In Azure environments, there are circumstances where a VM resize can be especially disruptive. In a given region, the infrastructure can be made up of different clusters that have different sets of underlying hardware. Further, some templates that are available in the given region are only available on different clusters. If Turbonomic recommends resizing from a template on one cluster, to a template on another cluster, then the resize action can take longer to complete than usual.

Decommission

Decommissioning actions either suspend entities (set resources aside without removing them from the environment) or terminate entities (remove them from the environment). Suspended capacity is still available to be brought back online, but is currently not available for use. Suspended resources are candidates for termination. Turbonomic can decommission the following:

- Application Servers (only with Provision scaling policy)
- VMs
- PMs
- Storage
- Disk Arrays

Turbonomic can also recommend that you decommission a virtual datacenter.
Buy RI

Turbonomic can recommend that you purchase RI capacity to reduce costs for your current workload. The analysis looks at workload history for template families to identify RI candidates. This considers the count of workloads in a family, plus their hours of active-state condition, plus RI costs to arrive at the RI capacity you should purchase. Note that different types of RIs have different costs, so the choice between using on-demand or RI pricing can vary depending on the RI Pricing configuration in your Budgets and Costs settings. For more information, see RI Purchase Profile on page 200.

You should note that Turbonomic uses a weighted history of workload activity. For a given scope, if you suspend workloads then Turbonomic still takes them into account as it calculates RI purchases. The longer ago that the workload was suspended, the less weight it has in the RI Buy calculation.

For AWS environments that use the Instance Size Flexible rules, Turbonomic can recommend that you buy multiple RIs of smaller instance types to cover the resource requirements of larger instance types. For example, rather than buying one t2.small RI, Turbonomic can recommend that you buy four t2.nano RIs to offer an equivalent discount.

For AWS environments that consolidate billing into Billing Families, Turbonomic recommends purchases for RIs that are within the given billing family. For more information, see AWS Billing Family Recognition on page 191.

NOTE: As Turbonomic calculates actions to purchase RI capacity, it assumes that any other pending actions for the workload will also be executed. For example, assume a workload running on an r4.xlarge template. If Turbonomic recommends changing that instance type to an m5.medium, it can recommend that you purchase an m5 RI to cover the workload and reduce costs. This purchase could be on a region that currently doesn't have any m5 workloads — The purchase recommendation assumes you will move the workload to that other region.

Action Categories

Turbonomic groups entries in the Actions List by different categories. These categories do not strictly define the severity of an issue, but they indicate the nature of the issue.

Performance

Ultimately, the reason to manage workloads in your environment is to assure performance and meet QoS goals. When Turbonomic detects conditions that directly put QoS at risk, it recommends associated actions in the Performance category. You can consider these critical conditions, and you should execute the recommended actions as soon as possible.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Risks/Opportunities</th>
</tr>
</thead>
</table>
| • Bind a new application (to a virtual application) | • <Resource> Congestion  
High utilization of application managed by a load balancer. High utilization of resources on workload, Host, or datastore. |
| • Provision a new VM, Host, Datastore | |
| • Increase number of VCPUs | |
| • Decrease number of VCPUs | |
| • Scale the resource capacity on an entity | |
**Prevention**

Turbonomic constantly monitors conditions, and works to keep your environment running in a desired state. As it finds issues that risk moving the environment out of this state, it recommends associated actions in the Prevention category. You should attend to these issues, and perform the associated actions. If you do not, the environment may drift away from the desired state, and the QoS for some services may be put at risk.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Risks/Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move VM</td>
<td>&lt;Resource&gt; Congestion</td>
</tr>
<tr>
<td>Storage Move</td>
<td>High resource utilization on the named VM, host, or datastore. For example, CPU congestion or Memory congestion can occur on a VM or physical machine, or an IOPS bottleneck can occur on a datastore.</td>
</tr>
<tr>
<td>Start VM or Host</td>
<td>Workload Balancing</td>
</tr>
<tr>
<td></td>
<td>Excess workload on a given physical machine that can be addressed by moving a VM to another host.</td>
</tr>
</tbody>
</table>

**Efficiency**

Efficient utilization of resources is an important part of running in the desired state. Running efficiently maximizes your investment in hardware and reduces cost. When Turbonomic discovers underutilized resources, it recommends actions to consolidate your operations. For example, it can recommend that you move certain VMs onto a different host. This can free a physical machine to be shut down.

There are times when Turbonomic suspends a VM in order to free up resources for a critical application. When those resources are no longer stressed by the critical application, Turbonomic can restart the suspended VM. This is a special type of efficiency improvement — rather than consolidating workload and shutting down unused machines, this action restarts a suspended VM to increase resource utilization and provide more services.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Risks/Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disconnect Virtual App</td>
<td>Overprovisioning</td>
</tr>
<tr>
<td>Move VM</td>
<td>Excess resource capacity in a Host or datastore.</td>
</tr>
<tr>
<td>Suspend VM</td>
<td></td>
</tr>
<tr>
<td>Delete VM</td>
<td></td>
</tr>
<tr>
<td>Terminate VM</td>
<td></td>
</tr>
<tr>
<td>Scale down resource allocation</td>
<td></td>
</tr>
<tr>
<td>Restart suspended VM</td>
<td></td>
</tr>
</tbody>
</table>
Compliance

A virtual environment can include policies that limit workload placement or availability of resources. It’s possible that the environment configuration violates these defined policies. It’s also possible that an entity is mis-configured in some way. For example, a VM might be configured to access a network that is not available in its current cluster. In such cases, Turbonomic identifies the violation and recommends actions that bring the entity back into compliance.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Risks/Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Move VM</td>
<td>• Placement Violation</td>
</tr>
<tr>
<td>• Provision VM, Host, Datastore, Network</td>
<td>The placement of a VM is in violation of a Turbonomic policy or an imported Placement Policy.</td>
</tr>
<tr>
<td></td>
<td>• Misconfiguration</td>
</tr>
<tr>
<td></td>
<td>The configuration violates discovered requirements. For example, a VM is configured to access a network that is not available from the current cluster.</td>
</tr>
</tbody>
</table>

Resource Descriptions

To perform intelligent workload balancing, Turbonomic collects raw data from its target servers – hypervisors, cloud management stacks, public cloud accounts, etc. Turbonomic polls its targets at 10-minute intervals to collect the latest data samples. It then uses these 10-minute data points for analysis and to display data in the GUI.

The way Turbonomic collects host memory data from vCenter Server illustrates how this works. vCenter Server collects peak metrics from its managed VMs at 20-second intervals. Every ten minutes Turbonomic polls vCenter Server to collect its last round of data samples (30 samples in 10 minutes). To track a VM's utilization of host memory, Turbonomic requests `memory.active` data samples from vCenter. From that polling, Turbonomic can track:

- Peak Memory Utilization - Turbonomic uses the greatest value in each polling sample. This gives the highest percentage of active memory utilization for the selected VM (or group of VMs), calculated over the selected time period. For a maximum value, Turbonomic uses the highest observed active memory value in the data sample.
- Average Memory Utilization - Turbonomic averages all the values in each polling sample.

**NOTE:** The above example describes utilization calculations for on-prem entities. For workloads on the public cloud, Turbonomic includes the Aggressiveness and Max Observation Period settings to calculate a percentile of utilization. By using a percentile, Turbonomic can recommend more relevant actions to take advantage of elasticity on the public cloud. For more information, see “Aggressiveness” or “Max Observation Period” in “Analysis Policies: VMs” in the Target Configuration Guide “Max Observation Period” in the Target Configuration Guide.

The following table lists the metrics Turbonomic collects, and includes details about how they are collected or measured. When the Turbonomic user interface plots charts of clusters or groups of devices, these charts show the average of the percentage of allocated resources that are used.

<table>
<thead>
<tr>
<th>Resource:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- 2- 4-CPU Rdy</td>
<td>Wait time in the ready queue on the host, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues on hosts. Charts show 1 - 4 CPU values. The charts show the percentage allocated ready queue capacity that is in use on the host. For host charts, this is a measure of the total ready queue wait time for all the VMs running on that host.</td>
</tr>
<tr>
<td>Resource:</td>
<td>Description:</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Balloon       | Ballooning capacity on the PM, measured in KBytes. This capacity is the greater of:  
• 65% of the VMem configured for all powered-on VMs that the PM hosts  
• The physical memory capacity of the PM  
Charts show the percentage of the PM’s ballooning capacity that is in use. |
| Buffer        | For network environments that support buffered switch ports (Arista networks), this resource measures utilization of a port buffer. For example, if a host connects to the network through port 1 on a switch, and that port has enough traffic to cause packet buffering, this resource will show utilization. |
| Connection    | The connections in use, as a percentage of the maximum connections allowed on the database. Database configuration determines the capacity for this resource. |
| Cooling       | Allocated cooling indicates the highest acceptable running temperature for a physical device, such as a chassis in a compute fabric. |
| CPU           | Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions.  
• Host charts show the percentage of the host’s CPU capacity that is in use.  
• VM charts show the percentage of the host’s CPU capacity that is consumed by the given VM. |
| DBMem         | The memory in use by the database, as a percentage of the allocated capacity. Database configuration determines the capacity for this resource. Note that for databases, Turbonomic uses this resource to drive actions, instead of the VMem on the hosting VM. This means that actions are driven by the actual memory consumption on the database. |
| Flow0 — InProvider Flow | For measuring network flow, the flow that is within a single provider — For example, the network flow between VMs that are hosted by the same physical machine. This measures network flow between consumers that are on the same set of closely connected providers. Charts show the percentage of capacity that is utilized. Note that Turbonomic assumes an unlimited supply of InProvider Flow because this flow does not go across the physical network. |
| Flow1 — InDPOD Flow | For measuring network flow, the flow that is local to the given DPOD. This measures network flow between consumers that are on the same set of closely connected providers. Charts show the percentage of capacity that is utilized. |
| Flow2 — CrossDPOD Flow | For measuring network flow, the flow that is between different DPODs. This measures network flow between consumers that are on different sets of closely connected providers. Charts show the percentage of capacity that is utilized. |
| Heap          | The heap capacity allocated for an application. Charts show the percentage of capacity that is used by an application. |
| HotStorage    | For Nutanix platforms, the storage capacity on the server-attached flash. |
| IO            | Data rate through the host’s IO adapter, measured in KBytes/sec.  
• Datacenter charts show the average percentage of the host IO capacity that is in use, for all the hosts in the datacenter.  
• Host charts show the percentage of the host’s total IO capacity that is in use. |
| IOPS          | Storage access operations per second. Charts show the percentage of allocated IOPS capacity that is used on a datastore. |
| Latency       | Allocated capacity for latency on a datastore. This measures the latency experienced by all VMs and hosts that access the datastore. Charts show the percentage of allocated latency that is in use on the datastore. |
| Mem           | Host memory, measured in Kbytes.  
• Host charts show the percentage of the host’s memory that is in use.  
• VM charts show the percentage of the host’s memory that is consumed by the given VM. |
<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
</table>
| NET | Data rate through the host’s Network adapter, measured in Kbytes/sec.  
- Datacenter charts show the average percentage of the host NET capacity that is used for all the hosts in the datacenter.  
- Host charts show the percentage of the host’s total NET capacity that is in use. |
| nfu | Normalized Factor Unit.  
For RIs in AWS environments, the nfu is a measure of RI capacity that you can use to compare or combine the capacity for different template families. For example, the normalized factors for some template families include:  
- nano: 0.25  
- micro: 0.5  
- small: 1  
- medium: 2  
- large: 4  
Turbonomic measures RI utilization and coverage in terms of these normalized factors. |
| Power | A measure of the power that is consumed by a physical device. |
| QoS | A measure of impact on the QoS for an application or group of applications. Increased utilization of SLA indicates an increased impact on the QoS for the affected application. Charts show the percentage of the SLA “capacity” that is utilized.  
Increased utilization of SLA also increases the budget available to the application. By increasing the budget, impact to QoS can drive actions to resize or provision VMs. If an application has no SLA capacity set to it, then the application has infinite budget, and resize actions are driven by VM utilization.  
SLA depends on custom monitoring to measure the features that define an application’s QoS requirements. This is implemented outside of Turbonomic — typical deployments use the Turbonomic REST API to integrate with the monitoring process.  
**NOTE:** You should not set SLA capacity to applications unless you have integrated a system that monitors QoS impact and updates the SLA consumption. |
| Storage | Datastore capacity, measured in Kbytes. Datastore charts show the percentage of a datastore’s capacity that is in use. |
| Storage Provisioned | How much the given storage is over-subscribed. Storage Provisioned capacity is the storage capacity multiplied by the Storage Overprovisioned Percentage (200 by default). The higher this value, the greater the risk that storage is over-committed. |
| Swap | The rate of memory swapping to disk, in bytes per second. The default capacity is 5,000,000 Byte/sec. |
| Threads | Allocated thread capacity. Charts show the percentage of thread capacity that is consumed by an application server. |
| TransactionLog | The disk space devoted to transaction logging for a database. |
| Transactions | Transactions per second in an application. Charts show the percentage of an application’s allocated transaction capacity that is in use. |
| UI | A measure of the impact on Quality of Service (QoS) that a consumer will experience. The higher the UI on a provider, the more risk to QoS for any consumer of that provider’s services.  
For all the resources that impact performance or risk, charts show the UI for the most utilized resource of a given entity. For example, if a host has a UI of 6 for MEM and 12 for CPU, the chart will show the higher value. |
<p>| VCPU | The CPU capacity allocated to a VM guest OS, measured in MHz. Charts show the percentage of a VM’s VCPU cycles that are devoted to processing instructions. |</p>
<table>
<thead>
<tr>
<th>Resource:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMem</td>
<td>The memory allocated to a VM guest OS, measured in Kbytes. Charts show the percentage of a VM’s allocated VMem that is in use. Note that percentages of allocated VMem are measured against whichever is the less of: The VMem limit (if set) or the allocated VMem capacity. This is also true in reports and recommended actions. For example, assume a VM with allocated VMem of 8 GB, but a limit of 4 GB. In this case, the percentage in a chart shows the percentage utilized of 4 GB.</td>
</tr>
<tr>
<td>VStorage</td>
<td>Virtual storage allocated to a VM, measured in Kbytes. Charts show the percentage of a VM’s allocated VStorage that is in use.</td>
</tr>
</tbody>
</table>
Logging In to Turbonomic

To get started with the platform, open a web browser to your Turbonomic installation. The Turbonomic platform serves the user interface to your browser, where you can log in and get started managing your environment. In this way, you can access the unique capabilities of Turbonomic from any internet connection.

Before you can log in, an instance of Turbonomic must be installed in your environment. To get the IP address of your Turbonomic installation, contact your system administrator.

To log in to Turbonomic:

1. Navigate your Web browser to the Turbonomic installation.
   For the URL, provide the IP address or machine name for the installation. This URL opens the Turbonomic Login page. You should bookmark this URL for future use.

2. Provide the user name and password for your account.
   Your system administrator creates user accounts. Contact your system administrator for login information.

After you log in, the browser opens to the The Home Page on page 30. This page is your starting point for sessions with the Turbonomic platform. From the Home Page you can see the following overviews of your environment:

- HYBRID – See all the actions that are pending for the entire environment, both on-prem and in the cloud.
- ON-PREM – See details for the on-prem environment. Notice that the Supply Chain excludes cloud entities and only shows the entities that are on-prem.
- CLOUD – See details for the cloud environment, including pending actions, a listing of your cloud accounts by cost, the locations of cloud datacenters that you are using, estimated costs, and other cost-related information.

To display this information, Turbonomic communicates with target services such as hypervisors, storage controllers, and public cloud accounts. Note that your Turbonomic administrator sets up the target configuration. For information about supported targets and how to configure them, see the Target Configuration Guide.
The Home Page

When you launch Turbonomic, the Home Page is the first view you see. From the Home Page you can:

- Use the Supply Chain Navigator to inspect lists of entities
  Click an entity tier in the Supply Chain to see a list of those entities. For example, click Virtual Machine to see a list of all the VMs in your environment.
- Choose a View to see overviews of your environment:
  - HYBRID – See all the actions that are pending for the entire environment, both on-prem and in the cloud.
  - ON-PREM – See details for the on-prem environment. Notice that the Supply Chain excludes cloud entities and only shows the entities that are on-prem.
  - CLOUD – See details for the cloud environment, including pending actions, a listing of your cloud accounts by cost, the locations of cloud datacenters that you are using, estimated costs, and other cost-related information.
• Navigate to other Turbonomic pages, including:
  - Search – Set the session scope to drill down to details about your environment
  - Plan – Run what-if scenarios or plan migrations to the cloud
  - Place – Use Turbonomic to calculate the best placement for workloads, and execute the placement at the time you specify
  - Dashboard – Set up custom views with charts that focus on specifics in your environment
  - Reports – Generate reports and manage subscriptions to those reports
  - Settings – Configure Turbonomic to set up business rules and policies, configure targets, define groups, and perform other administrative tasks

Getting Home

Wherever you are in your Turbonomic session, you can always click the Home icon to return to the Home Page.

Hybrid View

When you set your session to the Global Scope (click HOME), you can then select the HYBRID view. This view shows all the actions that are pending for the entire environment, both on-prem and in the cloud.

Because this view shows both the on-prem and cloud aspects of your environment, it displays only those charts with data common to both. You can see information about actions, including:

• Lists of pending actions
• Overviews of pending actions
  If you have pending actions in the public cloud, the overview includes the estimated monthly savings or cost associated with those actions. For on-prem actions, the overview can include estimated one-time savings or cost.
• Action history – You can see a history of all actions that have been recommended and executed, or of just the actions that have been accepted and executed.

To see complete lists of actions, click the SHOW ALL link at the bottom of the Actions chart.
**ON-PREM View**

When you set your session to the Global Scope (click **HOME**), you can then select the **ON-PREM** view. This view shows an overview of your on-prem environment. If you don’t have any workload on the public cloud, then you should use this as your starting point for a Turbonomic session. If you have a hybrid environment (on-prem and on the public cloud), then you can refer to this view to see a detailed on-prem overview.
The Supply Chain shows all the on-prem entities in your environment. The charts show details about your environment, including:

- **Overviews of pending actions**
  When appropriate, the overview includes estimated one-time savings or costs associated with the actions.

- **Action history**
  You can see a history of all actions that have been recommended and executed, or of just the actions that have been accepted and executed.

- **Top Cluster utilization**
  See a list of the five most utilized clusters. The chart shows these clusters, along with a count of actions for each. To drill down into the cluster details, click the cluster name. To see and execute the specific actions, click the **ACTIONS** button for that cluster. To see all the clusters in your environment, click **SHOW ALL**.

- **Optimized Improvements**
  Compare current resource utilization with the utilization you would see if you choose to execute all the pending actions.

- **Headroom**
  See how many more workloads can run on your current infrastructure while maintaining performance.

- **Risk Index**
  This chart indicates the overall health of your environment over time. The Risk Index shows whether your environment is keeping in a healthy state, or whether it’s on a trend toward overutilization or underutilization of resources.
CLOUD View

When you set your session to the Global Scope (click HOME), you can then select the CLOUD view. This view shows an overview of your cloud environment. If all your workload is on the public cloud, then you should use this as your starting point for a Turbonomic session. If you have a hybrid environment (on-prem and on the public cloud), then you can refer to this view to see a detailed cloud overview.

To view cloud cost information, you must have one or more public cloud targets set up in your Turbonomic installation. For information about setting up public cloud targets, see the Turbonomic Target Configuration Guide.

In addition, to view full cost information in AWS, you must have created a Cost and Usage report in your AWS account and you must store it in an S3 bucket.

For more information, see Displaying AWS Spend In Turbonomic.

In this view, the Supply Chain shows all the cloud entities in your environment. The charts show details about your cloud environment, including:

- **Overviews of pending actions**
  The overview includes the estimated monthly savings or cost associated with those actions.

- **Top Accounts utilization**
  See a list of the five most utilized public cloud accounts. The chart shows these accounts, along with an estimate of the monthly cost for each. To see all the cloud accounts in your environment, click SHOW ALL.

- **Necessary Investments and Potential Savings**
  For the current set of pending actions, these charts show the impact in dollar value. Necessary Investments are from actions to provision more workloads or to resize workloads up. Potential Savings are from actions to resize down, or to purchase RI resources and put them into active use.
Charts that show your current Reserved Instance strategy:
- Recommended RI Purchases shows the projected inventory of pending Reserved Instance purchases.
- RI Coverage compares the capacity of your current VM workload to the capacity of workload that is covered by Reserved Instances.
- RI Inventory shows the RI workloads that Turbonomic discovers and lists them by templates.
- RI Utilization shows how well you have utilized the reservation inventory. The chart compares the capacity for all reservations versus the RI consumption by virtual machines.

Location
This chart displays the locations of your cloud accounts' regions or zones on a map. Hover on a data point to see the region or zone name. Click a region to set the view's scope.

Cloud Estimated Cost
See your overall cloud costs, over time. This chart shows estimated costs, assuming you continually execute the pending cloud actions.

Action history
You can see a history of actions that have been recommended and executed, or of just the actions that have been accepted and executed.

Cost Breakdown by Cloud Account
This chart shows costs over time for each account that you have set up as a target in Turbonomic.

Cloud Cost Comparison
For all of your public cloud workload, compare your current costs with the costs you would see if you execute the pending actions. This chart lists the workloads according to the types of actions that are pending for them. For example, you might see that 10 out of 100 VMs have pending Performance Assurance actions. Also, you can see the current monthly and yearly costs, the savings these actions would realize, and the resulting difference of those savings.

Cost Breakdown by Cloud Service
This chart shows costs over time for each cloud service that you use in your cloud accounts. For example, you can see the cost for AWS CloudWatch, compared to the cost for AWS S3 storage.

Cost Breakdown by Component
This chart shows costs over time for each component of your cloud utilization. You can see costs for:
- Compute
- IP (static IPs for workloads)
- License (OS license)
- Storage
- Capacity

Cost Breakdown by Cloud Service Provider
This chart shows costs over time for each cloud service provider.

Cost Saved by Actions
This chart shows what your costs would be if you had not taken any actions (missed opportunities), compared with the cost savings you have gained by taking Turbonomic actions.

Tracking Cloud Cost
Turbonomic tracks your cloud spend from the top-down (cost for services) and from the bottom-up (workload expenses):

- Cost for Services
  Turbonomic uses the billing reports from your cloud service providers, as they are associated with your cloud targets. Turbonomic parses these reports to get cost breakdowns by service, service provider, and cloud account.
You can see cost data in charts such as:
- Cloud Estimated Cost
- Cost Breakdown by Cloud Accounts, Component, or Service Provider
- Cloud Cost Comparison
- Expenses

- **Workload Expenses**

  Workloads are the VMs running in your environment, or other hosted processes such as database servers, application servers, or containers. Turbonomic tracks the following expenses for your workloads:
  - Compute
    For compute expenses Turbonomic uses hourly expense per template as specified in the associated public cloud account.
  - Storage
    Turbonomic discovers the storage tier that supports a given workload, and uses the tier pricing to calculate storage cost.
  - License
    For AWS environments, Turbonomic can calculate OS costs. To calculate the OS cost for a VM, Turbonomic subtracts the template cost from the published workload cost. It assumes the difference is the license cost for that workload. If the OS is open source, then there will be no difference, and license cost is zero.
  - IP
    For some workloads, you might use IP services that incur a cost. For example, your cloud provider might charge to grant a static IP to a VM. On AWS environments Turbonomic can include that cost in its calculation and analysis.

  Turbonomic uses this cost information when making VM resize and placement decisions, both in real time and in plans. You can see this information in Expenses charts and in the results of Migrate to Cloud plans.

  **NOTE:** For AWS clouds, Turbonomic can get the information it needs to display license costs for database instances. For Azure clouds, Turbonomic does not display database license costs because Azure does not make that information available.

**Resizing Cloud Workloads**

To resize a workload (for example, a VM or an RDS instance) on the cloud, Turbonomic chooses the cloud template that best matches the workload requirements. This can be to reduce cost by choosing a smaller template, or it can be to assure performance by choosing a larger template. To accomplish the resize, Turbonomic actually moves the workload to the new template. This can include moving to a new availability zone.

Note that resize decisions also take into account the discount you can realize by using RI purchases. Turbonomic can recommend to purchase more RI resources. When considering workload resize actions, Turbonomic can recommend resizing to a larger RI template because the overall cost will be less.

As it considers a resize, Turbonomic also considers the storage and network requirements. Even if the compute resources are underutilized on a workload, if the available templates cannot support the storage or network requirements then Turbonomic will not recommend the change.
### Scaling on the Public Cloud

On the cloud, scaling actions move the VM to a different template. These can include:

- Moving a VM to a template with different capacity
- Moving an on-demand workload to an RI template
- Moving a workload from one RI template to another

For these actions the action list shows the current cost for the source workload, and also the projected cost given the change. To show the current cost, Turbonomic uses the actual costs for that workload. However, to show the projected cost it uses an estimate based on average utilization for the VM, for the costs of the given template.

Note that such a move can result in placing the VM on a larger RI template (one that has a greater NFU value), even though the VM does not need that capacity and there are other smaller templates available. In the public cloud, the cost of usage takes precedence over the resource capacity of the template, assuming the template fully satisfies workload demand.

In Azure environments, there are circumstances where a VM resize can be especially disruptive. In a given region, the infrastructure can be made up of different clusters that have different sets of underlying hardware. Further, some templates that are available in the given region are only available on different clusters. If Turbonomic recommends resizing from a template on one cluster, to a template on another cluster, then the resize action can take longer to complete than usual.

### Reserved Instances (RIs)

Turbonomic analysis takes advantage of AWS Reserved Instances and Azure Reserved VM Instances to calculate optimal workload placement and to arrive at the best possible costs for your deployments on the cloud. The Cloud View includes charts that illustrate this:

- **Pending Actions**
  - If Turbonomic has found actions you can take to improve performance or to reduce cost, then you can see an overview of them in the Pending Actions chart. To see a listing of the specific actions, click **Show All** at the bottom of the chart.

- **RI Utilization**
  - This chart shows how well you have utilized the reservation inventory. The chart compares the capacity for all reservations versus the RI consumption by virtual machines. The chart measures utilization in normalization factor units (NFUs).

- **RI Coverage**
  - This chart compares the capacity of your current VM workload to the capacity of workload that is covered by Reserved Instances.
    - If you have a high percentage of on-demand workload, then you should be able to reduce your monthly costs by increasing RI coverage. To increase coverage, you resize workloads to instance types that have existing RI capacity.
    - If you need more RI capacity, then Turbonomic will recommend the RI templates that you should buy.
• RI Inventory
  This chart lists the RI templates that are active in your inventory. For a tabular listing, click **Show All**. This lists the active instances, including:
  - Template details (template name, number used, and platform)
  - RI Type (Standard, Convertible, or Scheduled)
  - Payment details (term and up-front payment status)
  - Location (region or availability zone)
  - Account ID
  - Effective cost (monthly payment, accounting for up-front payments)
  - Utilization (Percentage of time the RI is utilized)
  - Savings (Based on utilization, the estimated monthly savings as compared to on-demand pricing)
  - Expiration date

• Recommended RI Purchases
  This chart shows the projected inventory of pending Reserved Instance purchases as generated by Turbonomic. For a tabular listing, click **Show All**. This lists the RI templates that Turbonomic recommends, including:
  - Template details (template name, number used, and platform)
  - RI Type (Standard, Convertible, or Scheduled)
  - Term (1 year, for example)
  - Payment details (All Up-front, for example)
  - Location (region or availability zone)
  - Account ID
  - Up-front cost
  - Net savings
  - Break-even period (The time at which reservation savings will exceed the purchase cost of the reservation, rounded to the month)

Turbonomic can recommend that you purchase RI capacity to reduce costs for your current workload. For information about the analysis, see **Buy RI** on page 23.
To perform intelligent workload management, Turbonomic models your environment as a market of buyers and sellers linked together in a supply chain. This supply chain represents the flow of resources from the datacenter, through the physical tiers of your environment, into the virtual tier and out to the cloud. By managing relationships between these buyers and sellers, Turbonomic provides closed-loop management of resources, from the datacenter, through to the application.
Reading the Supply Chain

By looking at the Supply Chain, you can see:

- How many entities you have on each tier
  Each entry in the supply chain gives a count of entities for the given type.

- The overall health of entities in each tier
  The ring for each entry indicates the percentage of pending actions for that tier in the datacenter. Ring colors indicate how critical the actions are - Green shows the percentage of entities that have no actions pending. To get actual counts of pending actions, hover on a ring to more details.

- The flow of resources between tiers
  The arrow from one entry to another indicates the flow of resources. For example, the Virtual Machine entry has arrows to Physical Machine and to Storage. If the VMs are running in a Virtual Data Center, it will have another arrow to that as well. This means that your VMs consume resources from PMs, storage, and possible from VDCs.

Listing Entities From the Home Page

The Supply Chain shows the relationships of entities in your environment. When you’re on the Home Page with a global scope, the supply chain filters its display according to the view you have chosen:

- HYBRID view – All the entities in your environment
- ON-PREM – All your on-prem entities
- CLOUD – All your entities on the public cloud

To see a list of entities, click an entity tier in the Supply Chain.
Supply Chain Entity Types

The Turbonomic user interface displays the following entity types in the supply chain:

- **Supply Chain - Load Balancer** on page 42
- **Supply Chain - Virtual Application** on page 44
- **Supply Chain - Application** on page 45
- **Supply Chain - Application Server** on page 47
- **Supply Chain - Business Application** on page 49
- **Supply Chain - Database Server** on page 51
- **Supply Chain - Container** on page 54
- **Supply Chain - ContainerPod** on page 56
- **Supply Chain - Virtual Machine** on page 58
- **Supply Chain - Virtual Datacenter** on page 61
- **Supply Chain - Host** on page 65
- **Supply Chain - Storage** on page 67
- **Supply Chain - Disk Array** on page 69
Supply Chain - Load Balancer

An Application Load Balancer provides a single point of contact for clients to application targets. It distributes client traffic to multiple targets to increase availability of the application services. For client requests to a virtual application, the load balancer forwards the requests to actual applications that perform the service.
Turbonomic shows AWS and Azure load balancers in the Supply Chain. You can set the session scope to specific load balancers to see the constituent virtual applications, and the rest of the supply chain.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>A load balancer has unlimited budget and will never be suspended.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides:</td>
<td>Transactions to end users.</td>
</tr>
<tr>
<td>Consumes:</td>
<td>Transactions from virtual applications.</td>
</tr>
<tr>
<td>Discovered through:</td>
<td>Turbonomic discovers load balancers that are running in AWS accounts or Azure subscriptions.</td>
</tr>
</tbody>
</table>

### Monitored Resources

Turbonomic does not monitor load balancer resources.

### Actions

Turbonomic does not recommend actions to perform on the load balancer itself, but it does recommend actions to perform on the VMs that host the underlying applications.
A virtual application is the client’s point of contact to request services from an application that is managed by a load balancer. The virtual application is a proxy for multiple instances of actual applications. For client requests to a virtual application, the load balancer forwards the requests to actual applications that perform the service.

To create a virtual application, the load balancer binds actual application instances to the virtual application.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>A virtual server has unlimited budget to buy application resources. As a result, a virtual application will never be suspended.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides:</td>
<td>Transactions to end users and other applications.</td>
</tr>
<tr>
<td>Consumes:</td>
<td>Applications running on VMs.</td>
</tr>
<tr>
<td>Discovered through:</td>
<td>Turbonomic discovers virtual application servers through load balancer targets.</td>
</tr>
</tbody>
</table>
Monitored Resources

Turbonomic monitors the following resources for a virtual application:

- Transaction (transactions per second)
  The percentage utilization of the allocated transactions per second for the given virtual application.

Actions

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.

Supply Chain - Application

In a virtualized environment, an application is a process running on a VM. Applications typically serve human users or other applications. They provide transactions to their users.
## Application Discovery

To discover applications, you can set up the following targets:

- **Guest Os Processes targets** to discover applications through WMI and SNMP
  - Applications by signature
    - These currently include LSASS, ISS, XenDesktop, VMView, MSSQL, and SharePoint.
  - **Guest Load**
    - The resources that Turbonomic has not assigned to any specific application. By default, every VM has a Guest Load application. (For more information, see *Guest Load*, below.)

- **Microsoft Applications**
  - Microsoft Exchange 2012

### Guest Load

The **Apps_GuestLoad** item is a special entry in the Applications hierarchy. This item tracks the resources that Turbonomic has not assigned to any specific application. This can occur for the following reasons:

- **You do not have the licenses required to support Application monitoring**
  In this case, Turbonomic lists all the consumed VM resources in the Apps_GuestLoad entry—this is the only entry under Applications.

- **Turbonomic cannot discover some applications, or some applications are not registered for discovery.**
  In this case, Turbonomic displays entries for the applications it has discovered, and lists the VM resources that are not accounted for under Apps_GuestLoad.

- **VM resources are devoted to infrastructure, and not part of any application**
  Turbonomic lists these resources under Apps_GuestLoad, and provides entries for the applications it has discovered.
Monitored Resources

Turbonomic can monitor the following resources for an application:

- **VMem**
  The percentage utilization of the VMem (in Kbytes) that was allocated to the hosting VM.

- **VCPU**
  The percentage utilization of the VCPU (in MHz) allocated for the hosting VM.

Actions

For Guest OS processes, 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 its host VM will never be suspended. You can override this priority for select applications. For more information, see Analysis Policies: Applications on page 244.

Supply Chain - Application Server

An application server is a service that creates web applications and provides the environment to run them in. For example, IBM WebSphere is a framework that hosts Java based web applications, or Apache Tomcat is a Java Servlet container that hosts a range of Java applications on the web.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>By default application servers have a priority of Mission Critical. This gives them unlimited budget. If you override this setting to lower an application server’s priority, it gains budget as a function of its activity, as measured by utilization of transactions. The more active an application server is (the more transactions it performs), the more it is selling its services to a user.</th>
</tr>
</thead>
</table>
Application Server Discovery

To discover Application Servers, you can set up the following targets:

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

Monitored Resources

Turbonomic monitors the following resources for an application server:

- VMem
  The percentage utilization of the VMem (in Kbytes) that was allocated to the hosting VM.

- VCPU
  The percentage utilization of the VCPU (in MHz) allocated for the hosting VM.

- Transaction (transactions per second)
  For virtual applications discovered through a Load Balancer target or for application servers, the percentage utilization of the allocated transactions per second.

- Heap
  The percentage utilization of the application server’s heap.

- Transactions
  The percentage utilization of the server’s transaction capacity, in transactions per second.

- Response Time
  The percentage utilization of the server’s allocated response time.

- Threads
  The percentage utilization of the server’s thread capacity.
Actions

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

**NOTE:** For IBM WebSphere actions, it's possible that one WebSphere application server can have actions on heap and threads at the same time. In that case, do not execute both actions at the same time. In many cases, a WebSphere action is disruptive, and requires a restart of the WebSphere node. If you execute an action while the node is restarting, the action will fail. Before executing a second action on the same WebSphere node, be sure the node is not restarting in response to the first action.
A Business Application is a logical grouping that serves as the top-level container for a business service. It contains the nodes for that service (for example underlying services or applications), and the infrastructure to support those nodes.

In the Turbonomic supply chain, a Business Application consumes resources from one or more applications or databases. The supply chain extends from there to the VMs that host the application nodes, and any other infrastructure the applications require. The supply chain displays the nodes that the Business Application consumes as:

- **Database Servers**
  Any database server that AppDynamics supports and manages.
- **Application Servers**
  Any application server that AppDynamics supports and manages.
- **Applications**
  Applications discovered through AppDynamics that Turbonomic cannot recognize as application servers.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>Business Applications have unlimited budget.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides:</td>
<td>Transactions to other applications and to end users</td>
</tr>
<tr>
<td>Consumes:</td>
<td>Resources from one or more Database Servers, Application Servers, or Applications</td>
</tr>
<tr>
<td>Discovered through:</td>
<td>AppDynamics targets</td>
</tr>
</tbody>
</table>

### Monitored Resources

Turbonomic monitors the following resources for an application:

- **Transactions**
  The utilization of the Business Application’s transaction capacity, in transactions per second.
- **Response Time**
  For on-prem, the utilization of the database server’s allocated response time.

### Actions

Turbonomic does not recommend actions for the Business Application, but it does recommend actions for the applications and infrastructure that the Business Application consumes.

**NOTE:** The credentials for the service account that Turbonomic uses to access the AppDynamics target are read-only. For this reason, all of the actions that Turbonomic recommends through a Business Application are Recommend, only.
In AWS public cloud environments, a Database Server is a relational database that you have configured using AWS Relational Database Service (RDS). Turbonomic discovers RDS instances through your AWS targets, and uses its analysis to recommend or execute scaling actions as needed. Turbonomic uses AWS billing records to track the actual costs associated with your RDS instances, and to calculate potential savings or investment for scaling actions.

For on-prem, a database server is a database discovered through one of the associated database application targets or through an AppDynamics monitoring solution.
### Database Server Discovery

To discover database servers, you can set up the following targets:

- **Public Cloud targets:**
  AWS accounts that have been set up as Turbonomic targets. Turbonomic discovers RDS instances on those AWS accounts.

- **AppDynamics Monitoring Solutions:**
  Turbonomic discovers database servers that are managed by AppDynamics solutions that you have set up as targets.

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

### Monitored Resources

Turbonomic monitors the following resources for an application:

- **VMem**
  The percentage utilization of the VMem (in Kbytes) that was allocated to the hosting database.

- **VCPU**
  The percentage utilization of the VCPU (in MHz) allocated for the database.

- **DBMem**
  The utilization of the database’s memory capacity.
- **Transaction**
  For on-prem, the utilization of the server’s transaction capacity, in transactions per second.
- **Response Time**
  For on-prem, the utilization of the database server’s allocated response time.
- **DBCacheHitRate**
  For on-prem, the percentage utilization of the database’s allocated cache hit rate, where a greater value indicates fewer disk reads for data.
- **TransactionLog**
  For on-prem, the percentage utilization of the database server’s capacity for storage devoted to transaction logs.
- **Connection**
  For on-prem, the utilization of the allocated connection capacity.
- **Cost**
  For AWS public clouds, the cost for the given RDS instance.

## Actions

For RDS database servers, Turbonomic can recommend actions to scale the database according to demand.

For on-prem database servers, TurbonOMIC can recommend actions on database memory, connections, and the transaction log.

---

**NOTE:** Resize actions based on the TransactionLog resource depend on support for vStorage in the underlying hypervisor technology. Because current versions of Hyper-V do not provide API support for vStorage, Turbonomic cannot support TransactionLog resize actions for database servers running on the Hyper-V platform.
An application container is a standalone, executable image of software that includes components to host an application.

**Synopsis**

| Budget: | A container obtains its budget by selling resources to the hosted application. |
| Provides: | Resources for the applications to use: |
| | • Virtual CPU |
| | • Virtual Memory |
| Consumes: | Resources from container pods, virtual machines, and virtual datacenters. |
| | Note that container pods are not applicable for Pivotal Cloud Foundry. |
| Discovered through: | For CloudFoundry, Turbonomic discovers containers through the Cloud Foundry target or the Pivotal Operations Manager target. |
| | For Kubernetes, Turbonomic discovers containers through the Kubeturbo pod that you have deployed in your environment. |

**Monitored Resources**

Turbonomic monitors the following resources for a container:
• Virtual CPU
  The CPU capacity the container utilizes, measured in Gigahertz (Ghz)

• Virtual Memory
  The memory capacity the container utilizes, measured in Megabytes (MB)

**Actions**

Turbonomic can execute vertical Resize Container actions in Kubernetes and Pivotal Cloud Foundry platforms.

**Constraints**

Turbonomic considers the following constraints when making Resize Container decisions:

• For Kubernetes, Turbonomic represents ResourceQuota attributes as the commodities MemAllocation and CPUAllocation which are the defined Memory and CPU limits.

• For Cloud Foundry and Pivotal Cloud Foundry, Turbonomic imports the Quota Plan of the Organization and Spaces where Turbonomic represents MemAllocation as the memory limit (maximum memory allowed) and number of consumers as the total number of containers allowed.
## Supply Chain - ContainerPod

A ContainerPod is a Kubernetes pod, which is a group of one or more containers with shared storage or network resources and a specification for how to run the containers together.

### Synopsis

| Budget: | A container pod obtains its budget by selling resources to containers. |
|———|———|
| Provides: | Resources for containers to use: |
| | • Virtual CPU |
| | • Virtual Memory |
| Consumes: | Resources from virtual machines and virtual datacenters. |
| Discovered through: | Turbonomic discovers Kubernetes containers through the Kubeturbo pod that you have deployed in your environment. |
Monitored Resources

Turbonomic monitors the following resources for a container pod:

- Virtual CPU
  The CPU capacity the ContainerPod utilizes, measured in Gigahertz (Ghz)
- Virtual Memory
  The memory capacity the ContainerPod utilizes, measured in Megabytes (MB)

Actions

Turbonomic can execute or recommend these actions:

- Move Pod to another Kubernetes Node
- Provision a new container pod (as part of application horizontal scaling)
- Suspend a container pod (as part of application horizontal scaling)

Kubernetes Constraints

Turbonomic respects constraints when making placement decisions. Kubernetes taints for nodes and tolerations for pods are treated as constraints. For example, if a pod has a toleration attribute that restricts it from moving to a certain node, Turbonomic will not move that pod to the restricted node.

In addition, Kubernetes node labels which Turbonomic imports are treated as constraints. Turbonomic considers node labels for Move Pod actions. For example, if a pod has a defined node label, Turbonomic will move that pod to a node with a matching label.
A virtual machine (VM) is a software emulation of a physical machine, including OS, virtual memory and CPUs, and network ports. VMs host applications.

### Synopsis

**Budget:**
A VM gains its budget by selling resources to the applications it hosts. If utilization is high enough, Turbonomic can allocate more resources to the VM, or move the VM to a host that has more resources.
If utilization falls off, the VM loses budget. Ultimately, if the budget isn’t enough to pay for the host services it consumes, Turbonomic will recommend suspending or power off the VM.

**Provides:**
Resources for hosted applications to use:
- VMEM (Kbytes)
- VCPU (MHz)
- VStorage
- IOPS (storage access operations per second)
- Latency (capacity for disk latency in ms)

**Consumes:**
- Physical host resources, including CPU and Mem. For public cloud environments, the Host node corresponds to cloud zones
- Storage

**Discovered through:**
Turbonomic discovers VMs through hypervisor targets.
Monitored Resources

Turbonomic monitors the following resources for a VM:

- **VMem**
  The percentage utilization of the virtual memory (measured in Kbytes) allocated for the VM.

- **VCPU**
  The percentage utilization of the virtual CPU capacity (measured in MHz) allocated for the VM.

- **VStorage**
  The percentage utilization of the virtual storage capacity (measured in Kbytes) allocated for the VM.

- **IOPS (Storage Access Operations per Second)**
  The percentage utilization of IOPS allocated for the VStorage on the VM.

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

Actions

Turbonomic recommends the following actions for a VM:

- **Terminate (Remove) VM**
  For a VM that has been suspended for a long period.

- **Suspend VM**
  For low utilization of VM’s resources.

- **Resize Up VM**
  - High resource utilization on VM

- **Resize Down VM**
  - Low resource utilization on VM that must not shut down

- **Move VM for:**
  - High resource utilization on VM
  - High resource utilization on hosting PM
  - Excess IOPS or Latency in VStorage
  - Workload placement violation
  - Hosting PM is underutilized (move before suspending PM)

- **Move VM Storage**
  For excess utilization of the current datastore, or for more efficient utilization of datastores in the environment.

- **Reconfigure Storage**
  For overutilized storage resources, add VStorage capacity.
  For underutilized storage resources, remove VStorage capacity.

- **Reconfigure VM**
  Change network and storage configuration. For example, Turbonomic recommends this action if the VM is configured to use a network that it cannot access.
AWS Template Requirements

In AWS some templates require workloads to be configured in specific ways before they can move to those templates. If Turbonomic recommends moving a workload the is not suitably configured onto one of these templates, then it sets the action to Recommend Only, and describes the reason. Turbonomic will not automate the move, even if you have set the action mode for that scope to Automated. You can execute the move manually, after you have properly configured the instance.

Note that if you have workloads that you cannot configure to support these requirements, then you can set up a policy to keep Turbonomic from making these recommendations. Create a group that contains these workloads, and then create a placement policy for that scope. In the policy, exclude the templates that do require ENA support. For information about placement policies, see Automation Policies on page 217. For information about excluding templates, see the entry on “Excluded Templates” in Analysis Policies: VMs on page 256.

The template requirements that Turbonomic recognizes are:

- **Enhanced Network Adapters**
  Some Windows instances can run on templates that support Enhanced Networking via the Elastic Network Adapter (ENA), while others can run on templates that do not offer this support. Turbonomic can recommend moving an instance that does not support ENA onto a template that does. To make that move, you must perform the required configuration of the instance before you can execute the move. If you move a non-ENA VM to a template that requires ENA, then AWS cannot start up the instance after the move. Before executing the move, you must enable ENA on the VM.
  For information about ENA configuration, see “Enabling Enhanced Networking with the Elastic Network Adapter (ENA) on Windows Instances” in the AWS documentation.

- **Linux AMI Virtualization Type**
  An Amazon Linux AMI can use ParaVirtual (PV) or Hardware Virtual Machine (HVM) virtualization. Turbonomic can recommend moving a PV instance to an HVM template that does not include the necessary PV drivers.
  To check the virtualization type of an instance, open the Amazon EC2 console to the Details pane, and review the Virtualization field for that instance.

- **64-bit vs 32-bit**
  Not all AWS templates can support a 32-bit instance. Turbonomic can recommend moving a 32-bit instance to a template that only supports a 64-bit platform.

- **NVMe Block**
  Some templates expose EBS volumes as NVMe block devices, but not all instances are configured with NVMe drivers. Turbonomic can recommend moving such an instance to a template that supports NVMe. Before executing the move, you must install the NVMe drivers on the instance.

Resizing Storage Capacity in AWS Environments

When a VM instance needs more storage capacity Turbonomic recommends actions to move the instance to a template that provides more storage. Note that AWS supports both Elastic Block Store (EBS) and Instance storage. Turbonomic recognizes these storage types as it recommends storage actions.

If the root storage for your instance is Instance Storage, then Turbonomic will not recommend a storage action. This is because Instance Storage is ephemeral, and such an action would cause the instance to lose all the stored data.

If the root storage is EBS, then Turbonomic recommends storage actions. EBS is persistent, and the data will remain after the action. However, if the instance uses Instance Storage for extra storage, then Turbonomic does not include that storage in its calculations or actions.
VM Naming in Pivotal Operations Manager

When Turbonomic discovers VMs in a Pivotal Operations Manager environment, it assigns VM names that identify the VM in the context of your Pivotal environment. The name is expressed in the following tokens:

{PCF Job name}#{index number}{{IaaS VM name}}

Supply Chain - Virtual Datacenter

A virtual datacenter (vDC) is a collection or pool of resources that groups the resources around specific requirements or business needs. These vDCs can implement boundaries for the cloud infrastructure, and then can establish tenant groups on that infrastructure.
Turbonomic displays these pools in the Supply Chain as Virtual Datacenter entities. It discovers vDCs for:

- **Container Orchestration Platforms:**
  - Kubernetes
  - Cloud Foundry
  - Pivotal Operations Manager

- **Private Cloud Platforms**
  - vCloud Director
  - vCenter Server
  - Virtual Machine Manager
  - CloudStack
  - OpenStack

### Container Orchestration Virtual Datacenters

Container Orchestration platforms like Kubernetes or Cloud Foundry use logical pools of resources to manage scheduling of workload. For example, administrators can pool resources for different organizations within the enterprise, and assign different policies to each pool. Turbonomic represents these pools as Virtual Datacenters (vDCs).

Turbonomic creates vDCs for the following platforms:

- **Kubernetes**
  
  Each Namespace appears in Turbonomic as a vDC. A Namespace includes a ResourceQuota object to determine the capacity of this vDC.

- **Cloud Foundry**
  
  An Org appears in Turbonomic as a vDC. The Org includes a current Quota Plan, which determines the capacity of this vDC.

### Synopsis

<table>
<thead>
<tr>
<th><strong>Synopsis</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget:</strong></td>
<td>The vDC gains its budget as a function of its activity. The higher the utilization of the vDC, the more Turbonomic assumes the vDC is selling its services to containers or container pods.</td>
</tr>
<tr>
<td><strong>Provides:</strong></td>
<td>Resources to host containers or container pods.</td>
</tr>
<tr>
<td><strong>Consumes:</strong></td>
<td>Resources from VMs, hosts, and storage.</td>
</tr>
<tr>
<td><strong>Discovered through:</strong></td>
<td>Turbonomic discovers these vDCs through Kubeturbo pods, Cloud Foundry targets, or Pivotal Operations Manager targets.</td>
</tr>
</tbody>
</table>

### Monitored Resources

Turbonomic monitors the following resources for a Container Orchestrator vDC:

- **Mem**
  
  The percentage of memory that is reserved or in use for this vDC, measured in Kbytes.

- **CPU**
  
  The percentage utilization of CPU resources allocated to the vDC.

- **Storage**
  
  The percentage usage of storage that is allocated to the vDC.
Actions

Turbonomic does not recommend actions to perform on a Container Orchestrator vDC. Instead, it recommends actions to perform on the entities that provide resources to the vDC.

Private Cloud Virtual Datacenters

In private cloud environments, Turbonomic discovers the infrastructure that provides resources to the cloud, and the workloads that run on the cloud. To manage these resources, private clouds organize the infrastructure into Provider and Consumer Virtual Datacenters.

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

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

Provider Virtual Datacenters

A provider virtual datacenter (vDC) is a collection of physical resources (hosts and datastores) within a cloud stack. The cloud administrator has access to these resources, and defines the datacenter members. A Provider vDC is created to manage resources that will be allocated to external customers through one or more Consumer vDCs.

Synopsis

Budget: A Provider vDC gains its budget by selling resources to the Consumer vDCs that it hosts. If utilization falls off, the datacenter loses budget. Ultimately, if the budget isn’t enough to pay for the services it consumes, Turbonomic will recommend decommissioning the Provider vDC.

Provides: Physical resources such as hosts and datastores to Consumer vDCs.

Consences: Hosts and datastores from the physical infrastructure

Discovered through: Turbonomic discovers vDCs through private cloud stack managers such as vCloud Director.

Monitored Resources

Turbonomic monitors the following resources for a Provider vDC:

- Mem
  The percentage of physical machine memory that is reserved or in use, measured in Kbytes.
- CPU
  The percentage utilization of CPU resources allocated to the Provider vDC.
- Storage
  The percentage usage of storage that is allocated to the Provider vDC.
Actions

Turbonomic does not recommend actions to perform on a Provider vDC. Instead, it recommends actions to perform on the entities that provide resources to the vDC.

Consumer Virtual Datacenters

A Consumer Virtual Datacenter (vDC) is a collection of resources that are available for external customers to manage workload through the private cloud. It is an environment customers can use to store, deploy, and operate virtual systems. Consumer Datacenters use the resources supplied by a Provider Datacenter.

While users can see some of the physical resources that support the Consumer vDC, consumer-level users cannot modify these physical resources. Users of Consumer vDCs make changes to how the virtual devices are deployed in that environment, but they must ask the Provider vDC administrator to add more physical resources to be used by the Consumer vDC. Likewise, Turbonomic can change resources on the VMs running in the vDC, but it does not make any changes to physical resources through this vDC.

Monitored Resources

Turbonomic monitors the following resources for a Consumer vDC:

- **Mem**
  The percentage of physical machine memory that is reserved or in use for this datacenter, measured in Kbytes.

- **CPU**
  The percentage utilization of CPU resources allocated to the datacenter.

- **Storage**
  The percentage usage of storage that is allocated to the vDC.

Actions

Turbonomic does not recommend actions to perform on a Consumer vDC. Instead, it recommends actions to perform on the entities running in the Provider vDC.
For on-prem environments, a host is a server that runs processes, including hypervisor processes to host virtual workloads. Note that a host is not necessarily a physical piece of hardware. A VM can be set up as a server that runs a hypervisor, and in turn it can host other VMs within its processing space. However, it’s most usual to use physical hardware as your hosts.

On the public cloud a host is an availability zone. This is where your cloud workloads run.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
</tr>
</thead>
<tbody>
<tr>
<td>For public cloud environments, you can specify cloud budgets or budget groups that allocate money to the cloud scope.</td>
</tr>
<tr>
<td>In the on-prem environment a host gains its budget by selling resources to the workloads it hosts. The more workloads running on a host, the more budget the host has to purchase storage and datacenter resources. If utilization of a host is high enough, Turbonomic can recommend that you provision a new one. If utilization falls off, the host loses budget. Ultimately, if the budget isn’t enough to pay for the services it consumes, Turbonomic will recommend to suspend or power off the host.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provides:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host resources for VMs to use:</td>
</tr>
<tr>
<td>• Mem (Kbytes)</td>
</tr>
<tr>
<td>• CPU (MHz)</td>
</tr>
<tr>
<td>• IO (throughput on the I/O bus)</td>
</tr>
<tr>
<td>• Net (network throughput)</td>
</tr>
<tr>
<td>• Swap (swap rate capacity measured in bytes/sec)</td>
</tr>
<tr>
<td>• Ballooning (sharing of memory among hosted VMs)</td>
</tr>
<tr>
<td>• CPU Ready Queue (wait time on the queue in ms)</td>
</tr>
</tbody>
</table>
Monitored Resources

For public cloud environments, Turbonomic discovers the resources that an availability zone provides, including:

- **Templates**
  The templates and template families that each zone or region delivers. This includes template capacity and cost for workload resources.

- **Account Services**
  These include storage modes, services the accounts offer for enhanced metrics, and services for different storage capabilities.

- **Relational Database Services (RDS)**
  The RDS capabilities each cloud account provides.

- **Storage Tiers**
  Turbonomic discovers the storage tier that supports your workloads, and uses the tier pricing to calculate storage cost.

- **Billing**
  Turbonomic discovers the billing across the zones and regions to predict costs in the future, and to track ongoing costs. This includes comparing on-demand pricing to Reserved Instance billing.

For on-prem environments, Turbonomic monitors the following resources on a host:

- **Mem**
  The percentage of the host’s memory that is reserved or in use, measured in Kbytes.

- **CPU**
  The percentage of the host’s CPU cycles that are reserved or in use, measured in MHz.

- **IO**
  The data rate through the host’s IO adapters. Charts show the percentage of the host’s IO capacity that is in use, measured in Kbytes per second.

- **Net**
  The data rate through the host’s network adapters. Charts show the percentage of the host’s network throughput capacity that is in use, measured in Kbytes per second.

- **Swap**
  The percentage of the host’s allocated swap space that is in use, measured in Kbytes.

- **Balloon**
  The sharing of memory among VMs running on the host. Charts show percentage of the host’s ballooning capacity that is in use, measured in Kbytes.

- **1, 2, 4... CPU Ready**
  The percentage of the host’s allocated ready queue capacity (measured in msec) that is in use, for the CPU ready queues. Charts show the percentage of wait time for all the VMs on a given host.

**Synopsis**

<table>
<thead>
<tr>
<th>Consumes:</th>
<th>Datacenter resources (physical space, cooling, etc.) and storage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovered through:</td>
<td>Turbonomic discovers hosts through hypervisor targets. For some hypervisor vendors, the host is the target, and for others the hosts are managed by the specified target.</td>
</tr>
</tbody>
</table>
Actions

For the public cloud, Turbonomic does not recommend host actions.

Turbonomic recommends the following actions for an on-prem host:

- **Start Host**
  For increased demand on physical resources, start up a suspended host.

- **Provision Host**
  For increased demand of physical resources, install a new host in the environment. Turbonomic will then move workload to that host.

- **Suspend Host**
  For underutilized resources on a host, move existing workload to other hosts and suspend the host.

- **Terminate (Remove) Host**
  For a host that has been suspended for a period of time, remove the PM.

**NOTE:** Turbonomic discovers VMware HA configurations in clusters, and considers the reserved resources in its calculations. For tolerated host failures, or a reserved percentage of cluster resources, Turbonomic automatically sets utilization constraints for that cluster. If you configure a failover host, Turbonomic reserves that host for HA and will not move VMs to it.

Supply Chain - Storage

Turbonomic represents storage as Datastores. A Datastore is a logical grouping of one or more physical storage devices that serve workload storage requirements.

**Synopsis**

<table>
<thead>
<tr>
<th>Budget:</th>
<th>A Datastore gains its budget by selling resources to the VMs it serves. If utilization of a Datastore is high enough, Turbonomic can recommend that you provision a new one.</th>
</tr>
</thead>
</table>
| Provides:     | Host resources for VMs to use:  
  • Storage amount  
  • IOPS (storage access operations per second)  
  • Latency (capacity for disk latency in ms) |

User Guide
Monitored Resources

Turbonomic monitors the following resources for a datastore:

- **Storage**
  The percentage of the datastore’s capacity (measured in Kbytes) that is in use.

- **IOPS**
  Storage access operations per second. Charts in the user interface show the percentage of allocated IOPS capacity that is used on a datastore.

- **Latency**
  The percentage of allocated latency (measured in ms) that is in use on the datastore. This measures the latency experienced by all VMs and hosts that access the datastore.

Actions

Turbonomic recommends the following actions for a datastore:

- **Start Storage**
  For high utilization of storage resources, start a suspended datastore.

- **Provision Storage**
  For high utilization of storage resources, provision a new datastore.

- **Suspend Storage**
  For low utilization of storage resources, move served VMs to other datastores and suspend this one.

- **Terminate Storage (Remove)**
  For a datastore that has been suspended for a period of time, remove the datastore.

- **Move**
  For high utilization of physical storage, move datastore to a different disk array (aggregate).

- **Resize**
  Increase or decrease the datastore capacity.
A Disk Array (an aggregate) is a data storage system made up of multiple disk drives. For example, a RAID is an aggregate that implements redundancy and other data management features. A disk array provides storage volumes to serve the storage requirements of physical machines. It uses the resources of one storage controller, which manages the disk array operation.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>A disk array gains its budget by selling resources to the datastores it serves. If utilization of a disk array is high enough, Turbonomic can recommend that you provision a new one.</th>
</tr>
</thead>
</table>
| Provides: | Storage resources for datastores to use:  
  • Storage amount  
  • Storage Provisioned  
  • IOPS (storage access operations per second)  
  • Latency (capacity for disk latency in ms) |
| Consumes: | Storage controllers |
| Discovered through: | Turbonomic discovers disk arrays through storage controller targets. |

### Monitored Resources

Turbonomic monitors the following resources for a disk array:

- **Storage**
  The percentage utilization of the storage (measured in Kbytes) allocated for the given disk array. Allocated storage is the sum of the aggregated physical storage that the array exposes to the environment.
• **Storage Provisioned**  
The percentage utilization of the storage that was provisioned for this disk array. This encompasses over-provisioning of storage, as well as thin-provisioning on the VMs, deduplication, compression, and other storage optimizations. For example, assume storage over-provisioning of 200% as the only storage optimization. If Storage Utilization was at 100%, then Storage Provisioned would be 50% (half of the over-provisioned storage in use). A more realistic situation would have the current Storage Utilization at 50%, and Storage Provisioned would show a value of 25%.

• **IOPS - Storage Access Operations per Second**  
The percentage utilization of allocated IOPS. The disk array aggregates this value for all its volumes. In other words, all volumes on a given disk array show the same value for this resource.

• **Latency**  
The percentage utilization of allocated latency. The disk array aggregates this value for all its volumes. In other words, all volumes on a given disk array show the same value for this resource.

## Actions

Turbonomic recommends the following actions for a disk array:

• **Provision Disk Array**  
For high utilization of the disk array’s storage, provision a new disk array (recommendation, only).

• **Start Disk Array**  
For high utilization of disk array, start a suspended disk array (recommendation, only).

• **Suspend Disk Array**  
For low utilization of the disk array’s storage, move VMs to other datastores and suspend volumes on the disk array (recommendation, only).

• **Move Disk Array (for NetApp Cluster-Mode, only)**  
For high utilization of Storage Controller resources, Turbonomic can move an aggregate to another storage controller. The storage controllers must be running.  
For high IOPS or Latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues.

• **Move VM**  
For high utilization of Storage on a volume, Turbonomic can move a VM to another volume. The new volume can be on the current disk array, on some other disk array, or on any other datastore.  
For high IOPS or Latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues.

• **Move Datastore**  
To balance utilization of disk array resources, Turbonomic can move a datastore to another array.
Action Automation for NetApp Storage Systems

For NetApp storage systems, the actions Turbonomic can automatically perform depend on the NetApp version you are running, and whether the system is running in cluster mode:

<table>
<thead>
<tr>
<th>Automated Action</th>
<th>7-Mode</th>
<th>Cluster-Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move VM between datastores, on the same disk array</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Move VM between datastores on different disk arrays</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Move Datastore between disk arrays on the same storage controller</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Move Datastore between disk arrays on different storage controllers</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Resize Storage</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Resize Disk Array</td>
<td>No — Resize up, only</td>
<td>No — Resize up, only</td>
</tr>
</tbody>
</table>

In addition, for a system running in Cluster-Mode, Turbonomic can recommend moving an aggregate to another storage controller.

Supply Chain - Storage Controller

A Storage Controller is a device that manages one or more disk arrays. The storage controller provides CPU cycles to perform storage management tasks for each disk array it manages.

<table>
<thead>
<tr>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget:</strong> A storage controller gains its budget by selling resources to the disk arrays it manages. If utilization of the storage controller’s CPU resources is high enough, Turbonomic can recommend that you provision a new one and move disk arrays (aggregates) to it.</td>
</tr>
<tr>
<td><strong>Provides:</strong> CPU resources to manage disk arrays.</td>
</tr>
<tr>
<td><strong>Consumes:</strong> NA</td>
</tr>
<tr>
<td><strong>Discovered through:</strong> Turbonomic directly accesses storage controller targets.</td>
</tr>
</tbody>
</table>
Monitored Resources

Turbonomic monitors the following resources for a storage controller:

- **CPU**
  The percentage utilization of CPU resources allocated to the storage controller.

- **Storage**
  The percentage of the storage capacity that is in use. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

- **IOPS**
  Storage access operations per second. Charts show the percentage of allocated IOPS capacity that is used by the aggregates managed by the storage controller.

- **Latency**
  The percentage of allocated latency (measured in ms) that is in use for this storage controller. This measures the latency experienced by all VMs and hosts that access the managed storage.

Actions

Turbonomic recommends the following actions for a storage controller:

- **Provision Storage Controller (recommendation, only)**
  For high utilization of the storage controller’s CPU, provision a new storage controller, and then move disk arrays to it.

Supply Chain - IO Module

An IO Module connects the compute resources on a chassis to the fabric domain via the Fabric Interconnect. It provides the servers on the chassis with Net resources. Typical installations provide two IO Modules per chassis.

Turbonomic supports IO Modules when you have installed the Fabric Control Module license.

<table>
<thead>
<tr>
<th>Synopsis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget:</td>
<td>An IO Module gains its budget by selling Net resources to a physical machine.</td>
</tr>
<tr>
<td>Provides:</td>
<td>Net resources</td>
</tr>
<tr>
<td>Consumes:</td>
<td>Chassis and Fabric Interconnect</td>
</tr>
<tr>
<td>Discovered through:</td>
<td>Turbonomic discovers IO Modules through the fabric managers that use them.</td>
</tr>
</tbody>
</table>
Monitored Resources

Turbonomic monitors the following resources for an IO Module:

- Net
  The percentage utilization of the total throughput (storage and network, combined) allocated for the IO Module.

Actions

Turbonomic does not recommend actions to perform on an IO Module.

Supply Chain - Fabric Interconnect

A Fabric Interconnect connects servers in a computing fabric to the fabric’s network and storage resources. It provides network bandwidth to the servers in the platform.

<table>
<thead>
<tr>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget: A Fabric Interconnect gains its budget by selling Net resources to the IO Modules.</td>
</tr>
<tr>
<td>Provides: Net resources</td>
</tr>
<tr>
<td>Consumes: N/A</td>
</tr>
<tr>
<td>Discovered through: Turbonomic discovers Fabric Interconnects through managers of fabric platforms (such as UCS) that use them.</td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for Fabric Interconnect:

- Net
  The percentage utilization of the total network throughput allocated for the Fabric Interconnect.

Actions

Turbonomic recommends the following actions to perform on a Fabric Interconnect

- Resize port to increase size.
Supply Chain - Chassis

A chassis houses the servers that are part of a computing fabric. It provides compute, memory, storage, and bandwidth resources.

<table>
<thead>
<tr>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget:</strong></td>
</tr>
<tr>
<td><strong>Provides:</strong></td>
</tr>
<tr>
<td><strong>Consumes:</strong></td>
</tr>
<tr>
<td><strong>Discovered through:</strong></td>
</tr>
</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for the servers in a chassis:

- **Power**
  The percentage of the acceptable range of power consumption that is utilized by this chassis.

- **Cooling**
  The percentage of the acceptable temperature range that is utilized by this chassis. As the chassis temperature nears the high or low running temperature limits, this percentage increases.

Actions

Turbonomic does not recommend actions for a chassis.

Supply Chain - Domain

A Domain represents the computing fabric network. It provides Network Throughput resources to give the fabric northbound network connectivity.

<table>
<thead>
<tr>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget:</strong></td>
</tr>
<tr>
<td><strong>Provides:</strong></td>
</tr>
<tr>
<td><strong>Consumes:</strong></td>
</tr>
<tr>
<td><strong>Discovered through:</strong></td>
</tr>
</tbody>
</table>
Actions

Turbonomic does not recommend actions to perform on a Domain.

Supply Chain - Datacenter

For on-prem environments, a datacenter is the sum of VMs, PMs, datastores, and network devices that are managed by a given hypervisor target. A datacenter provides compute, memory, storage, and bandwidth resources.

For public cloud environments, a datacenter is the cloud region. The hosts that get resources from the datacenter are availability zones within that region.

<table>
<thead>
<tr>
<th>Synopsis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget:</td>
<td>A Datacenter has unlimited budget.</td>
</tr>
<tr>
<td>Provides:</td>
<td>For on-prem, physical space, cooling, etc.</td>
</tr>
<tr>
<td></td>
<td>For the cloud, billing records, templates, and services.</td>
</tr>
<tr>
<td>Consumes:</td>
<td>N/A</td>
</tr>
<tr>
<td>Discovered through:</td>
<td>• On-prem</td>
</tr>
<tr>
<td></td>
<td>Turbonomic discovers Datacenters through hypervisor targets.</td>
</tr>
<tr>
<td></td>
<td>• Public Cloud</td>
</tr>
<tr>
<td></td>
<td>Turbonomic discovers zones through public cloud targets.</td>
</tr>
</tbody>
</table>
Monitored Resources

For public cloud environments, Turbonomic discovers the regions and availability zones that are managed by each cloud account you have set up as a target. This discovery includes:

- **Templates**
  The templates and template families that each zone or region delivers. This includes template capacity and cost for workload resources.

- **Account Services**
  These include storage modes, services the accounts offer for enhanced metrics, and services for different storage capabilities.

- **Relational Database Services (RDS)**
  The RDS capabilities each cloud account provides.

- **Storage Tiers**
  Turbonomic discovers the storage tier that supports your workloads, and uses the tier pricing to calculate storage cost.

- **Billing**
  Turbonomic discovers the billing across the zones and regions to predict costs in the future, and to track ongoing costs. This includes comparing on-demand pricing to Reserved Instance billing.

For on-prem environments, Turbonomic does not monitor resources directly from the datacenter, but it does monitor the following resources, aggregated for the hosts in a datacenter:

- **Mem**
  The percentage of the PM’s memory that is reserved or in use, measured in Kbytes.

- **CPU**
  The percentage of the PM’s CPU cycles that are reserved or in use, measured in MHz.

- **IO**
  The data rate through the PM’s IO adapters. Charts in the user interface show the percentage of the PM’s IO capacity that is in use, measured in Kbytes per second.

- **Net**
  The data rate through the PM’s network adapters. Charts in the user interface show the percentage of the PM’s network throughput capacity that is in use, measured in Kbytes per second.

- **Swap**
  The percentage of the PM’s allocated swap space that is in use, measured in Kbytes.

- **Balloon**
  The sharing of memory among VMs running on the host. Charts in the user interface show percentage of the PM’s ballooning capacity that is in use, measured in Kbytes.

- **1, 2, 4 CPU Ready**
  The percentage of the PM’s allocated ready queue capacity (measured in msec) that is in use, for 1, 2, and 4 CPU ready queues. Charts in the user interface show the percentage or wait time for all the VMs on a given host PM.

**Actions**

Turbonomic does not recommend actions to perform on a datacenter. Instead, it recommends actions to perform on the devices running in the datacenter.
Supply Chain - VPod

A VPod represents a set of consumers that communicate frequently with each other over the network. For example, VMs that host processes for the same distributed application are likely to pass data between each other on a regular basis. VPods provide a way to calculate the cost of network throughput according to where the VPod entities reside in the hardware layer. Turbonomic groups providers into DPods — For more information, see Supply Chain - DPod on page 78.

There are four levels of cost for network flow:

- **Zero cost**
  The consumers use the same provider — For example, VMs that reside on the same host. These consumers have access to infinite network capacity.

- **Low cost**
  The consumers use providers that are under the same switch. Network capacity for these consumers is determined by the capacity of the providers.

- **Medium cost**
  The consumers communicate across switch nodes. Network capacity is the capacity of the uplink, divided by the number of providers sharing it.

- **High cost**
  The consumers communicate across the cloud. Turbonomic calculates a high cost for throughput to reflect the impact to performance you would experience if consumers had cross-cloud dependencies.

### Synopsis

<table>
<thead>
<tr>
<th>Budget:</th>
<th>VPods have infinite budget — They can consume whatever network resources they need.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides:</td>
<td>Network throughput to VMs.</td>
</tr>
<tr>
<td>Consumes:</td>
<td>Network throughput.</td>
</tr>
</tbody>
</table>
| Discovered through: | Turbonomic discovers DPods through the following targets:  
  - Arista  
  - Cisco Tetration  
  - Netflow data collectors  
  - SFlow data collectors |

### Monitored Resources

Turbonomic monitors the following resources for a VPod:

- **Flow**
  The percentage of network flow capacity that is utilized by the VPod. This is divided into Flow1 (low cost) and Flow2 (medium cost) utilization.

- **Mem**
  The percentage of providers’ memory that is utilized by the VPod.

- **CPU**
  The percentage of the providers’ CPU cycles that are utilized by the VPod.

- **Storage**
  The percentage of the providers’ allocated storage that is utilized by the VPod.
Actions

Turbonomic recommends the following actions for a VPod:

- Move a VPod to different DPods (to providers under a different switch)

In addition, Turbonomic can move a VM into a VPod to reduce network latency.

Supply Chain - DPod

A DPod represents a set of closely connected providers — For example a storage controller, its datastores, and the hosts that consume those storage resources. A unified fabric chassis or an Arista switch can also identify the makeup of a DPod. Turbonomic uses DPods as providers for VPods — For more information, see Supply Chain - VPod on page 77.

<table>
<thead>
<tr>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget:</strong></td>
</tr>
<tr>
<td><strong>Provides:</strong></td>
</tr>
<tr>
<td><strong>Consumes:</strong></td>
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<td><strong>Discovered through:</strong></td>
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</tbody>
</table>

Monitored Resources

Turbonomic monitors the following resources for a DPod:

- **Flow**
  The percentage of network throughput capacity that is utilized by the DPod.
- **Mem**
  The percentage of underlying host memory that is utilized by the DPod.
- **CPU**
  The percentage of the underlying host CPU cycles that are utilized by the DPod.
- **Storage**
  The percentage of the allocated storage that is utilized by the DPod.
Actions

Turbonomic recommends the following actions for a DPod:

- Provision a new DPod — For example, recommend adding a new storage controller, its datastores, and hosts consuming the storage resources
Working With a Scoped View

By default, the Home Page shows a Global view of your environment. To drill down into specifics of your environment, you can set a scope to your Turbonomic session. A scoped view shows details about the specific entities in that scope.

Once you have set a scope, you can use the Supply Chain to zoom in on a related tier to see details about the entities on that tier.

If you find the current scope to be useful, you can save it as a named group. Using named groups is an easy way to return to different scopes that you have saved.

Things You Can Do

- Scoping the Turbonomic Session on page 80
- Navigating With the Supply Chain on page 97

Scoping the Turbonomic Session

The default scope for the Home Page shows an overview of the global environment. What if you want to focus on less than the global environment? Assume you are responsible for a subset of workloads in your environment. This could be:

- Workloads managed on a single host cluster
- The workloads in a single datacenter
- The workloads managed by a given public cloud account
- A custom group of workloads you have created in Turbonomic
It's easy to set the session scope so that Turbonomic zooms in on the part of the environment that you want to inspect. Once you set the scope, you can get a quick picture of system health for that scope. If you find a certain scope to be useful, you can save it as a named group that you can return to later.

1. Navigate to the Search Page.
   
   ![Search Page](image)
   
   Click to navigate to the Search Page. This is where you can choose the scope you want.

2. Choose the type of entities to search.

   ![Search Types](image)
   
   In the Search Page, choose a type of entities that you want to search through. Find the list of entity types on the left. Select All to search the complete environment. Or you can focus on entities by type, by groups, or by clusters. When you select an entity type, the page updates to show all entities of that type.
3. **Use Search to filter the listing.**
   For example, if you’re showing All and you search for “Development”, then you will see all clusters, groups, and entities with “Development” in their names.
4. **Expand an entry to see details.**
   For example, expand a group or an entity to see utilization details and pending actions.

**NOTE:** For hosts in the public cloud, utilization and capacity for host and datacenter resources don't affect Turbonomic calculations. When you expand an entry for a public cloud host, the details do not include information for these resources.
5. Select one or more entries to set the focus of the Home Page.

If you choose a category of entities to limit the list, then you can select one or more of the entities for your session scope. After you select the entities you want to include in your scope, click **SCOPE TO SELECTION** to set the session scope to those entities.

If you choose **All**, or if you choose Groups or Clusters, then you can select a single entry to set the scope for your session. When you select an entry in the list, that sets the focus of the Home Page. For example, if you select a cluster in the **Search** listing, you set the Home Page focus to that cluster. Use the Home Page bread crumbs to set a different scope, or you can return to **Search** and set a different scope from there.
The Overview Charts show your environment’s overall operating health for the current session scope. A glance at the Overview gives you insights into service performance health, overall efficiency of your workload distribution, projections into the future, and trends over time.

The charts in this view show data for the current scope that you have set for the Turbonomic session. For the global scope, the charts roll up average, minimum, and peak values for the whole environment. When you reduce the scope (for example, set the scope to a cluster), the charts show values for the entities in that scope.

Some charts included in this view are:

- **Pending Actions**
  See all the actions that are pending for the current scope.

- **Health**
  Quickly see the health of the entities in this scope- How many entities have risks, and how critical the risks are.

- **Optimized Improvements**
  A comparison of utilization in your environment before executing the pending actions, and then after.

- **Capacity and Usage**
  This chart lists resources that are used by the current scope of entities, showing utilization as a percentage of the capacity that is currently in use.

- **Multiple Resources**
  See the utilization over time of various resources that are used by the current scope of entities.

- **Top Entities**
  For example, Top Virtual Machines. These charts list the top consumer entities in the current scope.
• Risks Avoided
  Each action addresses one or more identified risks or opportunities in your environment. This chart shows how many risks have been addressed by the executed actions.

• Accepted Actions
  This chart shows how many actions have been executed or ignored, and whether they have been executed manually or automatically.

What You Can Do:

• Set scope: See Scoping the Turbonomic Session on page 80
• Create new charts: See Creating and Editing Chart Widgets on page 147

Setting Chart Focus

The charts update to reflect the focus that you have set for your viewing session. While viewing the Overview Charts, you can set the focus in different ways:

• Set Supply Chain Focus
  Choose a tier in the supply chain to set the view focus - see Navigating With the Supply Chain on page 97

• Set Scope
  Use Search to set the scope of the viewing session - see Scoping the Turbonomic Session on page 80

Chart Time Frame

You can set a time frame from recent hours to the past year, and set that to the charts in the view. Use the Time Slider to set specific start and end times within that range. The green section in the slider shows that you can set the time range to include a projection into the future. For this part of the time range, charts show the results you would see after you execute the current set of pending actions.

For most charts, you can also configure the chart to hard-code the time range. In that case, the chart always shows the same time scale, no matter what scale and range you set for the given view.
Note that Turbonomic stores historical data in its database. As you run Turbonomic in your environment for more time, then you can set a time range to show more history.

## Details View

The Details View shows more details about the entities in your session scope. These charts focus on the utilization of resources by these entities, so you can get a sense of activity in that scope over time.

The Details View shows more details about the entities in your session scope. These charts focus on the utilization of resources by these entities, so you can get a sense of activity in that scope over time.

### What You Can Do:

- Set scope: See [Scoping the Turbonomic Session](page 80)
- Create new charts: See [Creating and Editing Chart Widgets](page 147)
Setting Chart Focus

The charts update to reflect the focus that you have set for your viewing session. While viewing the Overview Charts, you can set the focus in different ways:

- **Set Supply Chain Focus**
  Choose a tier in the supply chain to set the view focus - see *Navigating With the Supply Chain* on page 97

- **Set Scope**
  Use *Search* to set the scope of the viewing session - see *Scoping the Turbonomic Session* on page 80

Chart Time Frame

You can set a time frame from recent hours to the past year, and set that to the charts in the view. Use the Time Slider to set specific start and end times within that range. The green section in the slider shows that you can set the time range to include a projection into the future. For this part of the time range, charts show the results you would see after you execute the current set of pending actions.

For most charts, you can also configure the chart to hard-code the time range. In that case, the chart always shows the same time scale, no matter what scale and range you set for the given view.

Note that Turbonomic stores historical data in its database. As you run Turbonomic in your environment for more time, then you can set a time range to show more history.
The Policy View gives you a look at the Automation Policies that are set for the entities in the current scope. For each policy, you can see whether it has been enabled or disabled. In addition, you can create new policies and apply them to that scope.

To edit a policy, click the policy name. You can then change the policy settings, or enable/disable the policy.

To see the current policy settings, expand a settings category. For each setting, you can see which policy determines the value- Either the default policy or a custom policy that has been applied to this scope.

When you create a new policy, it automatically includes the current scope. You can add other groups to the policy scope if you like. Note that you can enable more than one policy for the same scope. If two policies apply different values for the same setting, then the most conservative value takes effect.

For more information, see Automation Policies on page 217.
Entity Placement Constraints

VM Placement Constraints

- PROVIDERS

<table>
<thead>
<tr>
<th>CURRENT PLACEMENT</th>
<th>OTHER POTENTIAL PLACEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>dce17-host-01.eng.vmturbo.com</td>
<td>4 Hosts</td>
</tr>
</tbody>
</table>

- CONSUMERS

<table>
<thead>
<tr>
<th>CURRENT CONSUMERS</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Server</td>
<td>1 Database Server</td>
</tr>
<tr>
<td>App</td>
<td>1 Application</td>
</tr>
</tbody>
</table>

When you drill down to a single entity, you can see details about the entity's relationships in the supply chain. This shows you which entities provide resources to this entity, and which entities consume resources that this entity provides. When considering providers for this entity, you can see the name of each current provider, and how many alternative providers Turbonomic can choose from if the current one becomes overutilized.

Reviewing the constraints on an entity helps you understand the actions that Turbonomic recommends. If an action seems questionable to you, then you should look at the constraints on the affected entities. It's possible that some policy or constraint is in effect, and it keeps Turbonomic from recommending a more obvious action.

Experimenting With Placement Constraints

For each provider or consumer in the list, you can open a Constraints fly-out that gives more details about limits on the current element's supply chain relationships.

For example, assume the PROVIDERS list shows your VM's CURRENT PLACEMENT is on Host A, and for OTHER POTENTIAL PLACEMENT you see that Turbonomic can choose from 4 hosts. When you click Constraints, the flyout displays a list of host constraints that currently result in the four potential hosts for this VM.
The list information includes:

- **CONSTRAINT TYPE**
  Most constraints are boundaries that are inherent in your environment such as a cluster boundaries or a networks, or the can be constraint rules such as discovered HA or DRS rules authored Turbonomic placement policies (sometimes called *segments*)

- **SCOPE NAME**
  For a given rule or constraint, the scope to which it was applied.

- **SOURCE**
  If this is a discovered constraint, the source shows the type of target that imposes this constraint. For example, for a DRS rule the source will be vCenter.

- **POTENTIAL PROVIDERS**
  For the given constraint, how many providers that constraint allows. To see a list of the potential providers, click the POTENTIAL PROVIDERS value.

To dig deeper into how these constraints affect your entity, click **FIND MORE PLACEMENT OPTIONS**. This puts you into a *simulation mode* that you can use to experiment with changing the effective constraints. For example, you might see that a cluster boundary is limiting your placement possibilities, and you would like the option to place the current VM on other clusters. Armed with this information, you could navigate to Policies and create a Merge Cluster policy.
In this mode you can enable and disable different combinations of constraints. As you do, the *POTENTIAL PROVIDERS* label updates to show how many providers are available to your entity. To see the resulting list of providers, click the *POTENTIAL PROVIDERS* label.

By turning off the 4-Host constraints, you have 12 potential hosts for this VM. Click this label to see the resulting list of providers.
The list of entities is a quick way to drill down to details about your environment, so you can see specifics about resource consumption or state. For example, you can see the amount of capacity that has been assigned to a VM that is currently idle.

This list always updates to reflect the focus you have selected in the Supply Chain Navigator. When you select an entity type in the supply chain, the entities list updates to show the entities of that type for your current scope. For example, select Physical Machine to see a list of hosts in the current scope. For more information, see Navigating With the Supply Chain on page 97.
Pending Actions List

To perform Intelligent Workload Management, Turbonomic identifies actions you can take to avoid problems before they occur. You can perform these actions manually, direct Turbonomic to perform the actions on command, or direct Turbonomic to perform actions automatically as they arise.

The Pending Actions list shows the actions that Turbonomic currently recommends. You can select actions to execute, and you can expand action items to see more details.
Controlling List Display

For a long list of pending actions, it's useful to sort or filter the list:

- **Filter the list**
  Filter the list by action type, action mode, and action category. For example, filter the list to only show resize actions that are manually executable, and that give efficiency improvements.

- **Search**
  Filter the list by names that match what you type in the Search field.

- **Sort**
  Sort the pending actions list by severity or by name of the action target, in ascending or descending order. Turbonomic determines action severity by the amount of improvement the affected entities will gain by executing the action. Action severities are:
    - Minor
    - Major
    - Critical
Showing Action Details

Expand an action item to see its details. The panel shows:

- A description of the recommended action
- Resource utilization for the affected entity
  For example, if the action is to move a VM, the details show resource utilization for that VM
- Resource utilization for the affected providers
  For example, for a VM move this shows utilization on the FROM and the TO host machines.
- Related risks or opportunities
  Risks and opportunities show the reasons for the recommended action.

**NOTE:** The action item gives the names of the affected entities. You can click on these entity names to drill down and set the Home View scope to that specific entity. To return after drilling down to an entity in the action details, use the browser’s **Back** button.
Navigating With the Supply Chain

After you have set the scope of your Turbonomic session, you can use the Supply Chain to change the focus of the main view, and see details about different types of entities within the current scope.

Drilling Down in a Scoped Session

When you set a scope to your Turbonomic session, the Home Page shows information about your environment, including:

- **Overview**
  Charts and lists to give you an overview of your environment for the current scope. This overview corresponds to all the entities in scope.
- **Details** - Charts that give you a more detailed look at your environment for the given scope
- **Policies** - Any policies that are defined for the entities in the current scope
- **Entity Lists** - Details about the entities in the current scope
- **Pending Actions** - Actions that are pending for any entities in the current scope
Working With a Scoped View

The Supply Chain shows the currently selected tier of entities. The change the focus of the scoped view, select different tiers in the Supply Chain. The Policies, Entities List, and Pending Actions tabs update to focus on the tier you selected. These tabs show information for all the entities of that type that are in the current scope. For example, if you click the Host tier, these tabs update to show information about the hosts in your current scope.

To zoom in on a specific entity, you can click its name in the Entities List. This sets the scope to that specific entity. To return to the previous scope, use the browser’s Back button.
Plans: Looking to the Future

Use the Plan Page to run simulations for what-if scenarios that explore possibilities such as:

- Migrating workloads from your enterprise datacenter out to the public cloud
- Changing hardware supply
- Impact of downsizing, or removing resources
- Projected infrastructure requirements
- Optimal workload distribution to meet historical peaks demands
- Optimal workload distribution across existing resources
How Plans Work

To run a plan scenario, Turbonomic creates a snapshot copy of your real-time market and modifies that snapshot according to the scenario. It then uses the Economic Scheduling Engine to perform analysis on that plan market. A scenario can modify the snapshot market by changing the workload, adding or removing hardware resources, or eliminating constraints such as cluster boundaries or placement policies.

As it runs a plan, Turbonomic continuously analyzes the plan market until it arrives at the optimal conditions that market can achieve. When it reaches that point, the Economic Scheduling Engine cannot find better prices for any of the resources demanded by the workload — the plan stops running, and it displays the results as the plan's desired state. The display includes the resulting workload distribution across hosts and datastores, as well as a list of actions the plan executed to achieve the desired result.

For example, assume a scenario that adds virtual machines to a cluster. To run the plan, Turbonomic takes a snapshot of the current market, and adds the VMs to the specified cluster. Turbonomic then runs analysis on the plan market, where each entity in the supply chain shops for the resources it needs, always looking for a better price — looking for those resources from less-utilized suppliers. This analysis continues until all the resources are provided at the best possible price.

The results might show that you can add more workload to your environment, even if you reduce compute resources by suspending physical machines. The recommended actions would then indicate which hosts you can take offline, and how to distribute your virtual machines among the remaining hosts.

Migration Plans

Turbonomic can run plans that calculate how to migrate workloads from one infrastructure to another. You can create:

- **On-prem migration plans**
  
  For example, assume you want to decommission one datacenter and move all its workload to a different datacenter. Does the target datacenter have enough physical resources to support the workload move? Where should that workload be placed? How can you calculate the effect such a change would have on your overall infrastructure?
  
  To calculate this information, create a plan that:
  
  - Limits the plan scope to two datacenters (or clusters) — the one you will decommission, and the one that will take on the extra workload
  - Removes all the hardware from the decommissioned datacenter
  - Calculates workload placement across datacenter (or cluster) boundaries
  - Does not provision new hardware to support the workload
• Migration to the public cloud
Turbonomic includes a special plan to simulate migration of on-prem workload to the cloud. This plan focuses on optimizing your costs on the cloud by choosing the best templates (most adequate compute resources) and regions to host your workloads. The plan results give you:
  - Projected monthly and yearly costs
  - The actions to execute your migration
  - The optimal templates to use, combining efficient purchase of resources with assured application performance
  - And more...
For more information about Migrate to Cloud plans, see Planning a Migration to the Cloud on page 120.

**NOTE:** For workloads, plans calculate optimal placement and optimal resource allocation for the given workload. However, plans do not include idle workloads. This is because an idle VM shows no utilization, so the plan cannot determine optimal placement or what percentage of allocated resources that workload will require when it restarts.

For example, a Migrate to Cloud plan might discover that your active on-prem VMs are overprovisioned, and that you can use smaller, more economic templates when you move them to the cloud. However, the plan will not calculate migrations for any idle VMs in the plan scope.
The Plan Management page is your starting point for creating new plans, viewing saved plans, and deleting saved plans that you don't need anymore. To display this page, click the Plan button in the Turbonomic navigation bar.

- **Create new plans**
  
  ![Create Plan Button](image)
  
  To create a new plan, click the CREATE PLAN button, then choose the type of plan to make. See Setting Up User Plan Scenarios on page 102

- **View saved plans**
  
  After you create and run a plan, Turbonomic saves it. You can return to the saved plan to review the results, or you can change its configuration and run it again.

- **Delete saved plans**
  
  To delete a saved plan, turn on the plan's check box and then click the Delete button.

- **Configure nightly plans**
  
  Turbonomic runs nightly plans to calculate headroom for the clusters in your on-prem environment. For each cluster plan, you can set which VM template to use in these calculations. See Configuring Nightly Plans on page 133

**NOTE:** By default, Turbonomic saves plans after you run them. However, when you update Turbonomic to a new major version these saved plans do not carry over to the update.

---

### Setting Up User Plan Scenarios

![Change Summary](image)
A plan scenario specifies the overall configuration of a plan. Creating the plan scenario is how you set up a what-if scenario to see the results you would get if you changed your environment in some way.

After you run a plan, Turbonomic saves the results and the scenario. You can run the same plan again at any time. This runs the plan scenario against the market in its current state.

**NOTE:** To set up Public Cloud planning scenarios, be sure to use the Migrate to Public Cloud or Optimize Cloud plan workflows. The other plan workflows give unreliable results when planning for environments that are managed by public cloud services.

Turbonomic provides workflows to create the following types of plans:

<table>
<thead>
<tr>
<th>Workflow</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Migrate to Public Cloud</strong></td>
<td>Choose groups of workload to migrate to a public cloud. Turbonomic chooses the appropriate cloud templates to support the VMs in your cloud account, and it chooses the best regions to host these VMs. The plan shows two results - migrating to templates that match your current VM resources, and migrating to the smallest templates that can assure performance of your applications without overprovisioning your cloud VMs. The plan shows the costs you would see in your cloud account for both sets of results.</td>
</tr>
<tr>
<td><strong>Optimize Cloud</strong></td>
<td>For the scope of your public cloud environment that you want to examine, run a plan to see all the opportunities you have to reduce cost while assuring performance for your workloads. This includes suggestions to buy RIs, comparisons of template and storage usage, and a comparison of current to optimized cost.</td>
</tr>
<tr>
<td><strong>Add Workload</strong></td>
<td>Adding workload increases the demand that you place on your environment’s infrastructure. You can set up a plan to add new workload based on individual VMs or groups of VMs in your environment, or based on templates.</td>
</tr>
<tr>
<td><strong>Workload Migration</strong></td>
<td>Use this setup to see whether you have enough resources to move your workload from one provider group to another. For example, assume you want to decommission one datacenter, and move all its workload to a different datacenter. Does the target datacenter have enough physical resources to support the workload you plan to move? Where should that workload be placed? Use this plan to calculate the effect such a change would have on your overall infrastructure.</td>
</tr>
<tr>
<td><strong>Decommission Hosts</strong></td>
<td>If your environment includes underutilized hardware, you can use a plan to see whether you can decommission hosts or storage.</td>
</tr>
<tr>
<td><strong>Reconfigure Hardware</strong></td>
<td>Choose hosts or storage that you want to replace with different hardware. For example, assume you are planning to upgrade the hosts in a cluster. How many do you need to deploy, and still assure performance of your applications? Create templates to represent the upgraded hosts and let the plan figure out how many hosts you really need.</td>
</tr>
</tbody>
</table>
Creating Plan Scenarios

The first step for running a plan is to create the scenario to specify how you want to change your environment. You can begin creating a scenario from different places in the user interface:

- From the Home Page:
  
  ![PLAN]

  You can always click the **Plan** button to get started creating a scenario. Remember that you can use the **Search** page to set the current scope for the Home Page (see Scoping the Turbonomic Session on page 80). When you start planning from the Home Page, the plan scenario automatically begins with the current Home Page scope.

- From the Plan Page:
  
  ![PLAN] ➔ **CREATE PLAN**

  Navigate to the Plan Page, and then click **Create Plan**. These scenarios start with a global scope, but you can always edit the scope later.
After you click the **Create** button, choose the type of scenario you want. Turbonomic opens the appropriate wizard to guide you through creating the scenario.

### Creating a Custom Scenario

- **Add Workload**: Check whether you have enough resources to support more workloads.
- **Replace Workload**: Use templates to see how changing your workload impacts resources.
- **Remove Workload**: Calculate the resources you would free up if you remove unneeded workload.
- **Migrate workload**: Migrate workload
- **Migrate to cloud**: Choose workloads to move from on-prem into cloud.

No Changes Yet
1. Set the scope
2. Change workload and supply
3. Set plan settings
4. Click Run
When you create a custom scenario you skip the plan wizards and jump straight into setting up the plan parameters. You can name the plan, set the plan scope, change workload demand and the supply of resources, and specify other changes to the plan market.

To create a custom scenario, navigate to the Plan Page and click **Create Plan**. Then choose **Custom** to open a new custom scenario.

This opens the new Plan Scenario page.

**The Plan's Change Summary**

To the right of the Plan Scenario page you can see the Change Summary. For a new scenario, this summary says “No Changes Yet”.

As you make changes to the plan scenario, those changes appear in the Change Summary. You can edit some changes in the list (for example, add more workloads), and you can delete entries from the summary to remove those changes from the scenario.
Name the Plan

Be sure to give a name that helps you recognize the purpose of this plan.

Set the Plan’s Scope

Setting plan scope is optional, but it usually helps to focus on a subset of your environment. For a very large environment, scoped plans run faster. Also, to run a plan that projects cycles into the future, you must set a scope.

After you set the scope, the user interface shows the group name and the supply chain for that scope.

The plan determines scope differently, depending on the type of entity you base it on:

- **Scope by VM**
  Limits the plan to the physical hosts that those VMs are able to run on. Likewise, the plan includes all the datastores that are available to the VMs in your scope.

- **Scope by Host**
  Limits the plan to those physical hosts. For datastores, Turbonomic identifies all the VMs that can run on the hosts in your scope, and identifies all the datastores that are available for those VMs.

- **Scope by Storage**
  The plan includes the VMs that can run on those datastores, and the physical hosts that those VMs are able to run on.
• **Scope by Provider Virtual Datacenter**
  Limits the plan to the VMs on the virtual datacenters — For those VMs, the scope operates similarly to scope by VM.

**Make Changes to Demand, Supply, and General Configuration**

To make specific changes to the plan, select different tiers in the plan’s Supply Chain Navigator and make configuration changes associated with the given tier.

**General Plan Configuration**

The general settings for a plan have an effect on the overall planning environment.

To set up general configurations for your plan, click the General tier, and then make your settings.

**Change Current Utilization Level**

Setting baseline by increasing utilization by percent is a way to globally increase or decrease the workload for the full scope of your plan. Turbonomic uses the resulting utilization values as the baseline for the plan.

**Set Historical Baseline**

Use these settings to set up the baseline of utilization metrics for your plan:

• **Use current state data**
  This setting runs the plan against the current state of your environment. You can set up the plan to add or remove entities, or otherwise affect the plan calculations. But the utilization metrics will be based on the current state of the plan. If you run the same plan multiple times, each run begins with a fresh view of your inventory.
• **Use historical data**
  This loads the utilization statistics from a previous time period into the plan. Use this to run the plan against utilization that you experienced in the past. For example, assume a peak utilization period for the month before the winter holidays. During the holidays you want to plan to add new capacity that can better handle that peak. You would set the baseline to the utilization you saw during that pre-holiday peak.
  If you enable the **Use current inventory** option, the plan sets historical utilization metrics to the inventory that is current in your environment. Also, each run of the plan will start with a fresh view of your inventory.

**Ignore Constraints**

Globally disable all constraints including:

- Placement Policies that you may have configured in Turbonomic
- Placement policies Turbonomic has discovered (for example, DRS rules)
- Cluster boundaries

**NOTE:** If you are adding hosts to a plan, and use host templates, then you must turn on **Ignore Constraints**.

**Adjust Desired State**

The desired state is a condition in your environment that assures performance for your workloads, while it utilizes your resources as efficiently as possible and you do not overprovision your infrastructure. Turbonomic uses default Desired State settings to drive its analysis. You should never change the settings for real-time analysis unless you are working directly with Technical support. However, you can change the settings in a plan to see what effect a more or less aggressive configuration would have in your environment.

You can think of the desired state as an n-dimensional sphere that encompasses the fittest conditions your environment can achieve. The multiple dimensions of this sphere are defined by the resource metrics in your environment. Metric dimensions include VMem, storage, CPU, etc. While the metrics on the entities in your environment can be any value, the desired state, this n-dimensional sphere, is the subset of metric values that assures the best performance while achieving the most efficient utilization of resources that is possible.

The Desired State settings center this sphere on Performance (more infrastructure to supply the workload demand), or on Efficiency (less investment in infrastructure to supply the workload demand). The settings also adjust the diameter of the sphere to determine the range of deviation from the center that can encompass the desired state. If you specify a large diameter, Turbonomic will have more variation in the way it distributes workload across hosting devices.

For more information, see **The Desired State** on page 11.
Changing Workload

Changing the plan's workload makes a change in demand for resources. The plan then calculates how the providers can best satisfy that demand, and the best placement of workloads on those providers.

To change the workload in your plan, click the Virtual Machine tier and then make your settings.

**Add Workload**

When you add workload, you add VMs to the plan market. To add workload, copy from the list of VMs in your inventory, or copy from a template. When choosing a VM, you can filter the list to show VMs with certain properties (name, number of CPUs, etc.) or by the host, storage, or network that the VM runs on. This makes it easier to sort through a long list of VMs.

**NOTE:** Do not set up an Add Workload plan to add workloads based on public cloud templates. For example, do not choose to add 10 copies of an AWS template.

To set up an Add Workload plan, you should use Turbonomic templates that describe the allocations you want. Then to add workloads to the cloud, the plan can calculate which cloud template best suits that workload, depending on what templates are available for the given regions.
When you choose the VM or template you want to add, it appears as an entry in the Change Summary. Then you can set how many copies to add.

![Set how many to add](image)

**Replace Workload**

Replacing workload is a way to change the properties of VMs in your plan market. When you replace workload, you select one or more VMs that you want to change, and then you select a template to use in their place. The list of changed VMs displays in the Change Summary. You can delete individual entries from the Change Summary if necessary.

**Remove Workload**

Removing workload frees up resources for other workloads to use. Choose the VMs you want to remove from the plan market, and they appear in the Change Summary list.

**Migrate Workload**

Migrating workload means that you move VMs from their current hosts to a different group of hosts. A typical case would be to select a group of VMs running on one cluster, and migrate them to a different cluster. Then you can run the plan to see whether the target cluster has sufficient resources to host the new VMs. You can use such a plan to see whether you can shut down a given cluster, or free up all of its resources.

When choosing VMs to migrate, you can filter the list to show VMs with certain properties (name, number of CPUs, etc.) or by the host, storage, or network that the VMs run on.

The VMs you choose to migrate appear in the Change Summary list.

---

**note:** Do not use this configuration to migrate workload from an on-prem environment onto the cloud. To perform cloud migrations, use the Migrate to Cloud plan (see Planning a Migration to the Cloud on page 120). Also, do not use this configuration to migrate public cloud workload from one service or region to another. For this type of scenario, use the Optimize Cloud plan (see Planning Cloud Optimization on page 128).
**Change Automation**

Use this to enable or disable automatic resize actions for the entities in the plan.

**Ignore Constraints**

Choose to ignore all constraints on the VMs in your environment, or choose a specific type of boundary to ignore. By default, VMs are constrained to the cluster, network group, or storage group that their hosts belong to. You can choose to ignore these boundaries.

For example, by default a plan does not consider moving VMs to physical hosts outside of the current cluster. If you disable the Cluster constraint for the VMs in your plan, then the plan can evaluate the results of hosting those VMs on any other physical machine within the scope of your plan. If the best results come from moving that VM to a different cluster, then the plan will show that result.

**Change Placement Policies**

By default, the plan includes all the placement policies that apply to the plan scope. Also, these policies are in their real-time state (enabled or disabled).

You can use these settings to enable or disable existing policies, or you can create new policies to apply only to this plan scenario. For information about creating placement policies, see Creating Placement Policies on page 213.
Changing Host Providers

Changing the hosts that provide compute resources in your plan makes a change in supply for workloads. The plan then calculates how the providers can best satisfy workload demand, and also the best placement of workloads on those providers.

To change the hosts in your plan, click the Host tier and then make your settings.

**Add Hosts**

When you add hosts, you increase the compute resources for the plan. To add hosts, copy from the list of hosts in your inventory, copy a group of hosts, or copy from a template.

**NOTE:** When you add hosts by copying from a template, you must then configure the plan to ignore constraints. Go to the General settings and turn on the **Ignore Constraints** setting (see “Ignore Constraints” in the Target Configuration Guide).

**Replace Hosts**

Replacing hosts is a way to plan for a hardware upgrade. For example, if you replace your hosts with a more powerful template, the plan might show that you can use fewer hosts, and it will show the best placement for workloads on those hosts.
You begin by selecting the hosts you want to replace, and when you click REPLACE you can then choose a template that will replace them. Note that you can only choose a single template for each set of hosts you want to have replaced. You can configure different replacements in the same plan, if you want to use more than one template.

**Remove Workload**

Removing hosts means you have fewer compute resources for your workloads. If you think you have overprovisioned your environment, you can run a plan to see whether fewer hosts can still support the same workload.

**Change Automation**

For hosts, you can enable or disable Provision and Suspend actions. For example, if you want to plan for more workload, but know that you don’t want to add more hardware, use this setting to disable Provision of hosts for your plan.

**Change Placement Policies**

By default, the plan includes all the placement policies that apply to the plan scope. Also, these policies are in their real-time state (enabled or disabled).

You can use these settings to enable or disable existing policies, or you can create new policies to apply only to this plan scenario. For information about creating placement policies, see Creating Placement Policies on page 213.

**Change Max Utilization Level**

Max Host utilization levels specify the percentage of the physical resource that you want to make available in the given plan. By default, hosts have utilization set to 100%. For a given plan, you can set the utilization to a lower value.

For example, assume you want to simulate High Availability of 25% for some hosts in the plan. In that case, you can select these hosts and set their utilization levels to 75%.
Changing Storage Providers

Changing the storage resources in your plan makes a change in supply for workloads. The plan then calculates how the providers can best satisfy workload demand, and also the best placement of workloads on those providers.

To change the storage in your plan, click the Storage tier and then make your settings.

**Add Storage**

When you add storage, you increase the storage resources for the plan. To add storage, copy from the list of datastores in your inventory, copy a group of stores, or copy from a template.

**Replace Storage**

Replacing storage is a way to plan for a hardware upgrade. For example, if you replace datastores with a more powerful template, the plan might show that you can use fewer datastores, and it will show the best placement for workloads on that storage.

You begin by selecting the storage you want to replace, and when you click REPLACE you can then choose a template for the replacement. Note that you can only choose a single template for each set of datastores you want to have replaced. You can configure different replacements in the same plan, if you want to use more than one template.
**Remove Storage**

Removing hosts means you have fewer storage resources for your workloads. If you think you have overprovisioned your environment, you can run a plan to see whether less storage can still support the same workload.

**Change Automation**

For hosts, you can enable or disable Provision and Suspend actions. For example, if you want to plan for more workload, but know that you don't want to add more hardware, use this setting to disable Provision of storage for your plan.

**Change Placement Policies**

By default, the plan includes all the placement policies that apply to the plan scope. Also, these policies are in their real-time state (enabled or disabled).

You can use these settings to enable or disable existing policies, or you can create new policies to apply only to this plan scenario. For information about creating placement policies, see [Creating Placement Policies](#) on page 213.

**Change Max Utilization Level**

Max Storage utilization levels specify the percentage of the physical resource that you want to make available in the given plan. By default, storage has utilization set to 100%. For a given plan, you can set the utilization to a lower value.

For example, assume you have one data store that you want to share evenly for two clusters of VMs. Also assume that you are creating a plan for one of those clusters. In that case, you can set the datastores to 50% utilization. This saves storage resources for the other cluster that will use this storage.
Planning to Alleviate Pressure on a Cluster

Use the Alleviate Pressure plan to find out how to migrate workloads from a stressed or hot cluster over to a cluster with more headroom. This plan shows the minimal changes you need to make to reduce risks on the hot cluster.

Run these plans to see how to move your on-prem workload onto the public cloud. The plan results:

- Show the actions to migrate workloads from the hot cluster to the cold one
- Compare the current state of your clusters to the optimized state
- Show resulting headroom for both the hot and the cold clusters
- Show trends of workload-to-inventory over time for both clusters

Alleviate Pressure plans make use of the headroom in your clusters. Headroom is the number of VMs the cluster can support, for CPU, Memory and Storage.

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

To specify the templates these plans use, you can configure the nightly plans for each cluster. For more information, see Configuring Nightly Plans on page 133
NOTE: To execute, this plan must ignore certain constraints. The plan ignores cluster constraints to allow migrating workloads from the hot cluster to the cold one. It also ignores network constraints, imported DRS policies, and any Turbonomic that would ordinarily be in effect.

**Configuring an Alleviate Pressure Plan**

The first step for running a plan is to create the scenario to specify how you want to change your environment. You can begin creating a scenario from different places in the user interface:

- **From the Home Page:**

  You can always click the **Plan** button to get started creating a scenario. Remember that you can use the **Search** page to set the current scope for the Home Page (see Scoping the Turbonomic Session on page 80). When you start planning from the Home Page, the plan scenario automatically begins with the current Home Page scope.

- **From the Plan Page:**

  Navigate to the Plan Page, and then click **Create Plan**. These scenarios start with a global scope, but you can always edit the scope later.

In the list of plan wizards, choose **Alleviate Pressure**.

The wizard first gives you a list for you to choose the hot cluster. This is the cluster that shows risks to performance. The list sorts with the most critical clusters first, and it includes the calculated headroom for CPU, Memory, and Storage in each cluster.

After you select the hot cluster, click **Next** and choose the cold cluster.
Setting Up User Plan Scenarios

After you have chosen the hot and cold clusters, click Run. Turbonomic then executes the plan.

Viewing Alleviate Pressure Results

After the plan runs, you can view the results to see how the migration of workloads off of your hot cluster affects your environment.

The Cloud results include the following charts:

- Recommended Actions
  You can see a list of actions to reduce the pressure on the hot cluster. It's typical to see actions to move workloads from the hot cluster over to the cold cluster. If some VMs are overprovisioned, you might see actions to reduce the capacity for those workloads.

- Optimized Improvements
  This chart compares the current state of the hot cluster to its state after executing the plan actions. It displays the resource utilization of the cluster's hosts both before and after the plan.

- Headroom and Density for the Hot Cluster
  Put together, these charts show the headroom for the hot cluster and they show the counts of VMs, Hosts, and Storage over time.

- Headroom and Density for the Cold Cluster
Planning a Migration to the Cloud

Turbonomic includes a special plan to simulate migration of on-prem workload to the cloud. This plan focuses on optimizing your costs on the cloud by choosing the best templates (most adequate compute resources) and regions to host your workloads. If analysis discovers on-prem workloads that are good candidates for Reserved Instances (RIs), then it recommends migrating to those templates, and can even recommend purchasing more RI capacity.

Run the Migrate to Cloud plan to see how to move your on-prem workload onto the public cloud. The plan results:

- Give you projected monthly and yearly costs.
- Show the actions to execute your migration.
- Identify the optimal templates to use, combining efficient purchase of resources with assured application performance.
- Choose the best regions to run your workload.
- Show the cost difference between using current workload allocations and using the optimized allocations that Turbonomic has calculated.
- Identify candidates for Reserved Instance (RI) pricing, and show the cost benefits you can see by running those workloads as RI instances.
- If you need more RI capacity, the results identify the RI templates you should purchase, and in which region.

**NOTE:** Migration to Cloud plans rely on controlled policies to calculate and execute the workload migration. For this reason, the plan ignores any workload placement policies you might have configured that affect any part of the plan's scope.
Configuring a Migrate to Cloud Plan

To configure a Migrate to Cloud plan, you choose the set of workloads you want to migrate, and then you identify the cloud service provider, region, or group you want them to migrate to. You can configure a Migrate to Cloud plan to simulate:

- Migrating workloads from an on-prem datacenter to a cloud account
  Choose to migrate VMs that are managed by on-prem hypervisors. Choose a cloud provider, cloud region, or group on the cloud as the destination.
- Migrating workloads on the cloud from one region to another
  Choose to migrate cloud VMs on a given region, and choose a different region as the destination.
- Migrating workloads on the cloud from one service provider to another
  Choose to migrate cloud VMs on one service provider, and choose a different service provider as the destination.

**NOTE:** Do not use Migrate to Cloud plans to freely migrate your cloud workloads to any region within their current service provider. For example, do not choose to migrate AWS workloads, and then choose the AWS provider as the destination. Such a plan would simulate the best placement for your AWS workloads, within the AWS environment. To get these results, run the Optimize Cloud plan (see Planning Cloud Optimization on page 128).

The Migrate to Cloud plan calculates the costs for your workloads, according to the billing you have negotiated with your cloud service provider. These costs include compute costs, service costs (for example, IP services), and license costs. The plan also calculates RI purchases for workloads that can benefit from such pricing. You should consider the following points:

- **Cloud Budgets**
  Turbonomic uses Cloud Budgets to assign your desired monthly spend for your public cloud providers. You express this in real cost. If you have configured cloud budgets, you should make sure your budgets are high enough to account for the workloads you are migrating. For information, see Cloud Budgets on page 197.

- **RI Purchase Profile**
  Turbonomic uses the RI Purchase Profile to determine RI costs for any migrated workloads that can use RI capacity. For information, see RI Purchase Profile on page 200.

- **OS Configuration**
  On the cloud, VM templates usually include an OS platform to run processes on the VM. As you migrate workloads to the cloud, you can specify the OS you prefer to run. You can keep the same OS that the original workload has, or you can choose to map the workload to a different OS. For example, you can choose to migrate all RHEL workloads to VMs that run the service provider’s deployment of open source Linux. For information, see OS Migration Profile on page 202, or see the steps below to override the global OS profile for this plan.

**Setting Up the Plan**

The first step for running a plan is to create the scenario to specify how you want to change your environment. You can begin creating a scenario from different places in the user interface:

- **From the Home Page:**

  ![Plan Button]

  You can always click the Plan button to get started creating a scenario. Remember that you can use the Search page to set the current scope for the Home Page (see Scoping the Turbonomic Session on page 80). When you start planning from the Home Page, the plan scenario automatically begins with the current Home Page scope.
• From the Plan Page:

Navigate to the Plan Page, and then click **Create Plan**. These scenarios start with a global scope, but you can always edit the scope later.

Clicking to create a plan opens the **Select Plan Type** list of plan wizards. In this list, choose **Migrate to Public Cloud** and use the wizard to configure the plan:

1. **Select the workloads to migrate.**
   
The wizard first gives you a list of VMs to migrate. You can choose from groups or individual VMs. Note that you can choose to migrate on-prem workloads to the cloud, or you can choose cloud workloads to migrate them to a different region or cloud service provider.

   ![Select the virtual machines to migrate](image)

   After you choose the workloads to migrate, click **Next**.
2. Choose the destination for this migration.

In the fly-out that appears, set up the migration destination. You can choose from:

- **Providers**
  Choose from a list of providers. Each public cloud target is an account on a given public cloud provider. Turbonomic shows all of the providers that host your current public cloud accounts. Choose to migrate to one of these providers, or to have the plan choose from all of the providers.
  If you are migrating cloud workloads, then they are already on a provider. For the migration destination, you should not choose the same provider that already hosts the workloads.

- **Regions**
  Turbonomic discovers all the regions that you can access from your target cloud accounts. You can choose one region to restrict plan placement decisions.

- **Groups**
  Choose from a list of groups of VMs that are hosted on the public cloud. The list shows datacenter groups (Regions). This will restrict the plan to place your migrated workloads into that group.

3. Optionally, specify an OS Profile for this migration.

You can set a default OS Profile in the Budgets and Costs settings page (see OS Migration Profile on page 202). To override the default OS profile for this migration plan, click **OS Configuration** and make the settings you want.
The OS migration Profile determines how Turbonomic will map the OS of each workload as it places that workload on the cloud destination. This includes how to choose VM templates that provide the OS you want, and whether to include the license cost in the Migrate to Cloud plan results. To configure an OS Migration Profile, choose from:

- **Match source OS to target OS**
  As you migrate workloads to the cloud, keep the same OS. As Turbonomic calculates placement for the migrated workloads, it will only use templates that provide the same OS that the workload already has. This is important if your workloads host applications that depend on a specific OS.

- **BYOL (Bring your own license)**
  The same as **Match source OS to target OS**, except the plan does not include OS licensing costs in any of the cost calculations for on-cloud placement.

- **Custom OS**
  For each of the listed OS types, map the migrated VM to the OS you choose. The OS types are:
  - Linux – Any open source distribution of Linux. For the migration, Turbonomic will choose templates that provide the Linux platform that the cloud service provider delivers as a free platform. Note that this is always BYOL, because it assumes a free OS license.
  - RHEL – Red Hat Enterprise Linux.
  - SLES – SUSE Linux Enterprise Server.
  - Windows – Microsoft Windows.
  For each mapping, enable or disable **BYOL (Bring Your Own License)**. When you enable this, Turbonomic assumes that you are paying for the OS license, and will not include the license cost in the plan results. If you do not enable BYOL, then Turbonomic gets the license cost from the service provider and includes that cost in the plan results.
4. Execute the plan.

After you have set up the VMs to migrate, and you have set up the destination, click **MIGRATE TO CLOUD**. Turbonomic then executes the plan.

**Viewing Migrate to Cloud Results**

After the plan runs, you can view the results to see how the migration affects your environment. The plan gives hybrid results, divided into a **Cloud** section and an **On-Prem** section. This gives you insight into the complete effect of your migration – both the placement and costs on the cloud, and the resulting savings for your on-prem environment.

**Viewing Cloud Results**

**Cloud**

The Cloud section focuses on your cloud compute costs. As Turbonomic runs the plan, it inspects the VMs to determine the most efficient resource allocations they can have while still assuring performance of the applications they host. In many cases the plan discovers VMs that are over-provisioned. If you were to migrate such VMs to templates that match their current allocations, then you would spend more than necessary to host these VMs on the cloud. The Cloud results show VM compute costs based on the templates that the plan uses to deploy VMs.

NOTE: For AWS clouds, Turbonomic can get the information it needs to display license costs for database instances. For Azure clouds, Turbonomic does not display database license costs because Azure does not make that information available.

The Cloud results include the following charts:

- **Cloud Cost Comparison Table**
  
  This table shows compute costs for VMs on the cloud. You can see changes in cost that result from the migration (compute cost from adding workloads), and changes from resizing existing workloads and moving them to less expensive regions. To provide detail, the table shows how many VMs the plan found that need to be scaled up or down. If it finds undersized VMs, then costs should go up, and for oversized VMs the costs should go down. The plan also identifies workloads that can run as Reserved Instances (RIs).

  To identify RI candidates, Turbonomic considers the history of the workload (by default, the last 18 days), and it looks for:

  - **Workload Activity**
    
    If the workload shows VCPU utilization that is greater than zero, then Turbonomic considers it an active workload.

  - **Workload Stability**
    
    If there have been no start, stop, or resize actions for the VM over the historic period, then Turbonomic considers it stable.

  - **RI Inventory (AWS only)**
    
    For AWS environments, Turbonomic compares the RI candidates to your current inventory of RI resources, plus your desired RI coverage. If the inventory can support the workload, then Turbonomic considers it an AWS RI candidate. If the inventory cannot support the workload, or if supporting it would exceed your desired RI coverage, then Turbonomic can recommend purchasing more RI capacity.
The table then compares costs that you would see after migration, in the following ways:

- **Allocation Plan**
  This column shows compute and storage costs for VMs using templates that support the current on-prem resource allocations.

- **Consumption Plan**
  This column shows compute cost of VMs after the plan has optimized the VM resource allocations for those workloads. This gives placement decisions that use the most efficient compute allocations based on templates that are available in the cloud region. As a result, the compute costs are usually lower, and the plan shows the savings you can take advantage of while still assuring application performance on your migrated VMs.

- **Difference and %**
  These columns summarize the difference between the Allocation and Consumption results. For costs, the percentage column indicates the percentage of workloads that are affected by the Consumption cost calculations.

The table lists the following changes and costs:

- **Virtual Machines with performance risks**
  How many VMs are overutilized, and could be improved by scaling up, for Allocation and Consumption.

- **Virtual Machines with efficiency opportunities**
  How many VMs are underutilized, such that you could save money by scaling down, for Allocation and Consumption.

- **Compute Cost, Storage Cost, and Total Cost**
  The costs for the compute and storage capacity of the workloads for Allocation and Consumption. These costs assume On-Demand pricing for the migrated VMs. The costs are derived from the pricing plans you have for your given cloud accounts.

- **RI Discount and Total cost after RI discount**
  The RI discount for the Consumption results, and the resulting total cost after applying that discount. These costs assume all RI candidates use the appropriate RI pricing for their calculated location in the cloud. It’s likely that some migrated workloads are not RI candidates – the RI Discount and Total Cost show prices for all of the workloads, counting RI and on-prem together.

- **Cloud Cost Comparison Line Chart**
  This chart shows costs in the cloud environment over time. It adds the costs of the planned migration (for Allocation and Consumption results) at the date that the plan was run, and projects costs out to the future.

- **Cloud Template Summary by Type**
  This chart shows the types of templates the plan recommends for the migration, including how many of each it uses, plus the costs for each.
  
  Click **Show changes** to display a table of template details for each workload in the plan. This maps the cloud templates to the on-prem VMs, and for the Consumption Plan it shows whether Turbonomic recommends an RI for that VM.
• Volume Tier Breakdown
This chart shows the distribution of storage that supports your workloads. You can see how many workloads are supported by each storage tier. For a detailed breakdown, click Show changes at the bottom of the chart. The details show you:
- Disk ID
- Storage name
- Size
- Linked VMs
- Tier name
- Monthly Cost

• Recommended RI Purchases
This chart gives a breakdown of the recommended RI templates you should purchase to support the migration with the least cost. For details, click Show all at the bottom of the chart. Some of the details it shows are:
- Reserved Instances: The RI template to purchase
- Platform: The OS for that template
- Related VM: Which VM Turbonomic recommends the RI for
- Location: The region in your cloud account for this RI
- RI Cost: The estimated cost for this RI, assuming a 3-year purchase plan

**Viewing On-Prem Results**

**On-Prem**
The On-Prem section focuses on the physical resources this migration would free in your on-prem datacenter. It includes the following charts:

• Optimized Improvements
This chart compares your on-prem environment, showing a before/after snapshot. The bar charts show resource utilization by the workloads in the on-prem environment. If you migrate all of the on-prem workloads to the cloud, the right-hand chart will have no data – all the workloads have been migrated so there is no workload to report on.

• Resource Summary by Count
This chart shows the current status of your environment side-by-side with the status you would achieve after executing the migration. The chart shows the utilization index for the VMs in your environment. The higher this index is for a VM, the more its resources are utilized.
Planning Cloud Optimization

<table>
<thead>
<tr>
<th>Cloud Cost Comparison</th>
<th>Current</th>
<th>Optimized</th>
<th>Difference</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines with performance risks</td>
<td>19 Out of 108</td>
<td>0 Out of 108</td>
<td>19</td>
<td>-</td>
</tr>
<tr>
<td>Virtual Machines with efficiency opportunities</td>
<td>16 Out of 108</td>
<td>0 Out of 108</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>Virtual Machines out of compliance</td>
<td>0 Out of 108</td>
<td>0 Out of 108</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Compute cost</td>
<td>$6,372/mo</td>
<td>$7,616/mo</td>
<td>$1,244/mo</td>
<td>20 %</td>
</tr>
<tr>
<td>Storage cost</td>
<td>$854/mo</td>
<td>$918/mo</td>
<td>$64/mo</td>
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<tr>
<td>Total cost</td>
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<td>$8,534/mo</td>
<td>$1,307/mo</td>
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<tr>
<td>RI discount</td>
<td>$0/mo</td>
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<tr>
<td>Total cost after RI discount</td>
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<td>17 %</td>
</tr>
</tbody>
</table>

Run the Optimize Cloud plan to see how you can maximize savings while still assuring performance for your applications and workloads. This plan identifies ways to optimizing your costs by choosing the best templates (most adequate compute resources), regions, accounts, or resource groups to host your workloads. The plan also identifies workloads that can change over to RI pricing plans, and it compares your current costs to the costs you would get after executing the plan recommendations. The plan results:

- Compare current to optimized costs, including compute and storage costs, and RI discounts
- Compare current and optimized breakdowns of templates used
- Compare breakdowns of storage tiers in use
- Project the RI coverage (how many workloads use RI) and utilization (percentage of RIs that are active)
- Identify candidates for Reserved Instance (RI) pricing, and show the cost benefits you can see by running those workloads on templates that are reserved on your public cloud provider.

### Configuring an Optimize Cloud Plan

The first step for running a plan is to create the scenario to specify how you want to change your environment. You can begin creating a scenario from different places in the user interface:

- From the Home Page:

  ![PLAN](https://example.com/plan.png)

  You can always click the **Plan** button to get started creating a scenario. Remember that you can use the **Search** page to set the current scope for the Home Page (see Scoping the Turbonomic Session on page 80). When you start planning from the Home Page, the plan scenario automatically begins with the current Home Page scope.
Setting Up User Plan Scenarios

• From the Plan Page:

Navigate to the Plan Page, and then click Create Plan. These scenarios start with a global scope, but you can always edit the scope later.

In the list of plan wizards, choose Optimize Cloud.

1. **Select the scope for your plan.**
   The wizard first prompts you to set the scope of your plan. You can scope by cloud provider, region, account, or Azure resource group.

   ![Select Scope](image)

   **NOTE:** If you choose ACCOUNTS for the plan scope, then Turbonomic does not calculate RI Buy actions for this plan.
2. Optionally, click Advanced Configuration at the bottom of the Select Scope fly-out to change the plan profile and RI purchase profile.

In the PLAN PROFILE tab, you can choose:
- **Purchase RI and Optimize Workloads**
  - Purchase Reserved Instances and also resize VM workloads to move to the desired state.
- **Only Optimize Workloads**
  - Resize VM workloads to move to the desired state. No RI purchases are considered.
- **Only Purchase RI**
  - Purchase Reserved Instances based on current VM allocation and consumption to move to the desired state.
In the **RI PURCHASE PROFILE** tab, you can change RI Purchase Profile settings that match the cloud budget settings you have set up for real-time analysis. For more information about the cloud budget and RI Purchase, see **RI Purchase Profile** on page 200.

- **TYPE**
  - For AWS environments, these correspond to the RI offering class. TYPE can be one of **Standard** or **Convertible**. Choose the type that corresponds to the RI types that you typically use in your environment.

- **TERM**
  - The payment terms you contract for your RIs. TERM can be one of **1 Year** or **3 Year**. Typically, longer term payment plans cost less per year.

- **PAYMENT**
  - The payment option that you prefer for your RIs:
    - All Upfront – You make full payment at the start of the RI term.
    - Partial Upfront – You make a portion of the payment at the start of the term, with the remain cost paid at an hourly rate.
    - No Upfront – You pay for the RIs at an hourly rate, for the duration of the term.

- **COVERAGE**
  - Coverage specifies the percentage of your total workload inventory that you want to be running on RI resources. By default, Turbonomic calculates the coverage that gives you the best cost, for the workloads that are good RI candidates. For more information, see **Buy RI** on page 23.
  
  You can override the calculated coverage and specify a percentage that you want. You typically specify this override to satisfy a department or enterprise policy. When you set a coverage override, Turbonomic recommends RI purchases to reach that coverage, irrespective of the RI cost advantages.
For example, assume you set the RI coverage at 25%. If Turbonomic discovers 40% of your workload should be RI candidates, it will only recommend purchases to achieve 25% coverage. You will miss opportunities to save on cost. On the other hand, if Turbonomic discovers only 5% of your workload should be RIs, it will still recommend RI purchases to achieve 25% coverage. As a result, some purchases might never see a return on investment.

To set a different coverage, enable **Override coverage** and enter the percentage you want. As Turbonomic makes resize, placement, and RI Buy decisions, it will tend toward using the RI coverage you specify.

To return to the Turbonomic calculation of RI coverage, disable **Override coverage**.

3. **After you have made the settings, click OPTIMIZE to run the plan.**

### Viewing Optimize Cloud Results

After the plan runs, you can view the results to see how you can maximize savings or make other improvements to your cloud environment. The plan results show VM compute costs based on the templates it deploys VMs to, and based on the RI pricing that is available for those templates.

**NOTE:** For AWS clouds, Turbonomic can get the information it needs to display license costs for database instances. For Azure clouds, Turbonomic does not display database license costs because Azure does not make that information available.

The plan results include the following charts:

- **Cloud Cost Comparison**
  This chart shows compute costs for your workloads in Current and Optimized columns. You can see changes in cost that result from resizing existing workloads, moving them to less expensive regions, and using RI discounts. To provide detail, the chart shows how many VMs the plan found that need to be resized. If it finds undersized VMs, then costs should go up, and for oversized VMs the costs should go down.
  Turbonomic can recommend that you purchase RI capacity to reduce costs for your current workload. The analysis looks at 30 days of workload history for template families to identify RI candidates. This considers the count of workloads in a family, plus their hours of active-state condition, to arrive at the RI capacity you should purchase.

- **Cloud Estimated Cost**
  This chart gives a timeline of compute costs on the cloud, including your current cost, and projecting the optimized cost into the future.

- **Cloud Template Summary by Type**
  This chart shows the types of templates you currently use, compared to the templates the plan recommends, including how many of each type, plus the costs for each. To see a detailed breakdown of the template costs, click **SHOW CHANGES** at the bottom of the chart.

- **Volume Tier Breakdown**
  This chart shows the distribution of storage that supports your workloads. You can see how many workloads are supported by each storage tier. For a detailed breakdown, click **SHOW CHANGES** at the bottom of the chart. The details show you:
    - Disk ID
    - Storage name
    - Size
    - Linked VMs
    - Monthly cost per tier
Configuring Nightly Plans

- **RI Coverage**
  See how many workloads in your cloud environment are running as Reserved Instances.

- **RI Utilization**
  See how much of your purchased Reserved Instance inventory is utilized.

- **Recommended RI Purchases**
  This chart shows the RI templates the plan recommends. To see the details, click **SHOW ALL** at the bottom of the chart.

---

Turbonomic runs nightly plans to calculate headroom for the clusters in your on-prem environment. For each cluster plan, you can set which VM template to use in these calculations.

For information about viewing cluster headroom, see “Viewing Cluster Headroom” in the Target Configuration Guide.

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.
To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

To set templates to use for the nightly plans:

1. **Display the Plan page.**
2. **Display the configuration page.**
   - In the top-left of the Plan Management page, click **NIGHTLY PLAN CONFIGURATION**. This displays a list of all the nightly plans. Turbonomic creates a nightly plan for each cluster.
3. **Click the plan that you want to configure.**
   - A fly-out appears that lists all the available templates.
4. **Select the template you want for this plan.**
   - Choose the template and click **Select**.
Place: Reserve and Deploy Workload

From the Place Page, Turbonomic uses its intelligent workload management to calculate optimal placement for workloads and then actually deploy them to your on-prem or cloud environment.

To deploy workloads from this page, you will:

- Define the workload to deploy
  This includes choosing a VM template, setting how many instances to deploy, and specifying any placement constraints.

- Find the optimal placement
  Turbonomic runs a plan to determine the best placement for the workload you defined.

- Schedule deployment or create a reservation
  Either deploy the workload directly, or reserve the resources to deploy the workload at a later time.

About Templates for Workload Placement

To specify the workload to deploy, you choose a VM template and then specify how many instances you want to deploy. The template you choose must include a specification for one or more VM images. A VM image identifies the actual deployment package:

- To deploy on-prem, a path to the physical files (for example an OVA)
- For cloud deployments, the cloud provider's named VM image (for AWS, the AMI)

If the template definition includes multiple images, then as it places the workload Turbonomic will choose the image that corresponds with the given cloud region or on-prem datacenter it is deploying to. For more information about templates, see Templates: Resource Allocations for New Entities on page 262.
About Placement Constraints

When you define the workload to deploy, you specify a template to deploy and any constraints that you want Turbonomic to respect.

**NOTE:** The user interface does not force you to specify placement constraints. However, these constraints are how you ensure that the template you have chosen is viable in the given locations that Turbonomic will choose. For example, without placement constraints Turbonomic could choose to place a VM on a cluster that cannot access the template.

In OpenStack environments, when you set up reservations to deploy workloads via OpenStack templates you must constrain the deployment to the OpenStack datacenter. To deploy an OpenStack template, turn on the Limit initial placement to locations you specify constraint, and manually choose the datacenter or datacenters that support the OpenStack template.

The constraints you can choose include:

- **Limit initial placement to the template's image locations**
  For cloud deployment, the template you use specifies one or more VM images that are offered by the cloud providers. Each cloud region makes different images available – if you enable this constraint, then Turbonomic will only place the workload on the image's region.

- **Limit initial placement to locations you specify**
  To limit placement, you can manually specify the cloud regions or on-prem datacenters, the virtual datacenters, or the clusters that Turbonomic can deploy this workload to.

- **Limit placement with placement policy**
  Turbonomic discovers placement policies that are defined in your environment, and you can also create your own. With this setting, you can specify which placement policies to respect. For more information about these policies, see Placement Policies on page 212.

- **Limit placement to networks**
  Turbonomic discovers the different networks in your environment. Use this constraint to limit workload placement to the networks you choose.

Displaying the Workload Placement Page

To see the reservations that are currently active and to create new reservations, click the **PLACE** button.
Setting Up a Deployment

To set up a deployment or a reservation:

1. **Choose the workload you want.**
   On the Workload Placement Page, click FIND OPTIMAL PLACEMENT. Turbonomic displays a list of templates. Choose the template you want, and click SELECT.

2. **Define the workload you want to deploy, and find its placement.**
   Set the number of workloads you want to deploy. Remember that the more workloads you set up in a reservation, the more resources that Turbonomic will set aside.
   In addition to choosing your workload, you can also set up constraints to limit how Turbonomic calculates the deployment.

3. **When you’ve finished making the settings, click FIND PLACEMENT.**
   Turbonomic runs a plan to calculate the placement for the workloads you specified. If it succeeds, it then shows the proposed placement. You can see details including:
   • For cloud placement, the cloud regions and storage tiers that will host the workloads.
   • For on-prem, the physical machine and storage that will host the workloads.

4. **Create a reservation or schedule a deployment.**
   Provide a name for the reservation or deployment. For a reservation, you provide the reservation name – Turbonomic prepends that name to all the VMs it deploys. For a scheduled deployment, you provide names of the individual VMs.
   For either a reservation or a scheduled deployment, you provide dates:
   • For a reservation, set the start and end date. Turbonomic reserves the resources for that time, and deploys the workload by the end date.
   • For a scheduled deployment, you specify the date when you want Turbonomic to deploy the workloads. By default, the deploy date is the day that you define the placement. If the deploy date is today, then you can click DEPLOY to deploy the workloads immediately.
5. **Save your settings.**
   
   If you're creating a reservation, click **RESERVE**. For a deployment, click **DEPLOY**.
   
   For a deployment, if the deploy date is today, then Turbonomic deploys the workloads immediately. If the deploy date is later, or if you are creating a reservation, Turbonomic reserves the resources for the workloads, and deploys them on the specified date.
Dashboards: Focused Views

Dashboards give you views of your environment that focus on different aspects of the environment's health. At a glance, you can gain insights into service performance health, workload improvements over time, actions performed and risks avoided, and savings in cost. For cloud environments, you can see utilization of reserved instances, potential savings, required investments, and the cost/performance of specific cloud accounts.

The Dashboards page lists all the dashboards that are available to you, including the Executive Dashboards and any custom dashboards that your account can access. To view a dashboard, click its name in the list.
Turbonomic ships with two Executive Dashboards already in place. These dashboards give you overviews of your on-prem and cloud environments, showing how you have improved your environment over time.

From the Dashboard page, you can also create your own custom dashboards.

Things You Can Do

- Create custom dashboards:
  See Creating and Editing Custom Dashboards on page 144.
- View the On-Prem Executive Dashboard:
  See On-Prem Executive Dashboard on page 141.
- View the Cloud Executive Dashboard:
  See Cloud Executive Dashboard on page 142.

Executive Dashboards

Executive Dashboards are a scorecard of your On-Prem and Cloud environments. The Executive Dashboards demonstrate how well you are improving performance, cost, and compliance by leveraging the Workload Automation that Turbonomic provides as well as opportunities for further improvements that are available.

Turbonomic ships with two Executive Dashboards:

- On-Prem Executive Dashboard
- Cloud Executive Dashboard

NOTE: Turbonomic ships these dashboards with default configurations. To edit either dashboard, you must log in with the administrator user account. Users logged in with that account can add or remove chart widgets, and change widget scopes. For information about editing dashboards, see Creating and Editing Custom Dashboards on page 144.
On-Prem Executive Dashboard

The On-Prem Executive Dashboard shows the overall performance, capacity, and compliance in your on-prem infrastructure. This includes insights into:

- **Actions History**
  - The **On-Prem Environment** chart widget shows you an overview of your on-prem environment that Turbonomic is managing and controlling. The chart displays the workloads and the infrastructure that Turbonomic discovered.
  - The **Workload Improvements** chart widget shows how the efficiency, performance, and policy risks associated with your workloads have disappeared as you have increased your adoption of Turbonomic Workload Automation. The chart tracks how your workloads have grown as your execution of actions have increased or decreased as your environment achieves and maintains its desired states over time.
  - The **All Actions** chart widget shows the number of actions that Turbonomic has generated versus the ones executed. This gives you an understanding of where there were more opportunities for improvement that were not taken in the past versus those that are available today.

- **Opportunities**
  - The **Workload by Performance**, **Workload by Compliance**, and **Workload by Efficiency** chart widgets indicate workload health by showing the risks that are currently in your environment and each classification of those risks. You can click the Show Actions button on the chart to reveal all of the outstanding actions that need to be taken to resolve those risks on your workloads.
- The **Necessary Investments** and **Potential Savings** chart widgets together show how the current actions will impact the capacity of your environment normalized to a cost value. The cost value is defined in the Budget and Cost configuration (Scaling) as well as the Host and Storage template costs (Provision/Suspend) configuration. These values can be changed in the Settings Page.

- **Current State**
  - The **Top Clusters by Headroom** chart widget shows all of the clusters in your on-prem environment and what their current capacity is for CPU, memory, and storage. In the default view, the chart shows the top five clusters and you can click the Show All button to see all of the clusters. In the Show All fly-out, you can also export the headroom data as a CSV or PDF. Click on an individual cluster to navigate to that cluster and view more details about its current capacity and health.
  - The **Virtual Machines vs Hosts and Storage** and the **Virtual Machines vs Hosts and Storage -Density** chart widgets show how your overall density has improved in your on-prem environment. A high count of VMs per host or storage means that your workloads are densely packed.

## Cloud Executive Dashboard

![Cloud Executive Dashboard](image)

- **Cloud Environment**
  - Cloud Service Providers: AWS
  - Workloads: 77
  - Accounts: 1
  - Monthly Estimated Cost: $41,721

- **Workload Improvements**
  - Workloads: 10
  - Workload with Performance Risks: 8
  - Workload with Efficiencies: 2

- **Cost Saved by Actions**
  - Actions: 10
  - Cost Saved: $1,234

- **Workload by Performance**
  - 100% Performing Well

- **Workload by Compliance**
  - 100% In Compliance

- **Workload by Efficiency**
  - 82% Efficient
The Cloud Executive Dashboard shows your overall cloud expenditures and how you can improve performance and reduce cost. This includes insights into:

- **Actions History**
  - The **Cloud Environment** chart widget shows you an overview of your cloud environment that Turbonomic is managing and controlling. The chart displays the workloads, cloud service providers, and cloud accounts that you currently have set up as Turbonomic targets.
  - The **Workload Improvements** chart widget shows how the efficiency, performance, and policy risks associated with your workloads have disappeared as you have increased your adoption of Turbonomic Workload Automation. The chart tracks how your workloads have grown as your execution of actions have increased or decreased as your environment achieves and maintains its desired states over time.
  - The **Cost Saved by Actions** chart widget shows what your costs would be if you had not taken any actions (missed opportunities), compared with the cost savings you have gained by taking Turbonomic actions.

- **Opportunities**
  - The **Workload by Performance**, **Workload by Compliance**, and **Workload by Efficiency** chart widgets indicate workload health by showing the risks that are currently in your environment and each classification of those risks. You can click the Show Actions button on the chart to reveal all of the outstanding actions that need to be taken to resolve those risks on your workloads.
  - The **Necessary Investments** and **Potential Savings** chart widgets together show how the current actions will impact the capacity of your environment normalized to a cost value. The cost value is defined in the Budget and Cost configuration (Scaling) as well as the Host and Storage template costs (Provision/Suspend) configuration. These values can be changed in the Settings Page.
  - The **Cloud Estimated Cost** chart widget shows estimated monthly costs and investments for the cloud. Monthly cost amounts are summarized as amounts with and without actions.

- **Current State**
  - The **Top Accounts** chart widget shows all of the cloud accounts in your cloud environment and what the utilization is for each account. You can see the number of workloads, estimated monthly costs, saved by actions, and actions taken. In the default view, the chart shows the top five cloud accounts and you can click the Show All button to see all of the accounts. In the Show All fly-out, you can also export the account cost data as a CSV or PDF.
  - The **Cost Breakdown by Tag** chart widget shows the tags you have assigned to your cloud resources and the costs associated with each of these tagged categories. The **Cost Breakdown by Cloud Service Provider** chart widget is an Expenses chart widget that shows your expenses for each cloud service provider.
  - **Usage of Reserved Instances**
    
  - **Reserved Instances (RIs)** reduce cost by offering a subscription-based payment plan. Turbonomic discovers these RI plans and tracks usage patterns to identify workloads that are good RI candidates. The Cloud Executive Dashboard shows whether you are getting the most out of your current RI strategy.

  The **RI Utilization** chart widget shows how well you have utilized the reservation inventory. The chart compares the capacity for all reservations versus the RI consumption by virtual machines. The chart measures utilization in normalization factor units (NFUs), a measurement of capacity that does not depend on the instance family.

  The **RI Coverage** chart widget compares the capacity of your current VM workload to the capacity of workload that is covered by Reserved Instances.
Creating and Editing Custom Dashboards

A custom dashboard is a view that you create to focus on specific aspects of your environment. You can create dashboards that are private to your user account, or dashboards that are visible to any user who logs into your Turbonomic deployment.

Two common approaches exist for creating custom dashboards:

- **Scope First**
  You can create a dashboard in which all of the chart widgets focus on the same scope of your environment. For example, you might want to create a dashboard that focuses on costs for a single public cloud account. In that case, as you add chart widgets to the dashboard, you give them all the same scope.

- **Data First**
  You might be interested in a single type of data for all groups of entities in your environment. For example, each chart widget in the dashboard can focus on Cost Breakdown by Cloud Service, but you set the scope of each chart widget to a different cloud region or zone.

Of course, you can mix and match, according to your needs. You can set any scopes or data sources to the chart widgets in a dashboard to set up whatever organization and focus that you want.

**NOTE:** If you set a scope to your Turbonomic session, the specified scope does not affect your custom dashboards. For information about scoped views, see Working With a Scoped View on page 80.

Creating a Dashboard

To create a custom dashboard:

1. **Navigate to the Dashboard Page.**
   - Click to navigate to the Dashboard Page. This page lists all dashboards that are available to you. To view a dashboard, click its name in the list.

2. **Create a new dashboard.**
   - Click CREATE DASHBOARD to add a new dashboard to your Turbonomic session. The dashboard appears with a default name and without chart widgets. The time range in the Time Slider is set to 24 hours by default.
3. **Name the dashboard.**
   Give a name that describes the dashboard. If you will share the dashboard with all Turbonomic users, the name will help them decide whether to view it.

4. **Add chart widgets to the dashboard.**
   Add as many chart widgets to the dashboard as you want. See [Creating and Editing Chart Widgets](#) on page 147.

5. **Optionally, set the dashboard access.**
   Click **Gear** to change the setting.
   Dashboard access can be:
   - **Only Me** – The dashboard is only available to your Turbonomic user account.
   - **All Users** – Every Turbonomic user can see this dashboard.
   By default, access is set to **Only Me**.

As soon as you create a new dashboard, it appears in the list on the Dashboard Page. Users with access to it can click the dashboard name in the list to view it.

At any time, if you are an administrator or the dashboard owner, you can view and make the following changes to the dashboard:
- Add, edit, or delete widgets
- Change the dashboard name
- Change the dashboard access setting

For executive dashboards, only an administrator (username=administrator) can edit an executive dashboard.

### Editing a Dashboard

If you have created a dashboard, you can change the name of the dashboard, its access settings, and its chart widgets. To change the chart widgets, see [Creating and Editing Chart Widgets](#) on page 147.
To edit a dashboard's name or change its access settings:

1. **Navigate to the Dashboard Page.**

   ![Click to navigate to the Dashboard Page.](image)

2. **Click the name of the dashboard that you want to edit.**

3. **Click Gear in the dashboard.**

   In the dashboard's Edit fly-out, make your changes.

   - **Change the dashboard name**

4. **When you are done, close the fly-out panel.**

   Your changes take effect when you close the fly-out.

### Deleting a Dashboard

If you are an administrator or the dashboard owner, you can delete a custom dashboard. You cannot delete executive dashboards.

To delete a custom dashboard:

1. **Navigate to the Dashboard Page.**

   ![Click to navigate to the Dashboard Page.](image)

   This page lists all dashboards that are available to you.

2. **Delete one or more dashboards.**

   In the list, choose the checkbox for each dashboard you want to delete and click **Trash can.**
Creating and Editing Chart Widgets

Turbonomic displays information about your environment in various chart widgets. To focus on the information you need, you can add new chart widgets to scoped views and custom dashboards, and you can edit existing chart widgets. You can also change the display order of chart widgets in dashboards.

When you create or edit a chart widget, you can choose a variety of settings. For example, in the Top 5 Utilized chart widget, if you choose Clusters as the Entity Type, you can then choose Utilization as the Data Type and Storage Provisioned as the Commodity.

Creating a Chart Widget

To create a new chart widget:

1. **Click Add Widget or Add Chart.**

   ![Add Chart](image)

   On a custom dashboard, click **Add Widget** at the top-right corner. In a scoped view, each chart has **Add Chart** above or below it. Click the button to open the Widget Gallery.

2. **Choose a chart widget in the Widget Gallery.**

   The Widget Gallery is a list of thumbnail previews of chart widgets. You can scroll through the gallery or search it. For example, if you type “Health” in the **Search** field, the results are two chart widgets, Health and Workload Health. You can choose chart widgets from these categories:
   - Actions and Impact
   - Status and Details
   - Cloud
   - On-Prem

   To see the possible displays of a specific chart widget, use the horizontal scroll bar at the bottom of the thumbnail to scroll through the display choices.
   
   To choose a chart widget to add it to your custom dashboard, click the thumbnail preview. The Widget Preview window with the Edit fly-out opens.
3. **Configure the settings for your chart widget.**

Chart widget settings determine the data that the chart widget will show.

In the Edit fly-out, choose the settings and click **Update Preview** to display the result in the Widget Preview pane. When you are satisfied with your settings, click **Save**. The chart widget is added to your custom dashboard.

For information about settings, see [Chart Widget Settings](#) on page 149.

For example:

![Select the settings in the Edit fly-out](image)

To delete a chart widget from your custom dashboard, choose **Delete** in the More options menu at the top-right corner of the chart widget.

**Methods to Access Chart Widget Settings**

Two methods exist for accessing the chart widget settings in the Edit fly-out:

- You can access the settings in the Edit fly-out when you add a chart widget to your dashboard after you click a thumbnail preview.
- For an existing chart widget in a dashboard, you can choose **Edit** in the More options menu at the top-right corner.
Chart Widget Settings

Chart widget settings vary according to the type of chart widget. Also, depending on the value that you choose for a setting, additional settings may appear. The following is a list of frequently-used chart widget settings:

- **Scope**
  The set of entities in your environment that this chart widget represents. By default, the chart widget scope is set to **Global Environment**.
  For every type of chart widget, you have the option to set the chart's scope. To do so:

1. **Click Click to change scope to open the Entity Picker.**
2. In the Entity Picker, choose the entity or group that you want. The entity or group is added to the Scope field.

- **Timeframe**
  The timeframe for historical data or projections in the chart. Choices for the chart's timeframe are: Default, Last 2 Hours, Last 24 Hours, Last 7 Days, Last 30 Days, and Last Year.
  If you set the timeframe to Default, the dashboard Time Slider controls the timeframe setting. For example, if your dashboard Time Slider is set to one month (1M), then all chart widgets with the Default timeframe in that dashboard are set to one month and show information for one month. Note that the dashboard Time Slider does not override the other specific timeframe settings.

- **Chart Type**
  The chart widget's display type. Most chart widgets can display horizontal bar or ring charts. Other display choices can include tabular data, band chart, stacked bar, line, or area charts.

- **Entity Type**
  The type of entities or their data that you want to display in this chart widget. Choices vary (for example, Applications, Hosts, Virtual Data Centers, Storage Devices, and so on).

- **Commodity**
  The resources that you want this chart widget to monitor. Some charts can monitor multiple commodities. Choices vary (for example, CPU, Memory, Virtual Storage, and so on).
Chart Types

Turbonomic provides many different types of charts in the Widget Gallery. To design custom dashboards, you should be familiar with the data each chart presents. These charts provide information on actions, impact, status of your environment, and details about specific entities, cloud, and on-prem environments.

- Actions and Impact Chart Types on page 152
- Actions Charts on page 152
- Pending Actions Charts on page 154
- Risks Avoided Charts on page 157
- Improvement Statistics Charts on page 157
- Optimized Improvements Charts on page 158
- Cloud Cost Comparison Charts on page 159
- Potential Savings or Investment Charts on page 160
- Status and Details Chart Types on page 160
- Health Charts on page 161
- Basic Info Charts on page 161
- Capacity and Usage Charts on page 162
- Multiple Resources Charts on page 162
- Resources Charts on page 163
- Top 5 Utilized Charts on page 165
- Workload Health Charts on page 166
- Environment Charts on page 167
- Workload Improvements Charts on page 167
- Cloud Chart Types on page 168
- Billing Breakdown Charts on page 168
- Estimated Cost Breakdown Charts on page 168
- Compute Cost Breakdown Charts on page 169
- Expenses Charts on page 170
- Template Breakdown Charts on page 174
- Location Charts on page 174
- Cost Breakdown By Tag Charts on page 174
- Cost Saved By Actions Charts on page 175
- RI Inventory Charts on page 175
- Recommended RI Purchases Charts on page 176
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- Cloud Estimated Cost Charts on page 178
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- Density Charts on page 178
- Ports Charts on page 179
- Headroom Charts on page 179
- Exhaustion Time Charts on page 180
Actions and Impact Chart Types

These chart widgets provide information on actions, pending actions, risks that you avoided, improvements, resource comparison, and potential savings or investments.

Actions Charts

Actions charts keep a running history of the actions that Turbonomic has recommended, which actions you have ignored, which ones you have executed manually, and which ones Turbonomic executed.

These charts use historical data from the Turbonomic database. You can set the chart to show hourly, daily, weekly, or monthly data points.

Filter

You can filter the chart to show all actions or all accepted actions (actions that have been executed).

Chart Type

You can set the display to:

- Stacked Bar Chart
- Tabular
- Area Chart
- Text

Examples:

- Stacked Bar

To see the full list, along with action details and controls to execute actions, click Show All at the bottom of the chart.
**Executing and Viewing All Actions**

At the bottom of action charts, for tabular and text chart types, click **Show All Actions** to see a full listing of the actions that are in the scope of the chart.

To execute an action, select it and click **APPLY SELECTED**. You can execute more than one action at a time.

Use **Search** to filter the list by string match. You can also filter the list by action type, action mode (manual or automatable), or action category.

You can expand each list entry to see details about the recommended action.
Pending Actions Charts

Pending Actions charts show the actions that Turbonomic recommends to improve the current state of your environment. This chart gives an overview that includes how many actions are pending, and the estimated savings or costs associated with those actions.

**Chart Type**

You can set the display to:

- **Text**
- **Ring Chart**
- **Horizontal Bar**
- **List**

Examples:

- **Text**
  The counts of Start/Buy actions, Placement actions, Delete actions, and Scaling (resizing) actions for the current scope. If the chart's scope includes public cloud entities, then the chart also shows estimated savings and costs associated with the actions.
• **Ring Chart**  
The counts of different actions for the current scope. The ring chart gives a quick visual indication of the kinds of actions that are pending.

![pending actions ring chart]

• **Horizontal Bar**  
The counts of Start/Buy actions, Placement actions, Delete actions, and Scaling (resizing) actions for the current scope. The horizontal bar gives a quick visual indication of the kinds of actions that are pending.

![pending actions horizontal bar]
Dashboards: Focused Views

- **List**
  An abbreviated listing of the actions for the chart’s scope. To see the full list, along with action details and controls to execute actions, click **Show All** at the bottom of the chart.

![Pending Actions](image)

**Executing and Viewing All Actions**

At the bottom of action charts, for tabular and text chart types, click **Show All Actions** to see a full listing of the actions that are in the scope of the chart.

![1673 Pending Actions](image)

To execute an action, select it and click **APPLY SELECTED**. You can execute more than one action at a time. Use **Search** to filter the list by string match. You can also filter the list by action type, action mode (manual or automatable), or action category.

You can expand each list entry to see details about the recommended action.
Risks Avoided Charts

As you execute the actions Turbonomic has recommended, you improve your environment's health and avoid risks to performance or budget. These charts show how many risks you have avoided over time. For example, the charts can show how many over-provisioning and congestion risks you avoided.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Improvement Statistics Charts

Turbonomic automatically executes or recommends actions, depending on the automation policies that you set up. For the recommended actions, you can use Improvement Statistics charts to show how utilization of resources would change assuming you accept all of the pending actions.

Commodity

Depending on the entity type, you can add a different resource commodity that you want to measure. For example:

- Application Resources
- Consumed Application Resources
- Historical Performance
- Workload Density
- Compute Resources
- Provided Compute Resources
- Consumed Compute Resources
- Storage Resources
- Network Resources

Entity Type

Entity types you can choose include:

- Applications
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- Load Balancer
- Networks
- Hosts
- Storage Devices
- Virtual Applications
- Virtual Data Centers
- Virtual Machines
**Chart Type**

The chart shows information as Text. It lists the given resources, comparing current utilization with the expected utilization after you execute all pending actions.

**Optimized Improvements Charts**

Turbonomic automatically executes or recommends actions, depending on the policies that you set up. For the recommended actions, you can use Optimized Improvements charts to show how utilization of resources would change assuming you accept all of the pending actions.

**Entity Type**

Entity types you can choose include:

- Applications
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- Load Balancer
- Networks
- Hosts
- Storage Devices
- Virtual Applications
- Virtual Data Centers
- Virtual Machines

**Commodity**

Depending on the entity type, you can add different resource commodities that you want to measure. For example, for a chart of Hosts, you can measure commodities such as CPU, Memory, and even network flow between VMs that are on the same host (In-Provider flow) or on other hosts (In-DPOD or Cross-DPOD flow).

**Display**

The chart shows two bar charts for the entities that are in scope – One chart for current consumption, and the other for the consumption you would expect to see if you accept all the pending actions.
Cloud Cost Comparison Charts

Cloud Cost Comparison charts show current resource utilization before and after pending actions are executed. If you execute pending actions for an entity, then the entity will be in the After Actions state.

Entity Type

Entity types you can choose include:
- Databases
- Database Servers
- Storage Devices
- Virtual Machines

Chart Type

You can set the display to:
- Line Chart
- Tabular
- Text

Example: A tabular Cloud Cost Comparison chart with a scope of all cloud VMs. The After Actions column indicates the After Actions state the cloud VMs are in after you execute all pending actions.
Potential Savings or Investment Charts

Potential Savings or Investment charts help you examine potential savings or necessary investments. These charts show the potential savings or necessary investments, assuming you execute all pending actions that Turbonomic identifies as the result of its analysis.

For example, if there is a pending action to suspend a host, the Potential Savings chart shows a savings. For cloud and hybrid environments, you might be able to move workloads off of providers and decommission hosts or datastores. The Potential Savings chart shows the reduced cost that would result from those actions.

In cases where it is possible that some workloads are at performance risk, Turbonomic might decide on actions to provision more host or storage resources. The Necessary Investments chart shows how these actions translate to an increase in expenditure.

Type

You can choose potential savings or necessary investments.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Status and Details Chart Types

These chart widgets provide information on the status of your environment and details about specific entities.
Health Charts

Health charts show the current status of your environment, by entity type. For example, you can choose to show the health of all hosts in your environment, or the health of all the workloads running on a public cloud region.

**Entity Type**

Entity types you can choose include:

- Applications
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- Load Balancer
- Networks
- Hosts
- Storage Devices
- Virtual Applications
- Virtual Data Centers
- Virtual Machines

**Chart Type**

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

**Basic Info Charts**

The Basic Info charts provide an information overview of the single entity that you chose for the Chart Widget Scope value.

**Type**

You can choose:

- Entity Information.
  
  This lists a description of the entity (the ID, Name, State, Severity, Target Name, and so on).
- Related Group Information
  
  This lists all of the groups in which the entity participates.
- Related Tag Information
  
  This lists any available tag information for the entity. For example, in a cloud environment, if a virtual machine has tags applied to it, the chart shows those tags for the virtual machine.
Display

The chart shows the information as a Tabular chart.

Capacity and Usage Charts

These charts list the resources you want to view, showing their allocated capacity, and the amount of their allocated capacity that is in use.

Entity Type

Entity types you can choose include:

- Applications
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- Load Balancer
- Networks
- Hosts
- Storage Devices
- Virtual Applications
- Virtual Data Centers
- Virtual Machines

Commodity

Depending on the entity type, you can add different resource commodities that you want to measure. For example, for a chart of Hosts, you can measure commodities such as CPU, Memory, ready queue, and even network flow between VMs that are on the same host (In-Provider flow) or on other hosts (In-DPOD or Cross-DPOD flow).

Display

The chart shows the information as a Tabular chart.

Multiple Resources Charts

Multiple Resources charts show the historical utilization of commodities for an entity or a group of entities.

Entity Type

Entity types you can choose include:

- Applications
- Data Centers
- Databases
- Database Servers
• Disk Arrays
• Load Balancer
• Networks
• Hosts
• Storage Devices
• Virtual Applications
• Virtual Data Centers
• Virtual Machines

Commodity
Depending on the entity type, you can add different resource commodities that you want to measure. For example, for a chart of Hosts, you can measure commodities such as CPU, Memory, ready queue, and even network flow between VMs that are on the same host (In-Provider flow) or on other hosts (In-DPOD or Cross-DPOD flow).

Show Peaks
Choose the Show Peaks checkbox to include peak information in the chart.

Display
The chart shows the historical utilization and, if chosen, the peak information as a Line chart.

Resources Charts
Resources charts show the utilization of a resource over time, for the entities in the chart's scope. The plot shows Average Used, Peaks and Lows, and the Average Capacity. The chart title shows the resource that you are plotting, as well as the chart's current scope (if other than default scope).

To see finer details about your environment, you can set up charts that show utilization of specific commodities. For example, you can set up a dashboard with a number of Resources charts with their scopes set to the same cluster. Such a dashboard gives you a detailed look at the health of that cluster. Or you could make a dashboard with each chart scoped to a different cluster, but have all the charts show the same resource utilization.

Commodity
You can set a Resources chart to one of the following resources:

• Operational Cost
  For workloads on the cloud, the cloud providers' costs for VM compute, storage, OS license, and static IP.
• CPU
  Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions.
• IO Throughput
  Data rate through the host's IO adapter, measured in KBytes/sec.
• Memory
  Host memory, measured in Kbytes.
• Net Throughput
  Data rate through the host’s Network adapter, measured in Kbytes/sec.
• Clusters
• Number of Containers
• Containers Per Host
  The average number of containers per host, considering all hosts in the chart’s scope.
• Containers Per Storage
  The average number of containers per storage device, considering all storage in the chart’s scope.
• numDBSs
• Accounts
  The current usage accounts.
• numDBIs
• numDB
• Host
• Storage Devices
• numVDCs
• Virtual Machine
• Virtual Machines Per Host
  The average number of VMs per host, considering all hosts in the chart's scope.
• Virtual Machines Per Storage
  The average number of VMs per storage device, considering all storage in the chart's scope.
• Risk Index
  A measure of the impact on Quality of Service (QoS) that a consumer will experience. The higher the Risk Index on a provider, the more risk to QoS for any consumer of that provider’s services.
• Storage Access
  Storage access operations per second.
• Storage Amount
  Datastore capacity, measured in Kbytes.
• Storage Provisioned
  How much the given storage is over-subscribed. Storage Provisioned capacity is the storage capacity multiplied by the Storage Overprovisioned Percentage (200 by default). The higher this value, the greater the risk that storage is over-committed.
• Virtual CPU
  The CPU capacity allocated to a VM guest OS, measured in MHz.
• Virtual Memory
  The memory allocated to a VM guest OS, measured in Kbytes.

  Note that percentages of allocated VMem are measured against whichever is the less of: The VMem limit (if set) or the allocated VMem capacity. This is also true in reports and recommended actions. For example, assume a VM with allocated VMem of 8 GB, but a limit of 4 GB. In this case, the percentage in a chart shows the percentage utilized of 4GB.
• Virtual Storage
  Virtual storage allocated to a VM, measured in Kbytes.
**Chart Type**

You can set the following types of display:

- **Line Chart**
  A line plot showing resource utilization over time. The vertical green bar shows the current moment – Plots that extend to the right project utilization into the future.

- **Band Chart**
  Lines plot average capacity and average used. The chart shows a band where its thickness indicates peaks and lows.

**Top 5 Utilized Charts**

Top 5 Utilized charts show the five entities or groups with the most utilization.

**Entity Type**

Entity types you can choose include:

- Accounts (public cloud)
- Applications
- Clusters (of hosts)
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- Load Balancer
- Networks
- Hosts
- Resource Groups
- Storage Devices
- Virtual Applications
- Virtual Data Centers
- Virtual Machines
- Volumes
- Wasted Files

**Commodity**

Depending on the entity type, you can add one or more different resource commodities that you want to measure.

**Display**

The chart lists the top entities by consumption of the commodities that you have set. Depending on the entity type and scope, you can sort the information. To view the utilization details, hover over the entity to display the tooltip. To drill down to an entity, click the entity name in the chart widget. This sets the scope to that entity.

Example: A top five clusters chart widget which can be sorted by headroom or exhaustion.
Workload Health Charts

Workload Health charts show the health of workloads from the compliance, efficiency improvement, and performance assurance perspectives. These charts use current (real-time) data for the workloads chosen for the chart widget scope.

**Chart Type**

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

**Breakdown By**

You can choose:

- **Compliance**
  This indicates whether workloads are not violating a placement policy (“In Compliance”). Workloads that are not in compliance might be running on a host or placed on storage, for example, in violation of a placement policy.

- **Efficiency Improvement**
  This lists whether workloads are running on under-utilized hosts or whether the workload is not being utilized. The listed efficiency improvements indicate actions that you should consider to save money.

- **Performance Assurance**
  This indicates whether workloads are performing well or not. For example, if the utilization is poor, the chart indicates actions that you should consider to improve performance. For example, you might consider whether to resize the workload or move it to a host with more resources.
Workload Health charts indicate actions that you should consider to improve the health of workloads. To see a list of actions, click **Show Actions** at the bottom of the chart.

**Environment Charts**

Environment charts provide an overview of your environment. They show the targets that you are managing and count the entities that Turbonomic has discovered through those targets. For example, you can display the cloud service providers, hypervisors, and the number of workloads.

**Environment Type**

You can choose one of the following views:
- Hybrid (both on-prem and cloud)
- Cloud
- On-Prem

**Display**

The chart shows the information as a Text chart type.

**Workload Improvements Charts**

Workload Improvements charts track the health of workloads in your environment over time, and map the health to the number of actions Turbonomic has executed in that time period.

In the chart, you can see the significance and value of executed actions:
- Workloads Overall
  - This is the total number of workloads over time.
- Workloads with Performance Risks
  - These are the workloads that are not performing well.
- Inefficient Workloads
  - These are the workloads that are running on under-utilized hosts or are not being utilized.
- Workloads Out of Compliance
  - These are the workloads that are violating a placement policy. Workloads that are not in compliance might running on a host or placed on storage, for example, that violate a placement policy.
- Executed actions
  - Actions that Turbonomic executed.

The vertical line shows when the last data point was polled in your environment.

**Display**

The chart shows the information as a Line chart.
Dashboards: Focused Views

Cloud Chart Types

These chart widgets provide information on the status of your cloud environment.

For many cloud chart widgets that display costs and savings, Turbonomic uses the billing reports from your cloud service providers to build a picture of your overall costs. The data includes all costs that the service provider includes in the billing report. Turbonomic parses these reports into the formats that it uses for the cloud chart widgets.

NOTE: In order for Turbonomic to access AWS monthly reports, you must have created a Cost and Usage report in your AWS account and you must store it in an S3 bucket.

For more information, see Displaying AWS Spend In Turbonomic.

Billing Breakdown Charts

Billing Breakdown charts enable you track your expenditure on cloud services, so you can track overall cost, cost by region, or cost by cloud accounts. Turbonomic discovers pricing for cloud services through the cloud accounts that you configured as targets. Turbonomic uses the billing reports from your cloud service providers to build a picture of your overall costs. The data includes all costs that the service provider includes in the billing report.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Estimated Cost Breakdown Charts

To keep track of your costs on the public cloud, you can see costs for database, database servers, storage devices, and virtual machines. In this way, you can go to your custom dashboard or any view that includes this chart to quickly see how your cloud costs develop over time.

The Estimated Cost Breakdown charts show:

- Compute cost: The cost of resources that are allocated to a workload template.
- Storage: The cost for the utilization of storage on different storage tiers. For storage devices, you can also show the cost of utilization by unattached tiers.
- License: The cost of the operating system (OS) if the virtual machine is not on an open source operating system. It can also be the cost of an application license.
- IP: The cost of a static IP address for the virtual machine, if you have contracted to use a static IP address.
- RI Compute: The cost of Reserved Instances.
- Spot Compute: The cost of running spot instances.
- Other: A combination of other costs like network costs, for example.
**Entity Type**

Entity types you can choose include:

- Databases
- Database Servers
- Storage Devices
- Virtual Machines
- Workloads

**Chart Type**

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Example: Cost Breakdown for Virtual Machines

![Cost Breakdown](chart.png)

**Compute Cost Breakdown Charts**

Compute Cost Breakdown charts help you keep track of compute costs for your cloud virtual machines. Compute cost is the cost of resources that are allocated to a workload template. Over time, the Compute Cost Breakdown charts show the compute costs per hour for On-Demand, RI Usage, and Bidding.

**Chart Type**

You can set the display to:

- Area Chart
- Line Chart
- Stacked Bar Chart

Example:
Expenses Charts

To help you manage costs for your public cloud environment, Turbonomic tracks compute, storage, license, and IP costs for the workloads in your environment. Are you spending too much on your cloud resources? Do you have room in your budget to run more workloads on a cloud account? Use Expenses charts to see how your expenses evolve and to keep track of these costs over time.

Tracking Cloud Cost

Turbonomic tracks your cloud spending in two ways:

- **Cost for Services**
  Turbonomic uses the billing reports from your cloud service providers, as they are associated with your cloud targets. Turbonomic parses these reports to get cost breakdowns by service, service provider, and cloud account.

- **Workload Expenses**
  Turbonomic tracks the following expenses for your workloads:
  - **Compute expenses**
    Are derived from the hourly charge of a virtual machine, specific to the template size (instance type or VM size).
  - **Storage expenses**
    Are derived from the disks that are attached to the virtual machine, specific to the storage tier.
  - **License expenses**
    Are derived from the CSP compute charges. A CSP compute charge is the difference between a basic Linux template and the charges for the same template when running with a commercially licensed operating system. There are no license charges for AWS Linux or the equivalent operating system on Azure.
  - **IP expenses**
    Are derived from static IP addresses for the virtual machine, if you have contracted to use static IP addresses.

Turbonomic uses this cost information when making VM resize and placement decisions, both in real time and in plans. You can see this information in Expenses charts and in the results of Migrate to Cloud plans.
**Commodity**

To keep track of your spending on the public cloud, you can see costs by cloud service, cloud account, cloud provider, and budget group. In this way, you can go to your custom dashboard or any view that includes this chart to quickly see how your cloud costs develop over time.

You can choose:
- Expenses
- Average Expenses
- Cost Breakdown by Cloud Service Provider
- Cost Breakdown by Cloud Account
- Cost Breakdown by Cloud Budget
- Cost Breakdown by Cloud Service
- Cost Breakdown by Component

**Chart Type**

You can set the display to:
- Line Chart
- Stacked Bar Chart
- Area Chart

Examples:
- Expenses
  See your hourly expenses over time, as well as overall monthly and yearly costs.
- Cost Breakdown by Cloud Service Provider
  Costs over time for each cloud service provider that you use in your cloud environment. For example, you can compare the costs you incur on AWS to costs on Azure.
  For example:

![Cost breakdown by Cloud Service Provider](image)

You can open more than one account from a single service provider. If you are running workloads on different service providers, then this chart shows the distribution of costs across them.
- Cost Breakdown by Cloud Account
  Costs over time for each account that you have set up as a target in Turbonomic.
Each public cloud target that you configure for Turbonomic represents a public cloud account. If you have targeted numerous accounts, then this chart gives you a quick read out of your costs per each one. You can see whether one account shows unusually high cost, or perhaps an account is hardly used at all and you can consider closing it down.

- **Cost Breakdown by Cloud Budget**
  Cloud Budget Group

The chart tracks overall workload compute expenses over time. The chart time scale matches the time scale you set for the overall view (for the Overview, Cloud, or Details view). It includes a vertical line to show when the last data point that was polled from your environment. Data points to the right of the vertical line are projections into the future.

The line chart shows expenses figured as overall cost per hour. The red horizontal line shows your budget. If your costs are within budget, then they fall below the budget line. To see specific values, hover on a data point. The chart displays a tooltip within the date for the data point and the given values.

- **Cost Breakdown by Cloud Service**
  This chart shows cloud cost over time by cloud services. For example, you can see the breakdown of cloud cost by cloud services.
To evaluate your use of different services, you can follow your expenditure for each one. For example, if you purchase Amazon Cloudwatch, you can see that cost over time. Note that for AWS clouds the service names begin with “Amazon” or “AWS”. Other services show the names as they are presented in the service provider's billing report.

- Cost Breakdown by Component
  This chart shows costs over time for each component of your cloud utilization. You can see costs for:
  - Compute
  - IP (static IPs for workloads)
  - License (OS license)
  - Storage
  - Capacity

**Reading a Cost Breakdown Chart**

The chart tracks overall cost over time. The chart time scale matches the time scale you set for the overall view (for the Overview, Cloud, or Details view). It includes a vertical line to show when the last data point that was polled from your environment. Data points to the right of the vertical line are projections into the future.

**NOTE:** This cost information comes from billing reports. As you change the time scale, Turbonomic divides the reported information into the appropriate time units to match that scale. However, the source remains the same.

- Changing the scale does not affect the source data, or increase data polling.

The line chart shows expenses figured as overall cost per hour. The chart displays a tooltip with the date for the data point and the given values.
Template Breakdown Charts

Template Breakdown charts show the cloud templates that Turbonomic discovers for the chart widget scope. For example, if the Chart Widget Scope is set to All Cloud VMs and the Entity Type is set to Virtual Machine, the chart shows templates that the workloads use.

Entity Type

You can choose any entity type in the list.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Location Charts

Location charts show the regions in a world map. You can also click on any region to examine more detailed information in a scoped view.

Display

The chart shows the regions in countries in a Map chart.

Cost Breakdown By Tag Charts

Cost Breakdown By Tag charts show the costs for tagged cloud entities that Turbonomic discovered and commodities.
**Custom X-axis**

You can also define an X-axis using one of two commodities, Cost Breakdown by Zone or Cost Breakdown by Region, and choose one or more values for the commodity.

**Chart Type**

You can set the display to:

- Area Chart
- Stacked Bar Chart

Example: The Tag setting key is workload-type and the values are other and production.

![Cost Breakdown by Tag - workload-type](image)

**Cost Saved By Actions Charts**

Cost Saved By Actions charts show what your costs would be if you had not taken any actions (missed opportunities), compared with the cost savings you have gained by taking Turbonomic actions.

**Chart Type**

You can set the display to:

- Area Chart
- Text

**RI Inventory Charts**

RI Inventory charts show the Reserved Instance workloads that Turbonomic discovers, and lists them by the templates they use.

Click **Show all** to see the RI information for each template. The information includes the template name, count, platform, type, term, payment, location, Account ID, effective cost, utilization, savings, and expiration date. When you choose one or more checkboxes, the total appears at the top.
**Chart Type**

You can set the display to:
- Text
- Ring Chart
- Horizontal Bar

**Recommended RI Purchases Charts**

Recommended RI Purchases charts show the projected inventory of pending Reserved Instance purchases as generated by Turbonomic. The charts show the Reserved Instance workloads that Turbonomic discovers, and lists them by the available templates.

Click **Show all** to see the RI information for each template. The information includes the template name, count, platform, type, term, payment, location, Account ID, up-front cost, net savings, and break-even period. When you choose one or more checkboxes, the total count, cost, and savings of the chosen recommendations appear at the top.

**Chart Type**

You can set the display to:
- Text
- Ring Chart
- Horizontal Bar

Examples:
- Horizontal Bar
• Viewing the **Show all** list

**RI Coverage Charts**

RI Coverage charts compare the capacity of your current VM workload to the capacity of workload that is covered by Reserved Instances.

The charts also display the desired RI coverage if you configured the Coverage setting. By default, Turbonomic assumes 100% for RI coverage. For information about the Coverage setting, see **RI Purchase Profile** on page 200.

To see specific values, hover on a data point in the chart. A tooltip appears with a date for the data point and the normalization factor units (NFUs) for the workloads and the Reserved Instances.

Note that if you have a high percentage of on-demand workload, then you should be able to reduce your monthly costs by increasing RI coverage. To increase coverage, you resize workloads to instance types that have existing RI capacity. If you need more RI capacity, then Turbonomic will recommend the RI templates that you should buy.

**Chart Type**

You can set the display to:

• Area Chart
• Line Chart

**RI Utilization Charts**

RI Utilization charts shows how well you have utilized the reservation inventory. The chart compares the capacity for all reservations versus the RI consumption by virtual machines. The points that extend to the right of the vertical bar project utilization into the future. The chart measures utilization in normalization factor units (NFUs).

The desired goal is to use more or all of your purchased Reserved Instances which is indicated by the area to the right of the vertical bar.

**Chart Type**

You can set the display to:

• Area Chart
• Line Chart
Cloud Estimated Cost Charts

Cloud Estimated Cost charts show estimated monthly costs and investments for the cloud. Monthly cost amounts are summarized as amounts with and without actions.

Display

The chart shows the information as a Text chart.

On-Prem Chart Types

These chart widgets provide information on the status of your on-prem environment.

Density Charts

Density charts show the number of workloads per host or storage. Also, they show the desired count of workloads, assuming you want to fill the headroom completely. Note that the Desired Workloads values are the results of running plans. These plans can calculate workload moves within a cluster to gain more efficiency, but they always respect the cluster boundaries – the plans never move VMs to hosts on different clusters.

You can specify the following types of Density charts:

- Virtual Machines vs Hosts
- Virtual Machines vs Storage
- Containers vs Hosts
- Containers vs Storage
- Virtual Machines vs Hosts and Storage
- Containers vs Hosts and Storage
- Headroom – The total number of workloads running in the chart’s scope, plus the total headroom for that scope
- Host and Storage Units – The numbers of active Hosts and Storage devices
Choose the Show Density checkbox to see the ratio of consumers to providers.

**Chart Type**

You can set the display to:
- Stacked Bar Chart
- Line Chart

**Ports Charts**

Ports charts show the most utilized northbound or southbound ports in your on-prem environment over a given time period. These charts are useful in Fabric environments where you license port channels.

**Display**

The chart shows the information as a Tabular chart.

**Headroom Charts**

Headroom charts show the available headroom in your on-prem environment.

You can specify the following types of Headroom charts:
- CPU Headroom
- Memory Headroom
- Storage Headroom

**Commodity**

You can choose:
- CPU Headroom
- Memory Headroom
- Storage Headroom

**Display**

The chart shows the information as an Area chart.
Example:

**Exhaustion Time Charts**

Exhaustion Time charts show your current growth and project into the future when your workloads will exceed the capacity of your current infrastructure. This is useful for future planning (for example, if you might need to buy more hardware).

You can track CPU, memory, and storage as well as the average monthly Virtual Machine growth and the average VM template. The amount of time is presented as days. For example, storage will be used up in 41 days.

**Display**

The chart shows the information as a Text chart.
Reports: Viewing Historical Data

The Turbonomic database stores a history of your managed environment. Turbonomic ships with a list of standard reports that give you selective snapshots of this history. The Reports Page gives you access to these reports – On this page you can:

- View reports – Generate up-to-the-minute reports or view saved reports (see Viewing Reports on page 182)
- Schedule reports to be generated at regular intervals (see Scheduling Reports on page 184)
Storage of Generated Reports

Whenever you generate a report, Turbonomic saves the report file on the server. When setting up subscriptions, be sure to choose reports that are useful for your organization. For example, assume you set up a daily subscription to a *Monthly Overview with Cluster Summary* report. It’s likely that you could make do with a monthly subscription to such a report. Generating these reports daily can needlessly consume storage on the Turbonomic server.

You can set up subscriptions in a way that minimizes storage consumption. For example, if you make a weekly subscription to a report on Mondays, and then subscribe to the same report on Fridays, Turbonomic will save two copies of that report every week. Instead, make two subscriptions to the report on the same day, to save only one copy of the report each week.

Viewing Reports

To view a report, first select the type of report you want from the list. If the report has been scheduled, Turbonomic generates copies at regular intervals. You can view a copy of a scheduled report, or you can view an up-to-the-minute report — a report based on the current state of your environment.

To view a report, first select the type of report you want from the list. If the report has been scheduled, Turbonomic generates copies at regular intervals. You can view a copy of a scheduled report, or you can view an up-to-the-minute report — a report based on the current state of your environment.

Viewing an Up-To-The-Minute Report

To view a current report, you can:

- Create a new report and generate a copy
- Select a report in the list, and generate a copy

To create a new report and generate, click **NEW REPORT** in the Reports Page, and choose the type of report you want. Then make the settings you want:

- Format – Choose PDF or XLS.
- Schedule – You can leave this report unscheduled.
- Recipients – If you want to email the report, specify the addresses of the recipients.
When you're done, click **GENERATE** – Turbonomic generates the file and either sends it to your browser or sends it to the email addresses you specified.

To generate an up-to-the-minute copy from the list of scheduled reports, select the item in the list and click **GENERATE**. Turbonomic uses the current settings for this report to generate the file, and either sends it to your browser or sends it to the email addresses you have specified in the report's settings.

### Viewing Saved Reports

Whenever it generates a report, Turbonomic saves the report on the server. For a scheduled report that is in the list on the Reports Page, you can go back to these saved reports and view them.
To view a saved report:

1. **On the Reports Page, click the name of the report you want to view.**
   This opens the **CONFIGURATION** flyout page.
2. **Display the GENERATED REPORTS tab on the flyout.**
3. **Set a date range.**
   Turbonomic lists and copies of this report that were generated within that date range.
4. **Click a list entry to see the report.**

### Scheduling Reports

When you schedule a report, Turbonomic generates a copy of it at the times you specify. To set up a subscription, you can provide email addresses of the recipients and Turbonomic will mail the report at the specified intervals.

The Reports Page gives you access to the reports that are available on your instance of Turbonomic. Use this page to:

- Choose the reports you want to see
  Turbonomic ships with a full compliment of reports. To manage reports, you set up a list of the reports you want.
- Generate up-to-the-minute reports, on demand
- Schedule reports to be generated at regular intervals
To set up a subscription:

1. Navigate to the Reports Page.

Click to navigate to the Reports Page.

This page lists all the reports that you currently have set up and scheduled. You can select one or more of the listed reports and:

• Generate the selected report to see the latest data
  When you generate a report, you can choose to email it to its subscribers, or you can download the report to your browser.
• Clone the selected reports to add new items to the list
  After you clone a report, click the new report's name to change the report's configuration.
• Delete selected reports to remove them from the list
  This removes the report from the list, and cancels any schedules. However, this does not delete any report files that were already generated and saved on the Turbonomic server.

To edit a report’s configuration, click the entry in the list. This opens the Report CONFIGURATION fly-out where you can make your changes. Be sure to save your changes when you’re done.
2. Configure a report and add it to the list.

To start configuring a report, click NEW REPORT. The next step is to choose the type of entities you want to report on. For example, choose Virtual Machines or Hosts. Turbonomic ships with a set of predefined reports for each entity type.

For the report type that you choose, you then set up the report configuration:

- **Schedule**
  How often Turbonomic will generate the report.

- **Scope**
  If present, you must choose a group or an entity to set the scope of the report.

- **Format**
  Specify whether to generate PDF or XSL reports.

- **Recipients**
  Specify one or more email addresses to create subscriptions. Turbonomic will email the report to the specified recipients at the scheduled intervals. You can add as many recipients as you want.

3. **When you're finished making the settings, click SAVE.**

   Turbonomic adds the report to the list on the Reports Page, and generates copies of it at the scheduled intervals.
Configuring Targets

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. When you configure a target, you specify the address of the service, and the credentials to connect as a client to it.

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.

To configure a target, you will choose the target type, specify the target's address, and then provide credentials to access the target.

After you configure a target and add it to your installation, Turbonomic validates the connection, and then discovers the entities that target manages.

NOTE: Turbonomic regularly checks that your targets are valid. If it discovers that a target is invalid it then posts that status to the user interface. Under some circumstances, the target can become valid again, but the status does not update. If you see an Invalid message for a given target, try to manually validate the target again (click VALIDATE).

Configuring a Target

1. Navigate to the Settings Page.

   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Choose Target Configuration.

   Click to navigate to the Target Configuration Page.
This page lists all the targets that you currently have configured for Turbonomic. You can inspect these targets, you can edit them (change address and credentials), and you can add a new target to Turbonomic.

3. Filter the list of targets.

To work with a long list of targets, you can filter by the target type. You can also type a string in the Search field to filter the list, and you can sort the list by target status or target name.

4. Select one or more targets to work with.
When you select a target you can:

- **Rediscover** — Direct Turbonomic to fully discover the entities that this target manages. This will rebuild the topology that is associated with this target.
- **Validate** — Direct Turbonomic to validate its connection with the target. For example, if you create a new user account on the target, you can edit the target connection to use that account, and then revalidate.
- **Delete** — When you delete a target, Turbonomic removes all the associated entities from its model of the inventory.

5. **Expand an entry to see details, or click the entry to edit the target's configuration.**

For example, if you entered the wrong username or password, you can change those credentials and validate the target again.
6. Create a new target and add it to Turbonomic.

First, select the type of target to add. Then for the type you choose, select the specific target technology. For example, select Hypervisor/vCenter to add a VMware vCenter Server target. Then provide the address and credentials for that target.

For more details, including a list of supported targets and configuration requirements, see the Turbonomic Target Configuration Guide.
As you configure AWS targets, Turbonomic discovers AWS accounts that are consolidated into billing families. A billing family has one master account, and zero or more member accounts. By recognizing billing families, Turbonomic more accurately calculates cloud investments and savings, and makes more accurate recommendations for RI coverage.

In the Targets user interface, master accounts appear in bold, with a star next to them. You can expand the account entry to see the related member accounts. If you expand the entry for a member account, then the related accounts includes the family master, indicated by a star.

For RI purchases, different accounts in a billing family can share the same RI resources. At the same time, accounts in other billing families cannot use those RIs. This adds flexibility to your RI coverage, while maintaining order over the billing.

In Turbonomic, if you enable Billing Family Recognition, then you can see the billing family master and member accounts in the Targets user interface, and Turbonomic can recommend proper RI purchases within the correct billing families.
To enable Billing Family Recognition, ensure the following as you configure your AWS targets:

- **Use the proper role for each AWS target**
  To properly discover billing family information for a target, you must give Turbonomic credentials for an AWS role that includes the permission, `organizations:DescribeOrganization`. With that permission, Turbonomic can:
  - Discover master accounts and member accounts in different billing families
  - Display the account names in the user interface
  - Discover billing information for each family and account
  - Recommend RI actions that respect billing family boundaries

- **Configure targets for the complete billing family**
  One billing family can consolidate a number of AWS accounts. For Turbonomic to include these accounts in its analysis, you must configure each one as a separate target. If you do not configure all the accounts in a billing family, then Turbonomic cannot discover complete billing information for that family, and its analysis will be based on incomplete information.

  Turbonomic displays member accounts that have been configured as targets in regular text. For members that Turbonomic discovers but have not been configured as targets, Turbonomic displays their names in grayed text.

If you have enabled Billing Family Recognition, you should keep the following points in mind:

- **Billing families can grow**
  Turbonomic regularly checks the membership of your billing families. If it discovers a new member account, it adds that account to the list of members. If you have already configured the account as a target, then Turbonomic includes the new member in its analysis of billing families. If the new member is not already a target, then Turbonomic posts a notification, and lists the new member in grayed text.

- **You can configure discounts per billing family**
  Turbonomic includes a feature to set a discount for a billing group, and to override that discount for specific template families within that scope. For more information, see [Cloud Discounts](#) on page 203 and [Discount Override: AWS](#) on page 209.

- **You might see master accounts that have no member accounts**
  AWS treats every account you create as a part of a billing family. Assume you created an account, but you had no reason to consolidate its billing with any other accounts. In that case, the account appears in the Turbonomic user interface as a master account, but it has no member accounts.
Setting Up Business Rules

Turbonomic includes a number of ways that you can guide its analysis to recommend actions that satisfy your business requirements. You can set up parameters, or business rules, that enforce placement of certain workloads on specific hardware, set limits to resource allocations, and constrain Turbonomic actions in other ways.

Note that Turbonomic works to keep your environment as efficient as possible (use as few resources as possible) while also assuring the performance of your applications. A pure environment with no constraints or placement rules would result in Turbonomic actions that only consider the optimal utilization of resources. In real-world applications it is often necessary to impose constraints.

To learn more about setting up business rules in Turbonomic, see:

- **Creating Groups** on page 193
  Creating groups is a powerful way to divide your environment into logical sets of entities. You can use these groups to set scope for views and charts. Groups are also very useful to set scope for actions and policies.

- **Budgets and Costs** on page 197
  Set up budgets and costs to bring real monetary costs into the Turbonomic calculations.

- **Creating Placement Policies** on page 213
  Use workload policies to restrict certain workloads to specific hardware. For example, always place critical applications on gold-standard hardware, or to make sure certain workloads never run on specific hardware entities.
  You can also use placement policies to remove cluster constraints. Another placement policy can identify licensed hardware, and always make sure there is room on the hardware for applications that require those licenses.

- **Automation Policies** on page 217
  Create policies that determine how Turbonomic will execute recommended actions for a given scope.

Creating Groups

Groups assemble collections of resources for Turbonomic to monitor and manage. When setting scope for your Turbonomic session, you can select groups to focus on those specific resources. For example, if you have a number of VMs devoted to a single customer, you can create a group of just those VMs. When running a planning scenario you can set the scope to work with just that group.
Turbonomic discovers groups that exist in your environment. These groups include PM clusters, and entities grouped by different logical boundaries. For example, Turbonomic discovers Storage by Disk Array, Physical Machines by Data-center, and VMs by Network. In addition, Turbonomic discovers pools such as virtual datacenters, or folders that implement specific HA policies.

You can also create custom groups. Turbonomic supports two custom-grouping methods:

- **Dynamic** — You define these groups by specific criteria. You can group services according to naming conventions (all VM names that start with `ny`), resource characteristics (all physical machines with four CPUs), or other criteria such as time zone or number of CPUs. These groups are dynamic because Turbonomic updates the group as conditions change.
- **Static** — You create these groups by selecting the specific group members.

1. Navigate to the Settings Page.
2. **Choose Groups.**

   ![Groups](Image)

   Click to navigate to the Group Management Page.

   This page lists all the custom groups that you currently have configured for Turbonomic. You can:

   - Expand an entry to see group details
   - Select an entry to delete the group
   - Click a group name to edit it
     
     For a dynamic group, you can edit the set of criteria that select the group members. For a static group, you can add or subtract specific members.
   - Create new groups

   ![Group Management](Image)
To work with a long list of groups, you can filter by group type. For example, only show groups of VMs, or groups of host machines. You can also type a string in the **Search** field to filter the list, and you can sort the list by severity (per the most critical entity in group) or group name.

3. **Expand an entry to see group details.**

   ![Click to expand/collapse details](image)

The details show you information about related entities such as how many hosts provide resources for a group of VMs. If there are any pending actions for the group, the details list those actions as well.
4. **Create a new group.**

First, select the type of entities that will be in the group. Then specify the group settings:

- Give the group a name
- Set whether the group will be static or dynamic
  
  To create a static group, select the member entities from the list. To filter the list, set group criteria or enter a string in the **Search** field.

  To create a dynamic group, set group criteria. The list updates to show the resulting group members.

- Specify group criteria

  These criteria are entity attributes that determine group membership. You might create a group of all VMs that have 4 VCPUs. You can choose properties of the member entities, and you can choose properties of entities that are related to the members. For example, you can make a group of VMs that are hosted by PMs with the substring “Development” in their names.

  As you set criteria, the list of entities updates to show the member entities.

  Note that you can use regular expression to express your match strings.

- When you’re finished, save the group

  **Save** adds this group to the **My Groups** collection.
Budgets and Costs

As you work with Turbonomic, you can set up budgets and costs that bring real monetary costs into the Turbonomic calculations. This setup includes:

- **Cloud Budgets**
  Turbonomic uses Cloud Budgets to assign your desired monthly spend for your public cloud providers. You express this in real cost.

- **Reserved Instance Costs (Purchase Profiles)**
  To recommend placing workloads on Reserved Instances (RIs), Turbonomic uses the real pricing plans that are available to the targets public cloud accounts. Setting up an RI Purchase Profile adds even more detail to the pricing structure that Turbonomic uses in its calculations.

- **Hardware Costs**
  As it generates reports and plans, Turbonomic can show estimated savings and costs for changes in the hosts and storage in your environment. To calculate these values, Turbonomic uses the prices you set up for Hardware Costs.

- **Cloud Discounts**
  Cloud service providers can offer discounts for workloads. This adds to the savings you can gain as you use the cloud. However, Turbonomic does not discover these discounts. To reflect any discounted prices in the Turbonomic display and in Turbonomic analysis, you must manually configure the discounts for your cloud environment.

## Cloud Budgets

Turbonomic uses Cloud Budgets to assign your desired monthly spend for your public cloud providers. You express this in real cost.

Turbonomic requires a cloud budget in order to calculate workload placement on the cloud. If you do not create a budget for a given cloud scope, then Turbonomic assumes an infinite budget for that scope.

Turbonomic recommends moves and other actions based on the consumption of an allocated resource. On the cloud, the resource is actual cost. Assigning a Cloud Budget is the way to allocate a specific value for this resource — how much you are willing to spend — so that Turbonomic can determine how much of that budget capacity is currently in use.

To create a budget, choose the public cloud targets for that budget to manage. Then for those targets, specify the amount you want to spend per month. As it evaluates moves and other actions within a certain scope of your cloud environment, Turbonomic considers the utilization of the budget that you have assigned to that scope.

You can create multiple budgets. For example, assume you have two AWS targets and one Azure target. In that case, you could create individual budgets for each target, or create budgets that group similar targets together — say, one for the AWS targets, and another for the Azure target. Or you can create a single budget for all three targets.

If you set a budget for a cloud scope, when actual costs for that scope exceed the budget, then Turbonomic stops recommending actions for that scope. To resume action recommendations, one of the following must occur:

- Actual costs for the scope drop, and fall below the allocated Cloud Budget
- You edit the Cloud Budget to increase the allocated amount
- You delete the Cloud Budget for that cloud scope
You can set a budget to allocate unrealistically high spending capacity. Even if you set a budget very high, Turbonomic will still calculate optimal placement in plans and in real time. But if the budget is set below the current cost for the accounts, then Turbonomic will not recommend any actions for the cloud.

**NOTE:** When you run a Migrate To Cloud plan, Turbonomic uses the budget to calculate optimal placement for the migrated workflow. For best results, you should ensure that the budget is at least high enough to account for the migrated workloads.

**Creating a Cloud Budget**

A cloud budget specifies the monthly expenditure you want to devote to keeping workload on the public cloud. You can create a budget for one or more public cloud targets, depending on how you think about your cloud expenditures.

Before you can create a cloud budget, you must have at least one public cloud target set up for your Turbonomic installation.

**NOTE:** While you can create multiple budgets, a single target cannot have more than one budget assigned to it. Assume you have two targets – CloudA and CloudB. Now assume you have created a single budget to manage both targets. In that case, you cannot create a second budget to manage either target. For example, you cannot create a second budget to manage CloudA.

To create a budget:

1. **Navigate to the Settings Page.**
   
   ![Settings Page](image)
   
   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. **Choose Budget and Costs.**
   
   ![Budget and Costs](image)
   
   Click to navigate to the Budget and Costs page.
   
   The page opens showing the CLOUD BUDGET tab by default.
3. Inspect the list of cloud budgets.

   This page lists all the cloud budgets that you currently have configured for Turbonomic. You can:
   - Click an entry to see details and edit the budget
   - Select an entry to delete the budget
   - Create new cloud budgets

4. Create a new budget.
First click **CREATE BUDGET**, then specify the settings:

- Give the cloud budget a name
- Choose the cloud targets to budget
  
  You can create a budget for one or more public cloud targets. Plan your budgets carefully. You cannot add the same target to more than one budget.
- Specify a Monthly budget period
  
  Currently, Turbonomic supports monthly budgeting.
- Specify a Monthly budget period and amount
  
  Use **BUDGET AMOUNT** to specify the monthly expense limit you want to maintain for workloads managed by this budget group. For example, you might want to keep your costs within $15,000.00 a month.
- When you’re finished, click **ADD** to create the budget.

## Cloud Profile

To work with workload placement on the public cloud, Turbonomic takes advantage of Reserved Instance (RI) pricing as it chooses the appropriate templates to use. Turbonomic uses real pricing in its analysis, including the RI pricing plans, and OS license costs. Cloud profiles set up parameters that Turbonomic can use as it makes these cost-based decisions.

## RI Purchase Profile

![RI Purchase Profile](image)

To recommend placing workloads on Reserved Instances (RIs), Turbonomic uses the real pricing plans that are available to the targets public cloud accounts. Setting up an RI Purchase Profile adds even more detail to the pricing structure that Turbonomic uses in its calculations.
The RI Purchase Profile determines the costs that Turbonomic will use for all RI decisions in your environment. As it sees opportunities to move workloads to an RI term, Turbonomic determines the costs based on the purchase profile, and includes the cost information in action descriptions. Turbonomic also uses this information to calculate projected changes in cost, and to calculate costs for plan results.

You can also override the RI coverage that Turbonomic calculates for your environment. When you purchase RIs in AWS, you purchase a given footprint that AWS tracks in Normalization Factor Units (NFUs), where the value of one NFU is equivalent to one small template. Turbonomic displays RI Coverage in terms of NFUs, as the ratio of your current workload vs the workload that is running as RIs. You can let Turbonomic calculate the best coverage for your environment, or you can set the coverage that you want to aim for.

Note that the settings you make here globally affect all of your public cloud environment. You can also make different RI Purchase Profile settings for plans as a way to test those changes in your environment.

To set up the RI Purchase Profile, navigate to Settings > Budget and Costs, and display the CLOUD PROFILE tab. Then make the settings for your purchase profile:

- **TYPE**
  For AWS environments, these correspond to the RI offering class. TYPE can be one of Standard or Convertible. Choose the type that corresponds to the RI types that you typically use in your environment.

- **TERM**
  The payment terms you contract for your RIs. TERM can be one of 1 Year or 3 Year. Typically, longer term payment plans cost less per year.

- **PAYMENT**
  The payment option that you prefer for your RIs:
  - All Upfront – You make full payment at the start of the RI term.
  - Partial Upfront – You make a portion of the payment at the start of the term, with the remain cost paid at an hourly rate.
  - No Upfront – You pay for the RIs at an hourly rate, for the duration of the term.

- **COVERAGE**
  Coverage specifies the percentage of your total workload inventory that you want to be running on RI resources. By default, Turbonomic calculates the coverage that gives you the best cost, for the workloads that are good RI candidates. For more information, see Buy RI on page 23.

  You can override the calculated coverage and specify a percentage that you want. You typically specify this override to satisfy a department or enterprise policy. When you set a coverage override, Turbonomic recommends RI purchases to reach that coverage, irrespective of the RI cost advantages.

  For example, assume you set the RI coverage at 25%. If Turbonomic discovers 40% of your workload should be RI candidates, it will only recommend purchases to achieve 25% coverage. You will miss opportunities to save on cost. On the other hand, if Turbonomic discovers only 5% of your workload should be RIs, it will still recommend RI purchases to achieve 25% coverage. As a result, some purchases might never see a return on investment.

  To set a different coverage, enable Override coverage and enter the percentage you want. As Turbonomic makes resize, placement, and RI Buy decisions, it will tend toward using the RI coverage you specify.

  To return to the Turbonomic calculation of RI coverage, disable Override coverage.

When you are satisfied with your RI Purchase Profile settings, click APPLY SETTINGS. Or to reset the form, click RESET DEFAULTS.
OS Migration Profile

For Migrate to Cloud plans, Turbonomic calculates the best placement for workloads that you want to move onto the public cloud. The migration includes choosing the OS for each migrated VM. The OS Profile that you configure here configures the default for how to manage the OS choices in migration plans.

To set up the OS Profile that plans will use by default, navigate to Settings > Budget and Costs, and display the CLOUD PROFILE tab. Then make the settings for your OS profile:

- **Match source OS to target OS**
  Turbonomic will match selected OS and license with target OS and license for cost, size and reservations.

- **BYOL (“Bring your own license”)**
  Turbonomic will match the selected OS to an unlicensed, compatible target, assuming that license fees will be paid to a third party.

- **Custom OS**
  Turbonomic will use the specified Target OS and license for cost, size and reservations per source OS.

The OS migration Profile determines how Turbonomic will map the OS of each workload as it places that workload on the cloud destination. This includes how to choose VM templates that provide the OS you want, and whether to include the license cost in the Migrate to Cloud plan results. To configure an OS Migration Profile, choose from:

- **Match source OS to target OS**
  As you migrate workloads to the cloud, keep the same OS. As Turbonomic calculates placement for the migrated workloads, it will only use templates that provide the same OS that the workload already has. This is important if your workloads host applications that depend on a specific OS.

- **BYOL (Bring your own license)**
  The same as Match source OS to target OS, except the plan does not include OS licensing costs in any of the cost calculations for on-cloud placement.
Custom OS
For each of the listed OS types, map the migrated VM to the OS you choose. The OS types are:
- Linux – Any open source distribution of Linux. For the migration, Turbonomic will choose templates that provide the Linux platform that the cloud service provider delivers as a free platform. Note that this is always BYOL, because it assumes a free OS license.
- RHEL – Red Hat Enterprise Linux.
- SLES – SUSE Linux Enterprise Server.
- Windows – Microsoft Windows.
For each mapping, enable or disable BYOL (Bring Your Own License). When you enable this, Turbonomic assumes that you are paying for the OS license, and will not include the license cost in the plan results. If you do not enable BYOL, then Turbonomic gets the license cost from the service provider and includes that cost in the plan results.

When you are satisfied with your changes, click APPLY SETTINGS. Or to reset the form, click RESET DEFAULTS.

Hardware Costs
As it generates reports and plans, Turbonomic can show estimated savings and costs for changes in the hosts and storage in your environment. To calculate these values, Turbonomic uses the prices you set up for Hardware Costs.

Turbonomic uses the costs you set up here to estimate investments or savings for changes to hardware in your environment. For plans, if the plan uses templates and you have assigned prices to them, then Turbonomic uses those values. Otherwise, the plan uses the values that you set up here.

To specify Hardware Costs, navigate to Settings > Budget and Costs, and display the HARDWARE COSTs tab. Then make the settings for different hardware resources:
- HOST HARDWARE COST
  The cost for an average physical host machine in your environment.
- COST OF CPU PER UNIT
  The average cost of each CPU socket in your hosts.
- COST OF MEMORY PER GB
  The average cost of memory for your hosts, per GB.
- COST OF STORAGE PER TB
  The average cost of storage capacity for disk storage, per TB.

When you are satisfied with your changes, click APPLY SETTINGS. Or to reset the form, click RESET DEFAULTS.

Cloud Discounts
Cloud service providers can offer discounts for workloads. This adds to the savings you can gain as you use the cloud. However, Turbonomic does not discover these discounts. To reflect any discounted prices in the Turbonomic display and in Turbonomic analysis, you must manually configure the discounts for your cloud environment.

Turbonomic applies these discounts to:
- Storage cost
- Compute cost
- RI Compute cost
- License cost
- IP cost
Setting Up Business Rules

Note that in AWS environments, Turbonomic does not apply any discount to Spot Compute costs.

The general steps to configure a discount are:

- Create the discount:
  - Specify the discount scope
    To do this you choose which cloud service provider is giving you the discount, and then select one or more billing groups that you will apply the to.
  - Specify an Enterprise Discount value
    The Enterprise Discount is the overall discount that your cloud service provider offers for the billing groups in your current scope. For example, Microsoft Azure might offer you a 10% discount for a given subscription. For that billing group, you would set 10% for the Enterprise Discount.

- Specify discount overrides
  While your service provider might offer a general discount for the billing groups you chose, it might also offer further discounts for select services or template families. You configure these as discount overrides.

NOTE: Turbonomic uses the discounts that you configure to display costs in the user interface. The values for hourly cost per entity, total hourly cost, total monthly cost, or total yearly cost can show inaccuracies on the order of a fraction of a percent. This is due to rounding when calculating the discounted cost per entity.

Creating a Cloud Discount

A cloud discount configures the way Turbonomic reflects discounted workload pricing that you have negotiated with your cloud service provider. After you configure a discount, Turbonomic applies it to pricing in the affected cloud scope.

To create a discount in Turbonomic, you identify the discount's scope – the subscriptions or billing families the discount applies to – and then set the percentage for the Enterprise Discount. This specifies an overall discount for the workloads that fall within the billing groups. You can later drill into the discount to specify overrides for specific template families or services.

To create a discount:

1. Navigate to the Settings Page.

   ![Settings](image)

   Click to navigate to the Settings Page. From there, you can perform a variety of configuration tasks.

2. Choose Budget and Costs.

   ![Budget and Costs](image)

   Click to navigate to the Budget and Costs page.

   The page opens showing the CLOUD BUDGET tab by default.

3. Display the DISCOUNT tab.

   Click DISCOUNT to see all the discounts that have been configured for your environment. In this list you can:
   - Click an entry to see details and edit the discount
   - Select an entry to delete the discount
   - Create new discounts
4. Create a new discount.

First click **NEW DISCOUNT**, then specify the following settings to configure an Enterprise Discount:

- Give the discount a name.
- To set the scope for this discount, choose the Billing Groups this discount will apply to.

  Click in the **BILLING GROUPS** field to display the Billing Groups fly-out.

  In the Billing Groups fly-out, choose the cloud service provider you want to work with and then select the billing groups for the scope of this discount.
A Billing Group is a set of cloud service provider accounts that are consolidated into a single billing schedule. Billing group details depend on your service provider:

- **Azure**: For Azure environments, Turbonomic lists each Azure subscription as a billing group. You can select multiple subscriptions to set the scope of this discount.

- **AWS**: To consolidate billing, AWS supports billing families of AWS accounts, where there is a *master* account and other *member* accounts. Turbonomic lists each billing family as a billing group. You can choose a billing family to set the scope of this discount.

After you have chosen your billing groups, click **SAVE** to return to the Add New Discount fly-out.

- Specify the Enterprise Discount you want Turbonomic to apply to the scope you just set.
  
  This is the general discount for the current scope. Enter the discount percentage in **ENTERPRISE DISCOUNT**. For any costs within the discount scope, Turbonomic will apply this discount as it calculates the optimal workload capacity and placement.
5. Specify any Discount Overrides.

In the Add New Discount fly-out, click to add overrides.

The ENTERPRISE DISCOUNT you just specified applies as a default in the discount scope. However, you might have negotiated different discounts for specific services or template families in your cloud environment. To configure these special discounts, click DISCOUNT OVERRIDES to open the Cloud Cost Discount flyout. The overrides you can specify depend on the cloud service provider that manages the discount scope you have set:

- Azure: See Discount Override: Azure on page 208
- AWS: See Discount Override: AWS on page 209

6. Save your work.

After you have configured the discount, click SAVE.
### Discount Override: Azure

To override the Enterprise Discount for Azure billing groups, Turbonomic analysis can use discounts that you configure for services that Azure provides to subscriptions.

Assume you have specified a discount of 10% for an Azure subscription. But then assume the subscription includes extra discounts for some of the services the subscription provides. Then you can create overrides to add the extra discounts for those services.

In the Cloud Cost Discount fly-out, you can perform the following:

- To add an override, enter the absolute discount value for the given service. To completely remove discounts for a service, enter 0%. When you add an override to a service, its name displays in bold with an asterisk. When you're done, click **SAVE**.
- To remove all overrides and revert back to the Enterprise Discount, click **CLEAR ALL OVERRIDES**.
- To download a report of the discounts for each service, click **DOWNLOAD** and choose CSV or PDF.

The table lists the following information about your discounts:

- **SERVICES**
  - The different cloud services to which you can set an override discount. To see individual workload templates:
    - For Azure, expand **Virtual Machines**
    - For AWS, expand **AWS EC2 Compute** or **EC2 Reserved Instance**
- **ENT. DISCOUNT**
  - The Enterprise Discount that you have set for the current scope. This is the general discount that Turbonomic applies by default to the given service.

<table>
<thead>
<tr>
<th>SERVICES</th>
<th>ENT. DISCOUNT</th>
<th>DISCOUNT OVERRIDES</th>
<th>CSP COST (LINUX)</th>
<th>EFFECTIVE DISCOUNT</th>
<th>EFFECTIVE COST (LINUX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management</td>
<td>10%</td>
<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Networking</td>
<td>10%</td>
<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Storage</td>
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<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Virtual Machines*</td>
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<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>standardGFFamily*</td>
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<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Standard_G4*</td>
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<td>-</td>
<td>13%</td>
<td>-</td>
</tr>
<tr>
<td>azure-G...</td>
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<td></td>
<td>$4.928/hr</td>
<td>13%</td>
<td>$4.29/hr</td>
</tr>
<tr>
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<td>13%</td>
<td>$5.36/hr</td>
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<tr>
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<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Standard_G2*</td>
<td>10%</td>
<td></td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
</tbody>
</table>
DISCOUNT OVERRIDES
If you have entered a value, this is the discount Turbonomic applies to the given service.

CSP COST (LINUX)
The Cloud Service Provider’s cost for VM templates, per hour. To see these costs, expand the workload services to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

EFFECTIVE DISCOUNT
The actual discount for the given service. If you entered an override, it shows here.

EFFECTIVE COST (LINUX)
The discounted cost for VM templates, per hour. To see these costs, expand Virtual Machines to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

Discount Override: AWS

<table>
<thead>
<tr>
<th>SERVICES</th>
<th>ENT. DISCOUNT</th>
<th>DISCOUNT OVERRIDES</th>
<th>CSP COST (LINUX)</th>
<th>EFFECTIVE DISCOUNT</th>
<th>EFFECTIVE COST (LINUX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS CloudWatch</td>
<td>23 %</td>
<td>%</td>
<td>—</td>
<td>23 %</td>
<td>—</td>
</tr>
<tr>
<td>AWS Developer Supp...</td>
<td>23 %</td>
<td>%</td>
<td>—</td>
<td>23 %</td>
<td>—</td>
</tr>
<tr>
<td>AWS DynamoDB</td>
<td>23 %</td>
<td>%</td>
<td>—</td>
<td>23 %</td>
<td>—</td>
</tr>
<tr>
<td>AWS EC2 Compute *</td>
<td>23 %</td>
<td>%</td>
<td>—</td>
<td>23 %</td>
<td>—</td>
</tr>
<tr>
<td>m4 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m4.4xlarge *</td>
<td>23% 27%</td>
<td>%</td>
<td>—</td>
<td>27 %</td>
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</tr>
<tr>
<td>aws-US...</td>
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<tr>
<td>aws-As...</td>
<td>23%</td>
<td></td>
<td>—</td>
<td>27 %</td>
<td></td>
</tr>
</tbody>
</table>

To override the Enterprise Discount for AWS billing groups, you can configure special discounts for services or templates that AWS provides in the current scope. Turbonomic will use those discount overrides in its analysis.

In AWS you can set up a billing family that includes a master account and a given set of member accounts. Turbonomic treats the AWS billing family as a Billing Group. For more information about billing families, see AWS Billing Family Recognition on page 191.

Assume you have configured an Enterprise Discount of 10% for a billing family, to match the overall discount that AWS offers you for that scope. You can then create overrides to add extra discounts for other services or template families in that scope.
Turbonomic uses the discounted costs in its analysis as it calculates actions. For example, assume an Enterprise Discount of 10% for a billing group, and a discount of 20% for the M4.Large family of templates. As Turbonomic places a workload, it will consider both the template capacity and the template cost. Even if an M4 template is larger than the workload actually needs, the M4 template could be less expensive because of the added discount. In that case, Turbonomic will place the workload on the less expensive template.

**NOTE:** The Cloud Cost Discount table lists the services that are available to you for the AWS billing family that you have set up as the discount scope. The services this table displays depend on whether the billing family uses the given service, and whether there is any recorded cost at the time that you display the table. For this reason, under some circumstances you might see different services listed in the table.

Under all circumstances, the table lists the services, AWS EC2 Compute, AWS EC2 Reserved Instance, and AWS RDS.

In the Cloud Cost Discount fly-out, you can perform the following:

- To add an override, enter the absolute discount value for the given service. To completely remove discounts for a service, enter 0%. When you add an override to a service, its name displays in bold with an asterisk. When you’re done, click **SAVE**.
- To remove all overrides and revert back to the Enterprise Discount, click **CLEAR ALL OVERRIDES**.
- To download a report of the discounts for each service, click **DOWNLOAD** and choose CSV or PDF.

The table lists the following information about your discounts:

- **SERVICES**
  The different cloud services to which you can set an override discount. To see individual workload templates:
  - For Azure, expand **Virtual Machines**
  - For AWS, expand **AWS EC2 Compute** or **EC2 Reserved Instance**

- **ENT. DISCOUNT**
  The Enterprise Discount that you have set for the current scope. This is the general discount that Turbonomic applies by default to the given service.

- **DISCOUNT OVERRIDES**
  If you have entered a value, this is the discount Turbonomic applies to the given service.

- **CSP COST (LINUX)**
  The Cloud Service Provider’s cost for VM templates, per hour. To see these costs, expand the workload services to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

- **EFFECTIVE DISCOUNT**
  The actual discount for the given service. If you entered an override, it shows here.

- **EFFECTIVE COST (LINUX)**
  The discounted cost for VM templates, per hour. To see these costs, expand **Virtual Machines** to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

**NOTE:** For the Cloud Cost Discount table to display CSP Cost and Effective Cost, you must have created a Cost and Usage report in AWS, and you must store it in an S3 bucket.

For more information, see [Displaying AWS Spend In Turbonomic](#).
Policies set business rules to control how Turbonomic analyzes resource allocation, how it displays resource status, and how it recommends or executes actions. You can work with two kinds of policies:

- **Placement Policies**
  To modify workload placement decisions, Turbonomic divides its market into segments that constrain the valid placement of workloads. Turbonomic discovers placement rules that are defined by the targets in your environment, and you can create your own segments.

- **Automation Policies**
  Turbonomic ships with default settings that we believe will give you the best results from our analysis and control. But for some scopes of your environment, you might want to change these settings. For example, you might want to change action automation for that scope, or change the utilization constraints.

The Policy Management page shows all the currently defined policies. You can:

- Select an entry to delete the policy
- Click an entry name to edit the policy
  You can enable or disable discovered placement policies. For a Turbonomic segment (a placement policy that was created in Turbonomic), you can edit the policy definition as well as enable/disable it.
- Create new policies
To see the policies that are applied to a scope, go to the Search page and set the Turbonomic session to that scope. Then show the Policy view. For more information, see Details View on page 87.

**Things You Can Do**

- Manage Imported Placement Policies – Importing Workload Placement Policies on page 212
- Create a Placement Policy – Creating Placement Policies on page 213
- Create an Automation Policy – Automation Policies on page 217
- Create an Orchestration Policy – Setting Up Action Orchestration on page 237

**Placement Policies**

For planning and optimization, Turbonomic recommends actions to place workload from applications, VMs, physical machines, datastores, and disk arrays. Turbonomic can recommend these actions, or execute them automatically. When calculating workload placement, Turbonomic respects cluster boundaries, networks, and provisioned data stores. These boundaries impose segments on the market view that Turbonomic uses to model your virtual infrastructure.

In finance a market segment divides the market according to the criteria different groups of people use when they buy or sell goods and services. Likewise in the Turbonomic market, a workload placement segment uses criteria to focus the buying and selling of resources within specific groups of entities. It gives you finer control over how Turbonomic calculates moves. When managing segments you can:

- Importing Workload Placement Policies on page 212 — Review the placement policies that Turbonomic has discovered. These are policies that have been defined in your environment, outside of Turbonomic.
- Creating Placement Policies on page 213 — that restrict workload placement according to specific rules

**NOTE:** You can enable or disable any imported policy or created workload placement segment.

**Importing Workload Placement Policies**

The hypervisors that you set as targets can include placement policies of their own. Turbonomic imports these placement policies, and you can choose to enable or disable them as you wish. By default, Turbonomic enables imported placement policies.

Turbonomic imports:

- vCenter Server DRS Rules
- Virtual Machine Manager Availability Sets
- CloudStack Affinity Groups

**NOTE:** In vCenter environments, Turbonomic does not import DRS rules if DRS is disabled on the hypervisor. Further, if Turbonomic did import an enabled DRS rule, that somebody subsequently disables that DRS rule, then Turbonomic will discover that the rule was disabled and will remove the imported placement policy.

For more information about these imported rules, see the Target Configuration Guide.
Creating Placement Policies

Placement Policies set up constraints to affect how Turbonomic calculates the placement of workloads in your environment. In this way, you can direct Turbonomic to recommend actions that satisfy business rules for your enterprise.

Turbonomic discovers Placement policies that have been defined in your environment, and you can also create Placement policies through the Turbonomic user interface. Note that you can enable or disable any Placement policy, both for real-time analysis and for planning scenarios.

Turbonomic supports the following placement policies:

- **Place** — Determine which entities use specific providers
  For example, the VMs in a consumer group can only run on a PM that is in the provider group. You can limit the number of consumers that can run on a single provider — for PMs in the provider group, only 2 instances of VMs in the consumer group can run on the same host. Or no more than the specified number of VMs can use the same storage device.

- **Don’t Place** — Consumers must never run on specific providers
  For example, the VMs in a consumer group can never run on a PM that is in the provider group. You can use such a segment to reserve specialized hardware for certain workloads.

- **Merge** — Merge clusters into a single provider group
  For example, you can merge three PM clusters in a single provider group. This enables Turbonomic to move workload from a host in one of the clusters to a host in any of the merged clusters.

- **License** — Set up hosts with paid licenses to be the preferred providers for VMs or applications that require those licenses
  If you purchase licenses for hosts to run specific software, you want to place as many licensed VMs or applications on a licensed host as possible. A license segment identifies a group of host machines that provide a given license, and a group of VMs or applications that consume that license. When Turbonomic calculates workload placement, it will avoid moving the VMs to hosts that don’t provide the license, and will try to consolidate workload on as few licensed hosts as possible.

1. **Navigate to the Settings Page.**
   
   ![Settings](image)
   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. **Choose Policies.**
   
   ![Policies](image)
   Click to navigate to the Policy Management Page.

   This page lists all the policies that you currently have configured for Turbonomic.
3. Create a new Placement policy.

First, select the type of Placement policy to create, then specify the settings:
- Give the policy a name
- Choose the policy type and make the settings
- Save the policy when you’re done
4. **Create a Place policy.**

**POLICY NAME**

**TYPE**

PLACE  DON'T PLACE  MERGE  LICENSE

**PLACE**

Choose consumer type..  SELECT GROUP

**ON**

Choose provider type..  SELECT GROUP

- Limit workload entities to placement group

- Limit the maximum number of workload entities per placement entity to

These policies control where workload can be placed. For example, you can specify that a VM will only be placed on a PM that is a member of a specific cluster. Or you could specify that any applications in a specific group can only be placed on a datastore that is a member of a specific group.

- **Specify the consumer group** — The group or cluster of entities that will be placed on the identified providers
- **Specify the provider group** — The group or cluster of entities that will provide resources to the consumers
- **Limit workload entities to placement group** — Set the policy to only place consumer entities on members of the provider group
- **Limit the maximum number of workload entities per placement entity to** — Limit how many instances of the consumer entities can be placed on a single provider

5. **Create a Don't Place policy.**

**POLICY NAME**

**TYPE**

PLACE  DON'T PLACE  MERGE  LICENSE

**DON'T PLACE**

Choose consumer type..  SELECT GROUP

**ON**

Choose provider type..  SELECT GROUP
These policies identify groups or clusters that will never host the consumer entities. For example, you can specify that a VM will never be placed on a PM that is a member of a specific cluster. Or you can specify that a set of non-critical applications will never be placed on specialized hardware, as a way to ensure availability for critical applications.

- **Specify the consumer group** — The group or cluster of entities that will be excluded from the identified providers
- **Specify the provider group** — The group or cluster of entities that will not provide resources to the consumers

6. **Create a Merge policy.**

To remove cluster boundaries you can create Merge policies. These policies merge multiple clusters into a single logical group for the purpose of workload placement. For example, your environment might divide hosts into clusters according to hardware vendor, or by some other criteria. Workload placement typically does not cross such cluster boundaries. However, there might be no technical reason to apply these boundaries to workload placement. By creating a larger pool of provider resources, Turbonomic has even more opportunities to increase efficiency in your environment.

For merge policies, keep the following considerations in mind:

- For most policies that merge host and storage clusters, the clusters you place in the Merge segment must be members of the same datacenter.
- For vCenter environments, use Merge policies to support cross-vCenter moves. In this case, where a datacenter corresponds to a given vCenter target, the merged clusters can be in different datacenters.
- For cloud environments, you can create policies to merge datacenters. Use these merge policies to support Migrate to Cloud plans or to support VM moves that find better costs on other zones.

To create a Merge policy, choose the type of entity to merge, and then select the groups you will merge.
7. Create a License policy.

POLICY NAME

TYPE
PLACE  DON'T PLACE  MERGE  LICENSE

LICENSE
Choose consumer type..  SELECT GROUP

ON
Choose provider type...  SELECT GROUP

These policies keep VMs and applications that use a specific license running on the hosts that provide that specific license. For example, assume you have purchased a number of licenses for a database — You pay for the right to run that database on a certain number of host sockets. In that case, it’s most advantageous to do two things:

• Only place the associated workload on hosts that have the license assigned to them
• Consolidate workload on those hosts as much as possible, in case you can suspend a host and save on licensing cost

In the Turbonomic market, consumers purchase resources from providers. In a license policy, the consumers get a reduced price for resources from the hosts in the Provider Group. The result is that the workload will have strong tendency to be placed on these hosts. This helps to meet the goal of consolidating the workload on the licensed hosts. However, if the licensed hosts don’t have enough capacity, then the workload can be placed on other hosts. In that case, Turbonomic will also recommend provisioning a new licensed host.

To create a License policy:

• Specify the consumer group — The group or cluster of entities that get priority to run on the providers
• Specify the provider group — The group or cluster of hosts that are to give priority to the identified consumers

8. When you have made all your settings, be sure to save the Policy.

Automation Policies

As Turbonomic gathers metrics, it compares the metric values against specified constraint and capacity settings to determine whether a metric exhibits a problem, and what actions to recommend or execute to avoid a problem. With these policies you can set:

• Action Automation — Whether to execute automatically or manually, or whether to just recommend the action
• Action Orchestration — Whether to have Turbonomic execute the action, have Turbonomic direct an orchestrator to execute the action, or execute the action with Action Scripts
• Analysis Settings – Settings that affect the Turbonomic analysis of the state of your environment. These include:
  - Operational Constraints such as enabling HA on VMs or ignoring hyperthreading on hosts
  - Utilization Constraints such as memory or CPU utilization
  - Resize Increments
  - Application Priority
You assign an Automation Policy to a scope in your environment. For example, you might want to automate all VM moves and resizes in a development cluster. With these policies you can introduce automation of actions in a controlled way, for specific scopes of entities in your environment.

### About Policy Scope

Policy scope determines which entities will be affected by the settings you make. To set scope, you assign one or more groups to the policy. (For information about creating groups, see Creating Groups on page 193.)

It's possible to set up policies with conflicts on individual entities. Assume two groups, Group_A and Group_B. Now imagine that one host is a member of both groups. For example, the host cluster is one group, and you might have included the host in a custom group. What happens if you create two different Automation Policies, one for Group_A and another for Group_B? In that case, the host can have different policy settings.

For example, the Group_A policy could set the Suspend action to Manual, while the default for Group_B is Recommend. Note that Turbonomic always uses the most conservative setting. For this case, the Recommend setting is most conservative, so it wins.

### About Policy Schedules

You can set a schedule for an automation policy. The schedule acts as a window of time. When that window is open, the scheduled policy takes effect. A typical use for scheduling policies is to automate disruptive actions during a period of low activity.

**NOTE:** Turbonomic continually calculates actions that cause your environment to converge on the desired state. These actions are in response to the environment at a given point in time. When you restrict the automation of a given action to a certain time window, Turbonomic will only calculate and perform actions that are appropriate for the environment during that scheduled window.

For example, assume you want to always automate Resize actions for all but the most critical VMs. You would set Resize VMs to Automated at a global level. Then for a critical cluster, you could set a restriction window that overrides the automation (sets Resize to Manual) during peak hours (9:00 to 5:00 M-F).

You can also restrict action modes in reverse fashion. For example, if you want to automate Resize for only one set of VMs, you can set Resize to Manual at the global level, and for one cluster schedule it to be Automated for a given time window.

**NOTE:** For VM policies you can enable Enforce Nondisruptive Mode, and then schedule action windows to automate resize actions during downtimes. Be aware that scheduled actions do not respect the enforced nondisruptive mode — Scheduled resize actions will execute during the scheduled window even if they require a reboot. This is useful for setting up certain action behaviors, but you must be aware that enforced non disruptive mode has no effect on scheduled actions. For information about Nondisruptive mode, see Enforce Non Disruptive Mode on page 225.
Creating an Automation Policy

To create a policy:

1. **Navigate to the Settings Page.**
   
   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. **Choose Policies.**
   
   Click to navigate to the Policy Management Page. This page lists all the policies that you currently have configured for Turbonomic.

3. **Create a new automation policy.**

   The first step is to select the policy type. This sets the type of entity that your policy will affect. Note that Turbonomic supports different actions for different types of entities. For example, you cannot add VMem to a storage device. Setting policy type is the first step you take to focus on which actions you want to map to your workflows.
4. Name the policy.

Once you have chosen the policy type, you can make all your policy settings. Start by giving the policy a useful name.

5. Set the policy scope.

Expand the SCOPE section and choose one or more groups to set as the policy's scope. You can choose from groups of entities that match the type of entity you have set for the policy. You can also create new groups and add them to the policy scope.

**NOTE:** In Turbonomic you can find nested groups (groups of groups). For example, the “By PM Cluster” group contains host clusters, and each host cluster is a group. Do not set the policy scope to a parent of nested groups. When setting up policies, be sure you set them to individual groups. If necessary, create a custom group for the settings you want to apply.
The scope determines which entities this policy will affect. Click **SCOPE** to expand the section, and then add one or more groups. When you click **ADD GROUPS**, Turbonomic displays a list of all the groups of entities that match the policy type. You can also create new groups if necessary.

**NOTE:** A single entity can be a member of multiple groups. This can result in a conflict of settings, where the same entity can have different Action Policy settings. For more information, see Setting Policies on page 211.
6. **Optionally, set a schedule for the policy.**

   Expand the **SCHEDULE** section and specify the schedule parameters.

   The schedule’s date range determines how many days the window will be “open”, or be in effect. You should keep the following points in mind:

   - A non-recurring window has a start date, and no end date. The window will be open for the day you specify as the start date, and finish at the end of that day.
   - If you don’t want an end date for the schedule, turn on the **Perpetual** option.
   - For recurring windows you specify a date range. The window will open during times within that range.
   - For daily recurrence the window will be open for the hours you specify.
   - For weekly recurrence the window will be open on the days of the week that you specify, for the hours you specify.
   - For monthly recurrence, the window will open one day each month — on the day you set for the Start Date. But the window recurrence remains in effect until the End Date. For example, if you specify January 1st 2013 for the start date, and December 31st 2013 for the end date, the window will be open on the first day of each month for that year.
Now that you have named the policy and set its scope, you can make the settings that affect Turbonomic analysis and action recommendations. The settings you can make are:

- Action modes – see Setting Action Modes on page 223
- Action orchestration – see Setting Up Action Orchestration on page 237
- Analysis settings – see Analysis Settings on page 242

### Setting Action Modes

To avoid problems in your environment, Turbonomic analysis identifies actions that you can execute to keep things in optimal running order. Action modes specify the degree of automation you want for these given actions. For example, in some environments you might not want to automate resize down of VMs because that is a disruptive action. You would use action modes in a policy to set that business rule.

Turbonomic supports the following action modes:

- **Disabled** — Do not recommend or perform the action
  When you disable an action, the user interface hides all of the action modes.
- **Recommended** — Recommend the action so a user can execute it via the given hypervisor or by other means
- **Manual** — Recommend the action, and provide the option to execute that action through the Turbonomic user interface
- **Automated** — You have directed Turbonomic to execute the action automatically

To get the best results from Turbonomic’s Intelligent Workload Management, you should set as many actions as possible to *Automated*. If some clusters run applications that are highly critical, you can set them to *Manual*.

The available action modes are different for different types of entities, and for different targets that manage these entities. For a listing of the action modes that you can use for each type, see Action Modes on page 226.

**NOTE:** Turbonomic policies include Action Orchestration settings. These settings determine whether Turbonomic executes the actions, or whether to map the actions to workflows managed by external orchestrators. If you want to execute via an orchestrator workflow, you must set the action mode to Manual or Automated. For more information about action orchestration, see Setting Up Action Orchestration on page 237.

### Tuned Scaling Action Settings

For resizing VMs and Storage, Turbonomic includes tuned scaling action settings. These settings give you increased control over the action mode for the affected actions. With this feature you can rely on automation for resize actions within a normal range (the tuned scaling range), and direct Turbonomic to post more conservative actions when the issue lies outside of the scaling range.

For example, consider adding memory to VMs. As memory demand increases on a VM, Turbonomic can automatically allocate more memory. But what if the hosted application is in a runaway state, and will always request more memory? How can automated actions know when to stop in a runaway situation?

With tuned scaling actions, you set up a scaling range for action automation. For conditions that fall outside of the range, you set up more conservative action modes (Manual or Recommend). Following our example, the runaway application ultimately falls outside of the normal range, and Turbonomic will not automate memory resize for the VM.
You can set up tuned scaling actions for the following entities. Note that Resize Up and Resize Down settings are for conditions within the tuned scaling range, while Above Max and Below Min settings are for outlying conditions.

<table>
<thead>
<tr>
<th>Entity Type:</th>
<th>Action Settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM</td>
<td>• VCPU Resize Up</td>
</tr>
<tr>
<td></td>
<td>• VCPU Resize Down</td>
</tr>
<tr>
<td></td>
<td>• VCPU Resize Above Max</td>
</tr>
<tr>
<td></td>
<td>• VCPU Resize Below Min</td>
</tr>
<tr>
<td></td>
<td>• VMEM Resize Up</td>
</tr>
<tr>
<td></td>
<td>• VMEM Resize Down</td>
</tr>
<tr>
<td></td>
<td>• VMEM Resize Above Max</td>
</tr>
<tr>
<td></td>
<td>• VMEM Resize Below Min</td>
</tr>
<tr>
<td>Storage</td>
<td>• Storage Resize Up</td>
</tr>
<tr>
<td></td>
<td>• Storage Resize Down</td>
</tr>
<tr>
<td></td>
<td>• Storage Resize Above Max</td>
</tr>
<tr>
<td></td>
<td>• Storage Resize Below Min</td>
</tr>
</tbody>
</table>

To define the range, you specify the tuned scaling range as an Operational Constraint for the VM or Storage policy that you're creating.

<table>
<thead>
<tr>
<th>Entity Type:</th>
<th>Operational Constraints:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM tuned scaling range</td>
<td>• VCPU Max Resize</td>
</tr>
<tr>
<td></td>
<td>• VCPU Min Resize</td>
</tr>
<tr>
<td></td>
<td>• VMEM Max Resize</td>
</tr>
<tr>
<td></td>
<td>• VMEM Min Resize</td>
</tr>
<tr>
<td>Storage tuned scaling range</td>
<td>• Storage Max Resize</td>
</tr>
<tr>
<td></td>
<td>• Storage Min Resize</td>
</tr>
</tbody>
</table>

For example, assume the following settings:
- VCPU Min Size: 2
- VCPU Max Size: 8
- VCPU Resize Up: Automated
- VCPU Resize Down: Manual
- VCPU Resize Above Max: Manual
- VCPU Resize Below Min: Disabled

With this policy in effect, Turbonomic will post the following actions:
- A VM with 6 VCPUs requests 2 new VCPUs: Automated
- A VM with 8 VCPUs requests 2 new VCPUs: Manual
- A VM with 2 VCPUs requests to resize down to 1 VCPU: Disabled (Turbonomic does not post the action)

Action policies include scope to determine which entities will be affected by the given policy. It's possible for two or more policies to affect the same entities. As is true for other policy settings, tuned scaling uses the most conservative settings for the affected entities. The effective action mode will be the most conservative, and the effective tuned scaling range will be the narrowest range (the lowest MAX and highest MIN) out of the multiple policies that affect the given entities. For more information, see About Policy Scope on page 218.
You can schedule automation policies to take effect during a certain window of time. You can include tuned scaling settings in a scheduled window, the same as you can schedule other policy settings. For more information, see About Policy Schedules on page 218.

**Enforce Non Disruptive Mode**

VM actions include the modifier, Enforce Non Disruptive Mode. When you enable this modifier, Turbonomic ensures that for Automated and Manual modes any resize actions that can be executed will not require a reboot or any other disruption to the affected VM. If the action will disrupt the VM, Turbonomic posts the action in Recommended mode. If it will not cause any disruption, then Turbonomic can post it as Automated or Manual.

For example, with VMware technologies you must have VMware Tools installed to enable hot resize of a VM. Assume you have VMware Tools installed on the guest OS for VM-A, but not for VM-B, and you have set Resize up to Automated for the cluster:

- If you enable this modifier for VM actions:
  Turbonomic will automate resize actions for VM-A, but will only recommend resize actions for VM-B.
- If you do not enable this modifier for VM actions:
  Turbonomic will automate resize actions for VM-A and VM-B.

Another disruptive action is resizing up to more than 4 vCPUs on Windows 2008 and Windows 2008 R2 systems. Even if Hot Add is enabled for the system, Turbonomic considers such a resize to be disruptive.

If you have set the actions to Manual, the effect is the same — Turbonomic will post the manual actions to the To Do list only if they are not disruptive to the VM’s operation. Otherwise the actions will be Recommended. Enforcing non disruptive mode is a way to safely automate resize actions for VMs.

In addition to the Enforce Non Disruptive Mode setting, Turbonomic automatically discovers the VMs that support Hot Add of CPU and Memory, and places these VMs in groups. You can use these groups the same as you would any other groups.

In SEARCH, find groups that support Non Disruptive mode or Hot Add

Non Disruptive Groups — Find these groups in the SEARCH view
You can enforce non disruptive mode in the default VM policy, and then schedule action policies to automate resize actions during downtimes. Be aware that scheduled actions do not respect the enforced non disruptive mode — Scheduled resize actions will execute during the scheduled window even if they require a reboot. This is useful for setting up certain action behaviors, but you must be aware that enforced non disruptive mode has no effect on scheduled actions.

**Set Action Modes**

After you have specified the policy’s entity type, name, and scope, you can specify action modes. To set action modes:

1. **Set the action mode for the actions this policy affects.**

Choose an action... and set the automation mode

Click **ACTION MODE** to expand the section, and then set up one or more actions. When you click **ADD ACTIONS**, Turbonomic displays a list of all the actions that are viable for the policy type. Choose an action and then set the action mode. You can set the mode for one or more actions.

The action modes you can set are:
- **Disabled** — Do not recommend or perform the action
  - When you disable an action, the user interface hides all of the action modes.
- **Recommended** — Recommend the action so a user can execute it via the given hypervisor or by other means
- **Manual** — Recommend the action, and provide the option to execute that action through the Turbonomic user interface
- **Automated** — You have directed Turbonomic to execute the action automatically

2. **When you have made all your settings, be sure to save the Automation Policy.**

**Action Modes**

Turbonomic doesn’t automate the same actions equally for all technologies. This is because the underlying technologies do not provide the same degree of automation. For example, assume you set the Suspend action to be automated for all VMs. In that case, Turbonomic can automate suspension for VMs managed by vCenter and XenServer, but it cannot automatically suspend VMs managed by Hyper-V. This is because Hyper-V does not provide programmatic access to the Suspend VM operation. In this case, Turbonomic will recommend that you perform the suspension using the Hyper-V console.
The following table lists actions Turbonomic supports on each entity, showing whether the underlying technology supports automation, or recommended-only actions.

<table>
<thead>
<tr>
<th>Action</th>
<th>WebSphere</th>
<th>WebLogic</th>
<th>JBoss</th>
<th>Tomcat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Provision — VMware, only</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Provision — Other hypervisors</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Resize down (heap)</td>
<td>Auto</td>
<td>Auto</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize down (threads)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up (heap)</td>
<td>Auto</td>
<td>Auto</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up (threads)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>

Indicates full automation support.

Indicates recommended-only actions.

*Application Servers*

Turbonomic performs the following actions for application servers. Remember that if the Scaling Policy is set to Provision, it will not recommend resize actions, and if the Scaling Policy is set to Resize it will not recommend start, provision, or suspend actions.
**Database Servers**

Turbonomic performs the following actions for database servers. Remember that if the Scaling Policy is set to Provision, it will not recommend resize actions, and if the Scaling Policy is set to Resize it will not recommend start, provision, or suspend actions. Also note, while Turbonomic does not automate actions directly on the database, it does automate actions on the underlying VM.

<table>
<thead>
<tr>
<th>Action</th>
<th>Oracle</th>
<th>SQLServer</th>
<th>MySQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resize down (transaction log)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize down (MEM and connections capacity)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up (transaction log)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up (MEM and connections capacity)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>

Databases on the public cloud:

<table>
<thead>
<tr>
<th>Action</th>
<th>AWS</th>
<th>Azure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resize down</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>
**Microsoft Applications**

Turbonomic performs the following actions for Microsoft applications. Remember that if the Scaling Policy is set to Provision, it will not recommend resize actions, and if the Scaling Policy is set to Resize it will not recommend start, provision, or suspend actions.

<table>
<thead>
<tr>
<th>Action</th>
<th>Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Auto</td>
</tr>
<tr>
<td>Provision</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
</tr>
<tr>
<td>Resize down (heap)</td>
<td>Auto</td>
</tr>
<tr>
<td>Resize down</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize up (heap)</td>
<td>Auto</td>
</tr>
<tr>
<td>Resize up</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>

**VM Actions**

For on-prem VMs, Turbonomic supports the following actions:

<table>
<thead>
<tr>
<th>Action</th>
<th>vCenter</th>
<th>XenServer</th>
<th>Hyper-V</th>
<th>RHEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Move</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Action</td>
<td>vCenter</td>
<td>XenServer</td>
<td>Hyper-V</td>
<td>RHEV</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------</td>
<td>-----------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Terminate (Remove)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Provision</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Storage Move</td>
<td>Auto</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Auto</td>
</tr>
<tr>
<td>Reconfigure (Change network and storage configurations)</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>VCPU Resize Up (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Down (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Above Max (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Below Min (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Up (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Down (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Above Max (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Below Min (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Enforce Non Disruptive Mode</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
</tbody>
</table>

Actions for VMs on the public cloud:
<table>
<thead>
<tr>
<th>Action</th>
<th>AWS</th>
<th>Azure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase RI capacity</td>
<td>Rcmd</td>
<td>NA</td>
</tr>
<tr>
<td>Start</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Up (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Down (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Above Max (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VCPU Resize Below Min (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Up (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Down (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Above Max (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>VMEM Resize Below Min (uses tuned scaling)</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Reconfigure (based on custom policies)</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Move (to a different region)</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Provision</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>
VMEM and VCPU resize actions use Turbonomic tuned scaling settings. This gives you increased control over the action mode Turbonomic will use for the affected actions. Use VM Operational Constraints to set up the tuned scaling range (see OPERATIONAL CONSTRAINTS on page 256). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.

For resize on VMs, actions can change resources in the following ways:

- **Resize resource capacity**
  Change the capacity of a resource that is allocated for the VM. For example, a resize action might recommend increasing the VMem available to a VM.

- **Resize resource reservation**
  Change the amount of a resource that is reserved for a VM. For example, a VM could have an excess amount of memory reserved. That can cause memory congestion on the host — A resize action might recommend reducing the amount reserved, freeing up that resource and reducing congestion

- **Resize resource limit**
  Change the limit that is set on the VM for a resource. For example, a VM could have a memory limit set on it. If the VM is experiencing memory shortage, an action that decreases or removes the limit could improve performance on that VM.

**NOTE:** Actions for on-prem VMs include the modifier, **Enforce Non Disruptive Mode**. When you enable this modifier, Turbonomic ensures that for Automated and Manual modes, any resize actions that can be executed will not require a reboot or any other disruption to the affected VM. If the action will disrupt the VM, Turbonomic posts the action in Recommended mode. If it will not cause any disruption, then Turbonomic can post it as Automated or Manual.

**Host (PM) Actions**

<table>
<thead>
<tr>
<th>Action</th>
<th>vCenter</th>
<th>XenServer</th>
<th>Hyper-V</th>
<th>RHEV</th>
<th>UCS (blades only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Auto</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Terminate</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Provision</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Auto</td>
</tr>
</tbody>
</table>
### Storage (Datastore) Actions

Storage actions for environments that do not include Disk Array Storage Controllers as targets:

<table>
<thead>
<tr>
<th>Action</th>
<th>vCenter</th>
<th>XenServer</th>
<th>Hyper-V</th>
<th>RHEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspend</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Provision</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Start</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Delete</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Terminate</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Move</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Storage Resize Up (uses tuned scaling)</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Storage Resize Down (uses tuned scaling)</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Storage Resize Above Max (uses tuned scaling)</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
<tr>
<td>Storage Resize Below Min (uses tuned scaling)</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
<td>![Rcmd]</td>
</tr>
</tbody>
</table>
Storage actions for datastores on disk arrays:

<table>
<thead>
<tr>
<th>Action</th>
<th>Dell Compellent</th>
<th>HP 3Par</th>
<th>NetApp ONTAP</th>
<th>VNX</th>
<th>VMAX</th>
<th>Nutanix</th>
<th>Pure Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspend</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Provision</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Start</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Delete</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Terminate</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Move</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Storage Resize Up</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>(uses tuned scaling)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Resize Down</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>(uses tuned scaling)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Resize Above</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Max (uses tuned scaling)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Resize Below</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Min (uses tuned scaling)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Storage actions for datastores on the public cloud:

<table>
<thead>
<tr>
<th>Action</th>
<th>AWS</th>
<th>Azure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move (to a different EBS tier)</td>
<td>Rcmd</td>
<td>NA</td>
</tr>
</tbody>
</table>
Storage resize actions use Turbonomic tuned scaling settings. This gives you increased control over the action mode Turbonomic will use for the affected actions. Use Storage Operational Constraints to set up the scaling Range (see Operational Constraints on page 253). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.

Disk Array Actions

For environments that have Disk Array Storage Controllers as targets:

<table>
<thead>
<tr>
<th>Target</th>
<th>Move</th>
<th>Provision</th>
<th>Resize (up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell Compellent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP 3Par</td>
<td></td>
<td></td>
<td>Rcmd</td>
</tr>
<tr>
<td>NetApp ONTAP (C-Mode, only)</td>
<td>Rcmd</td>
<td>(C-Mode, only)</td>
<td>Rcmd</td>
</tr>
<tr>
<td>VMAX</td>
<td></td>
<td></td>
<td>Rcmd</td>
</tr>
<tr>
<td>VNX</td>
<td></td>
<td></td>
<td>Rcmd</td>
</tr>
<tr>
<td>Nutanix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pure Storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XTremiO</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Storage Controller Actions

Actions for individual Disk Array Storage Controllers:

<table>
<thead>
<tr>
<th>Target</th>
<th>Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell Compellent</td>
<td>Rcmd</td>
</tr>
<tr>
<td>HP 3Par</td>
<td>Rcmd</td>
</tr>
<tr>
<td>NetApp ONTAP</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>
### Setting Up Business Rules

**Switch Actions**

For environments that have Fabric Managers as targets:

<table>
<thead>
<tr>
<th>Target</th>
<th>Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMAX</td>
<td>Rcmd</td>
</tr>
<tr>
<td>VNX</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Nutanix</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Pure Storage</td>
<td>Rcmd</td>
</tr>
<tr>
<td>XTremIO</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action</th>
<th>Cisco UCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Move</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Suspend</td>
<td>Rcmd</td>
</tr>
<tr>
<td>Resize</td>
<td>Rcmd</td>
</tr>
</tbody>
</table>
Virtual Datacenter Actions

For direct actions on VCloud Director and CloudStack virtual datacenters, Turbonomic only supports resize actions. However, Turbonomic does automate actions for the underlying entities (VMs and hosts) that are managed by the virtual datacenter.

<table>
<thead>
<tr>
<th>Action</th>
<th>VCD</th>
<th>CloudStack</th>
<th>VMM</th>
<th>OpenStack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Suspend</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Terminate</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Provision</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
<tr>
<td>Resize (Change VCPU and memory capacities)</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
</tr>
</tbody>
</table>

Setting Up Action Orchestration

Action Orchestration specifies whether Turbonomic will execute an action, or whether Turbonomic will pass the action request to an orchestrator that will execute a complete workflow to effect the change in your environment. In this way, you can integrate supported orchestrators to execute actions for specific scopes of entities in your environment.

About Orchestrators

Turbonomic supports orchestrator targets. For this release, you can set UCS Director targets to execute actions.

Action Orchestration targets assign workflows that execute multiple actions to make changes in your environment. Turbonomic discovers workflows that you have defined on the orchestrator. You can then set up an automation policy that maps workflows to actions. If the action mode is Manual or Automatic, then when Turbonomic recommends the action, it will direct the orchestrator to use the mapped workflow to execute it.

This section shows how to link orchestration workflows to automation policies. It assumes you have already configured an Orchestration target. It also assumes that you have configured workflows on that target in such a way that Turbonomic can discover the workflows and map them to actions. For information about Orchestration target requirements, see the Target Configuration Guide.
About Action Scripts

Action Scripts provide a script interface that can add custom processing to Turbonomic actions at the following entry points:

- Pre
- Post
- Clear

You can set up action scripts to run on specific groups of entities. For example, you can enable the PRE-MOVE action script for one group of VMs, and enable the CLEAR-MOVE action script for a different group.

For more information about Action Scripts, see Creating Action Scripts on page 240.

Specifying Action Orchestration

After you have specified the policy's entity type, name, and scope, you can specify Action Orchestration:

1. For each action you want to execute, set which manager will run the action execution.
   
   First click ACTION EXECUTION to expand the section, and then set up one or more actions. When you click RUN IN, Turbonomic displays a list of the supported action managers. For this release, the supported managers are:
   - Turbonomic — Default: Use the standard Turbonomic execution for this action. For this choice, you can optionally specify Action Scripts to run for this action.
   - UCS Director — Configure Turbonomic to call UCS Director to execute a workflow for this action. For this choice you must also link a UCS Director workflow to this action. Also, you can optionally specify Action Scripts to run for this action.
   - Action Script — Direct Turbonomic to bypass action execution and invoke an action script instead. For this choice, you can you must also specify Action Scripts to run for this action.

   **NOTE:** To set up action execution, that action's mode must be set to Manual or Automated. Also, you must be sure to match the actions that you have set in the ACTIONS MODE section for this scope. For example, if you have set the Suspend action to Automated, then you can choose that action here to set up ACTION EXECUTION. For more information about action modes, see Setting Action Modes on page 223.
2. To execute an action via UCS Director, link a workflow.

In the ACTION EXECUTION section, click LINK WORKFLOW. Turbonomic displays a list of all the UCS Director workflows that it has discovered in your environment. Choose the workflow that you want to run for this action. Remember, Turbonomic will run that workflow for this action on any of the entities affected by this policy.

**NOTE:** For any workflow to work with Turbonomic, the workflow's configuration must include specific parameters. This list includes all workflows, whether they have been configured to work with Turbonomic or not. Also, when you choose a workflow, you must be sure it is a reasonable workflow for the policy type. For example, do not link a storage workflow to a host action.
3. Optionally, enable Action Scripts for this action.

Action Scripts provide a script interface that can add custom processing to Turbonomic actions at the following entry points:

- **Pre** — Before executing an action
  
  Example: Send an email to notify that the action has been recommended.

- **Post** — After executing an action
  
  Example: Send an email to notify that the action was executed.

- **Clear** — When the conditions that elicit an action recommendation have changed so that the action is no longer viable
  
  Example: Remove a Provision VM Request from a ticketing system (because the VM is no longer needed).

In the **ACTION EXECUTION** section, click **ACTION SCRIPT** to show options for these entry points. If you enable an entry point, then Turbonomic will execute the script for this action at the indicated entry point.

For more information about Action Scripts, see Creating Action Scripts on page 240.

4. When you have made all your settings, be sure to save the Action Policy.

### Creating Action Scripts

Action Scripts provide a script interface that can add custom processing to Turbonomic. When you enable an action script to run, you do not provide the script name. Instead, you create one script for each type of action, entity type, and entry point. The script name captures this to specify which action the script responds to, as follows:

<EntryPoint>_<Action>_EntityType>.sh

Some example script names are:

- **PRE.Move.VirtualMachine.sh**
  
  Execute the script when the move action appears as a recommendation.

- **RESIZE.VirtualMachine.sh**
  
  Execute the script instead of executing the Turbonomic Resize action. Note that you can include a REST API call to accept the action or to reject it as part of the script.
• **POST_RECONFIGURE_VirtualMachine.sh**
  `<Post>_<Reconfigure>_<VirtualMachine>`
  Execute the script after a Reconfigure action. Note that a POST script executes after an action has succeeded or failed.

• **CLEAR_MOVE_VirtualMachine.sh**
  `<Clear>_<Move>_<VirtualMachine>`
  Execute the script after a Move action has cleared.

The supported entry points and actions are:

<table>
<thead>
<tr>
<th>Entry Point</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Move</td>
</tr>
<tr>
<td>Replace (do not specify an entry point in the filename)</td>
<td>Change</td>
</tr>
<tr>
<td>Post</td>
<td>Reconfigure</td>
</tr>
<tr>
<td>Clear</td>
<td>Resize</td>
</tr>
</tbody>
</table>

To pass information into the script, Turbonomic sets values to environment variables. You can reference these environment variables in your scripts. For example, assume you want to send an email that includes the name of the VM that is an action target. You can get that name via the `VMT_TARGET_NAME` environment variable.

Turbonomic sets the following environment variables for an action:

• **VMT_TARGET_INTERNAL**
  The internal name of the entity this action will affect.

• **VMT_TARGET_UUID**
  The internal name of the entity this action will affect.

• **VMT_TARGET_NAME**
  The entity's display name.

• **VMT_CURRENT_INTERNAL**
  The internal name for the current configuration or placement.

• **VMT_CURRENT_NAME**
  The display name for the current configuration or placement.

• **VMT_NEW_INTERNAL**
  The internal name for the new configuration or placement.

• **VMT_NEW_NAME**
  The display name for the new configuration or placement.

• **VMT_ACTION_INTERNAL**
  The UUID for the proposed action. You can use this to access the action via the REST API.

• **VMT_ACTION_NAME**
  The name of the action.

• **VMT_STATE_NAME**
  Gives the state of the action's execution. Can be one of *Succeeded* or *Failed*. This variable is only available for POST_ and CLEAR_ action scripts.

• **VMT_STATE_DESCRIPTION**
  If execution has started, this gives the string *Start execution*. This variable is only available for POST_ and CLEAR_ action scripts.
Analysis Settings

Turbonomic collects metrics to drive the analysis that it uses when it calculates actions for your environment. It compares current utilization and demand against allocated capacities for resources, so it can recommend actions that keep your environment in optimal running condition.

Action policies include settings that you can make to adjust the analysis that Turbonomic performs. For example, you can set different levels of overprovisioning for host or VM resources, and Turbonomic will consider that as a factor when deciding on actions.

Turbonomic ships with a set of default analysis settings. These settings take effect until you create and apply a policy with different values for any of the given settings. You can edit the defaults if you want to change analysis settings globally.

The settings you can make are different for different types of entities. The default policies show all the settings you can make for each policy type. For a listing and additional information about these settings, see the following descriptions:

- Analysis Policies: Applications on page 244
- Analysis Policies: Application Servers on page 246
- Analysis Policies: Business Applications on page 247
- Analysis Policies: Containers on page 248
- Analysis Policies: Databases on page 249
- Analysis Policies: Database Servers on page 249
- Analysis Policies: Disk Arrays on page 250
- Analysis Policies: Hosts on page 251
- Analysis Policies: Logical Pools on page 252
- Analysis Policies: Storage Controllers on page 253
- Analysis Policies: Storage on page 253
- Analysis Policies: Switches on page 255
- Analysis Policies: Virtual Applications on page 255
- Analysis Policies: VMs on page 256
**Analysis Settings in a Policy**

After you have specified the policy's entity type, name, and scope, you can make analysis settings for the policy. To set make these settings:

1. **Click to expand the type of analysis setting you want to make, and add a new setting.**

   For example, expand **UTILIZATION CONSTRAINTS** and then click **Add Utilization Constraint**. After you click to add the item, you then choose from a list of available settings. Once you add the setting to the policy, you can then change its value. Each setting you add to the policy takes precedence over the default value for that setting.
2. When you have made all your settings, be sure to save the Automation Policy.

**Analysis Policies: Applications**

Turbonomic tracks utilization of resources for applications and application servers that you have set up as targets.

**Default Settings**

**APPLICATION SERVER DISCOVERY**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Set Transactions Capacity</td>
<td>Disabled</td>
</tr>
<tr>
<td>Connection Capacity</td>
<td>10000</td>
</tr>
<tr>
<td>Response Time Capacity [ms]</td>
<td>60000</td>
</tr>
<tr>
<td>SLA Capacity</td>
<td>60000</td>
</tr>
<tr>
<td>Threads Capacity</td>
<td>500</td>
</tr>
<tr>
<td>Transactions Capacity</td>
<td>10</td>
</tr>
</tbody>
</table>
APPLICATION PRIORITIES

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Priority</td>
<td>Mission Critical</td>
</tr>
</tbody>
</table>

By default, applications are Mission Critical. With this status, Turbonomic will not suspend the VMs that host them. However, you can set an application to a Normal priority. In that case, if there is a shortage of resources on the host, then Turbonomic can suspend the VM that runs that application. This can free up resources for other more critical applications on that host.

Assume you have set an application to Normal, and then Turbonomic suspended it. If you later decide the application should be Mission Critical, then you can change its priority. You can also use action scheduling to change application priority. After you have changed a suspended application from Normal to Mission Critical, Turbonomic will then start up the suspended VM.

One reason to set application priority to Normal is to enable the suspension of VMs on the cloud. For more information, see “Enabling VM Suspend Actions in the Public Cloud” in the Target Configuration Guide.

Transactions

This resource measures the number of transactions per second. Excess transactions indicate a heavy load on the application server, and usually means you should provision a new instance. You can set the transaction capacity, or direct Turbonomic to automatically set it.

- Transaction Capacity
  If you know the rate of transactions your applications can maintain, then you can set it here. The value that you set indicates when Turbonomic considers utilization to be 100%. The default value is 10 — If an application experiences 10 transactions per second or more, Turbonomic sets the utilization index for this resource to 100%.

- Auto Set Transaction Capacity
  If you enable this setting, Turbonomic adjusts the transaction capacity to the upper limit your application server experiences. For example, if the Transaction Capacity is set to 10, and the application server experiences 15 transactions per second, then the utilization of this resource would be 150%. However, if you enable Auto Set Transaction Capacity, then Turbonomic would increase the capacity to 15, and show utilization at 100%.

Response Time

Response time capacity determines the upper limit for acceptable response time in your applications, in milliseconds. Very high response time can be a result of excess load on the application. For excess response time, Turbonomic can recommend to provision another application instance.

Turbonomic maps Response Time utilization to QoS. This means that the higher the response time, the greater the utilization of QoS. QoS indicates the risk the application has for meeting its requirements. As QoS utilization increases, Turbonomic gives the affected application more priority. In cases of resource contention, other things being equal, the application with higher QoS utilization will win.

SLA Capacity

This sets how much the given application can be at risk for meeting its QoS requirements. The higher the risk, the more priority the application has to get resources from the underlying providers.
NOTE: Measurement of QoS against the capacity set for SLA requires instrumentation to monitor QoS-related metrics, or integration of third-party monitoring systems with Turbonomic. If you have such monitoring, then you can provide values for SLA in relation to the scale of your monitoring. Otherwise, you should leave this setting at the default. Also note that this SLA setting does not impact the mapping of Response Time consumption to QoS measurements in applications.

Connection Capacity

Connection capacity determines the upper limit for concurrent connections to the application. Excess connections can indicate the need to provision a new instance.

Threads Capacity

For most types of applications and servers managed by the Application Edition, Turbonomic discovers the thread pool capacity on the server, and uses that in utilization calculations. For this release, the following types of supported application targets do not provide thread pool data that Turbonomic can use:

- Microsoft Exchange Server

For entities of this type, you can select a group of these entities and specify the thread pool capacity. Turbonomic assumes a default capacity of 500 threads, which is according to best practices in the field.

Analysis Policies: Application Servers

Turbonomic tracks utilization of resources for applications and application servers that you have set up as targets.

Default Settings

UTILIZATION CONSTRAINTS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection Time Utilization</td>
<td>10</td>
</tr>
<tr>
<td>Heap Utilization</td>
<td>80</td>
</tr>
</tbody>
</table>

Collection Time Utilization and Heap Utilization

For Java applications, Collection Time Utilization tracks the percentage of CPU time spent on garbage collection. The default setting is 10 — if 10% of CPU is devoted to garbage collection, then this resource is utilized at 100%.

Turbonomic tracks this utilization to refine action recommendations in response to Heap utilization. Assume Heap is utilized at 80% of its capacity. This means that Heap Utilization gains a high return (consumers pay a high price for this resource), and that indicates a shortage that can be addressed by provisioning more resources. However, if garbage collection is high, 80% Heap utilization might not indicate a shortage after all. Assume that Collection Time is at 8% of CPU time, which is 80% of its capacity. In that case, both Heap and Collection are at 80%, and the high cost of Collection cancels out the high return for Heap. As a result, Turbonomic will not recommend provisioning more Heap resources.

In the case of highly utilized Heap, if you set the constraint for Collection to a lower number, that tends to suppress recommendations to provision more Heap. On the other hand, setting a high Collection constraint (Garbage Collection can use more CPU cycles) tends to enable more resize up actions for Heap.
Analysis Policies: Business Applications

Turbonomic tracks utilization of resources for applications and application servers that you have set up as targets.

Default Settings

APPLICATION SERVER DISCOVERY

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Set Transactions Capacity</td>
<td>Disabled</td>
</tr>
<tr>
<td>Response Time Capacity [ms]</td>
<td>60000</td>
</tr>
<tr>
<td>SLA Capacity</td>
<td>60000</td>
</tr>
<tr>
<td>Transactions Capacity</td>
<td>10</td>
</tr>
</tbody>
</table>

Transactions

This resource measures the number of transactions per second. Excess transactions indicate a heavy load on the application server, and usually means you should provision a new instance. You can set the transaction capacity, or direct Turbonomic to automatically set it.

- **Transaction Capacity**
  If you know the rate of transactions your applications can maintain, then you can set it here. The value that you set indicates when Turbonomic considers utilization to be 100%. The default value is 10 — If an application experiences 10 transactions per second or more, Turbonomic sets the utilization index for this resource to 100%.

- **Auto Set Transaction Capacity**
  If you enable this setting, Turbonomic adjusts the transaction capacity to the upper limit your application server experiences. For example, if the Transaction Capacity is set to 10, and the application server experiences 15 transactions per second, then the utilization of this resource would be 150%. However, if you enable Auto Set Transaction Capacity, then Turbonomic would increase the capacity to 15, and show utilization at 100%.

Response Time

Response time capacity determines the upper limit for acceptable response time in your applications, in milliseconds. Very high response time can be a result of excess load on the application. For excess response time, Turbonomic can recommend to provision another application instance.

Turbonomic maps Response Time utilization to QoS. This means that the higher the response time, the greater the utilization of QoS. QoS indicates the risk the application has for meeting its requirements. As QoS utilization increases, Turbonomic gives the affected application more priority. In cases of resource contention, other things being equal, the application with higher QoS utilization will win.

SLA Capacity

This sets how much the given application can be at risk for meeting its QoS requirements. The higher the risk, the more priority the application has to get resources from the underlying providers.

**NOTE:** Measurement of QoS against the capacity set for SLA requires instrumentation to monitor QoS-related metrics, or integration of third-party monitoring systems with Turbonomic. If you have such monitoring, then you can provide values for SLA in relation to the scale of your monitoring. Otherwise, you should leave this setting at the default. Also note that this SLA setting does not impact the mapping of Response Time consumption to QoS measurements in applications.
Analysis Policies: Containers

OPERATIONAL CONSTRAINTS

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resize Target Utilization</td>
<td>0</td>
</tr>
</tbody>
</table>

When resizing a workload, this sets how much you would like that workload to utilize its resources. This setting is especially useful on the public cloud if you want to keep your workloads on a smaller template as long as possible.

Turbonomic uses the Desired State setting to globally set the optimal utilization of resources. By default, this is set to 70%. However, with this setting you can increase target utilization for VMs − for example, 90%. For the scope of the policy, Turbonomic can recommend actions that result in resource utilization as high as 90%.

For example, assume you have a workload (a VM, container, database server, etc.) on a template T4 that has 4 VCPUs, and Turbonomic wants to reduce the VCPUs for that workload. Also assume there are two available templates, T2 with two VCPUs and T1 with a single VCPU. Assume that with default settings Turbonomic would resize the workload to T2. But assume the workload can run on T1, and use 85% of the template’s resources. If you set Resize Target Utilization to 90%, Turbonomic could resize the workload to T1. Also, it would avoid resizing to a larger template until utilization on that template exceeds the default and approaches 90%.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increment constant for Container VMEM [MB]</td>
<td>64</td>
</tr>
<tr>
<td>Increment constant for Container VCPU [MHz]</td>
<td>100</td>
</tr>
</tbody>
</table>

Scaling Constraints

Scaling constraints include settings that specify how Turbonomic takes actions to resize a container. The following table shows the default settings for Resize increments:

For resize increments, you should consider the following:

- For VMem, you should not set the increment value to be lower than what is necessary for the container to operate. If the VMem increment is too low, then it’s possible that Turbonomic would allocate insufficient VMem for the machine to operate. For a container that is under utilized, Turbonomic will reduce VMem allocation by the increment amount, but it will not leave a container with zero VMem. For example, if you set this to 64, then Turbonomic cannot reduce the VMem to less than 64 MB.

- For VCPU, the increment affects resize of VCPU limits and reservations in MHz, and it also affects the addition/removal of cores for VCPU capacity on a container.

For limits and reservations, Turbonomic recommends changes in terms of the specified resize increment. For example, assume the increment is 1800 MHz and you have reserved 3000 MHz for a VM. Turbonomic could recommend to reduce the reservation by 1800, down to 1200 MHz.

For VCPUs, Turbonomic can only resize allocation one core at a time. This means a resize is to the nearest core count that matches or exceeds the resize increment. Assume the cores all have a clock speed of 2000 MHz. If the resize increment is 1800 MHz, then a resize up will recommend to add one more core at 2000 MHz.
Analysis Policies: Databases

OPERATIONAL CONSTRAINTS

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resize Target Utilization</td>
<td>0</td>
</tr>
</tbody>
</table>

When resizing a workload, this sets how much you would like that workload to utilize its resources. This setting is especially useful on the public cloud if you want to keep your workloads on a smaller template as long as possible.

Turbonomic uses the Desired State setting to globally set the optimal utilization of resources. By default, this is set to 70%. However, with this setting you can increase target utilization for VMs – for example, 90%. For the scope of the policy, Turbonomic can recommend actions that result in resource utilization as high as 90%.

For example, assume you have a workload (a VM, container, database server, etc.) on a template T4 that has 4 VCPUs, and Turbonomic wants to reduce the VCPUs for that workload. Also assume there are two available templates, T2 with two VCPUs and T1 with a single VCPU. Assume that with default settings Turbonomic would resize the workload to T2. But assume the workload can run on T1, and use 85% of the template’s resources. If you set Resize Target Utilization to 90%, Turbonomic could resize the workload to T1. Also, it would avoid resizing to a larger template until utilization on that template exceeds the default and approaches 90%.

Analysis Policies: Database Servers

OPERATIONAL CONSTRAINTS

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resize Target Utilization</td>
<td>0</td>
</tr>
</tbody>
</table>

When resizing a workload, this sets how much you would like that workload to utilize its resources. This setting is especially useful on the public cloud if you want to keep your workloads on a smaller template as long as possible.

Turbonomic uses the Desired State setting to globally set the optimal utilization of resources. By default, this is set to 70%. However, with this setting you can increase target utilization for VMs – for example, 90%. For the scope of the policy, Turbonomic can recommend actions that result in resource utilization as high as 90%.

For example, assume you have a workload (a VM, container, database server, etc.) on a template T4 that has 4 VCPUs, and Turbonomic wants to reduce the VCPUs for that workload. Also assume there are two available templates, T2 with two VCPUs and T1 with a single VCPU. Assume that with default settings Turbonomic would resize the workload to T2. But assume the workload can run on T1, and use 85% of the template’s resources. If you set Resize Target Utilization to 90%, Turbonomic could resize the workload to T1. Also, it would avoid resizing to a larger template until utilization on that template exceeds the default and approaches 90%.
Analysis Policies: Disk Arrays

Default Settings

STORAGE SETTINGS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSeries LUN IOPS Capacity</td>
<td>5000</td>
</tr>
<tr>
<td>7.2k Disk IOPS Capacity</td>
<td>800</td>
</tr>
<tr>
<td>10k Disk IOPS Capacity</td>
<td>1200</td>
</tr>
<tr>
<td>15k Disk IOPS Capacity</td>
<td>1600</td>
</tr>
<tr>
<td>SSD Disk IOPS Capacity</td>
<td>50000</td>
</tr>
<tr>
<td>Disk Array IOPS Capacity</td>
<td>10000</td>
</tr>
<tr>
<td>DiskArray Overprovisioned Percentage</td>
<td>200</td>
</tr>
</tbody>
</table>

DiskArray Provisioned

How much overprovisioning Turbonomic assumes when recommending actions for disk arrays. For example, if a disk array has a 30 TB capacity, and DiskArray Overprovisioned Percentage is set to 200, Turbonomic will treat the datastore as though it has a capacity of 60 TB, or 200% of the actual disk array capacity.

IOPS Capacity

The capacity of IOPS (IO operations per second) that your storage devices can support. Turbonomic considers these settings when calculating utilization percentage. For example, assume IOPS Capacity of 5000 for a disk array. If utilization on the array is 2500 IOPS, then the disk array is at 50% of capacity for that metric.

Note that the IOPS setting for an array will determine IOPS calculations for all the storage on that array. If you made different IOPS settings for individual datastores hosted by the array, Turbonomic ignores the datastore settings and uses the disk array settings.

- Various Disk IOPS Capacity settings (SSD Disk IOPS, 7.2k Disk IOPS, etc)
  IOPS capacity settings for the different types of physical drives that are discovered on a disk array. If the storage controller exposes the types of disks in the array, Turbonomic uses multiples of these values to calculate the IOPS capacity of the disk array.

- Disk Array IOPS Capacity
  Some disk arrays do not expose data for their individual disks — This is typical for flash arrays, or arrays that aggregate storage utilization across multiple tiers. Turbonomic uses this setting for the IOPS capacity of such disk arrays. Set it to the global scope to specify IOPS capacity for all disk arrays. To override this setting, set a disk array or group of disk arrays as the property scope, and then set the value you want for IOPS Capacity.

**NOTE:** The user interface shows a disk array entity for any array that is discovered through a valid disk array or storage controller target. It also shows placeholder disk arrays for disk arrays that are not discovered through a configured target. For example, you might have disk arrays that Turbonomic does not natively support. Or you might have storage that is not hosted by any disk array. Such placeholder disk array entities appear with the string "DiskArray-" prefixed to their names. The user interface allows you to set IOPS Capacity to these placeholders, but those settings have no effect. To set IOPS Capacity for that storage, you must set it to the individual datastores.
**Analysis Policies: Hosts**

**OPERATIONAL CONSTRAINTS**

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignore Hyperthreading</td>
<td>Off</td>
</tr>
</tbody>
</table>

Turbonomic calculates extra CPU capacity when it detects hyperthreaded sockets.

**UTILIZATION CONSTRAINTS**

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Overprovisioned Percentage</td>
<td>1000</td>
</tr>
<tr>
<td>Host Memory Utilization</td>
<td>100</td>
</tr>
<tr>
<td>Host Net Throughput</td>
<td>50</td>
</tr>
<tr>
<td>Mem Overprovisioned Percentage</td>
<td>1000</td>
</tr>
<tr>
<td>Host Ready Queue Utilization</td>
<td>50</td>
</tr>
<tr>
<td>Host CPU Utilization</td>
<td>100</td>
</tr>
<tr>
<td>Host Swapping Utilization</td>
<td>20</td>
</tr>
<tr>
<td>Host IO Throughput</td>
<td>50</td>
</tr>
</tbody>
</table>

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity. For example:

- Setting 50 for Host Net Throughput means that Turbonomic considers 50% utilization of that throughput to be 100% of capacity and 25% utilization to be 50% of capacity
- Setting 1000 for Mem Overprovisioned Percentage means that overprovisioning memory by 5 times the physical capacity shows up as 50% utilization of the Mem Overprovisioned capacity in Turbonomic
- Setting 100 for Host Memory Utilization means that Turbonomic capacity reflects the physical capacity for this resource

**DESIRED STATE**

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>10</td>
</tr>
<tr>
<td>Center</td>
<td>70</td>
</tr>
</tbody>
</table>
The desired state for your environment is an n-dimensional sphere that encompasses the fittest conditions your environment can achieve. The multiple dimensions of this sphere are defined by the resource metrics in your environment. Metric dimensions include VMem, storage, CPU, etc. While the metrics on the devices in your environment can be any value, the desired state, this n-dimensional sphere, is the subset of metric values that assures the best performance while achieving the most efficient utilization of resources that is possible.

The Desired State settings define the center of the sphere as well as its diameter. This is a way for you to customize what Turbonomic considers to be the desired state.

Setting the center of the sphere chooses the priority for Turbonomic analysis. If you set the balance in favor of efficiency, Turbonomic tends to place more VMs on fewer physical hosts, and to give them storage capacity from fewer data stores. As a result, high utilization can have more impact on QoS. With a balance in favor of performance, Turbonomic tends to spread virtual loads across more physical devices. This can result in the provisioning of excess resources.

The diameter setting determines the range of deviation from the center that can encompass the desired state. If you specify a large diameter, Turbonomic will have more variation in the way it distributes workload across hosting devices.

As you move each slider, a tooltip displays the numerical value of the setting. **Center** indicates the percentage of resource utilization you want, within the range you specify as **Diameter**. For example, if you want utilization of 75%, plus or minus 10%, then you would set **Center** = 75 and **Diameter** = 20. Turbonomic recommends actions that tend toward this desired state much as possible, given the dependencies within the current environment.

---

**NOTE:** The setting for Target Utilization can have an effect on plans that you run. If you disable provisioning and suspension for hosts and datastores, then you should always set Center and Diameter to their default values.

**INTERNAL TOPOLOGY SETTINGS: HYPER-V**

**Default Settings**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Additional Polling Cycles</td>
<td>5</td>
</tr>
</tbody>
</table>

In Hyper-V environments, it is possible that the Hyper-V management software can report that an entity has been removed when in fact it has not been. In that case, Turbonomic can remove the entity from its market representation of your environment, when in fact the entity is still present. With the **Number of Additional Polling Cycles** setting, you can direct Turbonomic to wait a specified number of polling cycles before acknowledging that an entity has been removed.

---

**NOTE:** This is a special-case setting, and you should only use it if you are in contact with Turbonomic Support.

**Analysis Policies: Logical Pools**

**Default Settings**

**STORAGE SETTINGS**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LogicalPool Overprovisioned Percentage</td>
<td>200</td>
</tr>
</tbody>
</table>
LogicalPool Provisioned

How much overprovisioning Turbonomic assumes when recommending actions for logical pools. For example, if a pool has a 30 TB capacity, and LogicalPool Overprovisioned Percentage is set to 200, Turbonomic will treat the pool as though it has a capacity of 60 TB, or 200% of the actual pool capacity.

Analysis Policies: Storage Controllers

Default Settings

UTILIZATION CONSTRAINTS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Controller Storage Amount</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Maximum allowed utilization of storage that is managed by the Storage Controller.</td>
</tr>
<tr>
<td>Storage Controller CPU Utilization</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Maximum allowed utilization of Storage Controller CPU (from 20 to 100).</td>
</tr>
</tbody>
</table>

Analysis Policies: Storage

Operational Constraints

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Max Size (GB)</td>
<td>20480</td>
</tr>
<tr>
<td></td>
<td>Tuned Scaling Range Upper Limit: Turbonomic uses this range to set up tuned scaling actions for the datastore (see Storage (Datastore) Actions on page 233). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.</td>
</tr>
<tr>
<td>Storage Min Size (GB)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Tuned Scaling Range Lower Limit: Turbonomic uses this range to set up tuned scaling Actions for the datastore (see Storage (Datastore) Actions on page 233). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.</td>
</tr>
</tbody>
</table>

UTILIZATION CONSTRAINTS

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Amount Utilization</td>
<td>90</td>
</tr>
<tr>
<td>Disk Array Storage Amount Utilization</td>
<td>90</td>
</tr>
<tr>
<td>Storage IOPS Utilization</td>
<td>100</td>
</tr>
<tr>
<td>Storage Latency Utilization</td>
<td>100</td>
</tr>
</tbody>
</table>
Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity. For example, setting 90 for Storage Amount Utilization means that Turbonomic considers 90% utilization of the physical storage to be 100% of capacity.

**STORAGE SETTINGS**

**Default Settings**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directories to Ignore</td>
<td>`.dvsData.*</td>
</tr>
<tr>
<td>Files to Ignore</td>
<td>Empty String</td>
</tr>
<tr>
<td>Disable Datastore Browsing</td>
<td>On</td>
</tr>
<tr>
<td>Storage Latency [ms]</td>
<td>100</td>
</tr>
<tr>
<td>Storage Overprovisioned Percentage</td>
<td>200</td>
</tr>
<tr>
<td>IOPS Capacity</td>
<td>5000</td>
</tr>
</tbody>
</table>

- **Storage Overprovisioned Percentage**
  Storage Overprovisioned Percentage sets how much overprovisioning Turbonomic assumes when recommending actions for VM datastores. For example, if a datastore has a 30 GB capacity, and Storage Overprovisioned Percentage is set to 200, Turbonomic will treat the datastore as though it has a capacity of 60 GB, or 200% of the actual datastore capacity.

- **IOPS Capacity**
  IOPS Capacity is the IOPS setting for individual datastores. To set a specific capacity for one group of datastores, select that group as the property scope and override the global setting for that scope.
  Note that IOPS capacity for a disk array takes precedence — Datastores that are members of a disk array always have the IOPS capacity that is set to the disk array.
  Turbonomic considers these settings when calculating utilization percentage. For example, assume IOPS Capacity of 500 for datastores. If utilization on a datastore is 250 IOPS, then the datastore is at 50% of capacity for that metric.

- **Storage Latency**
  This sets the maximum storage latency to tolerate on a datastore, in ms. The default setting is 100 ms.
  Turbonomic measures the latency experienced by all VMs and hosts that access the datastore. Assume a default setting of 100 ms. If a datastore exhibits latency of 50 ms, then the Turbonomic will show latency utilization of 50%.

- **Wasted Storage Management**
  You can make settings to control how Turbonomic tracks and reports on wasted storage in your environment. Wasted storage is any disk space devoted to files that are not required for operations of the devices or applications in your environment. Wasted storage may indicate opportunities for you to free up disk space, and provide more storage capacity to running VMs and applications.
  The **Disable Datastore Browsing** setting disables wasted storage management — By default, the global setting is to **Disable** for the entire managed environment (**Disable Datastore Browsing** is ON for the Global scope).
NOTE: It’s possible that a single datastore can be managed by more than one instance of vCenter Server. Browsing over such a datastore can result in conflicting values for wasted storage in reports and in the Improve Overall Efficiency dashboard. You should not enable datastore browsing for a scope that includes such a datastore.

To enable the tracking of wasted storage for the full environment, enable this setting globally. If there are groups of datastores you don’t want to track for wasted storage, set the given scope and disable datastore browsing there. If you prefer not to use Turbonomic resources to track wasted storage, leave the global setting checked.

The settings for Directories to Ignore and Files to Ignore specify directories and files that Turbonomic will not consider when looking for wasted data storage space. Separate items in these lists with the OR bar ("|").

Analysis Policies: Switches

Default Settings

UTILIZATION CONSTRAINTS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch Net Throughput</td>
<td>70</td>
</tr>
</tbody>
</table>

Analysis Policies: Virtual Applications

LOAD BALANCER SETTINGS

To manage load balancers, Turbonomic tracks transactions that occur on the virtual applications (vservers) each load balancer manages. You can set the capacity of transactions per second as a policy for virtual applications. Turbonomic will list transaction utilization as a percentage of the capacity you set.

Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Application Transactions Capacity [per sec]</td>
<td>1000</td>
</tr>
</tbody>
</table>
## Analysis Policies: VMs

### OPERATIONAL CONSTRAINTS

#### Default Settings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignore During VPod Creation</td>
<td>Off</td>
<td>This specifies storage latency requirements for VMs in the given group in ms, from 20 to 2000. Turbonomic will not place the VMs on storage that cannot meet the specified requirement. For example, if you set a value of 20 ms (the minimum) and all the storage available to the VM has latency of 60 ms or higher, then Turbonomic will recommend provisioning new storage. To effectively ignore Storage Latency SLA when placing workload, set this to a very high number.</td>
</tr>
<tr>
<td>Storage Latency SLA Value [ms]</td>
<td>100</td>
<td>This sets the minimum number of VMs to place in a given scope. Ensuring a minimum number of VMs in a scope is a way to specify high availability for the virtual workload in your environment. For a setting of 0, Turbonomic does not enforce a minimum number of workloads in the given scope.</td>
</tr>
<tr>
<td>Enable High Availability (Workload HA)</td>
<td>0</td>
<td>This sets the scale of Geographic Redundancy. On a scale from 0 to 100, this sets how aggressively Turbonomic will keep workloads in this group on separate providers. With a setting of 100, Turbonomic will always try to place the workloads on different providers. With a setting of 0, Turbonomic does not alter its calculations to enforce a separation of workloads on different providers. For a setting of 0, Turbonomic does not enforce separation of workloads on different providers.</td>
</tr>
<tr>
<td>Enable Geographic Redundancy</td>
<td>0</td>
<td>When resizing a workload, this sets how much you would like that workload to utilize its resources. This setting is especially useful on the public cloud if you want to keep your workloads on a smaller template as long as possible. Turbonomic uses the Desired State setting to globally set the optimal utilization of resources. By default, this is set to 70%. However, with this setting you can increase target utilization for VMs – for example, 90%. For the scope of the policy, Turbonomic can recommend actions that result in resource utilization as high as 90%. For example, assume you have a workload (a VM, container, database server, etc.) on a template T4 that has 4 VCPUs, and Turbonomic wants to reduce the VCPUs for that workload. Also assume there are two available templates, T2 with two VCPUs and T1 with a single VCPU. Assume that with default settings Turbonomic would resize the workload to T2. But assume the workload can run on T1, and use 85% of the template’s resources. If you set Resize Target Utilization to 90%, Turbonomic could resize the workload to T1. Also, it would avoid resizing to a larger template until utilization on that template exceeds the default and approaches 90%.</td>
</tr>
<tr>
<td>Resize Target Utilization</td>
<td>0</td>
<td>Tuned Scaling Range Upper Limit: Turbonomic uses this range to set up tuned scaling actions for the VM (see VM Actions on page 229). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.</td>
</tr>
<tr>
<td>VCPU Max Size (CPUs)</td>
<td>62</td>
<td>Tuned Scaling Range Lower Limit: Turbonomic uses this range to set up tuned scaling actions for the VM (see VM Actions on page 229). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.</td>
</tr>
<tr>
<td>VCPU Min Size (CPUs)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Scaling constraints include settings that specify how Turbonomic takes actions to resize a VM. These settings include:

- **Resize Increments:**
  These increments specify how many units to add or subtract when resizing the given resource allocation for a VM. For example, it makes sense to change VMem by steps of 1024 MB at a time, but for VStorage it’s better to make changes by 0.5 GB steps.

### Attribute | Default Value
---|---
VMEM Max Size (MB) | 131072
  Tuned Scaling Range Upper Limit:
  Turbonomic uses this range to set up tuned scaling Actions for the VM (see VM Actions on page 229). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.

VMEM Min Size (MB) | 512
  Tuned Scaling Range Lower Limit:
  Turbonomic uses this range to set up tuned scaling actions for the VM (see VM Actions on page 229). For an overview of tuned scaling, see Tuned Scaling Action Settings on page 223.

Minimum Sustained Utilization | 0
  The percentage of VCPU utilization for a VM to indicate that the VM is being utilized by the applications it hosts. For example, a VM can show VCPU utilization to maintain the Guest OS, even though the application it hosts is idle. To enable suspend actions even though some utilization is present on the VM, set this to a value greater than zero.
The following table shows the default settings for the Resize increments:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increment constant for VDC Mem Allocation [MB]</td>
<td>1024</td>
</tr>
<tr>
<td>Increment constant for VMEM[MB]</td>
<td>1024</td>
</tr>
<tr>
<td>Increment constant for Storage Amount [GB]</td>
<td>100</td>
</tr>
<tr>
<td>Increment constant for VDC Storage Allocation [GB]</td>
<td>1</td>
</tr>
<tr>
<td>Increment constant for VCPU [MHz]</td>
<td>1800</td>
</tr>
<tr>
<td>Increment constant for VStorage [GB]</td>
<td>999999</td>
</tr>
<tr>
<td>Increment constant for VDC CPU Allocation [MHz]</td>
<td>1800</td>
</tr>
<tr>
<td>Increment constant for Heap [MB]</td>
<td>100</td>
</tr>
</tbody>
</table>

For resize increments, you should consider the following:

- For VMem, you should not set the increment value to be lower than what is necessary for the VM to operate. If the VMem increment is too low, then it’s possible that Turbonomic would allocate insufficient VMem for the machine to operate. For a VM that is under utilised, Turbonomic will reduce VMem allocation by the increment amount, but it will not leave a VM with zero VMem. For example, if you set this to 1024, then Turbonomic cannot reduce the VMem to less than 1024 MB.

- For VCPU, the increment affects resize of VCPU limits and reservations in MHz, and it also affects the addition/removal of cores for VCPU capacity on a VM.

For limits and reservations, Turbonomic recommends changes in terms of the specified resize increment. For example, assume the increment is 1800 MHz and you have reserved 3000 MHz for a VM. Turbonomic could recommend to reduce the reservation by 1800, down to 1200 MHz.

For VCPUs, Turbonomic can only resize allocation one core at a time. This means a resize is to the nearest core count that matches or exceeds the resize increment. Assume the cores all have a clock speed of 2000 MHz. If the resize increment is 1800 MHz, then a resize up will recommend to add one more core at 2000 MHz.

- For VStorage, the default setting is very high to disable resize actions. This is usually preferred because VStorage resize requires that you reformat the storage.

• Rate of Resize

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Resize</td>
<td>2 (Medium)</td>
</tr>
</tbody>
</table>
When resizing resources for a VM, Turbonomic calculates the optimal values for VMem, VCPU and VStorage. But it does not necessarily make a change to that value in one action. Turbonomic uses the Rate of Resize setting to determine how to make the change in a single action, as follows:

- **Low**
  Change the value by one increment, only. For example, if the resize action calls for increasing VMem, and the increment is set at 1024, Turbonomic increases VMem by 1024 MB.

- **Medium**
  Change the value by an increment that is 1/4 of the difference between the current value and the optimal value. For example, if the current VMem is 2 GB and the optimal VMem is 10 GB, then Turbonomic will raise VMem to 4 GB (or as close to that as the increment constant will allow).

- **High**
  Change the value to be the optimal value. For example, if the current VMem is 2 GB and the optimal VMem is 8 GB, then Turbonomic will raise VMem to 8 GB (or as close to that as the increment constant will allow).

- **Aggressiveness**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressiveness</td>
<td>95th Percentile</td>
</tr>
</tbody>
</table>

When evaluating VCPU and VMEM performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization in the public cloud, the analysis considers a given utilization percentile. For example, assume a 95th percentile. The percentile utilization is the highest value that 95% of the observed samples fall below. However, average utilization is the average of all the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is especially important in the cloud, so that analysis can better exploit the elasticity of the cloud.

For example, consider decisions to reduce the capacity for CPU on a VM. For on-prem entities, Turbonomic never resizes below the recognized peak utilization. For most VMs there are moments when peak CPU reaches high levels. Assume utilization for a VM peaked at 100% just once. On-prem resizing does not use a percentile, and Turbonomic will not reduce allocated CPU for that VM.

For calculations on the public cloud, instead of using the single highest utilization value, Turbonomic uses a percentile. For the above example, assume a single CPU burst to 100%, but for 95% of the samples CPU never exceeded 50%. If you set **Aggressiveness** to 95th Percentile, then Turbonomic can see this as an opportunity to reduce CPU allocation for the VM.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- **100th Percentile** – The least aggressive, recommended for critical workloads that need maximum guaranteed performance at all times.
- **95th Percentile (Default)** – The recommended setting to achieve maximum performance and savings.
- **90th Percentile** – The most aggressive, recommended for non-production workloads that can stand higher resource utilization.

- **Max Observation Period**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Observation Period</td>
<td>Last 30 Days</td>
</tr>
</tbody>
</table>
To refine the calculation of resource utilization on the public cloud, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. (If the database has fewer days' data then it uses all of the stored historical data.) A shorter period means there are fewer data points to account for when Turbonomic calculates utilization percentiles. This results in more dynamic, elastic resizing, while a longer period results in more stable or less elastic resizing. You can make the following settings:

- Less Elastic – Last 90 Days
- Recommended – Last 30 Days
- More Elastic – Last 7 Days

Excluded Templates

Use this setting to ensure that a scope of VMs only uses the templates you want. There are certain environments that use templates to specify the resource allocations for a VM or other workload. Public cloud environments such as AWS or Azure use templates, and some private cloud environments use templates also.

For example, assume you need to add memory to a VM. For VMs running on hypervisors, Turbonomic calculates the amount of memory to add, and can then use the hypervisor's API to add exactly that memory to the VM. In a template-based environment, Turbonomic chooses the template that most closely meets the resize requirements and applies that template to the VM.

For a given scope, you might want to make sure that the VMs never use certain templates. For example, you might want to exclude templates for cost or licensing reasons. You can add those templates to this setting, and any VMs in the policy's scope will not use those templates for a resize.

NOTE: In public cloud environments, both resize and move actions use templates. This setting excludes the named templates for all of these actions. Turbonomic will not use an excluded template for move or resize action. In addition, if you exclude a template for a scope, but some workloads already use that template, then Turbonomic will recommend moving the workload off of that excluded template.

This policy setting affects both real-time actions and actions in a plan. The default setting is No Exclusions.

Policy Examples

Policies provide a way to affect Turbonomic analysis so that the recommended actions satisfy your requirements. These examples show some common requirements you can set up.

Enabling VM Suspend Actions in the Public Cloud

To save money in the public cloud, Turbonomic can identify VMs that you can suspend. To enable VM suspend actions, you must set up policies on the affected applications as well as the VMs that host those applications.

To set up suspend actions for VMs on the cloud:

- Set the priority for the affected applications to Normal
  
  By default, Turbonomic gives all applications a priority of Mission Critical. For Turbonomic to suspend a VM, the priority for the hosted application must be Normal.

  To set the priority for the affected applications, first create a group that contains these applications. Note that you must create the group. You cannot use any groups that have been discovered by Turbonomic. For information about creating groups, see Creating Groups on page 193.

  Once you have created the group, create an Applications policy that uses the group as its scope. Then set the Application Priority to Normal. For information about application policies, see Analysis Policies: Applications on page 244.
Note that you might later decide these applications really are critical. In that case, you can set their priority back to Mission Critical. When you do, Turbonomic recognizes the change of priority, and powers up any suspended VMs in that scope.

- Set up action mode and operational constraints for the affected VMs
  Turbonomic does not enable automatic suspension of VMs on the public cloud, so you must set the action mode to Manual. You also must set the Minimum Sustained Utilization to a value that indicates that the VM is not being utilized. To do this, you will create an automation policy.
  
  The first step is to identify the scope of VMs you want to affect. You can use groups that Turbonomic discovers. For example, you can use a group of all the VMs in a given region or zone, or all the VMs for a given cloud target. You can also create your own group. Once you identify the group or groups you want, set the scope to the policy. For information, see Automation Policies on page 217.
  
  Once you have set the policy scope, set the action mode for Suspend to Manual. For information, see Setting Action Modes on page 223.

  The other setting to make for this policy is Minimum Sustained Utilization. This setting gives the percentage of VCPU utilization for a VM to indicate that the VM is being utilized by the applications it hosts. For example, a VM can show utilization of VCPU to maintain the Guest OS, even though the application it hosts is idle. Set the value to a percentage that is slightly above VM utilization when all hosted processes are idle. If utilization falls below that percentage, then Turbonomic can recommend suspending the VM. For information, see Analysis Policies: VMs on page 256.

**Fine Tune VM Resize Calculations for the Public Cloud**

Turbonomic analysis generates resize actions to change allocated capacity so that it better meets demand. In public cloud environments, to resize a VM you actually move the VM to a different template. The list of templates that’s available depends on the cloud account, and the given region or availability zone. When Turbonomic calculates a VM resize, it looks for the template that best matches the desired values and moves the VM to that template.

To calculate the new capacity for a resize, Turbonomic uses Resize Increments. To improve template selection, you can adjust the VCPU resize increment to better match the CPU offerings in the available templates.

The default resize increment for VCPU is 1800 MHz. To fine tune resizing, set this to a lower value. You can look at the templates in your accounts, and set this increment to the lowest common denominator among them.

Note that Resize Increment is a global setting for all VMs in your environment, both on-prem and on the public cloud. For more information, see Scaling Constraints on page 257 in “Analysis Policies: VMs”.

**Identifying Wasted Storage on the Public Cloud**

Full management of storage on the public cloud includes identifying wasted storage. Wasted storage is any disk space devoted to files that are not required for operations of the workloads in your cloud environment. It can indicate opportunities for you to free up disk space, and reduce your overall cloud costs.

To enable the management of wasted storage, create a policy for your cloud storage. Then under Storage Settings add the Disable Datastore Browsing setting, and then turn it off. Turbonomic disables datastore browsing by default, so you must add this setting to enable wasted storage management. You can also specify directories or files to ignore so that the datastore browsing does not consider these files to be wasted storage. For more information, see STORAGE SETTINGS on page 254.

To apply this policy to your cloud storage, you must set a scope to the policy. Turbonomic discovers groups of storage by cloud provider or cloud region. You can use these discovered groups to set the scope, or you can create your own groups of storage.
Templates: Resource Allocations for New Entities

Turbonomic uses templates to describe new entities that it will deploy in your environment or in plans. The templates specify resource allocations for these entities. For example, you can run a plan that adds new VMs to a cluster. If you add ten copies of a template, then the plan places ten new VMs that match the resource allocation you have specified for the given template.

A VM template definition can include one or more images that Turbonomic uses to deploy the VM in your environment. The image identifies the actual deployment package:

- To deploy on-prem, a path to the physical files (for example an OVA)
- For cloud deployments, the cloud provider’s named VM image (for AWS, the AMI)

As you deploy an instance of a VM template, Turbonomic chooses the best image for that instance. For cloud deployments, this includes finding the machine image configuration that best matches the template configuration.

The Template Catalog shows all of the templates that have been specified or discovered for your installation of Turbonomic. From this page, you can also create new templates and edit existing ones.
Creating Templates

Templates specify the resources for entities that Turbonomic can deploy in your environment, or in plans.

A VM template definition can include one or more images that Turbonomic uses to deploy the VM in your environment. The image identifies the actual deployment package:

- To deploy on-prem, a path to the physical files (for example an OVA)
- For cloud deployments, the cloud provider’s named VM image (for AWS, the AMI)

As you deploy an instance of a VM template, Turbonomic chooses the best image for that instance. For cloud deployments, this includes finding the machine image configuration that best matches the template configuration.

The Template Catalog shows all of the templates that have been specified or discovered for your installation of Turbonomic. From this page, you can also create new templates and edit existing ones.

Creating and Editing Templates

To create a new template, navigate to the Template Catalog and click NEW TEMPLATE. To edit a template, click the template's name. When you create a new template, the first step is to choose the entity type.

1. Navigate to the Settings Page.

2. Choose Templates.

3. Create or edit a template
   To create a new template, navigate to the Template Catalog and click NEW TEMPLATE. To edit a template, click the template's name.

4. If you're creating a new template, choose the entity type.
5. **Make the settings for your template.**
   For each type of template, you set allocations for different resources. You can make templates of the following types:
   - Virtual Machine
   - Host
   - Storage
   - Container

6. **Make the settings for your template, and then save your changes.**
   When the template window opens, it displays the most common resource settings. You can expand the settings to see the full collection for that template type.

7. **Save your changes.**
   After you have made your settings and named the template, click **CREATE** or **SAVE**.

### VM Template Settings

A VM template describes the resource allocation that you want to provide for a type of VMs. When Turbonomic deploys the associated VM to your environment or in a plan, it uses these values to determine the size of the VM. Turbonomic uses the Size settings to calculate the best placement for a VM of this type.

A VM template can optionally include an image description. When Turbonomic uses the template to deploy a VM to your environment, it uses the image to access the actual bits that install as the VM instance.

#### VM Size

- **CPU**
  The virtual CPUs assigned to the VM. Specify the number of **Cores** and the **VCPU** clock speed – Turbonomic multiplies these values to calculate the host CPU resources it will allocate when placing the VM.
  The **Utilization** value sets the percentage of allocated CPU that the placed VM will consume. To ensure the host has left over resources for infrastructure tasks, you should assign less than 100%.

- **Memory**
  The amount of memory to allocate for the VM, in MB.
  The **Utilization** value sets the percentage of allocated memory that the placed VM will consume. To ensure the host has left over resources for infrastructure tasks, you should assign less than 100%.
  Note that you should never allocate less memory than is required for the VM’s guest OS.

- **Storage**
  The storage resources to allocate for this VM.
  - **disk/rdm** – If you choose **rdm**, then the VM can use VMware Raw Device Mapping for its storage.
  - **IOPS** – The capacity for IO operations you give the VM for this datastore.
  - **Size** – The amount of storage capacity, in GB.
  The **Utilization** value sets the percentage of allocated memory that the placed VM will consume. To ensure the storage has left over resources for infrastructure tasks, you should assign less than 100%.
  Note that you can allocate multiple datastores to the VM.

- **Network**
  The amount of the host’s network throughput to assign to the VM, in Mb/s.

- **IO**
  The amount of throughput on the host’s IO bus to assign to the VM, in Mb/s
VM Image

To support VM deployment based on the template, you can specify one or more images. The image is the actual deployment package for that VM. To add images to the template, show the IMAGE tab, and click Add Image. Turbo-nomic displays a list of the datacenters and cloud regions that it has discovered. Choose from that list to add it to the template's images.

After you choose the datacenter or region, you then specify:

- For On-Prem Deployment – The path to the image files in that datacenter
- For Cloud Deployment – The name of the image for that cloud region
Host Template Settings

Host templates describe models of physical hosts that you can deploy in the on-prem datacenter. As part of capacity planning, you might want to see how to replace your current hosts with different models. To do that, you create templates to represent the hosts you want, and then use those templates when running hardware replacement plans.

The host template is a collection of these settings:

- **CPU**
  The processor for this host model. Note that CPU size and speed are not the only factors to determine processing power. To address this, you can specify the host CPU in the following ways:
  - Select from Catalog
    When you enable **Select from Catalog**, you can open up a catalog of CPU models that Turbonomic uses to map the model to an effective capacity for the CPU.
  - Cores and CPU Speed
    When you disable **Select from Catalog**, you can specify the number of **Cores** and the **CPU** clock speed – Turbonomic multiplies these values to calculate the host CPU resources.

- **Memory**
  The amount of memory to allocate for the VM, in MB.

- **Network**
  The host’s network throughput, in MB/s.

- **IO**
  The host’s IO bus throughput, in MB/s

- **Price**
  If you know the price of the host model that you’re specifying for the template, you can enter it here. When running a plan, Turbonomic can use the price to calculate costs or savings when adding or removing host machines in an on-prem datacenter.

Selecting CPUs from the Catalog

CPU processor speed is not necessarily an effective indicator of CPU capacity. For example, processor architecture can make a slower CPU have a greater effective capacity. Newer models of machines can often have fewer cores or less clock speed, but still have a higher effective capacity. This can affect planning in two ways:

- When planning hardware replacement, the plan knows the template’s effective capacity. This means the plan knows how to best place workloads on the new hardware.
- For already deployed hosts, Turbonomic discovers the effective capacity and uses that information when calculating workload placement.

To build the catalog of CPU capacity, Turbonomic uses the CINT2006 benchmark data from spec.org. When you set up the CPU for a host template, you can search this catalog for the processor you want, and set it to the template.
NOTE: Turbonomic also uses the effective processor capacity when calculating workload placement in real-time. For more information, see Effective CPU Capacity on page 20.

Storage Template Settings

Storage templates describe models of storage that you can deploy in the on-prem datacenter. As part of capacity planning, you might want to see how to replace your current storage with different models. To do that, you create templates to represent the storage you want, and then use those templates when running hardware replacement plans.
The storage template is a collection of these settings:

- **Storage**
  - The capacity for this storage.
  - **IOPS** – The capacity for IO operations on this storage.
  - **Size** – The amount of storage capacity, in GB.

- **Price**
  - If you know the price of the storage model that you're specifying for the template, you can enter it here. When running a plan, Turbonomic can use the price to calculate costs or savings when adding or removing storage in an on-prem datacenter.

## Container Template Settings

A container template describes the resource allocation that you want to provide for a type of containers. When Turbonomic deploys the associated container to your environment or in a plan, it uses these values to determine its size. Turbonomic uses these settings to calculate the best placement for a container of this type.

The container template is a collection of these settings:

- **CPU**
  - The VM's CPU capacity to allocate to this container, in MHz.

- **Memory**
  - The amount of memory to allocate for the container, in MB.

- **Storage**
  - The storage resources to allocate for this container.

- **Network**
  - The amount of the host's network throughput to assign to the VM, in Mb/s.

- **IO**
  - The amount of the host VM's IO throughput to assign to the container, in Mb/s

## Email and Trap Notifications

Turbonomic is designed to manage your environment in real time. If conditions arise in your environment that prevent Turbonomic from collecting the data it needs, or from executing control actions on the entities in your environment, then it posts notifications to the user interface to alert you to such problems. If Turbonomic control is especially critical for certain scopes in your environment, you can set up email and SNMP trap notifications to alert you to any issues that arise within those scopes.

For example, you can set up a notification to your email address whenever there’s a discovery problem within a specific scope of hosts, or an SNMP trap to your network management application whenever there’s a monitoring problem on specific storage.
To set up these notifications, you perform two steps:

- **Make Email Settings** to set up your SMTP relay, declare a “From” address for emails from Turbonomic, and set up the formats of notification emails.
- **Make Notification Settings** to configure the notifications you want to receive for specific scopes of entities in your environment.

## Email Settings

The first step for preparing email notifications is to configure email handling in Turbonomic.

1. **Navigate to the Settings Page.**
   - Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. **Choose Email and Trap Notifications.**
   - Click to navigate to the Email and Trap Notifications Page.
   - This page has a tab to configure **Email Settings** and a tab to configure **Notification Settings**.

3. **Display the Email Settings tab.**
   - From here, you can configure:
     - SMTP Relay Settings
     - General Email Settings
     - Email Content Format

### SMTP Relay Settings

The SMTP Relay fields identify the mail relay server you use on your network to enable email communication from Turbonomic. The relay you set up here enables emails from notifications, as well as emails to send reports to subscribers.
General Email Settings

Use this setting to specify the return address (the FROM address) for emails that Turbonomic generates and sends. This setting affects email notifications as well as emails for report subscriptions.

Email Content Format

To define message content, enter format variables and line breaks to determine what the message will include. For example, the following message format:

{6}: {5} \nDatastores: {9}\nTarget: {7}\nEvent: {0} - {4}\nCategory: {1}\nSeverity: {2}

Results in the following email message:

PhysicalMachine: myMachine.corp.mydomain.com
Datastores: No value
Target: 10.10.111.111
Category: Workload Placement
Severity: MINOR
State: NOTIFY
The message format variables for a message are:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>{0}</td>
<td>Event type - The problem name. For example, “WorkloadBalance”.</td>
</tr>
<tr>
<td>{1}</td>
<td>Sub category - One of:</td>
</tr>
<tr>
<td></td>
<td>• Performance Bottlenecks</td>
</tr>
<tr>
<td></td>
<td>• Storage Management</td>
</tr>
<tr>
<td></td>
<td>• Workload Placement</td>
</tr>
<tr>
<td></td>
<td>• Green IT</td>
</tr>
<tr>
<td></td>
<td>• Configuration Management</td>
</tr>
<tr>
<td></td>
<td>• Over Provisioning</td>
</tr>
<tr>
<td></td>
<td>• Capacity Management</td>
</tr>
<tr>
<td>{2}</td>
<td>Severity - One of:</td>
</tr>
<tr>
<td></td>
<td>• Critical</td>
</tr>
<tr>
<td></td>
<td>• Major</td>
</tr>
<tr>
<td></td>
<td>• Minor</td>
</tr>
<tr>
<td>{3}</td>
<td>State - Can be NOTIFY or CLEAR.</td>
</tr>
<tr>
<td>{4}</td>
<td>Description - A full description of the notification issue.</td>
</tr>
<tr>
<td>{5}</td>
<td>Affected entity - The name of the VM, host, or datastore associated with the problem.</td>
</tr>
<tr>
<td>{6}</td>
<td>Class name - The type of device that registers this problem. Can be one of:</td>
</tr>
<tr>
<td></td>
<td>• VirtualMachine</td>
</tr>
<tr>
<td></td>
<td>• PhysicalMachine</td>
</tr>
<tr>
<td></td>
<td>• Datastore</td>
</tr>
<tr>
<td>{7}</td>
<td>Target - The IP address or name of the hypervisor that manages the affected devices.</td>
</tr>
<tr>
<td>{8}</td>
<td>Host name - The name of the physical machine that hosts the affected VM. This variable only applies to VM problem notifications.</td>
</tr>
<tr>
<td>{9}</td>
<td>Datastore names - The names of the data stores that serve the affected Host or VM. This variable only applies to VM and Host problem notifications.</td>
</tr>
</tbody>
</table>

**Notification Settings**

To set up a notification, you set its scope, choose the issues to notify and their severity, and then set where to deliver the notification. For example, you can notify specific team members of issues on their critical storage infrastructure. To set the scope, you assign the notification to a group. You can use discovered groups as well as any custom groups defined in your environment. For information about defining custom groups, see *Creating Groups* on page 193.

To specify notifications in Turbonomic:

1. **Navigate to the Settings Page.**

   ![Settings Icon]
   
   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.
2. Choose Email and Trap Notifications.

Click to navigate to the Email and Trap Notifications Page.
This page has a tab to configure Email Settings and a tab to configure Notification Settings.

3. Display the Notifications Settings tab.
This tab displays a list of notifications that you have already set up. You can also create new notifications.

### Viewing Saved Notifications

The Notifications Settings tab displays a list of all the notifications that are currently configured for your environment. Each notification is listed by the group that defines the notification scope.

To edit a notification click its name and make the changes you want.

To delete a notification, select the entry and click the DELETE icon.

### Creating a Notification

To create a notification:

1. Click New Notifications.

The Choose Group Type flyout displays.
2. Set the scope of the notification.

The first step when creating a notification is to set the scope. To do this, you choose the entity type, and then you choose a group of those entities. Turbonomic will monitor the entities of this scope to generate the notifications you specify.

After you choose a group for the notification scope, the Notification Settings flyout displays.
3. **Configure the notification.**

In the Notification Settings flyout, display the tab for the type of notification you want to create:

- **Email Notifications**
  Turbonomic generates an email message and sends it to the email addresses you provide. The notification uses the email format that you specified for notifications on this type of entity (see Email Settings on page 269).

- **SNMP Trap Notifications**
  Turbonomic sends a trap notification to the IP address that you provide. These notifications arrive at port 162.

For **Issue Type**, you set the category of events that will trigger the notification:

- **Problem** - Issues Turbonomic identifies for the entities within your virtual environment.
- **Discovery** - Issues that occur as Turbonomic performs discovery on your environment.
- **Monitoring** - Issues that affect Turbonomic as it monitors your environment.
- **Control** - Issues that affect Turbonomic as it performs recommended actions

**Severity** sets the notification level - Critical only, Critical and Major, or Critical Major and Minor.

**Notify States** sets whether to notify when the event occurs, when it is cleared, or both.
Administrative Tasks

To perform Turbonomic administrative tasks, you will navigate to different pages from **Settings**. The different tasks you can perform for Turbonomic include:

- **Managing User Accounts** on page 275
  Create and manage user accounts for Turbonomic.
- **Maintenance: Proxies, Logging, and Troubleshooting** on page 285
  Perform general tasks such as managing HTTP proxies or sending troubleshooting data to Support.
- **Updating Turbonomic** on page 287
  See your current version, check the availability of update versions, and perform online updates.
- **License Configuration** on page 288
  Review the status of your current license, and apply any license upgrades.

Managing User Accounts

As an administrator, you specify accounts that grant users specific access to Turbonomic. User accounts determine the following for a given user login:

- **User Authentication**
  To configure an account, you set the type of authentication the account will use:
  - Local User – Configure the username and password and save those credentials on the Turbonomic server.
  - External User – Single user accounts that authenticate through Single Sign-on (SSO) or through Microsoft Active Directory (AD).
  - External Group – User group accounts that authenticate through SSO or AD.

- **User Authorization**
  Properties that determine the range of access and features for a given user:
  - Role – Access to specific Turbonomic features
  - Type – Dedicated user or tenant on a virtual datacenter
  - Scope – How much of the environment this user can manage
As you configure user accounts, you can set up access to specific clusters in your environment. You can even set up accounts for tenant customers, and only show them the virtual workloads they own in their specific virtual datacenters.

**IMPORTANT:** You can configure Turbonomic to use SSO authentication. When SSO is enabled, Turbonomic only permits logins via the SSO IdP. Whenever you navigate to your Turbonomic installation, it redirects you to the SSO Identity Provider (IdP) for authentication before displaying the Turbonomic user interface.

Before you enable SSO for your Turbonomic installation, **you must configure at least one SSO user with Turbonomic administrator privileges**. If you do not, then once you enable SSO you will not be able to configure any SSO users in Turbonomic. To authorize an SSO user as an administrator, use **EXTERNAL AUTHENTICATION** to do one of the following:

- Configure a single SSO user with administrator authorization. Add an external user. The username must match an account that is managed by the IdP.
- Configure an SSO user group with administrator authorization. Add an external group. The group name must match a user group on the IdP, and that group must have at least one member.

For information about configuring SSO user groups in SAML, see Configuring a Group for SSO Authentication on page 283. For information about configuring SSO authentication for Turbonomic, see “Single Sign-On Authentication” in the Turbonomic Installation Guide.

To work with Turbonomic accounts:

1. **Navigate to the Settings Page.**

   ![Settings](image)

   Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. **Choose User Management.**

   ![User Management](image)

   Click to navigate to the User Management Page.
This page lists all the user accounts that you currently have configured for Turbonomic. You can:

- Click to manage LOCAL USERS or EXTERNAL AUTHENTICATION
- Select an entry to delete the account
- Click a name to edit the account
- Create new user or group account
- Configure Active Directory settings

3. Filter the list of users.

To work with a long list of users, you can filter by role (for example, only show administrator or only show observer users). You can also type a string in the Search field to filter the list, and you can sort the list by name.
4. **Work with Local user accounts.**

Turbonomic stores local accounts and their credentials on the Turbonomic platform. Local authentication is for individual users, only.

When you choose **LOCAL USERS**, Turbonomic displays a list of all the local user accounts you have configured for this installation.
5. Create or edit a local user account.

To add a new local user, click **ADD LOCAL USER**. To edit an existing account, click the account name in the list. To configure a local account, specify:

- **Authentication:**
  
  Provide the username and password. Turbonomic stores these credentials on the local server.

- **Authorization – User Role:**
  
  - Observer — Can view the state of the environment, but cannot view or execute actions, and cannot run plans.
  - Advisor — Can run plans, but cannot execute actions or deploy workloads.
  - Automator — Can execute actions and deploy workloads, but cannot perform administrative tasks.
  - Deployer — Can view all Turbonomic charts and data, can use Place to deploy workloads, and can create policies and templates. However, this role cannot run plans or execute any recommended actions.
  - Administrator — Can access all Turbonomic features, and can perform administrative tasks to configure the Turbonomic platform.
  - Shared Observer/Advisor — Shared roles are for tenant users who are focused on a subset of the virtual environment. For example, a service provider would create a shared account for a customer who has purchased a set virtual of resources. Shared users can only have the Observer and Advisor roles. In addition, a Shared user account must be scoped (see next).
• Authorization – Scope (optional)
  The scope limits what the user can monitor. For example, you can scope to a group that contains only the physical machines that support this user’s VMs or applications. Click **DEFINE SCOPE** and choose which groups or clusters this user can see.

6. **Work with EXTERNAL AUTHENTICATION to set up SSO or AD accounts.**

For External Authentication, you configure Turbonomic to use SSO or AD services to manage the credentials and authentication of users. You can create external accounts to authorize user groups or individual users.

**NOTE:** If a user is a member of multiple groups, then Turbonomic logs the user on via the first SSO or AD group that successfully authenticates the user. Also note that Turbonomic does not support nested AD groups – AD logins must be for users in a top-level group.

To enable SSO, you must configure access to the given IdP. For information about configuring SSO, see “Single Sign-On Authentication” in the *Turbonomic Installation Guide*.

To enable AD you must specify either an AD domain, an AD server, or both. Turbonomic uses this connection for all AD users.
7. Enable AD authentication.

To enable AD, click **CONNECT TO AD** and configure:

- **Active Directory Domain** – To authenticate AD groups, specify a domain so that AD can find a given user via the User Principal Name (UPN). If you specify a domain, but not a server, authentication uses any AD server from that domain.
- **Active Directory Server** – To disable AD groups, specify a server but do not specify a domain. If you specify a domain and a server, authentication will use that server, and will also support groups.
- **Secure** – Use a secure connection when communicating with AD servers. Note that the AD domain must be configured to use LDAPS, and you must have imported a certificate into the Turbonomic server. For more information, see “Enforcing Secure Access” in the *Turbonomic Installation Guide*. 
8. Create or edit an SSO or AD account – This can be for a user group or for a single user.

To add a new account, click **ADD EXTERNAL GROUP** or **ADD EXTERNAL USER**. To edit an existing account, click the account name. To configure an external account, specify:

- **Authentication:**
  - Provide the group or user name for this account. The name you provide must meet certain requirements, depending on the type of account you are creating:
    - SSO Group – Provide a name that matches a group the IdP manages.
    - AD Group – The group name must match a group that is accessible from the domain and servers that you configured in **EDIT AD**.
    - SSO User – Provide a user name that matches a user managed by the IdP.
    - AD User – The username must be a valid User Principal Name (UPN). For example, john@corp.mycompany.com.
• Authorization – User Role:
  - Observer — Can view the state of the environment, but cannot view or execute actions, and cannot run plans.
  - Advisor — Can run plans, but cannot execute actions or deploy workloads.
  - Automator — Can execute actions and deploy workloads, but cannot perform administrative tasks.
  - Deployer — Can view all Turbonomic charts and data, can use Place to deploy workloads, and can create policies and templates. However, this role cannot run plans or execute any recommended actions.
  - Administrator — Can access all Turbonomic features, and can perform administrative tasks to configure the Turbonomic platform.
  - Shared Observer/Advisor — Shared roles are for tenant users who are focused on a subset of the virtual environment. For example, a service provider would create a shared account for a customer who has purchased a set virtual of resources. Shared users can only have the Observer and Advisor roles. In addition, a Shared user account must be scoped (see next).

• Authorization – Scope (optional)
  The scope limits what members of this group can monitor. For example, you can scope to a only the physical machines that support this group’s VMs or applications. Click DEFINE SCOPE and choose which entities this members of this group can see.

Configuring a Group for SSO Authentication

To use SSO authentication in Turbonomic, you should configure user groups on the IdP. The IdP can authenticate the group members, and then Turbonomic can assign the user role and scope according to that group’s authentication. To manage personnel changes, you only need to manage the membership in the IdP group. For example, if a user leaves your organization, you only need to remove the member from the group on the IdP. Because authorization on Turbonomic is by group, that user will not have any authorization settings stored on the Turbonomic server.

IMPORTANT: Before you enable SSO for your Turbonomic installation, you must configure at least one SSO user with Turbonomic administrator privileges. If you do not, then once you enable SSO you will not be able to configure any SSO users in Turbonomic. To authorize an SSO user as an administrator, use EXTERNAL AUTHENTICATION to do one of the following:

• Configure a single SSO user with administrator authorization.
  Add an external user. The username must match an account that is managed by the IdP.

• Configure an SSO user group with administrator authorization.
  Add an external group. The group name must match a user group on the IdP, and that group must have at least one member.

For more information about configuring SSO authentication, see “Single Sign-On Authentication” in the Turbonomic Installation Guide.

Specifying a Group in the SAML Response

To support SSO, Turbonomic recognizes IdP responses that comply with SAML 2.0. To create user groups, for each user response you include an attribute named group, and give the group name as the attribute value. For example, assuming the following users, setting the group attribute for each user assigns that user to the appropriate group.
As you specify the user response, to add the user to a group you include a group attribute. For example, to add a user to a group named turbo_admin_group, you would include the following attribute in that user’s SAML response:

```xml
<saml2:Attribute
    Name="group"
    NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:unspecified">
    <saml2:AttributeValue
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:type="xs:string">
        turbo_admin_group
    </saml2:AttributeValue>
</saml2:Attribute>
```

### Setting Group Authorization in Turbonomic

To set an account role and scope to a user group, you must use the group name that you specify as the value in the given SAML group attribute. In the above example, the group value is turbo_admin_group. To set authorization for that group:

1. **Open the User Management page to EXTERNAL AUTHENTICATION.**
   Navigate to **Settings > User Management**, and display the **EXTERNAL AUTHENTICATION** view.

2. **Create a new External Group**
   Click **ADD EXTERNAL GROUP**.

3. **Provide the group name.**
   *Be sure to use the name that you specify in the group attribute of the SAML response.* For the above example, use the name turbo_admin_group.

4. **Specify the group’s authorization**
   For the above example, since this is turbo_admin_group, you should set the **ADMINISTRATOR** role, and you should not set any scope (grant full access to the environment).
   After you configure this group in Turbonomic, then any member of turbo_admin_group that the IdP returns will have full administrator privileges on your Turbonomic installation.
Maintenance: Proxies, Logging, and Troubleshooting

The Maintenance Options Page provides tools to load configuration files onto your Turbonomic installation, set logging levels, export data for technical support, and import diagnostic files from Technical Support. Many of tools are for advanced users. You should contact Turbonomic technical support before you use them.

To execute these actions, navigate to the Maintenance Options page:

1. **Navigate to the Settings Page.**
   
   ![Settings Page](image)

   Click to navigate to the Settings Page.

2. **Choose Maintenance Options.**
   
   ![Maintenance Options](image)

HTTP Proxy

![HTTP Proxy](image)

If your environment requires an HTTP proxy for Turbonomic to access the web, provide the credentials here.
Export State

Export State

If you are experiencing problems with Turbonomic, your support engineer might request that you export diagnostic data. You can export the data and then send it to the support engineer as requested.

Configuration Files

Configuration Files

To help with diagnosis of some issues, a support engineer might want you to load configuration files into your Turbonomic server. You should only use these controls while working with a Turbonomic support engineer.

Logging Levels

Logging Levels

You can set the level of logging for different components of the Turbonomic platform. You should be aware that setting more verbose logging levels increases the disk space required to store the log files. You normally change these settings only while you’re working with a Turbonomic support engineer.

Usage Data and Analytics

With your permission, the Turbonomic platform can automatically collect analytics information from your installation and send it to Turbonomic to help improve our quality and performance. The data you share includes:

- Topology Data
  This information includes the types of targets you have set up, how many entities per target, and the relationships between these entities.
- Log Data
  Logs give us a history of any issues that might have occurred with your Turbonomic installation.
The data does not include any sensitive information such as user or target credentials. At weekly intervals, your Turbonomic platform collects and encrypts this data and sends it to Turbonomic.

**NOTE:** When you first install and start Turbonomic, you have the option to enable this feature. At any time after you have enabled **Usage Data and Analytics**, you can always turn it off again.

To enable or disable this setting, navigate to **Settings > Maintenance Options**. Then turn on the option to enable sharing of user data, or turn the option off to disable it.

### Updating Turbonomic

Use the Updates page to check whether any Turbonomic updates are available for your version, to see information about your version, and to perform online updates of your platform:

- **ABOUT**
  This shows the current version and build of your Turbonomic installation. It also lists the platform components by name and version.

- **CHECK**
  If Turbonomic can access the offline repository, and if the repository contains a version that is greater than your current version, this tells you that you can update to the indicated version.

- **UPDATE**
  If you can perform an online update to a new version, this executes the update. Be sure to give the update enough time to complete, and then refresh your browser.

**NOTE:** Before updating your Turbonomic platform, you should create a snapshot of your current Turbonomic virtual machine. For complete update instructions, see the Installation Guide.

To navigate to the Updates page:

1. **Navigate to the Settings Page.**
   
   ![Settings]
   Click to navigate to the Settings Page.

2. **Choose Updates.**
   
   ![Updates]
License Configuration

To activate the full range of Turbonomic features, you must purchase the appropriate license. When you purchase the license, Turbonomic sends the license file to you in an e-mail message.

**NOTE:** Starting with Turbonomic version 6.0, the basis for a license is the number of workloads that license supports. Earlier versions based their licenses on the number of sockets to support.

If you upgrade your Turbonomic product to version 6.1, you can still use your existing socket-based license to support the same environment. Turbonomic will continue to manage and control your workloads in that environment.

If you want to upgrade your license to support a larger environment, you must:

- Contact your sales representative to get the new license
  This license will be workload-based. Your sales representative will work with you to ensure that your new capacity equals your current capacity, plus the capacity you want to add on.
- Install the new license or licenses
  To install the new workload-based license, you must first delete the old socket-based license. Then you can install your new workload-based license.

In all circumstances, you should contact your sales representative to make sure that you get the correct license, and that you know how to install it properly.

A product license enables specific features as well as a specific number of workloads that you can manage. You can add additional licenses to Turbonomic as a way to increase the number of workloads you installation can manage. Note that as you add more licenses, they must all support the same feature set.
The License Configuration page shows you:

- The number of active workloads you can manage under this license
- How many workloads are currently active
- The set of features this license enables
- A list of current, active licenses

To navigate to the License Configuration page:

1. **Navigate to the Settings Page.**

2. **Choose License.**

To activate a license or to update your current license:

1. **Obtain your license.**
   
   Turbonomic sends the license file to you in an e-mail message. Save the license file on your local machine so you can upload it to your Turbonomic installation.

2. **Apply the license to your Turbonomic installation.**
   
   First click **UPDATE LICENSE**. Then browse to the license file that you saved and open it. Or you can drag the file into the **Enter License** fly-out.

   After you have uploaded the file, click **SAVE**.

After you have activated your license, you can then add more licenses to increase your workload coverage, or you can license a higher feature set.

**NOTE:** As you apply new licenses to Turbonomic, you must be sure that they are for the same edition or feature set. If you try to apply an incompatible license file, Turbonomic displays an *Invalid Feature Set* error. To apply the new license you must either delete your current license so you can install the new feature set, or you must obtain a different license file that matches your current feature set.

After you install a new license, it is a good idea to clear your browser cache.

To increase your licensed workload coverage:

1. **Obtain your additional license.**
   
   Note that your additional licenses must match the feature set of your current license.

2. **Apply the license to your Turbonomic installation.**

To upgrade your license to a higher feature set:

1. **Obtain your new license for the new features.**
   
   You should obtain a license that supports at least the same number of workloads as your current license.

2. **Delete your current license from Turbonomic.**
   
   On the license page, select all the licenses that you currently have installed, then click **DELETE**.

3. **Apply the license to your Turbonomic installation.**