Dell EMC Service Levels for PowerMaxOS

Dell Engineering
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Revisions

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<tr>
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<tr>
<td>May 2018</td>
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Executive Summary

Organizations are in constant need of IT infrastructures that can deliver instant access to largely increasing volumes of data. These organizations spend a great deal of time trying to understand new generations of technology and applications in order to keep up with the high demand of capacity along with providing high speed predictable access.

Dell EMC combined both flash solid state drives with traditional spinning disk drives in the VMAX Hybrid array. The mix of flash and spinning disk storage was cost effective while providing high speed performance and capacity. In order to utilize the capacity more effectively and provide predictability to performance, the array was equipped with a HYPERMAX OS feature called service level provisioning which allows users to classify priority applications at the storage group level. The prioritization was based on tiering, where the most important and frequently accessed applications resided on the upper tier flash storage. The colder data, or lower priority applications, would be on the lower tiered spinning disk storage.

With the cost of flash storage becoming economically viable, organizations are now moving away from array configurations of VMAX Hybrid with mixed drive technologies on to higher capacity and performance in all flash storage such as PowerMax and VMAX All Flash arrays. The capacity and performance of PowerMax and VMAX All Flash arrays provides users with a single tier system designed to provide high availability to keep up with increasing demand of data access. Having a single tier of flash storage, users need prioritize data access and have the ability to set priority on critical, high priority applications while managing lower priority applications. PowerMaxOS provides this ability with service levels. Service levels allows user to set expectations for applications in order to provide predictable and consistent performance.

This paper will define the service level feature for PowerMaxOS are and how it works.

Terminology

The following are explanations of terms that are used throughout the paper:

**PowerMaxOS**: Beginning with 5978, the operating environment run on PowerMax and VMAX All Flash systems.

**Storage Group (SG)**: A logical grouping of thin devices that are provisioned and associated with a particular application.

**Response Time (RT)**: The total amount of time it takes to respond to a request for service.

**Target Response Time**: The average response time expected for the storage group based on the selected service level.

**Upper Response Time Limit**: The maximum response time specified by the selected service level.

**Lower Response Time Limit**: The minimum response time specified by the selected service level.
1 Service Levels for PowerMaxOS

Service levels for PowerMaxOS address the challenge of ensuring applications have consistent and predictable performance by allowing users to separate storage groups based on performance requirements and business importance. PowerMaxOS gives the ability to set specified service levels to ensure the highest priority application response times are not impacted by lower priority applications. The available service levels are defined in PowerMaxOS and can be applied at the creation of a storage group or can be modified to an existing storage group at any time.

1.1 Service Levels Hybrid vs. All Flash

Service levels in VMAX3 hybrid arrays relied on tiers of mixed drive technology. Having a mix of flash and spinning disk drives allowed for storage groups with higher service levels to reside on faster flash technology while the lower service levels could be on the lower tiered spinning disks. Having mixed tiers also allowed for frequently accessed data to be transitioned internally to higher tiered flash for faster access. PowerMax and VMAX All Flash systems, with a single tier of flash backend storage, use response time management to set performance expectations. Having a single tier allows for all data to be stored on high speed flash storage without the need to move any data for better performance with access being managed per storage group with a specified service level.

1.2 Service Level Options

Service levels are offered with various ranges of performance expectations. The expectations of service levels are defined by their own characteristic of a target response time. The target response time is the average response time expected for the storage group based on the selected service level. Along with a target response time, service levels also have either an upper response time limit or both an upper and lower response time limit.

The service levels offered are:

<table>
<thead>
<tr>
<th>Service Level</th>
<th>DIAMOND</th>
<th>PLATINUM</th>
<th>GOLD</th>
<th>SILVER</th>
<th>BRONZE</th>
<th>OPTIMIZED</th>
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<tbody>
<tr>
<td>Target Response Time</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Upper Response Time Limit</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Lower Response Time Limit</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1  Service Levels for PowerMaxOS

In Figure 1 above, all service levels, with the exception of Optimized, have a target response time.
Diamond and Platinum service levels have the highest priority and performance. Both have an upper response time limit but no lower response time limit which ensures they will be serviced as fast as possible.

Gold, Silver, and Bronze service levels have both an upper and lower limit designed to allow higher priority service levels to be unaffected. These are managed such that their average response time will be >= the lower response time limit.

The Optimized service level does not have a target response time as well as no upper or lower limit. Optimized is designed to use all allowable resources, up to equal that of Diamond, until those resources are needed by a storage group with a service level set. Optimized is managed to assist all service levels with the exception of Bronze and used where application performance and consistency are not of relative importance.

### 1.3 How Service Levels Work

PowerMaxOS is continually monitoring the system to ensure that any lower priority applications are minimally disruptive to higher priority applications. When the higher priority applications’ response time begins to approach the upper limit of the selected service level, the system will begin to manage any lower priority storage groups. The process of monitoring and the management of lower priority applications both happen in real time.

PowerMaxOS uses real-time machine learning to model workload characteristics. This model provides a predictive function that allows PowerMaxOS to anticipate workload demand for a storage group. With these anticipated workload demands, it can adapt as necessary to changes in block size, write ratio, or IO load.

A storage group with a higher priority service level that is affected by any lower priority storage groups will trigger response time management to the lower priority service levels. When the higher priority storage group reaches its target response time, all lower storage groups will continue to be managed until the lowest priority set storage groups reaches their target response time.

In order to view the use cases for service levels, see the Service Level Functionality section.

### 1.4 Setting Service Levels

Service levels can be applied to a storage group when either creating a new storage group or by modifying an existing storage group. Users also have the ability to change service levels at any time to apply the desired response time performance expectation. Applying and modifying service levels are done through PowerMax management tools.

When creating a cascading storage group, service levels are applied to the child storage group and the parent storage group remains set to none.

The PowerMax management tools are:

- Unisphere for PowerMax
- SymCLI
- RestAPI

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1.4.1 Creating a Storage Group with a Service Level

Setting service levels in Unisphere for PowerMax can be accomplished through either the Storage Group Dashboard or the Service Level Dashboard.

Figure 2 Storage and Service Level Dashboard Selection

The following example to create a storage group and set a service level will use the service level dashboard. In the service level dashboard, the available service levels are displayed along with information such as the target response time. From this view, the user can select the desired service level and click on provision in the top left corner. This will bring up the provision wizard.

Figure 3 Service Level Dashboard

In the provisioning wizard, the user can select the desired service level from a drop down menu as well as name the storage groups, select the storage resource pool, and create devices.
At this point, the user can choose to either continue to complete provisioning storage to a host or create this storage group and provision to a host at some other time.

### 1.4.2 Modifying a Storage Group

Modifying a storage group to change service levels can be done through the storage group dashboard. In the storage group dashboard there is a list of existing storage groups as well as some storage group options.

![Figure 5: Storage Group Dashboard](image)

The user can choose to create a storage group from this dashboard. Clicking create will bring up the same provision wizard as in the previous step 1.4.1 Creating a Storage Group with a Service Level.
Once the storage group that is to be changed is selected, the user will click modify to change the service level. The modify storage group wizard will appear where the user can select a new service level from a drop down menu.

![Modify Storage Group](image)

**Figure 6  Modifying a Storage Group**

### 1.5 Alerting and Compliance

Alerts are offered with service levels, allowing users to be notified when a specific service level has reached its respective upper response time limit. Alerting is available on all service levels with the exception of Optimized, since Optimized does not have a target response time or upper response time limit.

Alerts are only available through Unisphere for PowerMax and are enabled by default. As with other alerts in Unisphere, users will be able to set-up email notifications to be advised when the alerts happen.

When a storage group with a service level sets an alert, it can be seen from either the alerts tab from the Unisphere Dashboard or under the compliance column in the Storage Group dashboard.

The following example demonstrates how to view a compliance alert for service levels and the details within the alert.

An alert is shown from the Storage Group dashboard as indicated by the yellow triangle under Compliance, as seen in Figure 7.
In Figure 8, users will be able to look further within the storage group to gather more information on the alert by navigating to the Compliance tab under the details of the storage group.

Under the compliance tab there are details of the timeframe and response time management. In Figure 9, the response time of the storage group exceeded the upper response time limit briefly on Thursday and then again somewhere between Thursday and Friday.
Figure 9  Compliance Tab

Figure 10 shows further details by clicking on view details where there are two timeframe buckets. The first 4 hour interval is the average response time within those 4 hours and the second is the average within 2 weeks.

Figure 10  Response Time Compliance
2 Service Level Functionality

Service levels for PowerMaxOS are designed as a functional approach to put relative importance on application storage groups. This function allows users to manage applications based on predictability and consistence in response time. With the ability to manage the performance of the array, users can determine whether to utilize as much of the resources the array allows or as little of the resources regardless of the system capabilities. With this ability to manage performance, users assign importance on applications based on specific needs.

Figure 11 Relative Response Time vs. IOPS

2.1 Priority Applications

Service levels allow users to insulate specific storage groups from performance impact of other “noisy neighbor” applications. The user can assign critical applications to higher service levels such as Diamond, Platinum, or Gold which allow for these storage groups to utilize all available resources at all times. These critical applications are not managed unless the system exhibits resource constraints causing the applications to fail to maintain desired performance levels.

In Figure 12, the lower priority storage groups begin to impede on the response time boundary of a storage group with a higher service level. The lower priority storage group is then managed by PowerMaxOS. The management of lower priority storage groups subsides once the higher priority storage group is within its respected target service level.
2.2 Service Providers

Service levels can be used to implement a chargeback model where service providers assign a higher cost to higher performing storage. Silver and Bronze service levels allow the provider with the ability to impose differentiated performance levels regardless of system resource constraints or whether or not higher priority service levels are reaching target performance levels. Users can also set service levels while applications are running, which allows providers to adjust the response times of storage groups based on revolving price points.

In Figure 13 the lower tiered Bronze and Silver storage groups are being managed by PowerMaxOS while all other storage groups remain at a lower response time.
Figure 13  Service Provider Response Time Management
3 Interoperability
Service levels operate seamlessly alongside all PowerMaxOS data services and features. Service levels are not supported in a mainframe environment.

3.1 Local and Remote Replication
Service levels are interoperable with replication features including TimeFinder SnapVX and SRDF.

3.1.1 Service Levels and SRDF
When creating remote replication of a storage group with SRDF, the user will have the ability to initially set the desired service level of the remote storage group through the SRDF wizard in the local array. Once SRDF protection of a storage group is set, the user can modify either the local or remote storage group service level with any of the PowerMaxOS management tools.

3.1.2 Service Levels and TimeFinder SnapVX
When linking a new target storage group to a snapshot using TimeFinder SnapVX, the target storage group will inherit the same service level of the source storage group. If linking an existing storage group to a snapshot, the existing storage group service level will remain the same as it was when created. The service level of the target storage group can be modified at any time to adjust a desired service level depending on the user requirements.

3.2 Service Levels and Host I/O Limits
Service levels ensure storage groups have an expectation of performance in terms of response time while Host I/O Limits provide a function to limit the amount of front end port performance. Host I/O Limits do this by allowing users to set a maximum front end throughput on either IOPS, MB/s, or a combination of both. When a Host I/O Limit is applied to a storage group that has a service level set, the storage group will still be managed by any higher priority storage group.

Both service levels and Host I/O Limits are set per storage group and can work together for more predictable and consistent performance. Host I/O Limits can be set on a storage group that has a specified service level to manage the front end throughput if the desired response time performance of the storage group is continually being exceeded or if the storage group is being impeded upon by other storage groups. Host I/O Limits are not a method to maintain response time but allow users to control how much data is being driven to the array which will assist service levels in providing consistency in the desired response time performance.

Figure 14 illustrates service levels as they apply to response time upper and lower limits and how Host I/O Limits relate to setting a maximum allowable throughput IOPS.
Summary

Service levels for PowerMaxOS provide organizations with the ability to prioritize importance of business critical applications while still consolidating lower priority applications. PowerMaxOS ensures that higher priority applications are not impacted by any other application with a lower service level. Users can set priority based off a range service levels that each provide varying performance expectations and relative target response times. This allows the user to set their desired expectations while providing predictable and consistent performance.