

Exadata Health and Resource Utilization Monitoring

Adaptive Thresholds

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Introduction

Enterprise Manager (EM) provides extensive monitoring capabilities for a wide range of system types. Once a target is configured in Enterprise Manager it is necessary to determine what information is important to monitor. This monitoring information is known as key performance indicators (KPIs). As an example, KPIs for the Exadata Database machine are documented in the white paper [Exadata Database Machine KPIs](#).

Once KPIs are identified it is necessary to determine thresholds that, when reached, notify administrators. Determining these thresholds can be challenging especially for environments unfamiliar to administrators. To address this difficulty Enterprise Manager has introduced the concept of Adaptive Thresholds.

Below are some terms that will be useful to understand for the remainder of the document. For additional information, please see the [Enterprise Manager Administrators Guide](#).

- Enterprise Manager Agent – A process that runs on a host to monitor the status, health, and performance of all managed components (also referred to as targets) on that host. In Exadata, the agents run only on the compute nodes. The Storage Servers and remaining rack components are monitored via the compute node agents.
- Target – A component monitored by Enterprise Manager through an agent.
- Metric – Measurement used to monitor target conditions or state.
- Threshold – A value defined for a metric. This value sets the level at which notifications or actions occur for the metric. There are two levels of thresholds: warning and critical.

Overview

Adaptive Thresholds can be used in two ways to help administrators set threshold values for metrics. The first method involves fully employing Adaptive Thresholds and letting Enterprise Manager set thresholds automatically based on settings within the tool. For the purposes of this document this will be referred to as dynamic. The second method allows end users to see the values Enterprise Manager recommends in a manual mode without automatically updating the thresholds. This method will be referred to as a guided configuration. Both methods will be explored below.

When using the guided method, administrators will setup Adaptive thresholds and manually evaluate the results to determine what the appropriate KPI thresholds should be. Administrators will then set one warning and one critical threshold for the evaluated KPI. This is a good approach for administrators whose environments are non-volatile and not subject to changes in workload.

The dynamic method, Full Adaptive Thresholds, gives administrators a much more granular approach to notifications. By creating windows upon which Thresholds can be defined, for example day and night or weekday and weekend, a fine grained approach to monitoring KPIs can be achieved. This can be a good choice when it is important to receive notifications based on changes in behavior as opposed to absolute capacity numbers. The downside to this approach is that it can result in excessive notifications to administrators.

Adaptive thresholds work by looking at a trailing window of data for a period of time, which can be 7, 14, 21 or 28 days. Based on this data Enterprise Manager uses a set of administrator-selected options to generate a set of warning and critical thresholds. However these thresholds are not always guided as they can be configured to adjust on a periodic basis to meet changes in business monitoring needs. The adjustment interval is configured while setting up Adaptive Thresholds.

Once the trailing window frequency is set, the threshold change frequency must be set. Due to changes in workload, a threshold set for one period of time, for example a standard business day of 8:00 AM until 5:00 PM, might not be correct for another period, for example a Saturday night. This is purely driven by the nature of the workload on the system. A threshold change frequency can be defined to accommodate these changes. The following are the options Enterprise Manager provides:

- None (one warning and critical threshold)
- Day and Night
- Weekend and Weekday
- Day and Night over weekdays and weekend
- By day of week
- By day and night per day of week

These options accommodate a wide variety of work patterns. In addition, Enterprise Manager allows the administrator to define what time period day and night is, for example 8-5, 9-6, 8-8, etc., as well as the time of day. Once set, Enterprise Manager will automatically change the warning and critical thresholds based on these values if the Adaptive Threshold is enabled.

By looking at the accumulated data, Adaptive Thresholds can use a configurable mathematical analysis to calculate a suggested value for warning and critical thresholds. The three available options are significance level, percentage of maximum and percentage of average. These are discussed in detail [below](#).

Configuring Adaptive Thresholds

To define an adaptive threshold, the first step is to go to the Adaptive Threshold screen for a target. For the purpose of this document, an Exadata Cell target will be used.

Navigate to the home page of the Cell target. Now select Exadata Storage Server → Monitoring → Metric and Collection Settings:

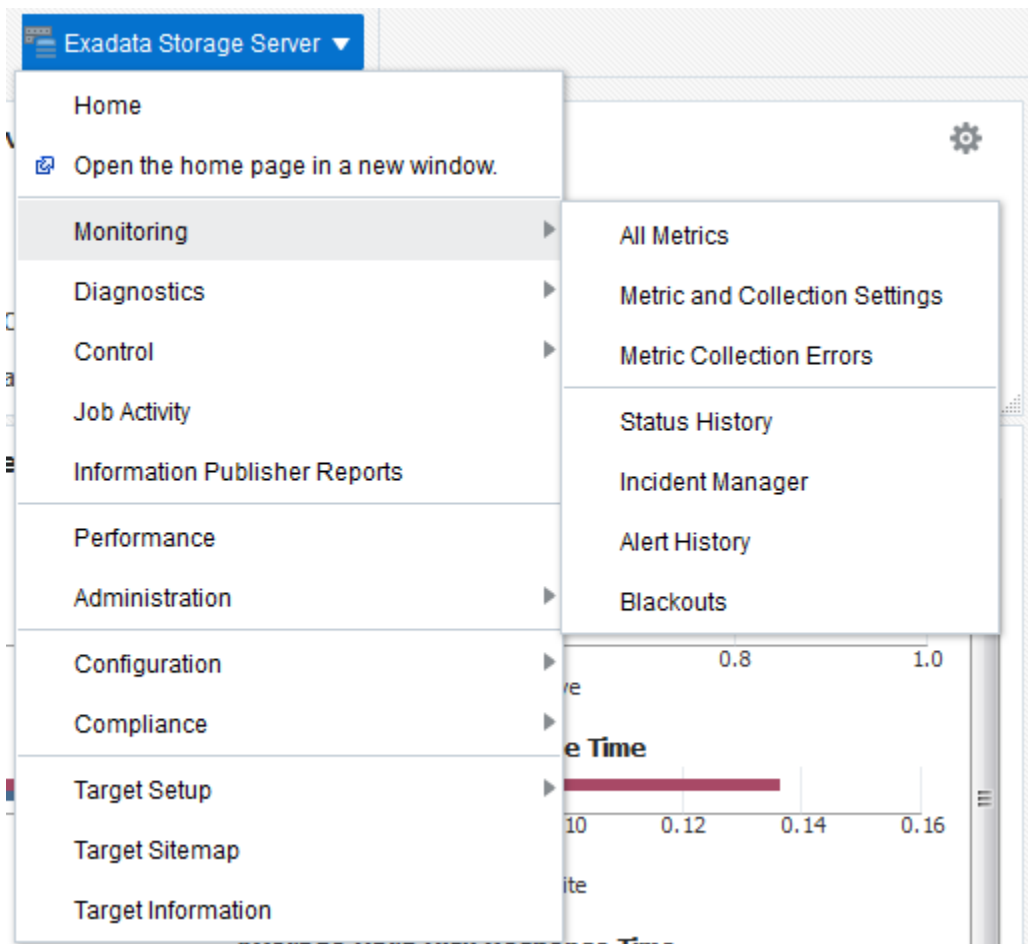


Figure 1

Scroll to the bottom of the screen and select “Advanced Threshold Management”

✔ TIP Empty Thresholds will disable alerts for that metric.

Related Links

[Advanced Threshold Management](#)
[Pending Apply Operations](#)

[Create Monitoring Template Using Target](#)

Figure 2

Now it is necessary to define the window and “Threshold Change Frequency.”

Adaptive Settings | Time Based Static Settings

▲ Select Active Adaptive Setting

Select Active Adaptive Setting: Moving window

Threshold Change Frequency: Moving window

Accumulated trailing data: Trailing 28 days

Day Setting: Start time 8 AM End time 6 PM Timezone: (UTC-08:00) Los Angeles - Pacific Time (PT)

Figure 3

Select “Moving window” from the Select Active Adaptive Setting dropdown menu. Next choose the Threshold Change Frequency. The most granular setting available is “By Day and Night, per Day of Week.” This would cause the thresholds to be changed to potentially 14 different values depending on the time of the week. The appropriate choice should be made based on the nature of the workload on the system as well as business needs.

▲ Select Active Adaptive Setting

Select Active Adaptive Setting: Moving window

Threshold Change Frequency: By Day and Night

Accumulated trailing data: None

Day Setting: By Day and Night, over Weekdays and Weekend

By Day of Week

By Day and Night, per Day of Week

Figure 4

Select the Save button in the upper right hand corner of the window:

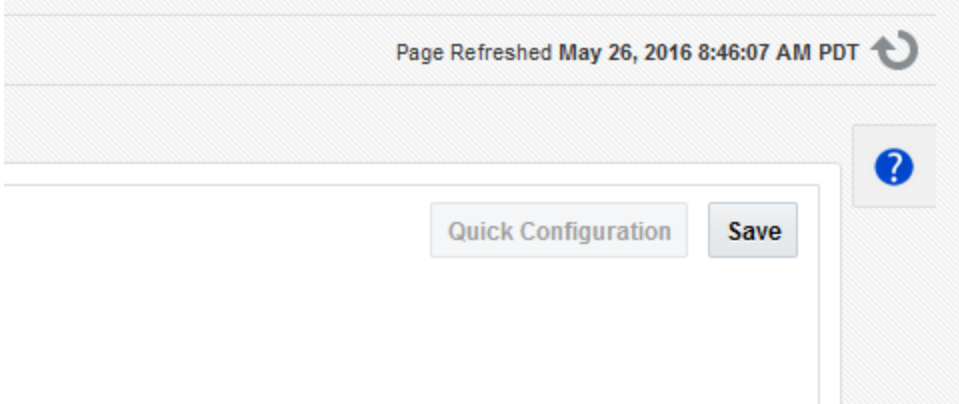


Figure 5

Now the actual metric can be defined. Note that not all metrics are eligible for Adaptive Thresholds; they must be in the category of Load, LoadType or Utilization. Select the Register Metrics button, select the metric to be added as an Adaptive Threshold and click the OK button.

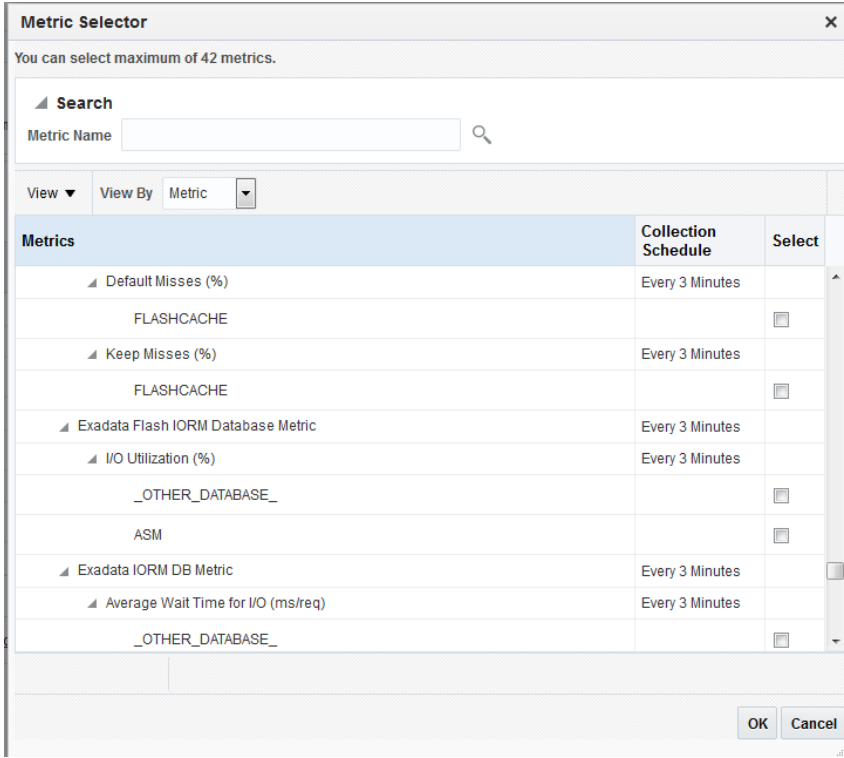


Figure 6

Next a confirmation window will popup. If dynamic Adaptive Thresholds monitoring is desired, select the check box. If Adaptive Thresholds is to be used via the guided method, de-select the check box. Then select the Yes button.

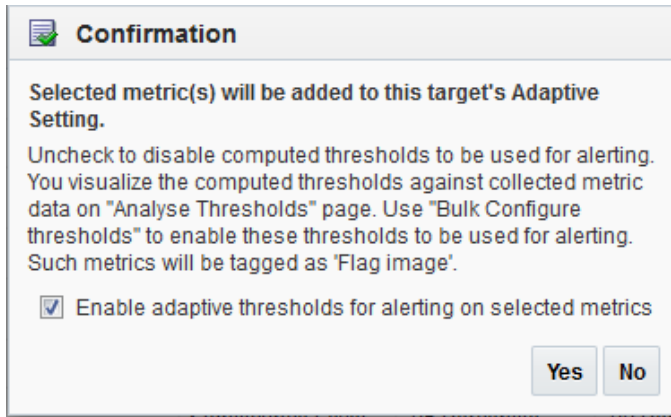


Figure 7

Now the configuration options can be defined for the threshold. Under the Register Adaptive Metrics pane, select the metric(s) that need to be configured. These can be done one at a time or all at once. Select the check box of the metrics needing configuration on the right hand side of the pane:

Test Data Fitness

	Threshold Type	Warning Level	Critical Level	Occurrences	Insufficient Data Action	Warning Threshold	Critical Threshold	Maximum Threshold	Select
	Percentage of Ma...	100	150	2	Preserve	-- ⚠	-- ⚠	--	<input checked="" type="checkbox"/>
	Significance Level	95 Percentile	99 Percentile	2	Preserve	8 ⚠	10 ⚠	Select for operation.	<input checked="" type="checkbox"/>

Figure 8

Next, select the Bulk configure thresholds button:



Figure 9

Figure 10

Now the method for threshold calculation can be defined. This can be:

- **Significance Level:** Alert thresholds can be dynamically set by the system to values representing statistical significance (percentile) as measured by the active adaptive settings.
- **Percentage of Maximum:** The Percentage of Maximum threshold allows administrators to set metric thresholds relative to the trimmed maximum values measured over a period of time and time partition. The measured 99th percentile value is used as the trimmed maximum value. 100% is the 99th percentile value.
- **Percentage of Average:** The Percentage of Average threshold allows administrators to set metric thresholds relative to the average of measured values over a period of time and time partition. 100% is the average value.

The MAA best practice is to select Significance Level for this setting.

Next, select the warning and critical percentile levels desired based upon business needs. The lower the warning level, the more time administrators will have to respond before the critical threshold is reached. However, this may also result in excessive notifications. Suggested settings are .95 Percentile for warning and .99 Percentile for critical.

If the guided method is being used to manually configure thresholds the remaining three options can be left at the default values.

Additional Settings for Dynamic Adaptive Thresholds

If allowing Enterprise Manager to dynamically set thresholds, there are three other important options on this screen.

The first is “Occurrences.” This option specifies how many times the threshold is allowed to be crossed before a notification is sent to administrators. The default value of two is usually sufficient.

The second option “Maximum allowed threshold” allows for a cap to be placed upon the adjusted value for thresholds. This prevents thresholds from slowly adjusting up over time to the point where thresholds are no longer meaningful. For example, if CPU load begins causing issues at 16 but performance degrades over a period of time to where the critical threshold is 18, by setting the maximum allowed threshold to 16 that behavior would be avoided. This value should be set based upon the nature of the metric as well as business rules and Service Level Agreements (SLAs).

The third option “Threshold action for insufficient data” is the desired action in the case that the data in the moving windows doesn’t meet the requirements of Adaptive Thresholds. These Adaptive Threshold requirements are:

- There must be a minimum of 300 data points
- There must be 50 distinct data points
- If using Significance Level to determine thresholds, Warning Level and Critical Level percentile values cannot be the same

The default value of “Preserve prior threshold” is the recommended setting for “Threshold action for insufficient data.”

“Enable adaptive thresholds for alerting” refers to whether Adaptive Thresholds should actively set thresholds or if manually-set thresholds should be preserved. Ensure this is set to “no.”

Select OK to save the settings.

Using Adaptive Thresholds

When looking at the Register Adaptive Metrics pane there may be yellow flags next to the registered metrics. This indicates that the metric is registered and thresholds will be calculated, but Enterprise Manager will not set the threshold values.

Register Adaptive Metrics

Actions ▾ View ▾ **+ Register Metrics** *Bulk configure thresholds* *X Deregister* *∞ Ar*

Metric
<ul style="list-style-type: none"> Total Avg Hard Disk Response Time <ul style="list-style-type: none"> TOTAL_CELL_HARDDISK_RSP_TIME Total Cell Flash IOPS <ul style="list-style-type: none"> TOTAL_CELL_FLASHDISK_IOPS Total Cell Flash Load <ul style="list-style-type: none"> TOTAL_CELL_FLASHDISK_IO_LOAD Total Cell Flash Throughput <ul style="list-style-type: none"> TOTAL_CELL_FLASHDISK_TPUT Total Cell Hard Disk Throughput

Columns Hidden 1

Collection schedule can be changed from 'Metrics and Collection Settings' or on the 'All Metrics' page.

Figure 11

On the main Adaptive Thresholds screen there are several key pieces of information to observe once the metrics have been added and enough data has been collected to fulfill the moving window duration.

The “Warning Threshold” and “Critical Threshold” columns will show the currently configured Warning and Critical threshold values. If there is a yellow triangle by this value, that means the criteria for a metric being evaluated for Adaptive Thresholds are not being met.

In this situation, if full Adaptive Threshold capabilities are setup as described above, any prior thresholds will be preserved until the data set for the metric meets all requirements. If this status never changes, the metric in question may not be a good candidate for Adaptive Thresholds.

Threshold Type	Warning Level	Critical Level	Occurrences	Insufficient Data Action	Warning Threshold	Critical Threshold	Maximum Threshold
Significance Level	.95 Percentile	.99 Percentile	2	Preserve	15	20	--
Significance Level	.95 Percentile	.99 Percentile	2	Preserve	12,500	125,000	--
Significance Level	.95 Percentile	.99 Percentile	2	Preserve	8	10	--
Significance Level	.95 Percentile	.99 Percentile	2	Preserve	4,860	5,400	--

Figure 12

To dig into this deeper, click on the “Test Data Fitness” button.

eregister | Analyze thresholds | Test Data Fitness

el	Critical Level	Occurrences	Insufficient Data Action	W Thi

Figure 13

This will open a window that will display the issue with the data being analyzed. In the example below, the threshold change frequency is set to Day and Night. For each of those periods there are two issues. The first is the “Total Data Points.” The metric is failing this condition because it doesn’t have the necessary 300 data points. The second failure is due to the fact that “Distinct Data Points” does not have the required 50 distinct data points.

Metric	Threshold Type	Total Data Points	Distinct Data Points	.95 Percentile Value	.99 Percentile Value	Average Value	Insufficient Data Action
scas11celadm04.us.oracle.com							
Aggregated Exadata CellDisk Metric							
Average CellDisk IO Load	Percentage of Maxi...						Preserve Prior Thresholds
Day		140	8	0.7	0.7	0.176	
Night		121	4	0.7	0.7	0.05	

Figure 14

If using Adaptive Thresholds in order to evaluate what threshold values should be manually set, select the “Analyze thresholds” button.

Register Adaptive Metrics

Actions ▾ View ▾ | Register Metrics | Bulk configure thresholds | Deregister | Analyze thresholds | Test Data Fitness

Metric	Threshold Type	Warning Level	Critical Level	Occurrences	Insufficient Data Action

Figure 15

This will bring up a screen that administrators can use to determine the best values for KPIs. In the below example, note there are red and yellow lines. The red line represents the calculated value for the critical threshold. The yellow line represents the calculated value for the warning threshold. On the left hand side of the screen, the options such as “Threshold based on,” “Warning Level” and “Critical Level”

can be dynamically altered to see how the options impact the thresholds. The below graph displays thresholds with the “Threshold based on” set as Significance Level, “Warning Level” set to .95 percentile and “Critical Level” set to .99 Percentile for the metric “Total Cell Flash Load.” The graph indicates that for the defined day, an appropriate warning threshold would be four and critical threshold would be six. For the night interval a warning threshold of .25 and critical threshold of 3.75 would be best. Actual values of points on the graph can be displayed by hovering over the desired data point.

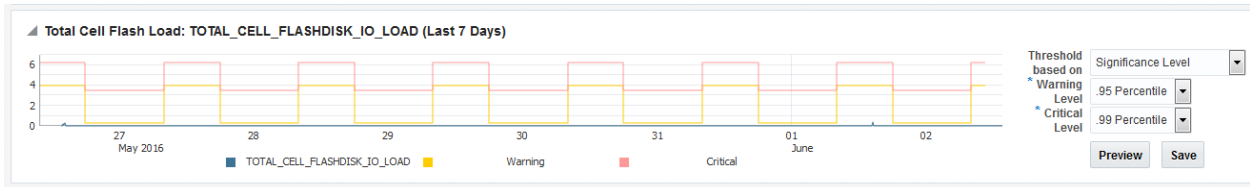


Figure 16



Conclusion

Setting threshold values for Key Performance Indicators can be time consuming and difficult. This is especially true in situations where administrators have new system types or are responsible for setting up monitoring for systems for which they are not directly responsible. By using the methodology described above, administrators can determine thresholds in a quick, easy and accurate manner.

References

[Enterprise Manager Cloud Control Administrators Guide](#)

[Exadata Database Machine KPIs](#)

[Exadata Health and Resource Usage Monitoring](#)



Exadata Health and Resource Usage Monitoring

Adaptive Thresholds

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