HP Network Node Manager iSPI Performance for Metrics Software

Software Version: 9.10

Using Baselines

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Using Baselines

The NNM iSPI Performance for Metrics is capable of monitoring network elements by using a calculated baseline for use in reporting, forecasting, and thresholds. You can use deviation from historical baseline as a threshold (instead of a fixed threshold value). Baselines are calculated based on previously collected values for each network element, taking into account variations based on the time of the day and the day of the week. The NNM iSPI Performance for Metrics creates exceptions and sends incidents to the NNMi Incident View when the monitored metric value violates the baseline threshold.

Baselines provide effective monitoring of network elements for which the pattern of usage varies over a period of time. For example, network usage during peak business hours is much higher than the network usage on weekends.

While using a baseline, the NNM iSPI Performance for Metrics uses the following workflow:

1. Analyzes the historical data (all the data samples polled over the monitoring cycle)
2. Computes a baseline for the metric by using the Triple Exponential Smoothing technique:

   Key features of the smoothing technique used by the NNM iSPI Performance for Metrics:

   - Uses an initialization period of three weeks from the start of the monitoring; during this period, no incidents are generated
   - Uses a seasonality cycle of one week (with 5-minute granularity)
   - Uses the number of deviations (above and below) from the values specified in the Baseline Settings form to compute the range of normal values or the **baseline sleeve**

     For more information, see "How the NNM iSPI Performance for Metrics Calculates Baselines" (on page 11).
3. Determines exceptions; you can view these exceptions by choosing the special *baseline exception count* and *baseline exception rate* metrics on reports.
4. Sends incidents to the Incident View of the NNMi console.

For an example, see "Example" (on page 8).

Step-by-Step Procedure to Configure a Baseline

1. Log on to the NNMi console as an administrator.
2. Click **Configuration > Monitoring Configuration**. The Monitoring Configuration form opens.
3. Go to the Interface Settings or Node Settings tab, select the interface or node group for which you want to configure a baseline, and then click  **Open**. The Interface Settings or Node Settings form opens.

> **Tip:** If monitoring settings are not already configured for the group, fill out the forms in the left pane.
>
> If you want to create a baseline for input or output utilization, make sure to select the Enable Interface Performance Polling check box. To create baselines for any other metrics (see "List of Metrics for Baselines" (on page 3)), make sure to select the Node Performance Polling check box.

4. In the Interface Settings or Node Settings form, go to the Baseline Setting tab.
5. Click **New**.The Baseline Setting form opens.
6. In the Baseline Threshold Settings section, specify the details with the help of Table: Baseline Settings.
7. In the Baseline Deviation Settings tab, specify the details with the help of Table: Baseline Deviation Settings.

Baseline Settings

Attribute	Description
Monitor Attribute	Select a metric from the Monitored Attribute list (one of the metrics listed in "List of Metrics for Baselines" (on page 3)).
Threshold Enabled	Select this option if you want to send incidents to the NNMi's Incident View. **Note:** If you do not select this check box, the NNM iSPI Performance for Metrics does not send incidents in NNMi's Incident View. However, you can still monitor exceptions with the help of reports.
Duration[a]	Designate the minimum time within which the value must remain out of the configured Baseline Range before the state changes to Abnormal Range and (optionally) an incident is generated. Use the Baseline Deviation Settings tab to set the upper and lower limits of the baseline range. Note the following: • If you do not configure a Baseline Range, the NNM iSPI Performance for Metrics uses the default value of 3 deviations. • The Polling Interval should be less than or equal to the Duration.
Duration Window[a]	Designate the window of time in which the Upper Baseline Limit or Lower Baseline Limit criteria must be met. **Note:** The value must be greater than 0 (zero) and can be the same as the Duration value.

[a]The Duration and Duration Window values are used for detecting exceptions and sending incidents to the NNMi Incident View. If you select a duration of A seconds and a duration window of B seconds (A<B), the NNM iSPI Performance for Metrics registers an exception and triggers an

incident when the metric value lies outside of the calculated baseline sleeve for A seconds (or longer) during the last B seconds. For more details, see "Example" (on page 8).

Baseline Deviation Settings

Attribute	Description
Upper Baseline Limit Enabled	If enabled, the NNM iSPI Performance for Metrics uses the Upper Baseline Limit attribute value to determine the number of deviations above the average that defines the upper baseline limit. If disabled, NNMi does not define the upper baseline limit.
Upper Baseline Limit - Deviations above average	Enter the number of deviations above the average values that the NNM iSPI Performance for Metrics should use to determine the upper baseline limit.
Lower Baseline Limit Enabled	If enabled, the NNM iSPI Performance for Metrics uses the Lower Baseline Limit attribute value to determine the number of deviations below the average that defines the lower baseline limit. If disabled, the NNM iSPI Performance for Metrics does not define the lower baseline limit.
Lower Baseline Limit - Deviations below average	Enter the number of deviations below the average values that the NNM iSPI Performance for Metrics should use to determine the lower baseline limit.

After configuration is complete, the NNM iSPI Performance for Metrics starts computing the baselines by using the collected data. During the initialization period (the first three weeks), you will not see any exceptions.

List of Metrics for Baselines

Irrespective of which network element (node or interface) you choose, all of the following metrics appear in the Baseline Settings form. You must carefully choose only the relevant metrics.

Metric	Interface/Node Monitoring	Description
Input Utilization	Interface	The total number of incoming octets traversing the interface as a percentage of the total possible number of octets (based on the ifSpeed value). From Interface to Interface, the exact MIB variables queried vary based on interface speed and whether the system supports the high speed counters for interfaces. Each interface in an Interface Groups has its utilization calculated by taking the total traffic on all administratively up interfaces in the group and dividing that by the total possible bandwidth.
Output Utilization	Interface	The total number of outbound octets traversing the interface as a percentage of the total possible number of octets (based on the ifSpeed value). From Interface to Interface, the exact MIB variables queried vary based on interface speed and whether the system supports the high speed counters for interfaces. Each

Metric	Interface/Node Monitoring	Description
		interface in an Interface Group has its utilization calculated by taking the total traffic on all administratively up interfaces in the group and dividing that by the total possible bandwidth.
Backplane Utilization	Node	Percentage of backplane usage in relation to the total amount of backplane resources available.
Buffer Utilization	Node	Percentage of buffer usage in relation to the number of buffers available.
CPU 1Min Utilization	Node	Percentage of CPU usage in relation to the total amount of CPU available. This percentage is measured at 1-minute intervals.
CPU 5Min Utilization	Node	Percentage of CPU usage in relation to the total amount of CPU available. This percentage is measured at 5-minute intervals.
CPU 5Sec Utilization	Node	Percentage of CPU usage in relation to the total amount of CPU available. This percentage is measure at 5-second intervals.
Disk Space utilization	Node	Percentage of disk space usage in relation to the total amount of disk space available.
Memory Utilization	Node	Percentage of memory usage in relation to the total amount of memory available.
Management Address ICMP Response Time	Node	Indicates the Internet Control Message Protocol (ICMP) response time (in milliseconds) from the management station to the target node.

Using Reports to Monitor Baselines

The NNM iSPI Performance for Metrics enables you to monitor the baseline with the help of the Baseline Sleeve report to monitor baselines. This report highlights the baseline sleeve on a line graph and shows a table that lists the lower and upper limits at each display grain.

To monitor a baseline sleeve:

1. Log on to the NPS console.
2. From the navigation pane, launch the Baseline Sleeve report.
3. Click **Options**. This prompt enables you to choose one of the metrics that was configured for baselining during interface or component monitoring configuration.
4. Click **Confirm Selection**. The report shows a line graph of the selected metric and highlights a range of values that is computed as the baseline sleeve for the selected period of time.

You can also launch other reports like Top N or Chart Details to monitor different characteristics of the baseline for the monitored metric. Table: Metrics to Monitor the Baseline provides a list of metrics that help you monitor baseline characteristics.

Metrics to Monitor the Baseline

Metric	Description
Baseline Average	Average value presenting the normal (expected) range of utilization for the selected topology filter based on the historical data Can analyze the following using this metric: • The actual utilization of the topology element as compared to the normal utilization ranges • Forecast the topology element utilization for a selected time range. • Identify the over-utilized and under-utilized topology elements before they violate the thresholds.
Baseline Deviation	Deviation of the samples spread over a specific time range. Represents the extent of the range of values normally seen for the selected time range in the seasonal cycle, based on historical data. Can analyze the following using this metric: • Analyze the utilization pattern for the selected topology elements over a selected time range. • Identify the utilization values that are lower or higher than the mean utilization. This in turn enables you to identify the over-utilized and under-utilized topology elements.
Lower Threshold	The lower deviation configured in the Baseline Settings form.
Upper Threshold	The upper deviation configured in the Baseline Settings form.
Upper Normal	Upper limit of the normal range for the sample. The normal range for the sample may vary for every iSPI Performance product. NNMi supplies the upper normal value based on values that you enter in the Threshold Configuration form. You can disable the upper normal value if you do not require to set the upper threshold for the metric. See the *HP Network Node Manager i Software Online Help for Administrators* for information about the Threshold Configuration form. The value is calculated using the following formula:

Metric	Description
	Upper Normal = Baseline Average + (N1 * Baseline Deviation) where N1 is the upper sleeve width
Lower Normal	Lower limit of the normal range for the sample. The normal range for the sample can vary for every iSPI Performance product. NNMi supplies the lower normal value based on values you enter in the Threshold Configuration form. You can disable the lower normal value if you do not set the lower threshold for the metric. See the *HP Network Node Manager i Software Online Help for Administrators* for information about the Threshold Configuration form. The value is calculated using the following formula: Lower Normal = Baseline Average - (N2 * Baseline Deviation) where N2 is the lower sleeve width
Days to Threshold	Forecast for the topology element utilization to reach the upper or lower threshold limit. Represents the number of days left for the utilization to reach the threshold value. NPS calculates this metric based on the following: • Baseline Slope • The static upper and lower thresholds defined in NNMi Threshold Configuration form

Using Reports to Monitor Exceptions

The NNM iSPI Performance for Metrics generates exceptions when a metric value is found to exceed the baseline sleeve. You can view those incidents in the Incident View in the NNMi console. In addition, you can use NPS reports to monitor exceptions detected by the NNM iSPI Performance for Metrics. Ideal reports to monitor exceptions are:

- **Top N** or **Top N Chart:** Shows Top N elements that reported most exceptions
- **Chart Details:** Shows a time-series chart to indicate total count of exceptions

To monitor exceptions:

1. Log on to the NPS console.
2. From the navigation pane, launch a report of your choice.
3. Click **Options**.

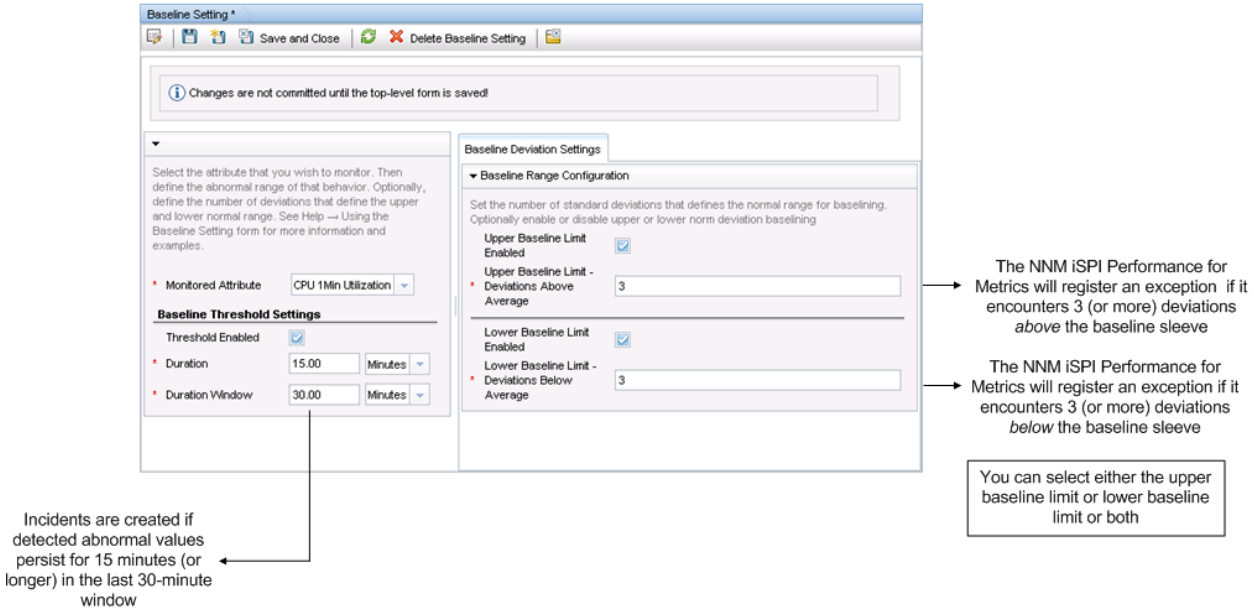
4. Select one of the metrics listed in Table: Metrics for Monitoring Exceptions.
5. Click **Confirm Selection**.

Metrics for Monitoring Exceptions

Metric	Description
Baseline Exception Rate	Percentage of samples that has the exception flag set.
Baseline Exception Count	Total number of sample counts marked for an exception. NPS raises an exception for the metric if a certain number of samples within a sample window is out of normal range. For example, NPS raises a baseline exception if 7 samples out of a sample window of 10 samples are beyond the upper normal range. You must configure NNMi for the upper and lower normal ranges to enable NPS to raise the exceptions. If the topology filter utilization is between Upper Normal and Lower Normal, the exception count is set to 0 (Zero) for the selected sample. If you disable the upper or lower normal thresholds in NNMi, NPS does not raise exceptions for the upper and lower normal ranges. The iSPI Performance products can analyze the following using this metric: • Analyze the performance of the selected topology filter for a specific time range. • Identify network performance problem if the exception count is persistently high for the selected time range.

Example

1. Configure a baseline threshold for nodes in the NNMi Baseline Setting configuration form.



   a. Select CPU 1Min Utilization as the monitored attribute.

   b. Select Threshold Enabled.

      This selection enables the NNM iSPI Performance for Metrics to send incidents to the NNMi Incident View.

   c. Type a duration of 15 minutes.

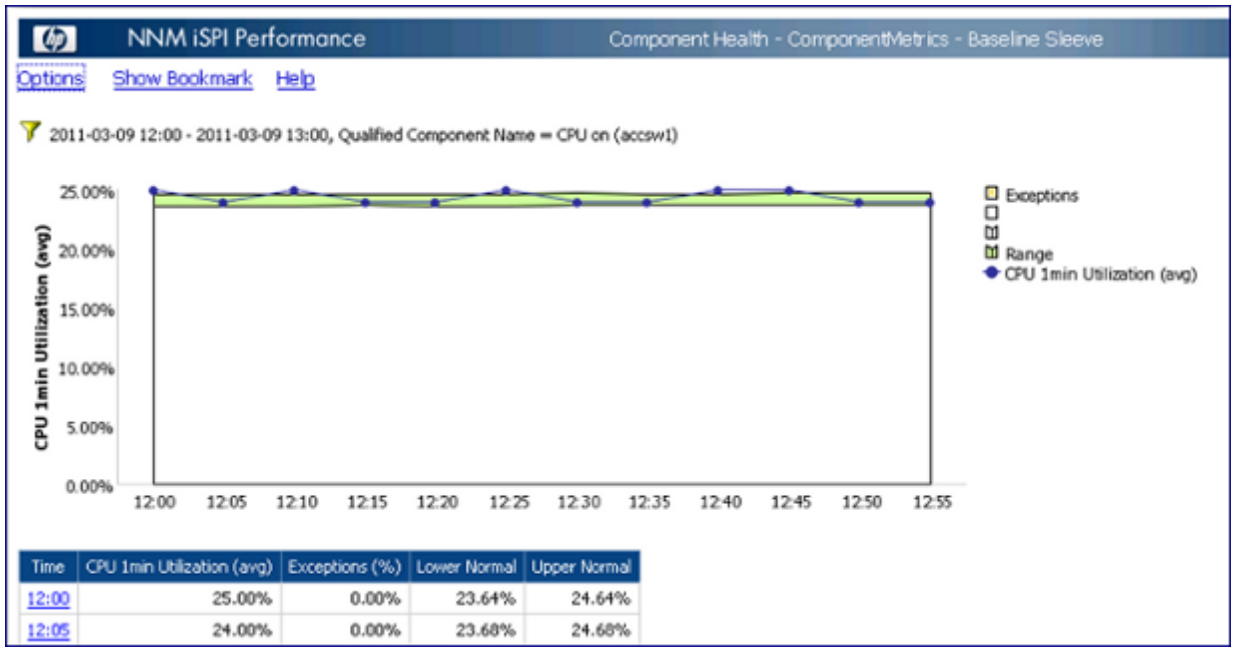
   d. Type a duration window of 30 minutes.

      Because of this configuration, the NNM iSPI Performance for Metrics will send incidents to the NNMi Incident View if an exception persists for 15 minutes of the last 30-minute window.

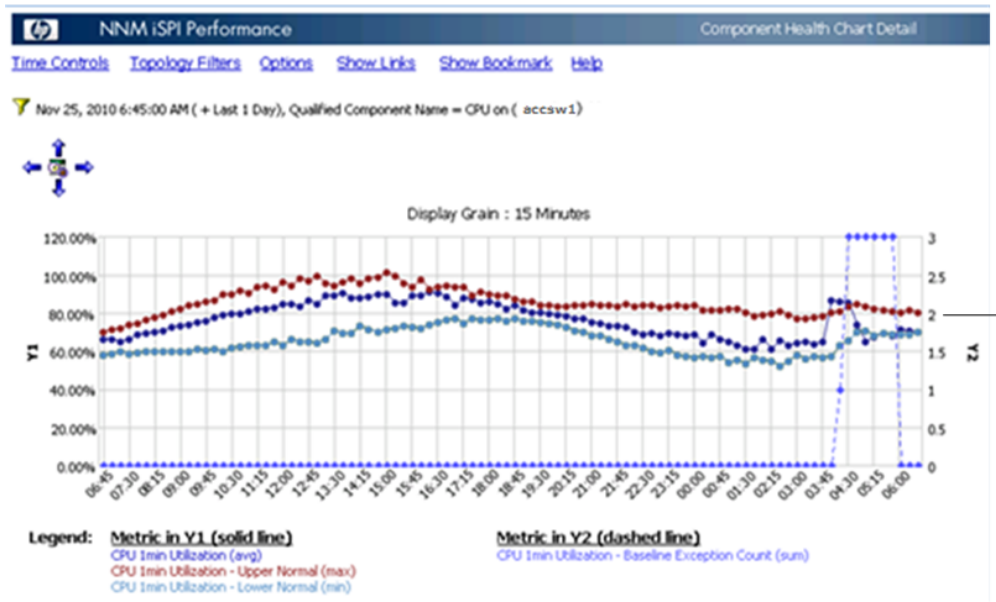
   e. In the Baseline Deviation Settings tab:
      i. Select the Upper Baseline Limit Enabled check box.
      ii. Type 3 for the deviation above average.
      iii. Select the Lower Baseline Limit Enabled check box.
      iv. Type 3 for the deviation below average.

      Tip: You can choose either the upper baseline limit or lower baseline limit or both.

2. After the initialization period (three weeks), launch the Baseline Sleeve Component Health report and view the baseline.



3. When the NNM iSPI Performance for Metrics detects a metric value that lies outside of the baseline sleeve for 15 minutes or longer within the last 30-minute window, the NNM iSPI Performance for Metrics raises an exception and sends an incident to the NNMi Incident View. You can view these exceptions on a Chart Detail report by selecting the `CPU 1Min Utilization - Baseline Exception Count` metric.



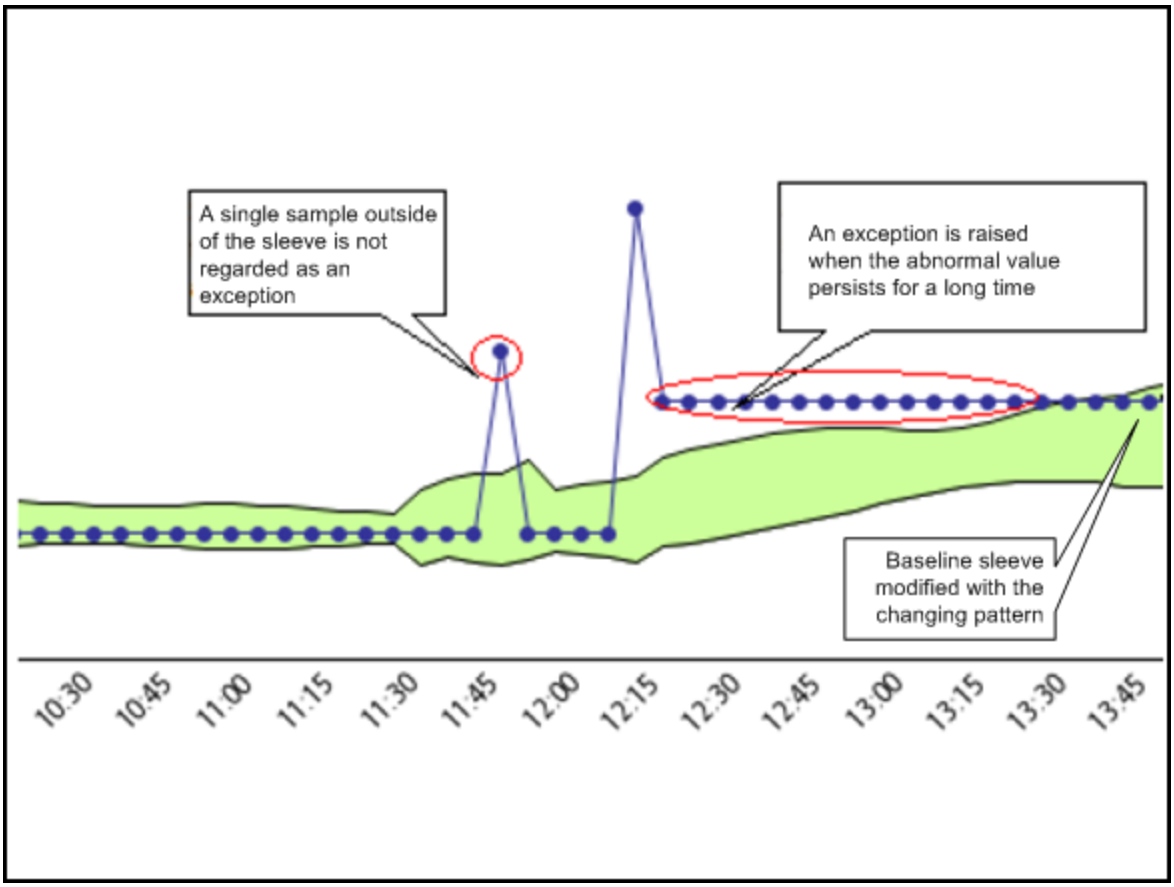
How the NNM iSPI Performance for Metrics Calculates Baselines

A baseline characterizes the normal pattern of behavior for the time series of the monitored metric instance. The normal operating range is defined by the upper and lower limits; the upper and lower limits are derived from the baseline and deviation values. The normal operating range is also referred to as the **baseline sleeve**.When the detected metric value lies outside of the baseline sleeve, an exception is detected.

The width of the baseline sleeve is a multiplier function of the historical deviation detected in the series of data samples; that is, if historically metric values do not vary a lot, the baseline sleeve remains narrow; if metric values vary significantly, the NNM iSPI Performance for Metricscreates a wider baseline sleeve. The selected multiplier is used by the NNM iSPI Performance for Metrics to tune the selectivity of the range–a multiplier of 2 captures about 95% of samples; a multiplier of 3 captures 99% of samples.

The baseline sleeve defines the range of values that are considered normal. The process of exception detection defines abnormal samples as the samples that lie outside of the sleeve. To minimize the number of false alarms, this process does not classify every abnormal sample as an exception. The sleeve width of 3 deviations (or, in other words, a sleeve calculated with a multiplier of 3) captures 99% of samples, which means, 1% of the samples lie outside of the sleeve.

When abnormal values persist for a long time, a new "normal " value is determined as the baseline and the baseline sleeve changes.



Triple Exponential Smoothing Technique

The NNM iSPI Performance for Metrics uses the Triple Exponential Smoothing technique to calculate baseline. This technique is used to predict the expected current value in a time series with the help of the previous value and the previous prediction.

$y_1, ..., y_{t-1}, y_t$ is a time series.

$\acute{y}_t$ is the predicted value at time t.

$\acute{y}_t = \alpha y_{t-1} + (1-\alpha)\acute{y}_{t-1}$

$\acute{y}_t$ is the weighted average of the previous sample in the time series and the previous prediction. The calculation of $\acute{y}_t$ is based on the principle that the most recent sample is the most relevant sample for making predictions. A sample becomes less relevant with age. The weight of a sample in calculating the prediction decays exponentially over time and eventually becomes insignificant.

The Triple Exponential Smoothing technique assumes that the time series can be broken down into three components:

- The overall mean smoothing component or **intercept** (a_t)
- The **trend** smoothing component (b_t)
- The **seasonal** smoothing component for changing seasonal patterns (c_t)

The prediction $\acute{y}_t$ is the sum of the above three components:

$\acute{y}_t = a_t + b_t + c_t$

Each component (a_t, b_t, and c_t) is calculated with the exponential smoothing technique:

- Intercept component = weighted average. of de-seasonalized sample and the previous intercept + previous trend

$$a_t = \alpha(y_t - c_{t-s}) + (1-\alpha)(a_{t-1} - b_{t-1})$$

- Trend component = weighted average of the difference between the current and the previous intercepts and the previous trend.

$$b_t = \beta(a_t - a_{t-1}) + (1 - \beta)b_{t-1}$$

- Seasonal component = weighted average of the difference between the current sample and the current intercept and the seasonal component from the previous season

$$c_t = \gamma (y_t - a_t) + (1-\gamma)c_{t-s}$$

All three parameters (α, β, and γ) control the rate at which the baseline is modified with the changing pattern.

Lower and Upper Limits of the Baseline Sleeve

The upper (u) and lower (l) limits of the baseline sleeve are calculated by adding or subtracting a defined multiple of the historic baseline deviation to or from the baseline average.

$u_t = \acute{y}_t + (\delta_+ * d_{t-S})$; $l_t = t - (\delta_- * d_{t-S})$

The values of δ_+ and δ_- (configured in the Baseline Deviation Settings tab) have an effect on the width of the baseline sleeve. Smaller values of δ create a narrow sleeve; larger values of δ create a wide sleeve.

Seasonality and Grain

A short season length, for example, of 24 hours, fails to capture weekly patterns such as lighter workload on weekends. This can result in:

- A very wide baseline sleeve
- A baseline slanted toward the weekday average at the start of the weekend and a baseline slanted toward the weekend average at the start of the week

For calculating baselines, the NNM iSPI Performance for Metrics uses a seasonality of 1 week with a grain of 5 minutes, and therefore, daily, as well as weekly, patterns are captured while calculating the sleeve.

Initialization

The NNM iSPI Performance for Metrics initializes the intercept component with the value obtained from the first sample. The deviation (δ), the trend component (b), and the seasonal component (c) are initialized to zero.

The initial values influence the baseline sleeve for some time. Gradually, with the arrival of new data samples, the baseline sleeve begins to stabilize. One of the contributing factors of the

seasonal component—γ—continues to change through the first three seasons, and then finally stabilizes and remain constant from the beginning of the fourth season.

Detecting Exceptions

After defining the baseline sleeve as the range of normal values, the NNM iSPI Performance for Metrics can detect abnormal samples as the ones that lie outside of the sleeve. By defining a moving window of Y samples, the NNM iSPI Performance for Metrics detects an exception if the window contains X samples (or more). The NNM iSPI Performance for Metrics uses a preset interval of 5 minutes (that is, for computing baselines, samples are read by the NNM iSPI Performance for Metrics at an interval of 5 minutes).

For example, if Y is 6 (30 minutes) and X is 3 (15 minutes), the NNM iSPI Performance for Metrics detects an exception when the abnormal behavior persists for at least 15 out of 30 minutes.