NOKIA

7450 Ethernet Service Switch
7750 Service Router
7950 Extensible Routing System
Virtualized Service Router

Releases up to 24.7.R2

OAM and Diagnostics Advanced Configuration Guide for Classic CLI

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Nokia is committed to diversity and inclusion. We are continuously reviewing our customer documentation and consulting with standards bodies to ensure that terminology is inclusive and aligned with the industry. Our future customer documentation will be updated accordingly.

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Preface

About This Guide

Each Advanced Configuration Guide is organized alphabetically and provides feature and configuration explanations, CLI descriptions, and overall solutions. The Advanced Configuration Guide chapters are written for and based on several Releases, up to 24.7.R2. The Applicability section in each chapter specifies on which release the configuration is based.

The Advanced Configuration Guides supplement the user configuration guides listed in the 7450 ESS, 7750 SR, and 7950 XRS Guide to Documentation.

Audience

This manual is intended for network administrators who are responsible for configuring the routers. It is assumed that the network administrators have a detailed understanding of networking principles and configurations.

OAM Performance Management Infrastructure

This chapter describes the OAM Performance Management Infrastructure.

Topics in this chapter include:

Applicability

The information and configuration in this chapter are based on SR OS Release 16.0.R7. This chapter provides information for the configuration of base OAM Performance Management (OAM-PM) components, common to all the supported tests. This chapter will not describe technology-specific test criteria. Those will be included in their own technology-specific sections.

Overview

OAM-PM infrastructure provides a common methodology to launch test PDUs that have been purpose-built for delay and loss metrics. The implementation provides a set of transmission, reception, processing, and reporting mechanisms for performance tools supported under the infrastructure. This common infrastructure allows for performance reporting of consistent metrics at the service and network level, regardless of service type (Layer 2 or Layer 3) or transport (Ethernet, IP, or MPLS).

Delay metric results are mapped to counters that represent configured bins, each of which contain a range of results. In addition to the binning function, various delay metrics report minimum, averages, and maximums. Results are reported and mapped for round-trip, forward, and backward measurements. The three key metrics for delay include:

- Frame Delay (FD): Time between applicable timestamps

- InterFrame Delay Variation (IFDV): Difference in delay between adjacent PDUs. This value represents the absolute value of the result.

- Frame Delay Range (FDR): PDU distances from the minimum measured or estimated in that measurement interval

Single-ended loss tools measure both forward and backward directions between peers, representing a unidirectional result. Frame Loss Ratio (FLR) reports the minimum and maximum observed values for the small samples used for loss comparison, and the average covering the overall measurement interval. Reliability metrics comprise availability, unavailability, high-loss intervals (sample slices "delta-t" where loss exceeds the configured threshold), and consecutive high-loss intervals. The reliability metrics are meant to enhance existing availability operational methods that use trouble tickets, alerts, alarms, correlation, and so on, to determine availability. Lost packets that cause recognized unavailability times, including undetermined times, are not included in FLR because they are counted toward unavailability.

Threshold Crossing Alarms (TCAs) can be configured for both delay and loss results, with the possibility to exclude outlying delay values based on the unique requirements of the network.

Results are stored in volatile system memory, written as discrete non-overlapping data sets that align with the configured **meas-interval**. The results stored in volatile memory may be polled. The completed session results can be recorded to non-volatile memory using **accounting-policy**. These non-volatile results are stored in XML files and can be retrieved using file transfer protocols. The number of measurement intervals stored in non-volatile memory is configurable. The file system and accounting process are mentioned for completeness, but are not the focus of this chapter.

OAM-PM sessions are the basis for configuring and linking all the test-specific information in one location.

Common reporting nomenclature is used regardless of the configured **test-family**. Although technologies may use different terminology, such as packet versus frame, the OAM-PM infrastructure uses single common normalized terms. This commonality simplifies the storage, reporting, collection, and the integration and higher-level analytics. The common approach provides significant operational and management optimization.

Configuration

Most of the configuration elements for the infrastructure components are directly located under the OAM-PM hierarchy. However, there are some linkages to other optional subsystems, such as accounting policies. Figure 1: Configuration Tree provides the topics that will be included in the configuration section. The "Tech specific (Ethernet, IP, MPLS)" block has been grayed out, because it is not included in this chapter.

Figure 1: Configuration Tree
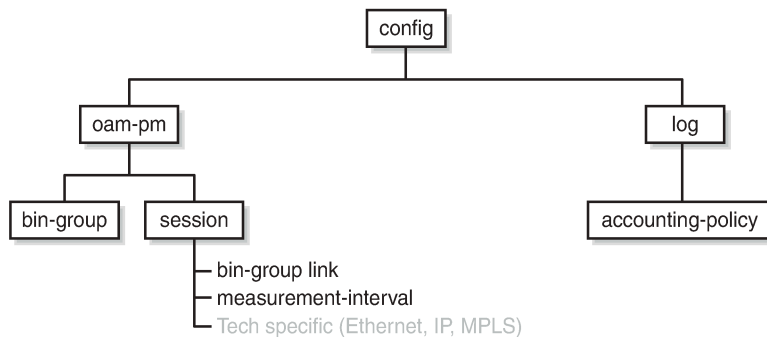
28878

Bin groups

The configurable ranges are based on the unique requirements of the session: delay metrics, direction (round-trip, forward, or backward), measurements of interest, critical measurement markers, network behavior, thresholds of concern, and likely many more operator-specific requirements. Bin groups are only used to store delay metric results.

A bin group can belong to multiple sessions. A session may refer to only one bin group.

It is necessary to indicate the number of bins per delay metric **fd-bin-count, ifdv-bin-count**, and **fdr-bin-count** at the time of **bin-group create**, to a maximum of ten each. Higher-numbered bins must have higher ranges than lower-numbered bins. Default ranges for unconfigured bins within the bin count defaults are 5000 microseconds times the bin number. The range of results stored in the bin is based on the **lower-bound** of that bin and the **lower-bound** of the next higher adjacent bin, with bin 0 having an unchangeable implicit **lower-bound 0**.

Figure 2: Graphical Representation of Bin Group 3 includes shading to demonstrate the importance of the bins. Dark gray shows the results furthest from the objective. These results, although very important to overall reporting and declaration for meeting the objective, should be judged differently than the light gray results. The light gray results are near enough to the objective that adjusting various network options may cause these results to fall into the objective range. The unshaded area of the range represents the objective range. In this case, FDR is only being recorded for interest purposes and has no directives.

Figure 2: Graphical Representation of Bin Group 3
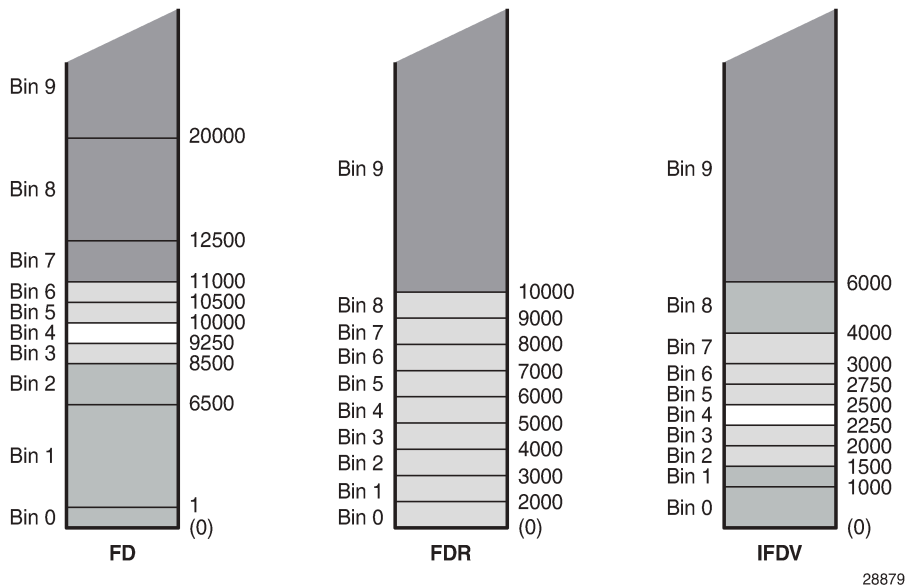
The configuration commands required to create the preceding representation are as follows:

```
configure oam-pm
        bin-group 3 fd-bin-count 10 fdr-bin-count 10 ifdv-bin-count 10 create
            bin-type fd
                bin 1
                    lower-bound 1
                exit
                bin 2
                    lower-bound 6500
                exit
                bin 3
                    lower-bound 8500
                exit
                bin 4
                    lower-bound 9250
                exit
                bin 5
                    lower-bound 10000
                exit
```

```
                bin 6
                    lower-bound 10500
                exit
                bin 7
                    lower-bound 11000
                exit
                bin 8
                    lower-bound 12500
                exit
                bin 9
                    lower-bound 20000
                exit
            exit
            bin-type fdr
                bin 1
                    lower-bound 2000
                exit
                bin 2
                    lower-bound 3000
                exit
                bin 3
                    lower-bound 4000
                exit
                bin 4
                    lower-bound 5000
                exit
                bin 5
                    lower-bound 6000
                exit
                bin 6
                    lower-bound 7000
                exit
                bin 7
                    lower-bound 8000
                exit
                bin 8
                    lower-bound 9000
                exit
                bin 9
                    lower-bound 10000
                exit
            exit
            bin-type ifdv
                bin 1
                    lower-bound 1000
                exit
                bin 2
                    lower-bound 1500
                exit
                bin 3
                    lower-bound 2000
                exit
                bin 4
                    lower-bound 2250
                exit
                bin 5
                    lower-bound 2500
                exit
                bin 6
                    lower-bound 2750
                exit
                bin 7
                    lower-bound 3000
                exit
```

```
                    bin 8
                        lower-bound 4000
                    exit
                    bin 9
                        lower-bound 6000
                    exit
            exit
            no shutdown
        exit
```

In addition to the basic configuration, three advanced features expand the binning infrastructure:

• Delay TCA (**delay-event**) against a threshold

• Exclude bin counts from the delay TCA (**delay-event-exclusion**)

• Exclude bins from the computed averages (**exclude-from-avg**)

Individual results are still mapped and accounted for in the appropriate bins. However, excluded results will not be counted toward the event threshold or included in the rolling average, if explicitly configured to exclude. The **delay-event** and the **delay-event-exclusion** can be configured while the bin group is enabled. The **exclude-from-avg** requires the bin group to be disabled. An example of the **delay-event** is as follows:

```
delay-event {forward|backward|round-trip} lowest-bin <bin-number> threshold
    <raise-threshold> [clear <clear-threshold>]
```

The delay TCA is per **bin-type {fd|ifdv|fdr}**, and requires the direction **{forward | backward | round-trip}**, the **lowest-bin <bin-number>**, the **threshold <raise-threshold>**, and a declaration of stateful [**clear <clear-threshold>**] or stateless (omission of the **clear** option).

The **lowest-bin <bin-number>** is the result count including the specified bin and all higher bins. When the total count in that bin and all higher bins equals the configured threshold, the TCA is triggered.

Stateful processing requires a subsequent measurement interval to complete with a count in the specified bin and all higher bins at or below the **clear** value. If the clear option is omitted, the TCA is stateless. Stateless TCA events are not carried over to subsequent measurement intervals. Each measurement interval is unique unto itself. Individual TCAs will only be raised once at the time of the event during a measurement interval.

The **delay-event-exclusion** allows bins to be removed from the event count. This configuration is per **bin-type {fd|ifdv|fdr}**, and requires the direction {**forward|backward|round-trip**} and the **lowest-bin <bin-number>**. The **lowest-bin** excludes the specified bin and all higher bins from the event count.

The following configuration expands **bin-group 3 bin-type fd** to include **delay-event** TCA and a **delay-event-exclusion**. When a test using bin group 3 counts 30 results in bin 7 and 8, it will generate a log event indicating that the threshold has been reached. Bin 9 results are not considered against the delay event TCA because of the exclusion statement.

```
configure oam-pm bin-group 3 bin-type fd
                delay-event round-trip lowest-bin 7 threshold 30 clear 0
                delay-event-exclusion round-trip lowest-bin 9
```

Some networks include elements with software clocks and possible transmission style equipment that performs circuit establishment on first packet reception. Because these can provide non-representative delay results, these results are typically excluded from the computed averages. The bin group must be shut down to make this modification.

The **exclude-from-avg** configuration is per **bin-type {fd|ifdv|fdr}**, and requires the direction {**forward|backward|round-trip**} and the **bins <bin-numbers>**. The results in these **bins** are specifically excluded from the computed average. The bins to be excluded should include the bins that have been configured to track obvious anomalies.

The following configuration further expands **bin-group 3 bin-type fd** to **exclude-from-avg** bins 0 and 9.

```
*A:PE-1# configure oam-pm bin-group 3 bin-type fd
            exclude-from-avg round-trip bins 0,9
```

The complete configuration, including the TCA and exclude configuration, is shown here for completeness.

```
        bin-group 3 fd-bin-count 10 fdr-bin-count 10 ifdv-bin-count 10 create
            bin-type fd
                bin 1
                    lower-bound 1
                exit
                bin 2
                    lower-bound 6500
                exit
                bin 3
                    lower-bound 8500
                exit
                bin 4
                    lower-bound 9250
                exit
                bin 5
                    lower-bound 10000
                exit
                bin 6
                    lower-bound 10500
                exit
                bin 7
                    lower-bound 11000
                exit
                bin 8
                    lower-bound 12500
                exit
                bin 9
                    lower-bound 20000
                exit
                delay-event round-trip lowest-bin 7 threshold 30 clear 0
                delay-event-exclusion round-trip lowest-bin 9
                exclude-from-avg round-trip bins 0,9
            exit
            bin-type fdr
                bin 1
                    lower-bound 2000
                exit
                bin 2
                    lower-bound 3000
                exit
                bin 3
                    lower-bound 4000
                exit
                bin 4
                    lower-bound 5000
                exit
                bin 5
                    lower-bound 6000
                exit
                bin 6
```

```
                        lower-bound 7000
                    exit
                    bin 7
                        lower-bound 8000
                    exit
                    bin 8
                        lower-bound 9000
                    exit
                    bin 9
                        lower-bound 10000
                    exit
                exit
                bin-type ifdv
                    bin 1
                        lower-bound 1000
                    exit
                    bin 2
                        lower-bound 1500
                    exit
                    bin 3
                        lower-bound 2000
                    exit
                    bin 4
                        lower-bound 2250
                    exit
                    bin 5
                        lower-bound 2500
                    exit
                    bin 6
                        lower-bound 2750
                    exit
                    bin 7
                        lower-bound 3000
                    exit
                    bin 8
                        lower-bound 4000
                    exit
                    bin 9
                        lower-bound 6000
                    exit
                exit
                no shutdown
            exit
```

There are several **show** commands that provide display-level information for bin groups. The power of some of the **show** commands is revealed when tests are mapped to the bin group. Background tests outside the scope of this chapter have been added to enhance the usefulness of this section.

The **show oam-pm bin-group <bin-group-number> detail** command provides information about the configured bin groups.

The base command with no options shows the following bin group information; the description, the admin state, and the ranges for each configured bin type (FD, FDR, and IFDV) are displayed.

```
*A:PE-1# show oam-pm bin-group
-------------------------------------------------------------------------------
Configured Lower Bounds for Delay Tests, in microseconds
-------------------------------------------------------------------------------
Group Description                  Admin Bin    FD(us)    FDR(us)   IFDV(us)
-------------------------------------------------------------------------------
1     OAM PM default bin group (not*  Up   0         0         0         0
                                           1      5000      5000      5000
                                           2     10000         -         -
```

```
-------------------------------------------------------------------------
2                                         Up  0         0          0          0
                                              1      1000       1000        500
                                              2      2000       1500        750
                                              3      3000       2000       1000
                                              4      4000       2500       1250
                                              5      5000       3000       1500
                                              6      6000       3500       1750
                                              7      7000       4000       2000
                                              8      8000       4500       2250
                                              9      9000       5000       2500
-------------------------------------------------------------------------
3                                         Up  0         0          0          0
                                              1         1       2000       1000
                                              2      6500       3000       1500
                                              3      8500       4000       2000
                                              4      9250       5000       2250
                                              5     10000       6000       2500
                                              6     10500       7000       2750
                                              7     11000       8000       3000
                                              8     12500       9000       4000
                                              9     20000      10000       6000
-------------------------------------------------------------------------
* indicates that the corresponding row element may have been truncated.
```

To display TCA and exclude information, filter on a single bin-group-number and include the **detail** option, as follows:

```
*A:PE-1# show oam-pm bin-group 3 detail
-------------------------------------------------------------------------
Configured Lower Bounds for Delay Tests, in microseconds
-------------------------------------------------------------------------
Group Description                  Admin Bin    FD(us)    FDR(us)    IFDV(us)
-------------------------------------------------------------------------
3                                         Up  0         0          0          0
                                              1         1       2000       1000
                                              2      6500       3000       1500
                                              3      8500       4000       2000
                                              4      9250       5000       2250
                                              5     10000       6000       2500
                                              6     10500       7000       2750
                                              7     11000       8000       3000
                                              8     12500       9000       4000
                                              9     20000      10000       6000
-------------------------------------------------------------------------


----------------------------------------
Bins Excluded from Average
----------------------------------------
Bin Type     Direction          Bins
----------------------------------------
FD           round-trip         0,9
----------------------------------------


-------------------------------------------------------------------
Delay Events Configured
-------------------------------------------------------------------
Bin Type     Direction    Lowest Bin    Lower Bound (us)    Raise    Clear
-------------------------------------------------------------------
FD           round-trip        7              11000          30        0
-------------------------------------------------------------------
-------------------------------------------------------------------
Bins Excluded from Delay Event Count
```

```
-------------------------------------------------------------
Bin Type      Direction      Lowest Excluded Bin    Lower Bound (us)
-------------------------------------------------------------
FD            round-trip                      9              20000
-------------------------------------------------------------
```

The **show oam-pm bin-group-using [bin-group <bin-group-number>]** command shows a mapping of sessions to bin groups. The base command shows all mappings, as follows. Adding the optional **bin-group <bin-group-number>** command limits the output to the specified bin group.

```
*A:PE-1# show oam-pm bin-group-using
===========================================================================
OAM Performance Monitoring Bin Group Configuration for Sessions
===========================================================================
Bin Group      Admin   Session                          Session State
---------------------------------------------------------------------------
1              Up      ip-rtr-telemetry-streaming             Act
---------------------------------------------------------------------------
2              Up      mpls-dm-rsvp-PE-2-PE-1                  Act
                       mpls-dm-static-PE-2-PE-1               Act
                       mpls-dm-rsvp-PE-2-PE-1-hop1            Act
                       mpls-dm-rsvp-auto-PE-2-PE-1            Act
                       mpls-dm-static-PE-2-PE-1-hop1          Act
---------------------------------------------------------------------------
3              Up      ip-lpb101-RSVP-LSP                     Act
                       ip-lpb111-SR-TE-LSP                    Act
                       ip-rtr-int-PE-1-PE-2                   Act
                       eth-port-int-PE-2-P-3                  Act
                       ip-circuit-service-vprn2              Act
                       eth-circuit-service-vpls3             Act
                       eth-circuit-service-epipe1            Act
                       eth-circuit-service-epipe1-2          Act
                       eth-circuit-service-epipe1-3          Act
---------------------------------------------------------------------------
===========================================================================
```

In summary, the bin group contains three configurable bin types: FD, IFDV, and FDR. Results are mapped to the counter in the appropriate bin, considering any configured TCA or event exclusions. The various delay metric average computations can be influenced by an optional configuration that excludes certain results from the calculation.

Session

The session is the container bringing the individual testing elements together. Most parameters under the session context cannot be changed if a test within the session is active. The session is created with specific mandatory fixed values that set the personality and behavior of the session.

The **session session-name** identifies the collection as one comprehensive entity. The **test-family < ethernet|ip|mpls>** defines the type of technology test that can be configured within that session and enforces various technology-specific configuration rules. The rules ensure that only technology relevant to the configuration parameter matching the test family can be configured. The **session-type {proactive| on-demand}** (as follows) defines whether the session is always on, proactive, or must be started manually using the **oam-pm session <session-name>{dm|dmm|lmm|slm|twamp-light} {start|stop}** command, on demand.

```
session <session-name> [test-family <ethernet|ip|mpls> [session-type {proactive|on-demand}]
  create
```

After the session is created, a **bin-group** can be assigned to the session. If **no bin-group** is specified, **bin-group 1** (the default bin group) will be used. A session can support multiple different tests from the same test family. If the test being configured is a loss only test, there is no need to add a **bin-group <bin-number>** to the session. Loss tests do not use bin groups. The following configuration defines a session "*ip-rtr-int-PE-1-PE-2*" with the appropriate session creation parameters, linking to the preferred bin group.

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
    bin-group 3
```

A description can be added to the session to provide more administrative information, as follows:

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        bin-group 3
        description "ip circuit connecting PE-1 to PE-2"
```

The final step before configuring the technology-specific test parameters within the session is defining the size of the sample window: the measurement interval. Each session requires at least one measurement interval to be assigned. There are four fixed-size measurement intervals, typical for service level agreement: **meas-interval {5-mins|15-mins|1-hour|1-day}**.

It is possible to assign more than one measurement interval to a session. Each measurement interval is updated independently and maintains its own statistics and memory allocation. Nokia recommends that only a single measurement interval be configured per session to avoid unnecessary processing and memory consumption. The value of configuring multiple measurement intervals is negligible. Higher-level systems can perform the necessary analytics and data merges.

The *raw* measurement interval is an always-on, never-ending collection of samples since the start or last clearing of the *raw* measurement interval. If the operator does not configure a measurement interval (**meas-interval**) within the session, the *raw* measurement interval will be the only one applied. An example of configuring the measurement interval is as follows:

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
```

The results are stored in volatile system memory, written as discrete non-overlapping datasets that align with the measurement interval time configuration.

> **Note:**
> The following does not apply to the *raw* measurement interval. This measurement interval has no configuration options and is only stored in non-volatile memory. Its intent is for troubleshooting, not SLA measurement.

The number of stored completed datasets in non-volatile memory is configurable. The results stored in volatile memory are available through polling tools. Optionally, but highly recommended, the completed session results can be written to the file system. The file system and accounting process are not the focus of this chapter. However, the following basic context is provided for completeness.

Accounting policies are defined as part of the logging function. The **location** defines where to store the file. The **collection-interval** defines how often the process collects the completed records. The **record-type** indicates the types of records to be collected, in the case of OAM-PM complete-pm is required. The rollover defines when the file is closed. The retention defines how long the closed file is kept.

This chapter provides the following basic sample configuration with mandatory requirements to write the appropriate OAM-PM record and maintain the file.

```
configure log
        file-id 19
            description "oam-pm file maintenance options id 19"
            location cf3:
            rollover 30 retention 2
        exit
        accounting-policy 9
            description "oam-pm accounting policy 19"
            record complete-pm
            collection-interval 10
            to file 19
            no shutdown
        exit
```

After the accounting policy is configured, the session can use that configuration, as follows:

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
            accounting-policy 9
```

The amount of system memory consumed by intervals stored in volatile memory can be reduced if write to file is the selected collection method. It is then possible to reduce the number of intervals stored because the reliance on data collection routines from volatile memory is reduced. The data is available from the non-volatile files system and remains for the **interval-stored <intervals> count**.

When the allocation reaches the maximum configured value, the oldest dataset is removed to make room for the newest. Nokia suggests using accounting policy to reduce the intervals stored when writing results to the XML file, balancing the requirements of the environment. The following configuration shows that 24 five-minute measurement intervals will be stored in volatile memory.

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
            accounting-policy 9
            intervals-stored 24
```

The alignment of the measurement interval to the timing reference is determined by the **boundary-type {clock-aligned | test-relative}**. Tests will start based on their operational state: enabled for proactive, or **oam oam-pm .. start** for on-demand. Measurement intervals that are **clock-aligned** align to wall clock time (time of day), starting and stopping on that specific time. For example, a five-minute measurement interval that is clock aligned will stop on every five-minute clock occurrence: 5, 10, 15, 20, 25, 30, and so on. A **test-relative** alignment means that the measurement interval time starts when the test becomes operational, and runs for the length of that interval. For example, if a test becomes operational at two minutes after the hour, the five-minute measurement intervals will stop at 7, 12, 17, 22, 27, 32, and so on.

Clock-aligned measurement intervals are typical for proactive sessions. Test-aligned measurement intervals are typically used for ad hoc on demand sessions. The default **boundary-type** is shown in the following output.

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
            accounting-policy 9
            boundary-type clock-aligned
            intervals-stored 24
```

The first completed clock-aligned measurement interval will typically have the suspect flag set, if it started ten or more seconds after a normally scheduled measurement interval. The suspect flag will also be set if a test is stopped ten or more seconds before the end of the regular measurement interval.

The **clock-offset** option allows for a divergence to be configured from the natural clock starting time. The option provides a method to stagger the measurement interval start, up to 299 seconds. The default clock-offset is as follows:

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
            accounting-policy 9
            boundary-type clock-aligned
            clock-offset 0
            intervals-stored 24
```

A session allows one of its configured measurement intervals to monitor configured TCA events. Delay events are configured under the bin group and were described earlier. Loss events are configured under the technology-specific test type and not part of this chapter.

Event monitoring (**event-mon**) reporting can be modified without having to disable the bin group. On modification, existing events and the ability to compute new TCAs will wait for the start of a subsequent measurement interval when changes are made during an active measurement interval. If the modification is made in near proximity to the completion of one measurement interval, the introduction of the new TCA may require a further measurement interval to implement the change and restart the TCA computations.

The following configuration example shows that event-mon is enabled for **delay-events** and disabled for **loss-events**, under the **meas-interval 5-min**.

```
session "ip-rtr-int-PE-1-PE-2" test-family ip session-type proactive create
        meas-interval 5-mins create
            accounting-policy 9
            boundary-type clock-aligned
            clock-offset 0
            event-mon
                delay-events
                no loss-events
                no shutdown
            exit
            intervals-stored 24
```

The infrastructure OAM-PM components are now configured.

The **test-family** attributes are technology-specific parameters that define the test parameters and influence the PDUs. This test-specific configuration is stored under the technology type: IP, Ethernet, or MPLS. The technology type must match the **test-family** personality configured as part of the session creation. Usually, the configuration parameters under this hierarchy include quality of service (QoS), source and destination, interval, padding, transport-specific parameters, and the type of test packet to be transmitted and processed. Technology-specific configurations are outside the scope of this chapter, which is specific to the OAM-PM infrastructure.

There are several **show** commands that provide display-level information for sessions. The power of some of the **show** commands are revealed when complete session configurations with technology-specific tests are available. Background tests outside the scope of this chapter have been added to enhance the usefulness of this section.

The command **show oam-pm sessions [test-family {ethernet|ip|mpls}] [detectable-tx-errors|event-mon]** provides information about the sessions that are configured.

The base command with no options shows the following session information sorted by test family: session name, admin state, mapped bin group, session type, and test types configured under the session. When the **test-family** option is included, the output will be limited to that family.

```
*A:PE-1# show oam-pm sessions


===============================================================================
OAM Performance Monitoring Session Summary for the Ethernet Test Family
===============================================================================
Session                        State   Bin Group   Sess Type   Test Types
-------------------------------------------------------------------------------
eth-port-int-PE-2-P-3          Act         3       proactive   DMM
eth-circuit-service-vpls3      Act         3       proactive   DMM     SLM
eth-circuit-service-epipe1     Act         3       proactive   DMM LMM SLM
eth-circuit-service-epipe1-2   Act         3       proactive   DMM     SLM
eth-circuit-service-epipe1-3   Act         3       proactive   DMM     SLM
===============================================================================


===============================================================================
OAM Performance Monitoring Session Summary for the IP Test Family
===============================================================================
Session                        State   Bin Group   Sess Type   Test Types
-------------------------------------------------------------------------------
ip-lpb101-RSVP-LSP             Act         3       proactive       TWL
ip-lpb111-SR-TE-LSP            Act         3       proactive       TWL
ip-rtr-int-PE-1-PE-2           Act         3       proactive       TWL
ip-circuit-service-vprn2       Act         3       proactive       TWL
ip-rtr-telemetry-streaming     Act         1       proactive       TWL
===============================================================================


===============================================================================
OAM Performance Monitoring Session Summary for the MPLS Test Family
===============================================================================
Session                        State   Bin Group   Sess Type   Test Types
-------------------------------------------------------------------------------
mpls-dm-rsvp-PE-2-PE-1         Act         2       proactive        DM
mpls-dm-static-PE-2-PE-1       Act         2       proactive        DM
mpls-dm-rsvp-PE-2-PE-1-hop1    Act         2       proactive        DM
mpls-dm-rsvp-auto-PE-2-PE-1    Act         2       proactive        DM
mpls-dm-static-PE-2-PE-1-hop1  Act         2       proactive        DM
===============================================================================
```

To display all sessions with detected transmission errors that prevent the transmission of test PDUs, the **detectable-tx-errors** filter can be added. The following output shows the Ethernet session *eth-cfm-31-28-rtr1* with a detectable error "MEP not fully configured or admin down".

```
*A:PE-1# show oam-pm sessions detectable-tx-errors


===============================================================================
OAM Performance Monitoring Transmit Error Summary: Ethernet Test Family
===============================================================================
                               Test
Session                        Type           Detectable Transmit Error
-------------------------------------------------------------------------------
eth-cfm-31-28-rtr1             DMM    MEP not fully configured or admin down
===============================================================================


===============================================================================
OAM Performance Monitoring Transmit Error Summary: IP Test Family
===============================================================================
                               Test
Session                        Type           Detectable Transmit Error
```

```
     -------------------------------------------------------------------------
     =========================================================================

     =========================================================================
     OAM Performance Monitoring Transmit Error Summary: MPLS Test Family
     =========================================================================
                                     Test
     Session                         Type            Detectable Transmit Error
     -------------------------------------------------------------------------
     =========================================================================
```

To display the event monitoring configuration of all sessions, the **event-mon** filter can be added. The
following output shows all the sessions and any related event monitoring configuration and state of the
event.

```
*A:PE-1# show oam-pm sessions event-mon

==============================================================================
OAM Performance Monitoring Event Summary for the Ethernet Test Family
==============================================================================
Event Monitoring Table Legend:
F = Forward,  B = Backward,  R = Round Trip,  A = Aggregate,
- = Threshold Not Config,  c = Threshold Config,  * = TCA Active,  P = Pending
==============================================================================
                          Test   FD FDR IFDV FLR CHLI HLI UNAV UDAV UDUN
Session                   Type   FBR FBR  FBR  FB  FBA FBA  FBA  FBA  FBA
------------------------------------------------------------------------------
eth-port-int-PE-2-P-3     DMM    --c ---  ---
eth-circuit-service-vpls3 DMM    --c ---  ---
eth-circuit-service-vpls3 SLM                  --  --- ---  ---  ---  ---
eth-circuit-service-epipe1 DMM   --c ---  ---
eth-circuit-service-epipe1 LMM                 --  --- ---  ---  ---  ---
eth-circuit-service-epipe1 SLM                 --  --- ---  ---  ---  ---
eth-circuit-service-epipe1-2 DMM --c ---  ---
eth-circuit-service-epipe1-2 SLM               --  --- ---  ---  ---  ---
eth-circuit-service-epipe1-3 DMM --c ---  ---
eth-circuit-service-epipe1-3 SLM               --  --- ---  ---  ---  ---
==============================================================================


==============================================================================
OAM Performance Monitoring Event Summary for the IP Test Family
==============================================================================
Event Monitoring Table Legend:
F = Forward,  B = Backward,  R = Round Trip,  A = Aggregate,
- = Threshold Not Config,  c = Threshold Config,  * = TCA Active,  P = Pending
==============================================================================
                          Test   FD FDR IFDV FLR CHLI HLI UNAV UDAV UDUN
Session                   Type   FBR FBR  FBR  FB  FBA FBA  FBA  FBA  FBA
------------------------------------------------------------------------------
ip-lpb101-RSVP-LSP        TWL    --c ---  ---  --  --- ---  ---  ---  ---
ip-lpb111-SR-TE-LSP       TWL    --c ---  ---  --  --- ---  ---  ---  ---
ip-rtr-int-PE-1-PE-2      TWL    --c ---  ---  --  --- ---  ---  ---  ---
ip-circuit-service-vprn2  TWL    --c ---  ---  --  --- ---  ---  ---  ---
ip-rtr-telemetry-streaming TWL   --- ---  ---  --  --- ---  ---  ---  ---
==============================================================================


==============================================================================
OAM Performance Monitoring Event Summary for the MPLS Test Family
==============================================================================
Event Monitoring Table Legend:
F = Forward,  B = Backward,  R = Round Trip,  A = Aggregate,
- = Threshold Not Config,  c = Threshold Config,  * = TCA Active,  P = Pending
==============================================================================
```

```
                                   Test    FD FDR IFDV FLR CHLI HLI UNAV UDAV UDUN
Session                            Type   FBR FBR  FBR  FB  FBA FBA  FBA  FBA  FBA
-------------------------------------------------------------------------------
mpls-dm-rsvp-PE-2-PE-1             DM     --c ---  ---
mpls-dm-static-PE-2-PE-1           DM     --c ---  ---
mpls-dm-rsvp-PE-2-PE-1-hop1        DM     --c ---  ---
mpls-dm-rsvp-auto-PE-2-PE-1        DM     --c ---  ---
mpls-dm-static-PE-2-PE-1-hop1      DM     --c ---  ---
===============================================================================
```

The command **show oam-pm session <session-name> [all|base|bin-group|event-mon|meas-interval]**
provides information about an individual session.

The base command with no options, which defaults to **all**, shows the configuration for the session,
technology-specific parameters, the test, the measurement interval specifics, the bin group specifics and
event information. The optional filters **[all|base|bin-group|event-mon|meas-interval]** are used to limit the
output to a specific section of the overall output.

```
*A:PE-1# show oam-pm session "ip-rtr-int-PE-1-PE-2"

-------------------------------------------------------------------------------
Basic Session Configuration
-------------------------------------------------------------------------------
Session Name      : ip-rtr-int-PE-1-PE-2
Description       : ip circuit connecting PE-1 to PE-2
Test Family       : ip                      Session Type       : proactive
Bin Group         : 3
-------------------------------------------------------------------------------


-------------------------------------------------------------------------------
IP Configuration
-------------------------------------------------------------------------------
Source IP Address : 192.0.2.2
Dest IP Address   : 192.0.2.1
Confg Src UDP Port: (Not Specified)     In-Use Src UDP Port: 49154
Dest UDP Port     : 862                 Time To Live       : 255
Forwarding Class  : be                  Profile            : out
DSCP              : resolve             Allow Remark DSCP  : no
Router            : Base                Bypass Routing     : no
Egress Interface  : (Not Specified)
Next Hop Address  : (Not Specified)
Do Not Fragment   : no                  Pattern            : 0
Router Instnce:(Not Specified)
-------------------------------------------------------------------------------


-------------------------------------------------------------------------------
TWAMP-Light Test Configuration and Status
-------------------------------------------------------------------------------
Test ID           : 1                   Admin State        : Up
Oper State        : Up                  Pad Size           : 0 octets
On-Demand Duration: Not Applicable      On-Demand Remaining: Not Applicable
Interval          : 100 ms              Record Stats       : delay-and-loss
CHLI Threshold    : 5 HLIs              Frames Per Delta-T : 1 frames
Consec Delta-Ts   : 10                  FLR Threshold      : 50%
HLI Force Count   : no
Detectable Tx Err : none
-------------------------------------------------------------------------------


-------------------------------------------------------------------------------
5-mins Measurement Interval Configuration
-------------------------------------------------------------------------------
Duration          : 5-mins              Intervals Stored   : 24
Boundary Type     : clock-aligned       Clock Offset       : 0 seconds
```

```
Accounting Policy : 9                   Event Monitoring  : disabled
Delay Event Mon   : disabled            Loss Event Mon    : disabled
-------------------------------------------------------------------------


-------------------------------------------------------------------------
Configured Lower Bounds for Delay Tests, in microseconds
-------------------------------------------------------------------------
Group Description                 Admin Bin    FD(us)    FDR(us)   IFDV(us)
-------------------------------------------------------------------------
3                                 Up   0          0          0          0
                                       1          1       2000       1000
                                       2       6500       3000       1500
                                       3       8500       4000       2000
                                       4       9250       5000       2250
                                       5      10000       6000       2500
                                       6      10500       7000       2750
                                       7      11000       8000       3000
                                       8      12500       9000       4000
                                       9      20000      10000       6000
-------------------------------------------------------------------------


-------------------------------------------
Bins Excluded from Average
-------------------------------------------
Bin Type    Direction          Bins
-------------------------------------------
FD          round-trip         0,9
-------------------------------------------


-----------------------------------------------------------
Bins Excluded from Delay Event Count
-----------------------------------------------------------
Bin Type    Direction    Lowest Excluded Bin    Lower Bound (us)
-----------------------------------------------------------
FD          round-trip              9                 20000
-----------------------------------------------------------


-------------------------------------------------------------------------
Delay Events for the TWAMP-Light Test
-------------------------------------------------------------------------
Bin Type   Direction   LowerBound(us)   Raise   Clear        Last TCA (UTC)
-------------------------------------------------------------------------
FD         round-trip         11000      30      0                     none
-------------------------------------------------------------------------


-------------------------------------------------------------------------
Loss Events for the TWAMP-Light Test
-------------------------------------------------------------------------
Event Type                  Direction    Raise    Clear        Last TCA (UTC)
-------------------------------------------------------------------------
-------------------------------------------------------------------------
```

The stored information in the volatile memory, **intervals-stored**, can be displayed using the **show oam-pm statistics session <session-name> <dm|dmm|lmm|slm|twamp-light> meas-interval {raw|{5-mins|15-mins|1-hour|1-day} interval-number <interval-number> [loss | delay]** command. The interval is with reference to the latest session data. The **interval-number 1** is current, and previously completed results are incremented from 1, representing their position to current. The **[loss|delay]** options can only be used for tests that include both loss and delay as part of the PDU; for example, twamp-light. The **interval-number** is not required when the **meas-interval raw** is the selected option; there is only one.

```
*A:PE-1# show oam-pm statistics session "ip-rtr-int-PE-1-PE-2" twamp-light meas-interval 5-mins
  interval-number 2
```

```
----------------------------------------------------------------------
Start (UTC)     : 2019/05/13 18:30:00       Status         : completed
Elapsed (seconds) : 300                     Suspect        : no
Frames Sent     : 3000                      Frames Received : 3000
----------------------------------------------------------------------
======================================================================
TWAMP-LIGHT DELAY STATISTICS


----------------------------------------------------------------------
Bin Type     Direction     Minimum (us)  Maximum (us)  Average (us)  EfA
----------------------------------------------------------------------
FD           Forward            205           899          440      no
FD           Backward            84           868          263      no
FD           Round Trip         457          1516          704      yes
FDR          Forward              0           687          233      no
FDR          Backward             0           784          179      no
FDR          Round Trip           0          1050          242      no
IFDV         Forward              0           537           73      no
IFDV         Backward             0           639           68      no
IFDV         Round Trip           0           680          108      no
----------------------------------------------------------------------
EfA = yes: one or more bins configured to be Excluded from the Average calc.


---------------------------------------------------------------
Frame Delay (FD) Bin Counts
---------------------------------------------------------------
Bin     Lower Bound      Forward      Backward     Round Trip
---------------------------------------------------------------
0              0 us          0            0              0
1              1 us       3000         3000           3000
2           6500 us          0            0              0
3           8500 us          0            0              0
4           9250 us          0            0              0
5          10000 us          0            0              0
6          10500 us          0            0              0
7          11000 us          0            0              0
8          12500 us          0            0              0
9          20000 us          0            0              0
---------------------------------------------------------------


---------------------------------------------------------------
Frame Delay Range (FDR) Bin Counts
---------------------------------------------------------------
Bin     Lower Bound      Forward      Backward     Round Trip
---------------------------------------------------------------
0              0 us       3000         3000           3000
1           2000 us          0            0              0
2           3000 us          0            0              0
3           4000 us          0            0              0
4           5000 us          0            0              0
5           6000 us          0            0              0
6           7000 us          0            0              0
7           8000 us          0            0              0
8           9000 us          0            0              0
9          10000 us          0            0              0
---------------------------------------------------------------


---------------------------------------------------------------
Inter-Frame Delay Variation (IFDV) Bin Counts
---------------------------------------------------------------
Bin     Lower Bound      Forward      Backward     Round Trip
---------------------------------------------------------------
0              0 us       3000         3000           3000
```

```
1              1000 us            0            0            0
2              1500 us            0            0            0
3              2000 us            0            0            0
4              2250 us            0            0            0
5              2500 us            0            0            0
6              2750 us            0            0            0
7              3000 us            0            0            0
8              4000 us            0            0            0
9              6000 us            0            0            0
             ----------------------------------------------------------------
===============================================================================
===============================================================================
TWAMP-LIGHT LOSS STATISTICS

             -------------------------------------------------
                       Frames Sent        Frames Received
             -------------------------------------------------
Forward                    3000                    3000
Backward                   3000                    3000
             -------------------------------------------------


             -------------------------------------------------
Frame Loss Ratios
             -------------------------------------------------
               Minimum     Maximum       Average
             -------------------------------------------------
Forward         0.000%      0.000%        0.000%
Backward        0.000%      0.000%        0.000%
             -------------------------------------------------


             ----------------------------------------------------------------------
Availability Counters (Und = Undetermined)
             ----------------------------------------------------------------------
             Available   Und-Avail Unavailable Und-Unavail       HLI       CHLI
             ----------------------------------------------------------------------
Forward         3000            0           0           0           0           0
Backward        3000            0           0           0           0           0
             ----------------------------------------------------------------------
===============================================================================
```

The **meas-interval raw** clear and statistics are as follows. It is the only measurement interval that may be cleared.

```
*A:PE-1# clear oam-pm session "ip-rtr-int-PE-1-PE-2" twamp-light

*A:PE-1# show oam-pm statistics session "ip-rtr-int-PE-1-PE-2" twamp-light meas-interval raw
-------------------------------------------------------------------------------
Start (UTC)        : 2019/05/13 18:39:54        Status          : in-progress
Elapsed (seconds) : 24                          Suspect         : yes
Frames Sent        : 241                        Frames Received : 241
-------------------------------------------------------------------------------
===============================================================================
TWAMP-LIGHT DELAY STATISTICS

             ----------------------------------------------------------------------
Bin Type     Direction     Minimum (us)   Maximum (us)   Average (us)   EfA
             ----------------------------------------------------------------------
FD           Forward            274            578            402        no
FD           Backward           147            571            260        no
FD           Round Trip         475            998            662        yes
FDR          Forward              0            304            117        no
FDR          Backward             0            424            112        no
FDR          Round Trip           0            516            178        no
```

```
IFDV       Forward              0         247          64    no
IFDV       Backward             0         334          61    no
IFDV       Round Trip           2         409         103    no
-------------------------------------------------------------------
EfA = yes: one or more bins configured to be Excluded from the Average calc.


-------------------------------------------------------------------
Frame Delay (FD) Bin Counts
-------------------------------------------------------------------
Bin     Lower Bound      Forward      Backward    Round Trip
-------------------------------------------------------------------
0              0 us            0             0             0
1              1 us          254           254           254
2           6500 us            0             0             0
3           8500 us            0             0             0
4           9250 us            0             0             0
5          10000 us            0             0             0
6          10500 us            0             0             0
7          11000 us            0             0             0
8          12500 us            0             0             0
9          20000 us            0             0             0
-------------------------------------------------------------------


-------------------------------------------------------------------
Frame Delay Range (FDR) Bin Counts
-------------------------------------------------------------------
Bin     Lower Bound      Forward      Backward    Round Trip
-------------------------------------------------------------------
0              0 us          262           262           262
1           2000 us            0             0             0
2           3000 us            0             0             0
3           4000 us            0             0             0
4           5000 us            0             0             0
5           6000 us            0             0             0
6           7000 us            0             0             0
7           8000 us            0             0             0
8           9000 us            0             0             0
9          10000 us            0             0             0
-------------------------------------------------------------------


-------------------------------------------------------------------
Inter-Frame Delay Variation (IFDV) Bin Counts
-------------------------------------------------------------------
Bin     Lower Bound      Forward      Backward    Round Trip
-------------------------------------------------------------------
0              0 us          261           261           261
1           1000 us            0             0             0
2           1500 us            0             0             0
3           2000 us            0             0             0
4           2250 us            0             0             0
5           2500 us            0             0             0
6           2750 us            0             0             0
7           3000 us            0             0             0
8           4000 us            0             0             0
9           6000 us            0             0             0
-------------------------------------------------------------------
===================================================================
===================================================================
TWAMP-LIGHT LOSS STATISTICS


-----------------------------------------------------------
              Frames Sent      Frames Received
-----------------------------------------------------------
Forward               266                  266
```

```
Backward                     266                 266
-----------------------------------------------------


-------------------------------------------------
Frame Loss Ratios
-------------------------------------------------
            Minimum     Maximum     Average
-------------------------------------------------
Forward       0.000%      0.000%      0.000%
Backward      0.000%      0.000%      0.000%
-------------------------------------------------


-----------------------------------------------------------------------------
Availability Counters (Und = Undetermined)
-----------------------------------------------------------------------------
          Available   Und-Avail Unavailable Und-Unavail      HLI       CHLI
-----------------------------------------------------------------------------
Forward         266           0           0           0        0          0
Backward        266           0           0           0        0          0
-----------------------------------------------------------------------------
=============================================================================
```

Conclusion

OAM-PM is a powerful performance management function. It uses a common architecture to configure, process, and report on technology-specific performance management tools for Ethernet, IP, and MPLS.

Customer document and product support
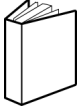
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