Exinda How to Guide:
Application Performance Score (APS)

Exinda Firmware Version 6.1

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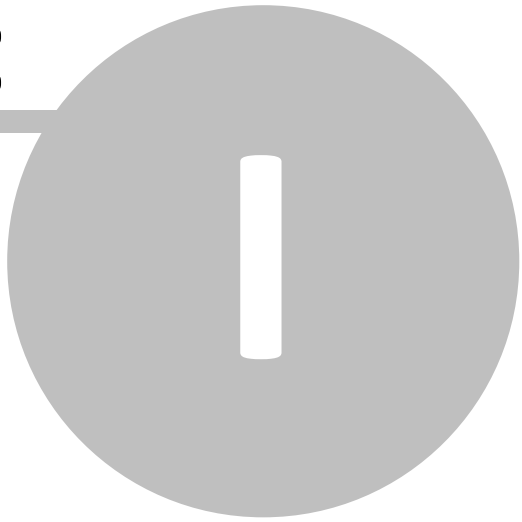

1 Introduction

Application Performance Score (APS)

Exinda Firmware Version: 6.1

1.1 Using this Guide

Throughout the manual the following text styles are used to highlight important points:

- Useful features, hints and important issues are called "notes" and they are identified in a light blue background.

Note: This is a note.

- Practical examples are presented throughout the manual for deeper understanding of specific concepts. These are called "examples" and are identified with a light green background.

This is an example.

- Warnings that can cause damage to the device are included when necessary. These are indicated by the word "caution" and are highlighted in yellow.

Caution: This is a caution.

Part

2 Overview

Analysing the performance of networked applications is a common task faced by network administrators. Often the root cause of an applications poor performance is not understood, and a common response is to undertake an expensive, often unnecessary upgrade of network capacity.

Application Performance Score (APS) is a technology provided by Exinda that monitors an application's network performance. The method works by passively measuring several properties of a TCP conversation and combining them to given an overall score. These properties are referred to as Application Performance Metrics (APM).

APS can be used to replace traditional non-passive methods that attempt to measure network performance - such as ICMP echo (ping) or SNMP measurements of server load.

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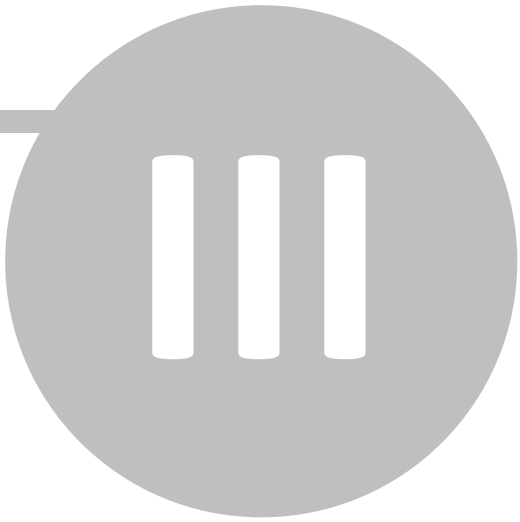


3 Application Performance Metrics

The following properties of a TCP conversation are measured by an Exinda appliance when the APM ASAM module is enabled.

- Round-Trip Time (RTT)
- Network Delay
- Server Delay
- Network Jitter
- Transaction Delay
- Packets / Bytes Lost (Retransmissions)
- Connections Started
- Connections Aborted
- Connections Refused
- Connections Ignored

The APM ASAM is enabled by default - it can be disabled under the System | Setup | Monitor page (ASAM section) on the Exinda's Web User Interface, advanced mode.

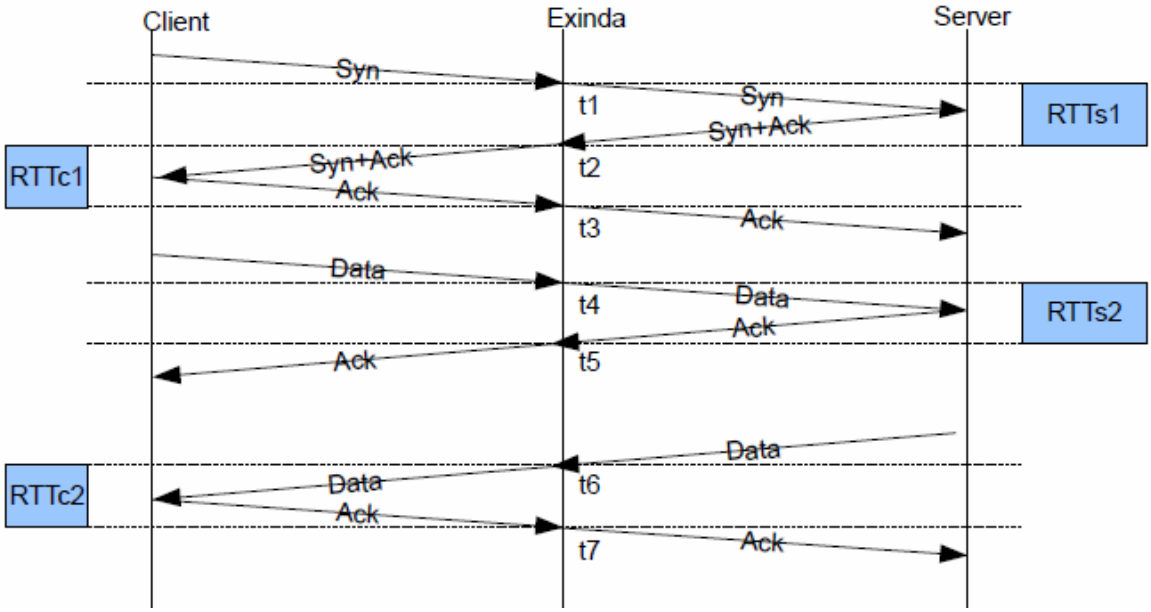
3.1 Definitions

This section describes the method used to measure each of the Application Performance Metrics.

3.1.1 Round Trip Time

Round-Trip Time (RTT) is a measure of the time it takes for a packet to travel from a device, cross a network and return. APM estimates RTT during the connection establishment part of a TCP connection, and continually updates this estimate as data is sent on the connection.

The following diagram illustrates the way in which RTT is calculated:



As each packet is intercepted, it is time stamped with a highly accurate nanosecond resolution clock source. Since an Exinda is positioned between the client and server, the RTT is calculated as the sum of a server end RTT and a client end RTT as follows:

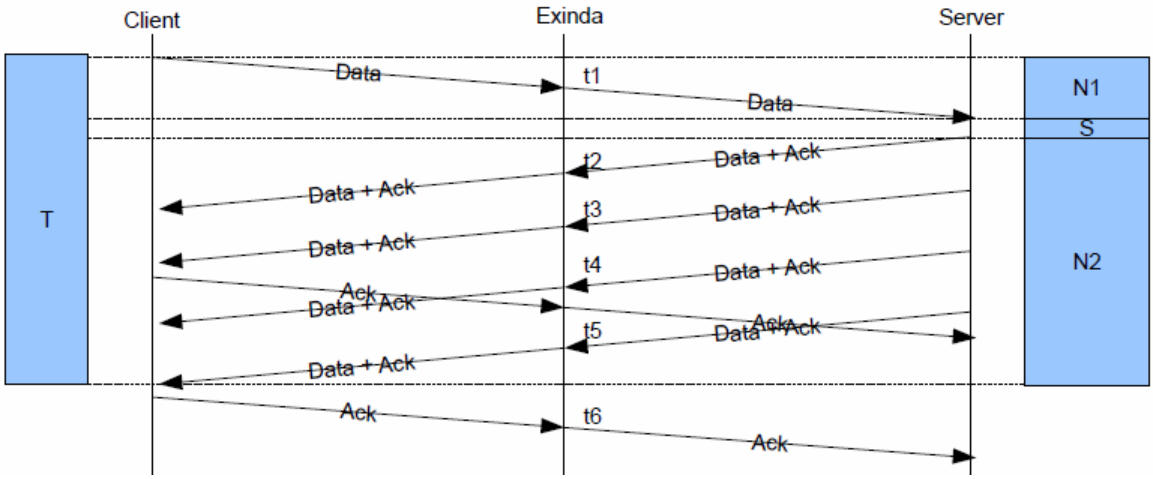
```
RTTs1 = t2 - t1, RTTc1 = t3 - t1

RTTs2 = t5 - t4, RTTc2 = t7 - t6

avRTTs = (RTTs1 + RTTs2)/2, avRTTc = (RTTc1 + RTTc2)/2

RTT = avRTTs + avRTTc
```

3.1.2 Transactions

Server Delay, Network Delay and Jitter are measured per transaction. A transaction is defined as a client request followed by a server reply.

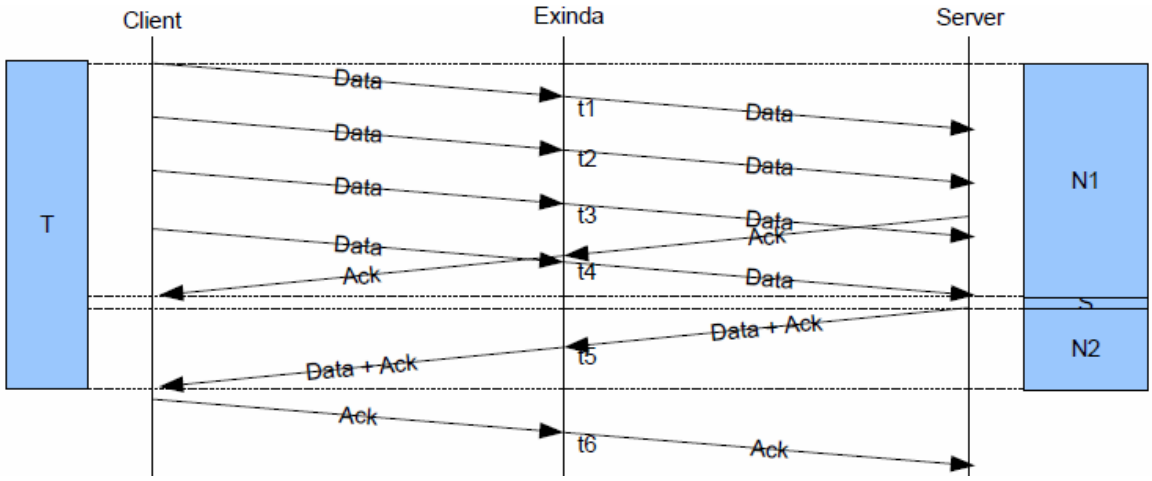
- Network Delay is the time taken for data to traverse the network (on the wire).
- Server Delay is the time taken for a server to respond to a request.
- Network Jitter is a measure of the variability of Network Delay. We define it one standard deviation of the Network Delay.

3.1.2.1 Read Transaction




```
N1 = t1 - t1 + 0.5 * RTT

S = t2 - t1 - RTTs

N2 = t5 - t2 + 0.5 * RTT
```

3.1.2.2 Write Transaction




```
N1 = t4 - t1 + 0.5 * RTT

S = t5 - t4 - RTTs

N2 = t5 - t5 + 0.5 * RTT
```

3.1.2.3 Normalization

All other factors being equal, we would expect transaction delays to increase with the amount of data transferred (the transaction size).

To make the APS score independent of transaction size, we normalise the transaction delay metrics using a normalization constant of 1024 bytes:

```
T' = T * (1024 / D), where D = the number of bytes transferred as part of the transaction
```

3.1.3 Packet Loss

The amount of data retransmitted per flow is used to calculate the Network Efficiency metric as:

```
Efficiency = 100% * (transferred - retransmitted) / transferred
```

and

```
Network Loss = 100 - Efficiency
```

Note: Network Loss, not Efficiency is used when calculating APS.

3.1.4 TCP Health

Each TCP flow is monitored for abnormal terminations:

- Aborted – a connection is reset by either the client or the server after being established.
- Refused – connection is reset and is not yet established.
- Ignored – connection expired without being fully established.

3.2 Alerts

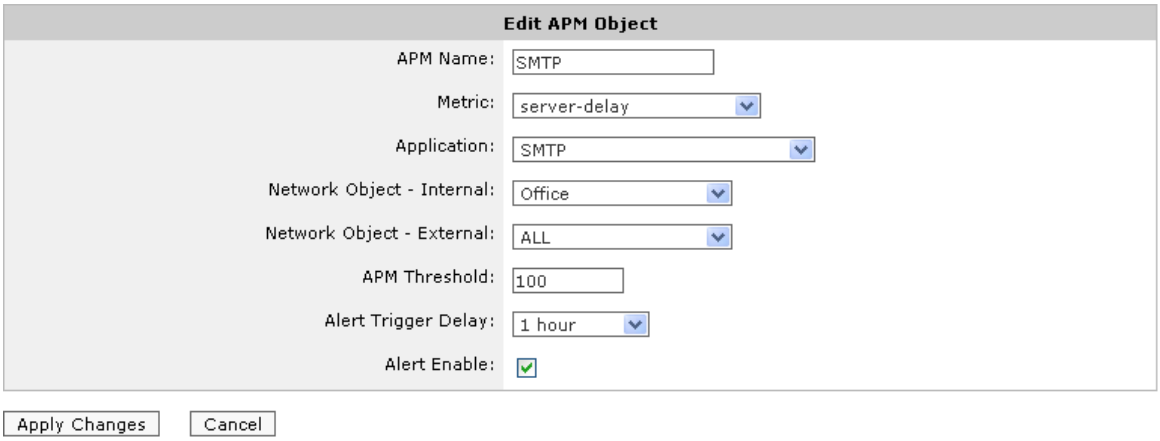
APM objects allow you to to send an alert when a metric rises above a set threshold.

Note: To configure an APM object, navigate to Objects | Service Levels | Application Performance Metric on the Web UI, advanced mode.

The table shows the currently configured APM objects.

Example: Configure an alert when the server-delay metric for SMTP traffic matching the Office internal network-object exceeds 100 ms over a period of 1 hour.

Click on the 'Add New APM Object' button and enter the settings as below.



Click on 'Apply Changes'

APM Name	Metric	Application Name	Network Object (Internal)	Network Object (External)	Alert Threshold	Alert Time Window	Alert Enabled	Edit	Delete
SMTP	server-delay	SMTP	Office	ALL	100 ms	1 Hour	☑	Edit	Delete

Note: ensure that APM alerts are enabled in System | Setup | Alerts

3.3 Display

APM values are available in realtime as well as summary form. This section describes how the Application Performance Metrics are accessed.

3.3.1 Realtime - Application Response

The APM values are available as a realtime display. To access, select the Application Response tab on the the Monitor | Realtime page:

Application Response						
Application Name	RTT (ms)	Network (ms)	Server (ms)	Transaction Delay (ms)	Transaction Count	Flows
Unclassified	420.80	3884.29	49.49	3905.79	2	102
HTTP	347.63	170.15	435.18	417.29	3	6
Replify	287.65	2403.08	0.00	2398.00	3	1
IMAP-SSL	206.36	558.94	37.31	520.19	35	1
HTTPS	182.18	55.04	1.10	55.68	7	9
slm	0.00	0.00	0.00	0.00	0	1
DNS	0.00	0.00	0.00	0.00	0	30
ssdp	0.00	0.00	0.00	0.00	0	2
ExindaCom	0.00	0.00	0.00	0.00	0	6
ICMP	0.00	0.00	0.00	0.00	0	13
PPTP	0.00	0.00	0.00	0.00	0	1
mDNS	0.00	0.00	0.00	0.00	0	2
IGMP	0.00	0.00	0.00	0.00	0	19
NTP	0.00	0.00	0.00	0.00	0	1

The realtime display shows the APM values by application for the selected time period. As well as the APM values, the number of flows and the number of transactions are shown.

To display realtime APM from the CLI, use the following command:

```
ex-240 (config) # show realtime apm applications
```

```
ex-240 (config) # show realtime apm applications


Application     RTT (ms) Network (ms) Server (ms) Transaction (ms) Transactions Flows
--------------- -------- ------------ ----------- ---------------- ------------ -----
ExindaWM        956.04    77706.24     206863.37   226125.26       48           4
Unclassified    459.74    35040.99     15000.30    37512.24        8            44
Replify         292.75    2660.00      0.00        2655.70         4            1
HTTP            256.16    202.86       147.08      338.41          10           9
HTTPS           217.45    97.34        26.83       124.18          10           6
CIFS            108.53    186.69       89.73       231.30          2            2
SSH             71.48     386.28       0.00        336.24          2            1
ExindaCom       0.00      0.00         0.00        0.00            0            16
mDNS            0.00      0.00         0.00        0.00            0            3
ICMP            0.00      0.00         0.00        0.00            0            7
ssdp            0.00      0.00         0.00        0.00            0            1
IGMP            0.00      0.00         0.00        0.00            0            15
NTP             0.00      0.00         0.00        0.00            0            2
slm             0.00      0.00         0.00        0.00            0            1

ex-240 (config) #
```

3.3.2 Realtime - TCP Health

The TCP Health values are available as a realtime display. To access, select the Host Health tab on the Monitor | Realtime page:

Health					
Internal IP	Retransmitted (bytes)	Aborted	Refused	Ignored	Flows
192.168.80.66	0	0	0	0	1
172.16.1.240	0	1	0	0	13
172.14.1.10	0	0	0	0	90
172.16.0.160	0	0	0	0	2
172.16.0.115	0	0	0	0	4
192.168.100.252	0	0	0	0	1
192.168.0.207	0	0	0	0	1
172.16.1.149	0	0	0	0	4
172.16.1.242	0	0	0	0	1
172.16.0.63	0	0	0	0	2
192.168.90.180	0	0	0	0	1
192.168.0.35	0	0	0	0	1
192.168.0.178	0	0	0	4	5
192.168.0.83	0	0	0	0	1
0.0.0.0	0	0	0	0	1
172.16.0.179	0	0	0	0	1
192.168.0.145	0	0	0	0	1
192.168.0.209	0	0	0	0	1
192.168.0.114	0	0	0	0	1
192.168.20.115	0	0	0	0	1
172.16.0.252	0	0	0	0	1
172.16.0.114	0	0	0	0	2
192.168.60.12	0	0	0	0	1
172.16.0.119	0	1	0	0	1
192.168.0.171	0	0	0	0	78
192.168.0.54	0	0	0	0	1

Health					
External IP	Retransmitted (bytes)	Aborted	Refused	Ignored	Flows
189.47.235.215	0	0	0	0	1
182.237.13.217	0	0	0	0	1
114.27.0.33	0	0	0	0	1
209.162.180.188	0	0	0	0	1
46.146.120.14	0	0	0	0	1
77.124.175.104	0	0	0	0	1
190.50.180.129	0	0	0	0	1
203.2.192.124	0	0	0	0	1
95.25.240.132	0	0	0	0	1
81.182.22.28	0	0	0	0	1
92.112.162.185	0	0	0	0	1
116.48.3.56	0	0	0	0	1
78.37.161.202	0	0	0	0	1
114.143.5.78	0	0	0	0	1
183.98.3.27	0	0	0	0	1
98.82.49.248	0	0	0	0	1
87.242.31.140	0	0	0	0	1
239.255.255.250	0	0	0	0	1
190.44.86.103	0	0	0	0	1
85.228.237.61	0	0	0	0	1
98.226.208.222	0	0	0	0	1
239.255.255.100	0	0	0	0	1
211.206.58.76	0	0	0	0	1
122.106.153.166	0	0	0	0	1
70.55.149.222	0	0	0	0	2
96.244.84.2	0	0	0	0	1

To display realtime TCP Health from the CLI:

```
ex-240 (config) # show realtime apm hosts
```

```
ex-240 (config) # show realtime apm hosts


Internal
Host            Retransmissions Aborted Refused Ignored Flows
--------------- --------------- ------- ------- ------- -----
172.16.1.240    0                     0       0       0    13
192.168.0.176   0                     0       0       0     1
172.16.0.213    0                     0       0       0     1
192.168.50.147  0                     0       0       0     1
192.168.0.179   0                     0       0       0     1
172.16.0.63     0                     0       2       0     3
172.16.1.242    0                     0       0       0     1
192.168.40.96   0                     0       0       0     1
192.168.0.178   0                     0       0       0     6
0.0.0.0         0                     0       0       0     1
192.168.0.209   0                     0       0       0     1
192.168.50.143  0                     0       0       0     1
172.16.0.252    0                     0       0       0     1
172.16.0.108    0                     0       0       0     3
172.16.1.149    0                     0       0       0     3
172.16.0.67     0                     0       0       0     5
172.16.0.190    0                     1       0       0     4
192.168.0.118   0                     0       0       0     1
192.168.0.145   0                     0       0       0     1
192.168.0.207   0                     0       0       0     1
```

3.3.3 Network Summary

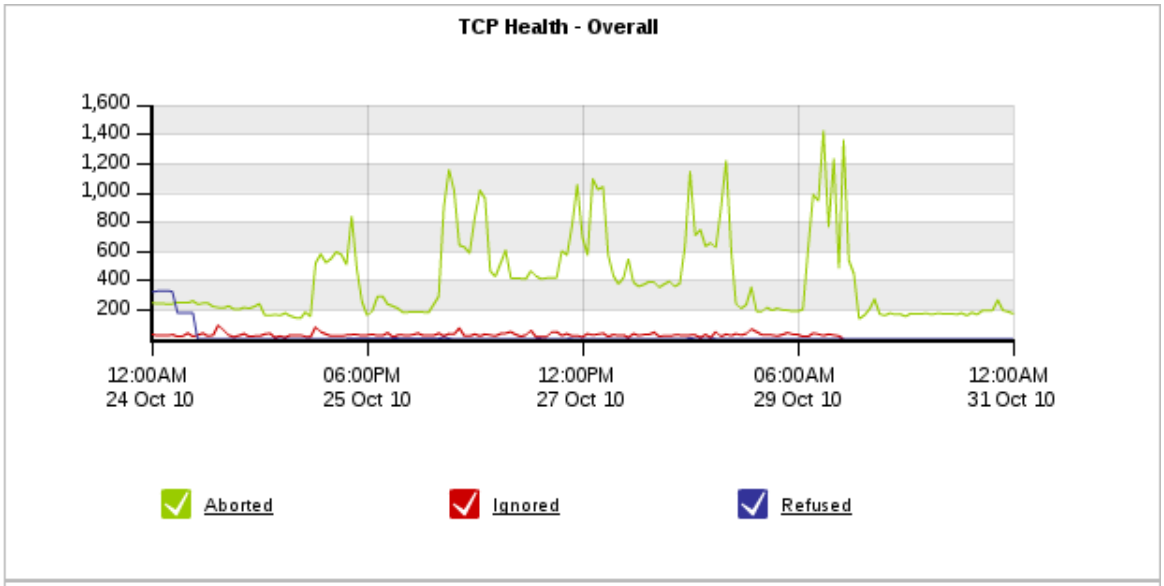
The APM values are available summarized by Applications, Users, Hosts and Conversations. To show the summarized APM values, select the "Show Details" link on upper left of the Network Summary Applications, Users, Hosts or Conversations table:

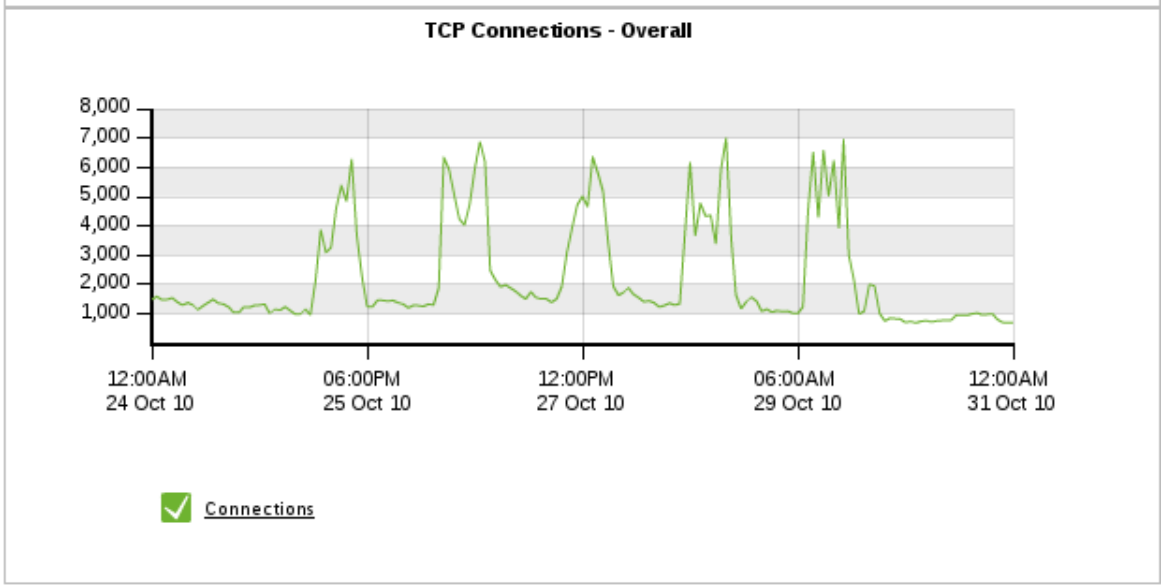
Top 500 Inbound Application Groups										
Name	Packets	Data (MB)	Throughput (kbps)		Flows	RTT (ms)	Transaction Delays (ms)			Efficiency (%)
[-] Hide Details			Average	Max			Network	Server	Total	
Mail	14493	17.567	71.95	1311.54	18	159	121	30	151	99.60
Web	14200	4.059	2.71	111.59	287	201	1287	68	1355	99.80
Voice	170	0.079	1.54	1.79	4	71	129	2	131	100.00
Interactive	560	0.043	1.10	3.45	10	12	71	0	71	100.00
Exinda	617	0.041	0.29	1.63	37	18	8279	14784	23063	99.95
P2P	141	0.035	0.53	0.71	52	6	0	0	0	100.00
Software Updates	28	0.023	6.22	8.90	2	222	287	58	345	100.00
Database Services...	351	0.018	0.94	1.05	1	231	0	0	0	100.00
Games	75	0.008	0.27	0.60	3	126	34351	29607	63958	100.00
VPN	58	0.004	0.23	0.31	3	0	0	0	0	100.00
Instant Messaging...	12	0.003	0.54	0.58	2	270	469	6	475	100.00
File Services	12	0.001	0.17	0.17	1	0	0	0	0	100.00

Top 500 Outbound Application Groups										
Name	Packets	Data (MB)	Throughput (kbps)		Flows	RTT (ms)	Transaction Delays (ms)			Efficiency (%)
[-] Hide Details			Average	Max			Network	Server	Total	
Web	15645	11.153	7.63	411.68	287	201	1287	68	1355	99.52
Mail	10854	0.609	2.49	37.18	18	159	121	30	151	100.00
Voice	169	0.106	2.07	2.39	4	71	129	2	131	100.00
Exinda	732	0.061	0.27	2.55	37	18	8279	14784	23063	99.98
Interactive	396	0.050	0.98	2.99	10	12	71	0	71	100.00
Database Services...	436	0.028	1.41	1.59	1	231	0	0	0	100.00
P2P	201	0.026	0.30	0.71	52	6	0	0	0	100.00
VPN	80	0.008	0.41	0.63	3	0	0	0	0	100.00
Games	63	0.006	0.23	0.46	3	126	34351	29607	63958	100.00
Software Updates	25	0.002	0.36	0.60	2	222	287	58	345	100.00
Instant Messaging...	15	0.001	0.29	0.34	2	270	469	6	475	100.00

3.3.4 TCP Health and Efficiency

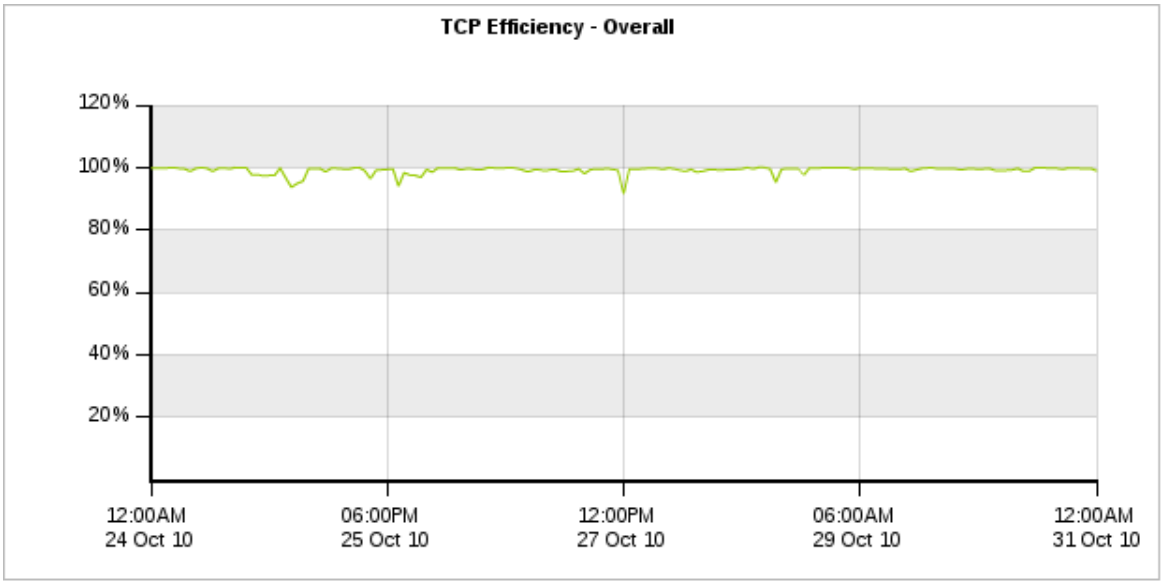
To display TCP Health, select the TCP Health tab from Monitor | Service Levels:





Top 500 Applications				
	Connections	Aborted	Ignored	Refused
HTTP	327840	70627	126	4989
HTTPS	209951	59257	19	67

To display TCP Efficiency, select TCP Efficiency from Monitor | Service Levels:



Top 500 Least Efficient Applications					
	Bytes Inbound (MB)		Bytes Outbound (MB)		Efficiency (%)
	Retransmitted	Total	Retransmitted	Total	
MSN	0.001	0.004	0.001	0.012	88.70
SIP-SSL	0.004	0.032	0.000	0.009	89.89
BitTorrent	0.044	0.422	0.011	0.400	93.25
iTunes	0.335	10.017	0.000	0.760	96.89
1002	0.012	0.354	0.000	0.053	96.96
SSH	0.010	26.057	2.857	141.633	98.29
ICMP	0.000	0.001	0.000	0.002	98.51
MySQL	0.000	18.999	0.886	42.468	98.56
Jabber	0.001	0.405	0.008	0.337	98.78
SSL	0.082	5.997	0.002	1.095	98.81
Replify	0.001	1.111	0.104	8.290	98.88

Part

4 Application Performance Score

The Application Performance Score combines selected Application Performance Metrics to form an overall score that is used to monitor the performance of a networked application.

To calculate the APS, each metric is classified into one of 3 categories. For a given metric threshold T, the categories are:

Satisfied	[0, T)
Tolerated	[T, 4T)
Frustrated	>= 4T

The APS score is a number between 0 and 10 that measures an applications network performance:

```
aps = 10 * (satisfied samples + (tolerated samples / 2)) / total samples
```

Example: Calculating an APS:

We configure a threshold for Network Delay as T = 300 msec for HTTP.

In one 10s period, we sample 10 flows for HTTP.

5 samples are > 300 ms but < 1200 ms

5 samples are < 300 ms

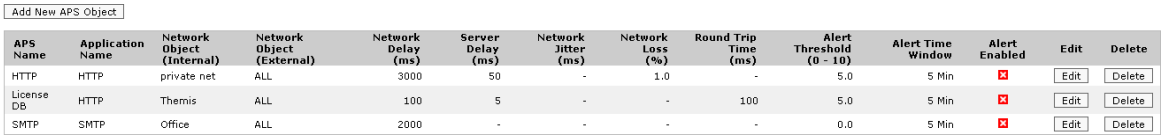
The APS score is:

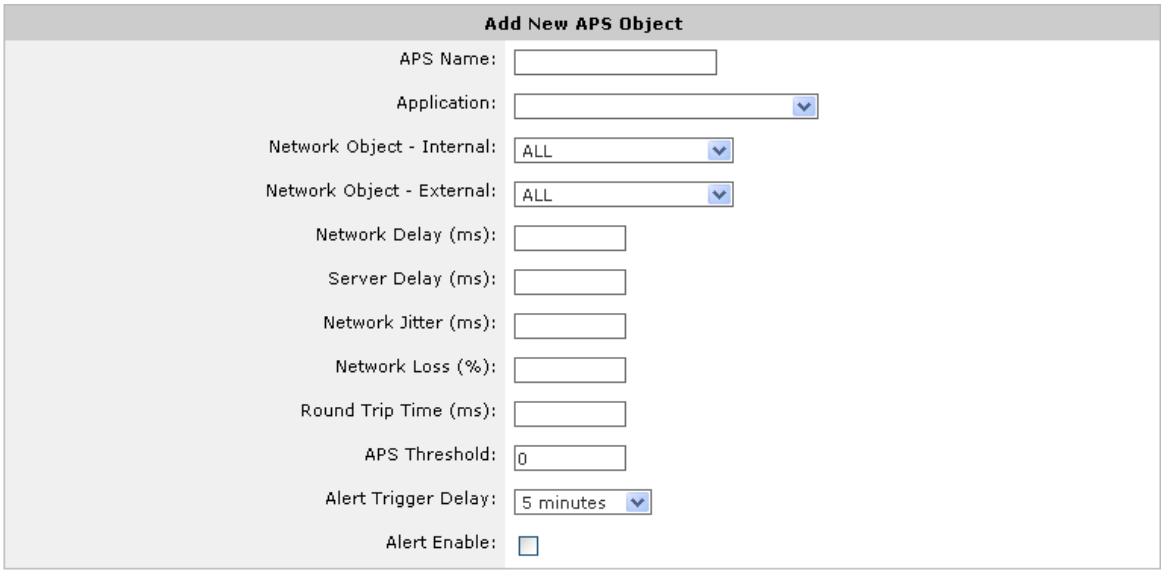
```
aps = 10 . (5 + 5/2) / 10 = 7.5
```

4.1 Configuration

Note: To configure an APS object, navigate to Objects | Service Levels | Application Performance Score on the Web UI, advanced mode.

A list of currently configured APS Objects is shown. To make changes to an existing APS object or to delete an APS object, select Edit or Delete. To add a new APS object select "Add New APS Object".





APS Name*	The name of the APS object
Application*	The application that this APS object monitors (e.g HTTP)
Network Object - Internal*	Specify the internal IP addresses that this APS object should measure (e.g ALL or a network object representing internal subnets)
Network Object - External*	Specify the external IP address that this APS object should measure (e.g ALL or a network object representing external application servers)
Network Delay (ms)**	Network Delay threshold in microseconds
Server Delay (ms)**	Server Delay threshold in microseconds
Network Jitter (ms)**	Network Jitter threshold in microseconds
Network Loss (%)**	Network Loss threshold in percentage
Round Trip Time (ms)**	Round Trip Time threshold in microseconds
APS Threshold	The APS value below which an alert will be generated (if enabled)
Alert Trigger Delay	The amount of time the APS value is required to be lower then the threshold in order to trigger the alert.
Alert enable	Enable APS alerts.

Note: * Indicates a required field.

Note: ** At least one threshold must be specified.

APS alerts can also be globally enabled or disabled from the Setup | Alerts page. SNMP traps and/or email alerts can be configured.

4.2 Display

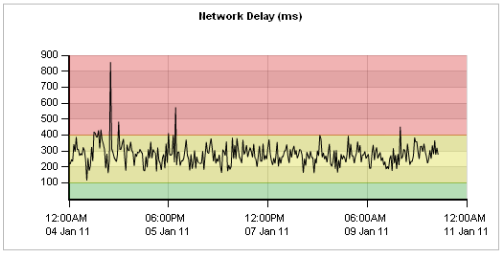
To show time series graphs for each configured APS object, select the Application Performance Score tab from Monitor | Service Levels:

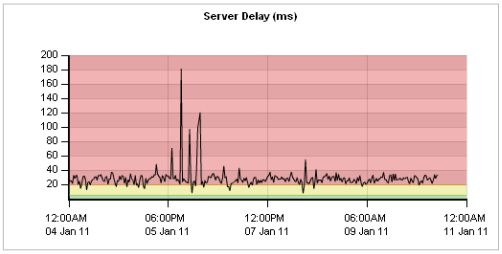
APS Scores							
Name	Score	Transaction Delays (ms)		Jitter (ms)	Loss (%)		RTT (ms)
		Network	Server		Inbound	Outbound	
HTTP	9.52	66.32	125.11	40.18	0.50	0.60	70.25
License DB	4.13	277.85	28.44	19.49	0.40	1.00	265.18
SMTP	9.98	41.86	2.57	1.40	2.10	0.00	250.79

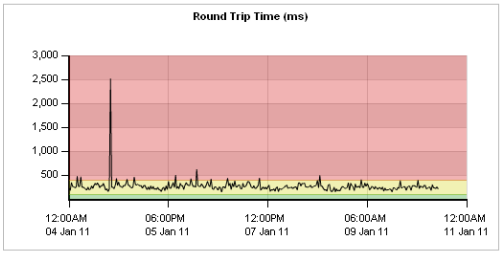
The graphs show APS values over the selected time period as well as a table summarizing the individual metrics over the selected time period. The colors indicate the category for each metric - green: satisfied, yellow: tolerated and red: frustrated. When no color is used it indicates a metric that does not contribute to the APS score because no threshold has been configured for that metric.

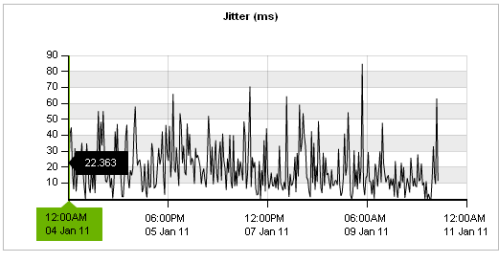
Click on the APS name to show time series graphs for individual metrics:

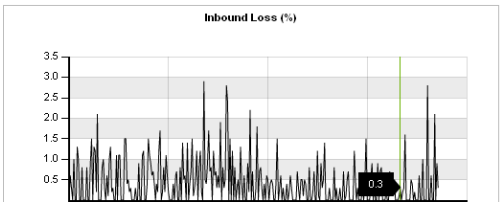
APS Metrics for License DB					
Transaction Delays (ms)		Jitter (ms)	Loss (%)		RTT (ms)
Network	Server		Inbound	Outbound	
277.85	28.44	19.49	0.40	1.00	265.18

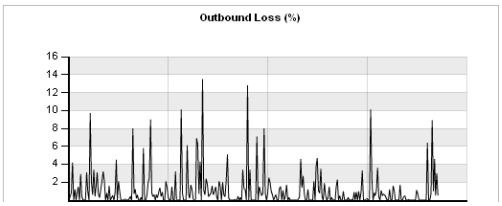






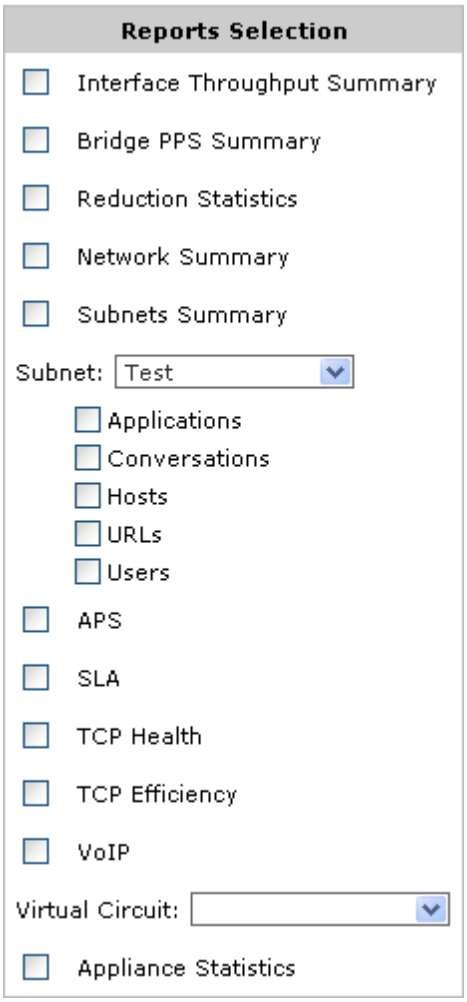






4.3 Reporting

Reports are available for APS (summary), TCP Efficiency and TCP Health. Choose which graphs are required when creating a report:

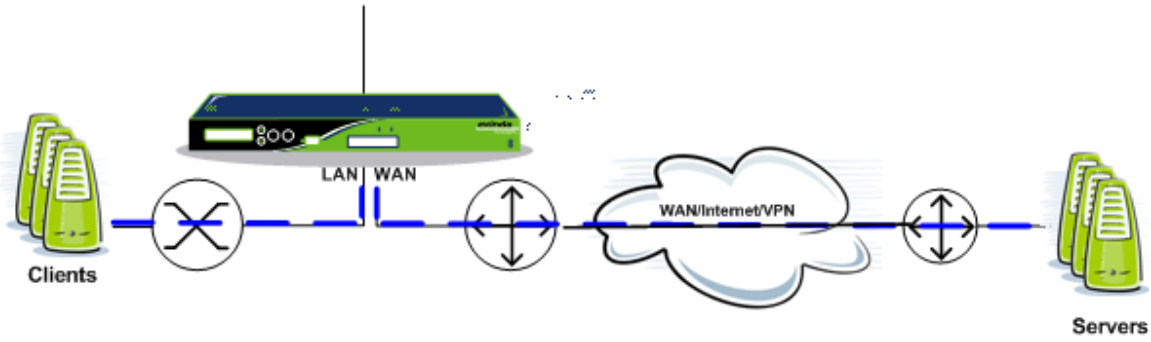


Part V

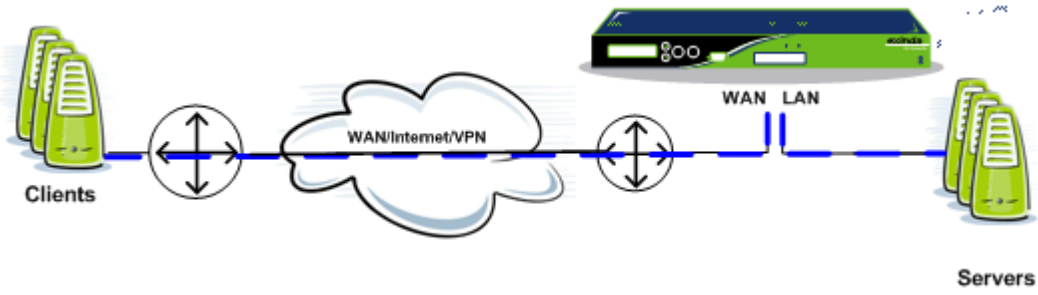
5 Deployment Topologies

Exinda APS technology needs to see all packets for TCP transactions in order to accurately estimate delays. The diagrams below show typical deployment options that are all compatible with APS.

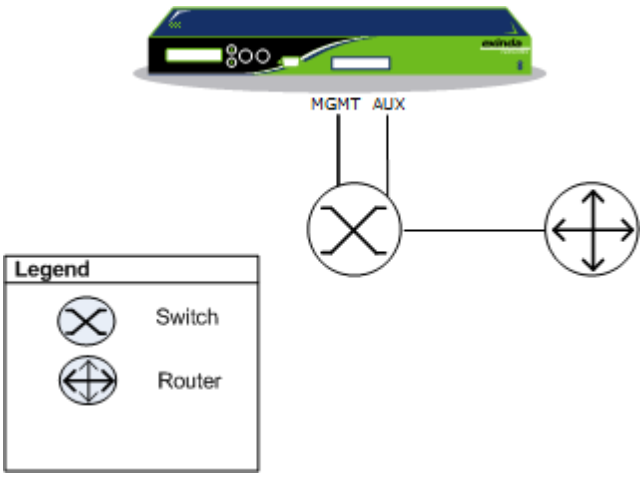
The Exinda appliance is deployed inline between the core switch and the WAN router:



The Exinda appliance is deployed inline between the remote router and the remote server(s):



The Exinda appliance is deployed out of path using a SPAN/mirror port on a switch or router:



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