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Terminology for Accelerated Stress Benchmarking

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ABSTRACT
This document provides the Terminology for performing Stress Benchmarking of networking devices. The three phases of the Stress Test: Startup, Instability and Recovery are defined along with the benchmarks and configuration terms associated with the each phase. Also defined are the Benchmark Planes fundamental to stress testing configuration, setup and measurement. The terminology is to be used with the companion framework and methodology documents.

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1. Introduction

Routers in an operational network are simultaneously configured with multiple protocols and security policies while forwarding traffic and being managed. To accurately benchmark a router for deployment it is necessary to test that router in operational conditions by simultaneously configuring and scaling network protocols and security policies, forwarding traffic, and managing the device. It is helpful to accelerate these network operational conditions so that the router under test can be benchmarked with faster test duration. Testing a router in accelerated network conditions is known as Accelerated Stress Testing.

This document provides the Terminology for performing Stress Benchmarking of networking devices. The three phases of the Stress Test: Startup, Instability and Recovery are defined along with the benchmark and configuration terms associated with the each phase. Benchmarks for stress testing are defined using the Aggregate Forwarding Rate and control plane Session Count during each phase of the test. Also defined are the Benchmark Planes fundamental to stress testing configuration, setup and measurement. These are the Control Plane, Data Plane, Management Plane and Security Plane For each plane, the Configuration Set, Startup Conditions, and Instability Conditions are defined. White Box benchmarks are provided in Appendix 1 for additional DUT behavior measurements. The terminology is to be used with the companion methodology document [6].

2. Existing definitions

RFC 1242 "Benchmarking Terminology for Network Interconnect Devices" and RFC 2285 "Benchmarking Terminology for LAN Switching Devices" should be consulted before attempting to make use of this document.

For the sake of clarity and continuity this RFC adopts the template for definitions set out in Section 2 of RFC 1242. Definitions are indexed and grouped together in sections for ease of reference.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

3. Term definitions

3.1 General Terms

3.1.1 Benchmark Planes

Definition:
The features, conditions, and behavior for the Accelerated Stress

Benchmarking.

Discussion:
There are four Benchmark Planes: Control Plane, Data Plane, Management Plane, and Security Plane as shown in Figure 1. The Benchmark Planes define the Configuration, Startup Conditions, Instability Conditions, and Failure Conditions used for the test.

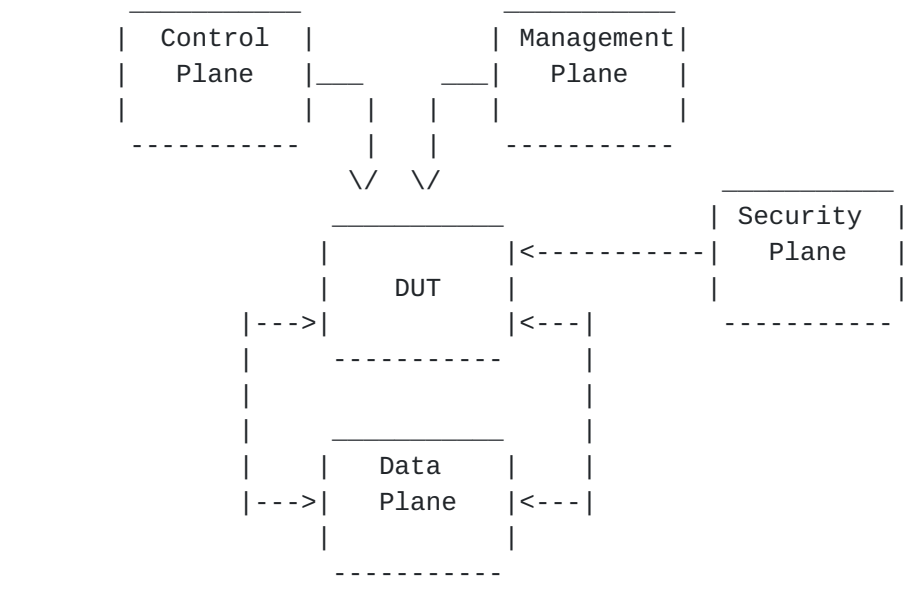

Figure 1. Router Accelerated Stress Benchmarking Planes

Measurement units:
N/A

Issues:
None

See Also:
Control Plane
Data Plane
Management Plane
Security Plane

3.1.2 Configuration Sets

Definition:
The features and scaling limits used during the Accelerated Stress Benchmarking.

Discussion:
There are four Configuration Sets: Control Plane Configuration Set, Data Plane Configuration Set, Management Plane Configuration Set, and Security Plane Configuration Set.

Measurement units:

N/A

Issues:
None

See Also:
Control Plane Configuration Set
Data Plane Configuration Set
Management Plane Configuration Set
Security Plane Configuration Set

3.1.3 Startup Conditions

Definition:
Test conditions that occur at the start of the Accelerated Life Benchmark to establish conditions for the remainder of the test.

Discussion:
Startup Conditions may cause stress on the DUT and produce failure. Startup Conditions are defined for the Control Plane and Security Plane.

Measurement units:
N/A

Issues:
None

See Also:
Control Plane Startup Conditions
Data Plane Startup Conditions
Management Plane Startup Conditions
Security Plane Startup Conditions

3.1.4 Instability Conditions

Definition:
Test conditions that occur during the Accelerated Stress Benchmark to produce instability and stress the DUT.

Discussion:
Instability Conditions are applied to the DUT after the Startup Conditions have completed. Instability Conditions occur for the Control Plane, Data Plane, Management Plane, and Security Plane.

Measurement units:
N/A

Issues:
None

See Also:
Control Plane Instability Conditions
Data Plane Instability Conditions
Management Plane Instability Conditions
Security Plane Instability Conditions

3.1.5 Aggregate Forwarding Rate

Definition:
Sum of forwarding rates for all interfaces on the DUT during the Startup Phase.

Discussion:
Each interface of the DUT forwards traffic at some measured rate. The Aggregate Forwarding Rate is the sum of forwarding rates for all interfaces on the DUT.

Measurement units:
pps

Issues:
None

See Also:
Startup Phase

3.1.6 Controlled Session Loss

Definition:
Control Plane sessions that are intentionally brought down during the Stress test.

Discussion:
The test equipment is able to control protocol session state with the DUT.

Measurement units:
None

Issues:
None

See Also:
Uncontrolled Session Loss

3.1.7 Uncontrolled Session Loss

Definition:
Control Plane sessions that are in the down state

but were not intentionally brought down during the Stress test.

Discussion:
The test equipment is able to control protocol session state with the DUT. The test equipment is also to monitor for sessions lost with the DUT which the test equipment itself did not intentionally bring down.

Measurement units:
N/A

Issues:
None

See Also:
Controlled Session Loss

3.2 Benchmark Planes

3.2.1 Control Plane

Definition:
The Description of the control protocols enabled for the Accelerated Stress Benchmarking.

Discussion:
The Control Plane defines the Configuration, Startup Conditions, Instability Conditions, and Failure Conditions of the control protocols used for the test. Control Plane protocols may include routing protocols, multicast protocols, and MPLS protocols. These can be enabled or disabled for a benchmark test.

Measurement units:
N/A

Issues:
None

See Also:
Benchmark Planes
Control Plane Configuration Set
Control Plane Startup Conditions
Control Plane Instability Conditions
Control Plane Failure Conditions

3.2.2 Data Plane

Definition:
The data traffic profile used for the Accelerated Stress Benchmarking.

Discussion:
The Data Plane defines the Configuration, Startup Conditions, Instability Conditions, and Failure Conditions of the data traffic used for the test. The Data Plane includes the traffic and interface profile.

Measurement Units:
N/A

See Also:
Benchmark Planes
Data Plane Configuration Set
Data Plane Startup Conditions
Data Plane Instability Conditions
Data Plane Failure Conditions

3.2.3 Management Plane

Definition:
The Management features and tools used for the Accelerated Stress Benchmarking.

Discussion:
A key component of the Accelerated Stress Benchmarking is the Management Plane to assess manageability of the router under stress. The Management Plane defines the Configuration, Startup Conditions, Instability Conditions, and Failure Conditions of the management protocols and features used for the test. The Management Plane includes SNMP, Logging/Debug, and Statistics Collection.

Measurement units:
N/A

Issues:
None

See Also:
Benchmark Planes
Management Plane Configuration Set
Management Plane Startup Conditions
Management Plane Instability Conditions
Management Plane Failure Conditions

3.2.4 Security Plane

Definition:
The Security features used during the Accelerated Stress

Benchmarking.

Discussion:
The Control Plane defines the Configuration, Startup Conditions, Instability Conditions, and Failure Conditions of the security features and protocols used for the test. The Security Plane includes the ACLs, Firewall, Secure Protocols, and User Login.

Measurement units:
N/A

Issues:
None

See Also:
Benchmark Planes
Security Plane Configuration Set
Security Plane Startup Conditions
Security Plane Instability Conditions
Security Plane Failure Conditions

3.3 Startup

3.3.1 Startup Phase

Definition
The portion of the benchmarking test in which the Startup Conditions are generated with the DUT. This begins with the attempt to establish the first session and ends when the last Control Plane session is established.

Discussion:
The Startup Phase is the first Phase of the benchmarking test preceding the Instability Phase and Recovery Phase. It is specified by the Configuration Sets and Startup Conditions for each Benchmark Plane. The Startup Phase ends and Instability Phase may begin when the Configuration Sets are achieved with the DUT.

Measurement Units:
None

Issues:
The 'last control plane session is established' may not be a sufficient indicator that steady-state is achieved and Instability Conditions can be applied to begin the Instability Phase.

See Also:
Benchmark Plane
Configuration Sets
Startup Conditions
Instability Phase
Recovery Phase

3.3.2 Benchmarks

3.3.2.1 Stable Aggregate Forwarding Rate

Definition:
Average rate of traffic forwarded by the DUT during the Startup Phase.

Discussion:
Stable Aggregate Forwarding Rate is the calculated average the Aggregate Forwarding Rates measured during the Startup Phase. It is recommended that the Aggregate Forwarding Rate is measured at one-second intervals until the Startup Phase ends.

Measurement units:
pps

Issues:
The act of the DUT establishing the Startup Conditions could influence the forwarding rate in certain implementations so that this "baseline" for the remainder of the test is lowered. The alternative is to change the definition of Startup Aggregate Forwarding Rate so that it measured during the Startup Phase, but after Startup Conditions are achieved. The disadvantage of this definition would be that it loses measurement of any impact establishing Startup Conditions would have on forwarding rate. When comparing the Startup Aggregate Forwarding Rate benchmark of two devices it is preferred to know the impact establishing Startup Conditions has on Forwarding Rate. The definition was therefore selected so that Stable Aggregate Forwarding Rate is calculated from measurement samples throughout the entire Startup Phase.

See Also:
Instability Conditions
Aggregate Forwarding Rate
Stable Aggregate Forwarding Rate

3.3.2.2 Stable Session Count

Definition:
Total number of control plane sessions/adjacencies established and maintained by the DUT prior to Instability Conditions being initiated.

Discussion:
This measurement should be made after the Control Plane Startup Conditions are applied to the DUT.

Measurement units:
sessions

Issues:
None

See Also:
Instability Conditions

3.3.3 Control Plane

3.3.3.1 Control Plane Configuration Set

Definition:
The routing protocols and scaling values used for the Accelerated Life Benchmarking.

Discussion:
Control Plane Configuration Set is shown in Figure 2 and specifies the Routing Protocols, Multicast, and MPLS configuration. Specific protocols can be enabled or disabled for a benchmark test.

Measurement units:
N/A

Issues:
None

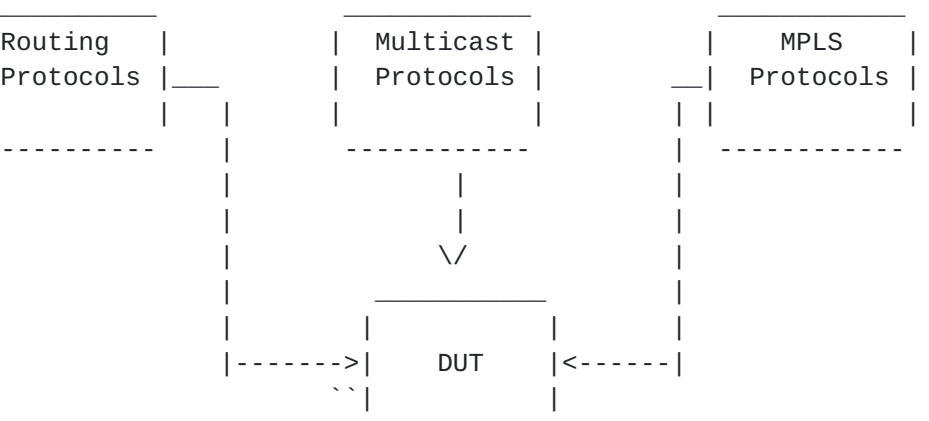

Figure 2. Control Plane Configuration Module

See Also:
Data Plane Configuration Set
Management Configuration Set
Security Configuration Set

3.3.3.2 Control Plane Startup Conditions

Definition:
Control Plane conditions that occur at the start of the Accelerated Stress Benchmarking to establish conditions for the remainder of the test.

Discussion:
Startup Conditions may cause stress on the DUT and produce failure. Startup Conditions for the Control Plane include session establishment rate, number of sessions established and number of routes learned.

Measurement units:
N/A

Issues:
None

See Also:
Startup Conditions
Security Plane Startup Conditions
Control Plane Configuration Set

3.3.4 Data Plane

3.3.4.1 Data Plane Configuration Set

Definition:
The data traffic profile enabled for the Accelerated Stress Benchmarking.

Discussion:
Data Plane Configuration Set includes the Traffic Profile and interfaces used for the Accelerated Stress Benchmarking.

Measurement Units:
N/A

Issues:
None

See Also:
Traffic Profile

3.3.4.2 Traffic Profile

Definition

The characteristics of the Offered Load to the DUT used for the Accelerated Stress Benchmarking.

Discussion

The Traffic Profile specifies the number of packet size(s), packet rate per interface, number of flows, and encapsulation used for the offered load to the DUT.

Measurement Units:
Traffic Profile is reported as follows:

Parameter	Units
Packet Size(s)	bytes
Packet Rate(interface)	array of packets per second
Number of Flows	number
Encapsulation(flow)	array of encapsulation type

Issues:
None

See Also:
Data Plane Configuration Set

3.3.5 Management Plane

3.3.5.1 Management Plane Configuration Set

Definition:
The router management features enabled for the Accelerated Stress Test.

Discussion:
A key component of the Accelerated Stress Test is the Management Configuration Set to assess manageability of the router under stress. The Management Configuration Set defines the management configuration of the DUT. Features that are part of the Management Configuration Set include SNMP, Logging/Debug, and Statistics Collection, and services such as FTP, as shown in Figure 3.

Measurement units:
N/A

Issues:
None

See Also:
Control Plane Configuration Set

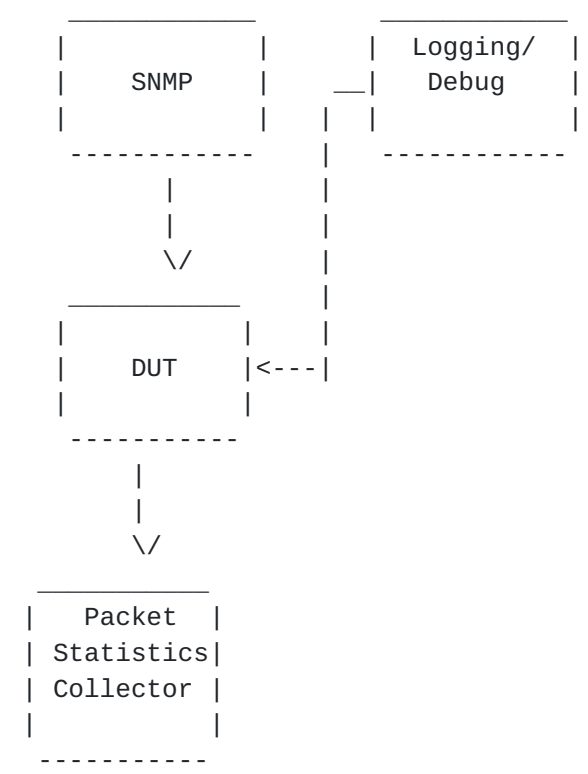

Figure 3. Management Plane Configuration Set

3.3.6 Security Plane

3.3.6.1 Security Plane Configuration Set

Definition:
Security features and scaling enabled for the Accelerated Stress Test.

Discussion:
The Security Plane Configuration Set includes the configuration and scaling of ACLs, Firewall, IPsec, and User Access, as shown in Figure 4.

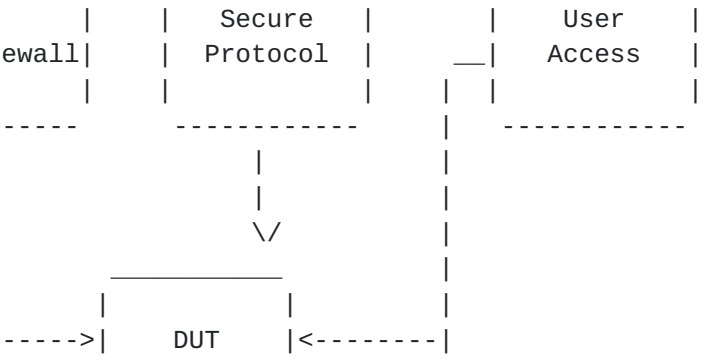

Figure 4. Security Configuration Module

Measurement units:
N/A

Issues:
None

See Also:
ACL Configuration Set
Secure Protocol Configuration Set
Password Login Configuration Set

3.3.6.2 Security Plane Startup Conditions

Definition:
Security Plane conditions that occur at the start
of the Accelerated Stress Benchmarking to establish conditions
for the remainder of the test.

Discussion:
Startup Conditions may cause stress on the DUT and produce
failure. Startup Conditions for the Security Plane include
session establishment rate, number of sessions established
and number of policies learned, and number of user access
sessions opened.

Measurement units:
N/A

Issues:
None

See Also:
Startup Conditions
Data Plane Startup Conditions
Management Plane Startup Conditions
Security Plane Startup Conditions

3.4 Instability

3.4.1 Instability Phase

Definition:
The portion of the benchmarking test in which the
Instability Conditions are offered to the DUT.

Discussion:
The Instability Phase is the middle Phase of
of the benchmarking test following the Startup
Phase and preceding the Recovery Phase.

Measurement Units:
None

Issues:
None

See Also:
Instability Conditions
Startup Phase
Recovery Phase

3.4.2 Benchmarks

3.4.2.1 Unstable Aggregate Forwarding Rate

Definition:
Rate of taffic forwarded by the DUT during the
Instability Phase.

Discussion:
Unstable Aggregated Forwarding Rate is an instantaneous
measurement of the Aggregate Forwarding Rate during the
Instability Phase. It is recommended that the
Unstable Aggregate Forwarding Rate is measured at
one-second intervals.

Measurement units:
pps

Issues:
None

See Also:
Instability Conditions
Aggregate Forwarding Rate

3.4.2.2 Degraded Aggregate Forwarding Rate

Definition:
The reduction in Aggregate Forwarding Rate during the
Instability Phase.

Discussion:
The Degraded Aggregate Forwarding Rate is calculated
for each measurement of the Unstable Aggregate
Forwarding Rate. The Degraded Aggregate Forwarding
Rate is calculated by subtracting each measurement
of the Unstable Aggregate Forwarding Rate from the
Stable Aggregate Forwarding Rate, such that

Degraded Forwarding Rate =
Stable Aggregate Forwarding Rate -
Unstable Aggregate Forwarding Rate

Ideally, the Degraded Aggregate Forwarding Rate is zero.

Measurement Units:
pps

Issues:
None

See Also:
Instability Phase
Unstable Aggregate Forwarding Rate

3.4.2.3 Average Degraded Aggregate Forwarding Rate

Definition
DUT Benchmark that is the calculated average of the obtained Degraded Forwarding Rates.

Discussion:

Measurement Units:
pps

Issues:
None

See Also:
Degraded Aggregate Forwarding Rate

3.4.2.4 Unstable Uncontrolled Sessions Lost

Definition:
Control Plane sessions that are in the down state but were not intentionally brought down during the Instability Phase.

Discussion:
The test equipment is able to control protocol session state with the DUT. The test equipment is also to monitor for sessions lost with the DUT which the test equipment itself did not intentionally bring down.

Measurement units:
sessions

Issues:
None

See Also:
Controlled Session Loss
Uncontrolled Session Loss

3.4.3 Instability Conditions

3.4.3.1 Control Plane Instability Conditions

Definition:
Control Plane conditions that occur during the Accelerated Stress Benchmark to produce instability and stress the DUT.

Discussion:
Control Plane Instability Conditions are experienced by the DUT after the Startup Conditions have completed. Control Plane Instability Conditions experienced by the DUT include session loss, route withdrawal, and route cost changes.

Measurement units:
N/A

Issues:
None

See Also:
Instability Conditions
Data Plane Instability Conditions
Management Plane Instability Conditions
Security Plane Instability Conditions

3.4.3.2 Data Plane Instability Conditions

Definition:
Data Plane conditions that occur during the Accelerated Stress Benchmark to produce instability and stress the DUT.

Discussion:
Data Plane Instability Conditions are experienced by the DUT after the Startup Conditions have completed. Data Plane Instability Conditions experienced by the DUT include interface shutdown, link loss, and overloaded links.

Measurement units:
N/A

Issues:
None

See Also:
Instability Conditions
Control Plane Instability Conditions
Management Plane Instability Conditions
Security Plane Instability Conditions

3.4.3.3 Management Plane Instability Conditions

Definition:
Management Plane conditions that occur during the Accelerated Life Benchmark to produce instability and stress the DUT.

Discussion:
Management Plane Instability Conditions are experienced by the DUT after the Startup Conditions have completed. Management Plane Instability Conditions experienced by the DUT include repeated FTP of large files.

Measurement units:
N/A

Issues:
None

See Also:
Instability Conditions
Control Plane Instability Conditions
Data Plane Instability Conditions
Security Plane Instability Conditions

3.4.3.4 Security Plane Instability Conditions

Definition:
Security Plane conditions that occur during the Accelerated Life Benchmark to produce instability and stress the DUT.

Discussion:
Security Plane Instability Conditions are experienced by the DUT after the Startup Conditions have completed. Security Plane Instability Conditions experienced by the DUT include session loss and uninitiated policy changes.

Measurement units:
N/A

Issues:
None

See Also:
Instability Conditions
Control Plane Instability Conditions
Data Plane Instability Conditions
Management Plane Instability Conditions

3.5 Recovery

3.5.1 Recovery Phase

Definition:
The portion of the benchmarking test in which the Startup Conditions are generated with the DUT, but the Instability Conditions are no longer offered to the DUT.

Discussion:
The Recovery Phase is the final Phase of the benchmarking test following the Startup Phase and Instability Phase. Startup Conditions must not be Restarted.

Measurement Units:
None

Issues:
None

See Also:
Startup Conditions
Startup Phase
Instability Conditions
Instability Phase

3.5.2 Benchmarks

3.5.2.1 Recovered Aggregate Forwarding Rate

Definition
Rate of traffic forwarded by the DUT during the Recovery Phase.

Discussion:
Recovered Aggregate Forwarding Rate is an instantaneous measurement of the Aggregate Forwarding Rate during the Recovery Phase. It is recommended that the Recovered Aggregate Forwarding Rate is measured at one-second intervals. Ideally, each measurement of the Recovered Aggregate Forwarding Rate equals the Stable Aggregate Forwarding Rate because the Instability Conditions do not exist in both the Startup and Recovery Phases.

Measurement Units:
pps

Issues:

None

See Also:
Aggregate Forwarding Rate
Recovery Phase
Recovered Aggregate Forwarding Rate
Startup Phase
Stable Aggregate Forwarding Rate

3.5.2.2 Recovery Time

Definition
The amount of time for the Recovered Aggregate Forwarding Rate to become equal to the Stable Aggregate Forwarding Rate.

Discussion
Recovery Time is measured beginning at the instant the Instability Phase ends until the Recovered Aggregate Forwarding Rate equals the Stable Aggregate Forwarding Rate for a minimum of 180 consecutive seconds.

Measurement Units:
seconds

Issues:
None

See Also:
Recovered Aggregate Forwarding Rate
Stable Aggregate Forwarding Rate

3.5.2.3 Recovered Uncontrolled Control Plane Sessions Lost

Definition:
Control Plane sessions that are in the down state but were not intentionally brought down during the Recovery Phase.

Discussion:
The test equipment is able to control protocol session state with the DUT. The test equipment is also to monitor for sessions lost with the DUT which the test equipment itself did not intentionally bring down.

Measurement units:
sessions

Issues:
None

See Also:

Controlled Session Loss
Uncontrolled Session Loss

4. Security Considerations

Documents of this type do not directly effect the security of the Internet or of corporate networks as long as benchmarking is not performed on devices or systems connected to operating networks.

5. References

[1] Bradner, S., Editor, "Benchmarking Terminology for Network Interconnection Devices", RFC 1242, July 1991.

[2] Mandeville, R., "Benchmarking Terminology for LAN Switching Devices", RFC 2285, June 1998.

[3] Bradner, S. and McQuaid, J., "Benchmarking Methodology for Network Interconnect Devices", RFC 2544, March 1999.

[4] "Core Router Evaluation for Higher Availability", Scott Poretsky, NANOG 25, June 8, 2002, Toronto, CA.

[5] "Router Stress Testing to Validate Readiness for Network Deployment", Scott Poretsky, IEEE CQR 2003.

[6] Poretsky, S. and Rao, S., "Methodology for Accelerated Stress Benchmarking", draft-ietf-bmwg-acc-bench-meth-00, work in progress, July 2004.

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Appendix 1. White Box Benchmarking Terminology

Minimum Available Memory

Definition:
Minimum DUT Available Memory during the duration of the Accelerated Stress Test.

Discussion:
It is necessary to monitor DUT memory to measure this benchmark.

Measurement units:
bytes

Issues:
None

See Also:
Maximum CPU Utilization

Maximum CPU Utilization

Definition:
Maximum DUT CPU utilization during the duration of the Accelerated Stress Test.

Discussion:
It is necessary to monitor DUT CPU Utilization to measure this benchmark.

Measurement units:
%

Issues:
None

See Also:
Minimum Available Memory