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Terminology for Accelerated Stress Benchmarking
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Status of this Memo

ABSTRACT
This document provides the Terminology for performing Accelerated 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 configured with multiple protocols and security policies while simultaneously forwarding traffic and being managed. To accurately benchmark a router for deployment, it is necessary to test that router under operational conditions by simultaneously configuring and scaling network protocols and security policies, forwarding traffic, and managing the device. It is useful to accelerate these network operational conditions so that the router under test can be benchmarked with a shorter test duration. Testing a router in accelerated network conditions is known as Accelerated Stress Benchmarking.

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. For each plane, the Configuration Set, Startup Conditions, and Instability Conditions are defined. 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 Multiple benchmarks are measured for each Benchmark Plane during each Phase. Benchmarks can be compared across multiple planes for the same DUT or at the same plane for 2 or more DUTS. Benchmarks of internal DUT characteristics such as memory and CPU utilization (also known as White Box benchmarks) are described in Appendix 1, to allow additional characterization of DUT behavior. The terminology is to be used with the companion methodology document [4]. The sequence of phases, actions, and benchmarks are shown in Table 1.

2. Existing definitions

RFC 1242 [1] and RFC 2285 [2] 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 BCP 14, RFC 2119

[5]. RFC 2119 defines the use of these key words to help make the intent of standards track documents as clear as possible. While this document uses these keywords, it is not a standards track document.

Table 1. Phase Sequence and Benchmarks

III. Recovery Phase	II. Instability Phase	I. Startup Phase
Remove Instability Conditions	Achieve Configuration Set	Apply Startup Conditions
Benchmark: Recovered Aggregate Forwarding Rate	Benchmark: Unstable Aggregate Forwarding Rate	Benchmark: Stable Aggregate Forwarding Rate
	Degraded Aggregate Forwarding Rate	
	Average Degraded Forwarding Rate	
Recovered Latency	Unstable Latency	Startup Latency
Recovered Uncontrolled Sessions Lost	Recovered Uncontrolled Sessions Lost	Stable Session Count
Recovery Time		

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. Configuration, Startup Conditions, Instability Conditions, and Failure Conditions used for each test are defined for each of these four Benchmark Planes.

Measurement units:
N/A

Issues:
None

See Also:
Control Plane

Data Plane
Management Plane
Security Plane

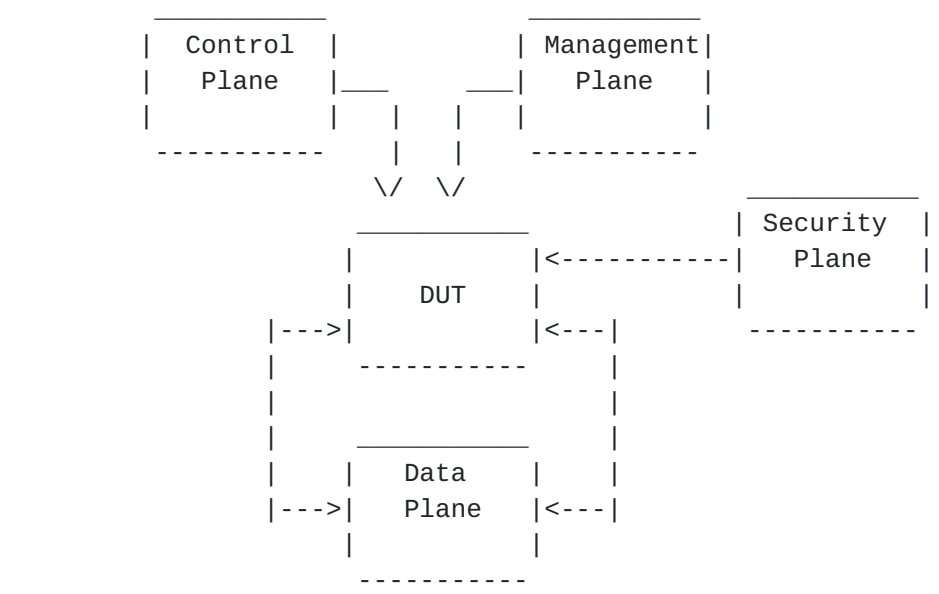


Figure 1. Router Accelerated Stress Benchmarking Planes

3.1.2 Configuration Sets

Definition:
The offered load, 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. The minimum Configuration Set that MUST be used is discussed in the Methodology document [4].

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 Stress 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:
Controlled Session Loss is performed during the test in order to stress the DUT by forcing it to tear down Control Plane sessions while handling traffic. It is assumed that the test equipment is able to control protocol session state with the DUT and is therefore able to introduce Controlled Session Loss.

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, and Instability Conditions of the control protocols. 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

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, and Instability Conditions of the data traffic. 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

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, and Instability Conditions of the management protocols and features. The Management Plane includes SNMP, Logging/Debug, Statistics Collection, and management configuration sessions such as telnet, SSH, and serial console.

Measurement units:
N/A

Issues:
None

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

3.2.4 Security Plane

Definition:
The Security features used during the Accelerated Stress Benchmarking.

Discussion:
The Security Plane defines the Configuration, Startup Conditions, and Instability Conditions of the security features and protocols. 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

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 MUST 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 of the Aggregate Forwarding Rates measured during the Startup Phase.

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 Stable Aggregate Forwarding Rate so that it is 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 that 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:
Startup Phase
Aggregate Forwarding Rate

3.3.2.2 Stable Latency

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

Discussion:
Stable Latency is the calculated average Latency during the Startup Phase.

Measurement units:
seconds

Issues:
None

See Also:
Startup Phase
Stable Aggregate Forwarding Rate

3.3.2.3 Stable Session Count

Definition:
Total number of control plane sessions/adjacencies established and maintained by the DUT during the Startup Phase and 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:
Startup Phase

3.3.3 Control Plane

3.3.3.1 Control Plane Configuration Set

Definition:
The routing protocols and scaling values used for the Accelerated Stress 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

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

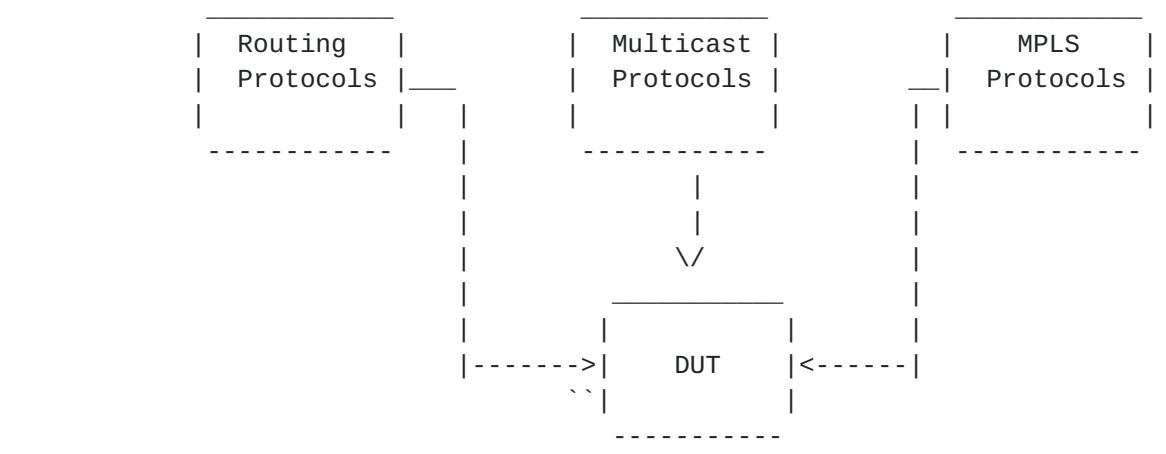


Figure 2. Control Plane Configuration Module

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 Benchmark.

Discussion:
A key component of the Accelerated Stress Benchmark 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 access, SNMP, Logging/Debug, and Statistics Collection, and services such as FTP, as shown in Figure 3. These features SHOULD be enabled throughout the Stress test.

Measurement units:
N/A

Issues:
None

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

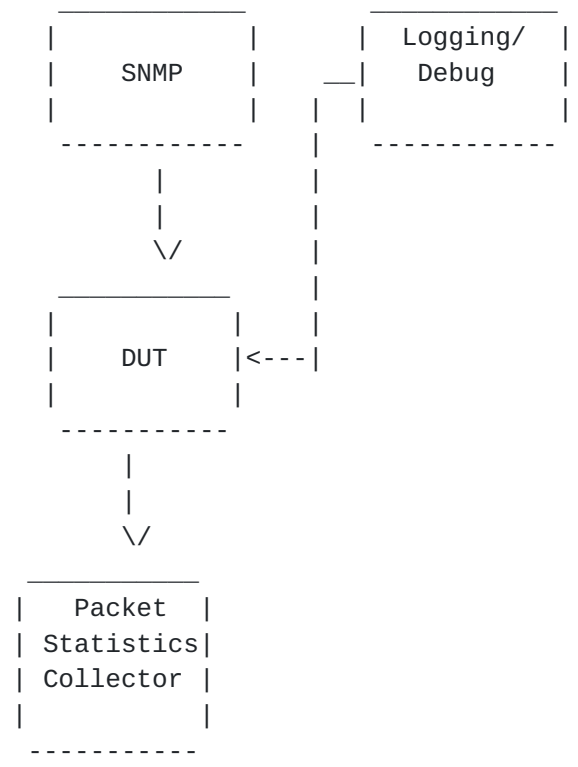


Figure 3. Management Plane Configuration Set

3.3.6 Security Plane

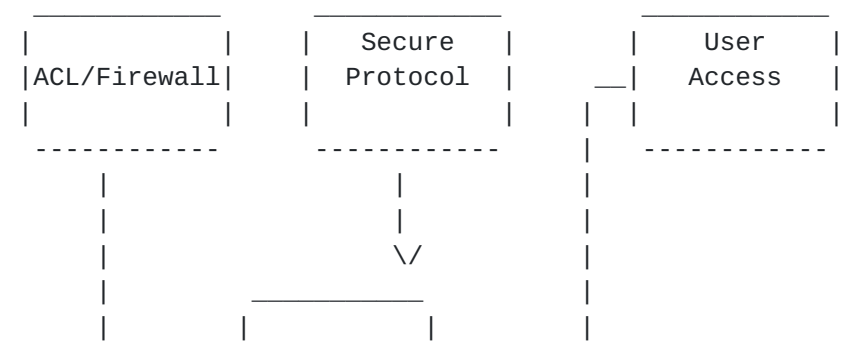
3.3.6.1 Security Plane Configuration Set

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. Tunnels SHOULD be established and policies configured. Instability is introduced by flapping tunnels and configuring and removing policies.



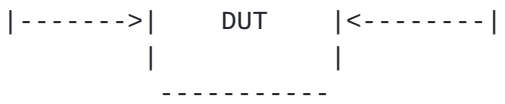


Figure 4. Security Configuration Module

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 traffic 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.

Measurement units:
pps

Issues:
None

See Also:
Instability Conditions
Aggregate Forwarding Rate

3.4.2.2 Aggregate Forwarding Rate Degradation

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

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

Aggregate Forwarding Rate Degradation=
Stable Aggregate Forwarding Rate -
Unstable Aggregate Forwarding Rate

Ideally, the Aggregate Forwarding Rate Degradation is zero.

Measurement Units:
pps

Issues:
None

See Also:
Instability Phase
Unstable Aggregate Forwarding Rate

3.4.2.3 Average Aggregate Forwarding Rate Degradation

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

Discussion:
Average Aggregate Forwarding Rate Degradation=
(Sum (Stable Aggregate Forwarding Rate) -
Sum (Unstable Aggregate Forwarding Rate)) / Number of Samples

Measurement Units:
pps

Issues:
None

See Also:
Aggregate Forwarding Rate Degradation

3.4.2.4 Unstable Latency

Definition:
The average increase in measured packet latency during the Instability Phase compared to the Startup Phase.

Discussion:
Latency SHOULD be measured at a fixed interval during the Instability Phase. Unstable Latency is the difference between Stable Latency and the average Latency measured during the Instability Phase. It is expected that there be an increase in average latency from the Startup Phase to the Instability phase, but it is possible that the difference be zero. The Unstable Latency cannot be a negative number.

Measurement units:
seconds

Issues:
None

See Also:
  Instability Phase
  Stable Latency

3.4.2.5 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 Stress 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 Stress 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. 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 Recovered Latency

Definition:
The average increase in measured packet latency during the Recovery Phase compared to the Startup Phase.

Discussion:
Latency SHOULD be measured at a fixed interval during the Recovery Phase. Unstable Latency is the difference between Stable Latency and the average Latency measured during the Recovery Phase. It is expected that there be no increase in average latency from the Startup Phase to the Recovery Phase. The Recovered Latency cannot be a negative number.

Measurement units:
seconds

Issues: None

See Also:
Recovery Phase
Stable Latency

3.5.2.3 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 duration of 180 consecutive seconds.

Measurement Units:
milliseconds

Issues:
None

See Also:
Recovered Aggregate Forwarding Rate
Stable Aggregate Forwarding Rate

3.5.2.4 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

3.5.2.5 Variability Benchmarks

Definition:
The difference between the measured Benchmarks of the same DUT over multiple iterations.

Discussion:
Ideally, the measured benchmarks should be the same for multiple iterations with the same DUT. Configuration Sets and

Instability Conditions MUST be held constant for this benchmark. Whether the DUT can exhibit such predictable and repeatable behavior is an important benchmark in itself.

Measurement units:
As applicable to each Benchmark. The results are to be presented in a table format for successive Iterations. Ideally, the differences should be zero.

Issues:
None

See Also:
Startup Period
Instability Period
Recovery Period

4. IANA Considerations

This document requires no IANA considerations.

5. Security Considerations

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

6. References

6.1 Normative References

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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 Benchmark.

Discussion:
This benchmark enables the assessment of resources in the DUT. 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 Benchmark.

Discussion:
This benchmark enables the assessment of resources in the DUT. It is necessary to monitor DUT CPU Utilization to measure this benchmark.

Measurement units: %

Issues: None

See Also:
  Minimum Available Memory

Full Copyright Statement

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