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**Terminology for Benchmarking
Core Router Software Accelerated Life Testing**

<draft-ietf-bmwg-acc-bench-term-00.txt>

Status of this Memo

ABSTRACT
     This terminology document provides the terms to be used for
benchmarking router software under accelerated stress conditions.
A framework is defined to configure routing protocols, security
policies, traffic forwarding, and management. Conditions to
produce instability and accelerate operational conditions are
also defined. Benchmarks for evaluating a router subjected to
the accelerated life test are introduced. The DUT configuration
and accelerated stress conditions emulate those of Internet
Core routers.

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1. Introduction

Router testing benchmarks have consistently been made in a
monolithic fashion in which a single protocol or behavior is
measured in an isolated environment. It is important to know the
limits for a router/switch's (hereby referred to as Router) behavior
for each protocol, however this does not produce a reliable benchmark
of the router's behavior in a deployed network. 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 the network protocols and security
policies, sourcing traffic, and managing the router. 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 Life Testing. White Box benchmarks are defined in
   Appendix 1.
   Accelerated Life Testing of Routers provides the following benefits:
   1. Evaluation of multiple protocols enabled simultaneously as
      configured in deployed networks
   2. Evaluation of System and Software Stability
   3. Evaluation of Manageability under stressful conditions
   4. Identification of Software Coding bugs such as:
        a. Memory Leaks
        b. Suboptimal CPU Utilization
        c. Coding Logic

   These evaluations are externally observable to the DUT as control
   plane or data plane errors.

   Configuration and operational conditions vary for Core, Peering,
   Aggregate, and Edge Routers. This document focuses on defining
   the terminology for Accelerated Life Testing of Core Routers.
   Terminology for configuring network conditions, accelerating
   operational parameters, accelerating network instability, and
   evaluating results are provided.

   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 Configuration Modules

      Definition:
        The features and protocols enabled for the Accelerated Life
        Test and conditions created during the test.

      Discussion:

Features and Protocols are divided into four configuration
modules as shown in Figure 1. These are the Control Plane,
Data Plane, Management Plane, and Security Plane.

Definitions for each of these modules are provided in the
following sections.

```
       _____                _____
      |  Control  |              | Management|
      |   Plane   |___      ___|   Plane   |
      |  Module   |  |    |   |   Module   |
       -----------   |    |    -----------
                    \/   \/                      _____
                     _____              | Security  |
                    |           |<-----------|   Plane   |
                    |    DUT    |              |  Module   |
              |--->|           |<---|        -----------
                    |  -----------        |
                    |                     |
                    |   _____       |
                    |  |   Data    |      |
              |--->|   Plane   |<---|
                    |  Module   |
                     -----------
```
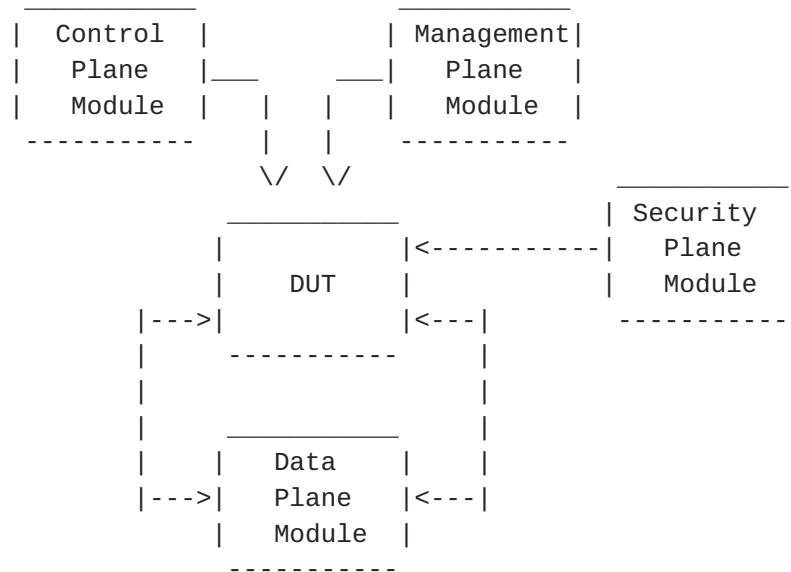
Figure 1. Configuration Modules

Measurement units: N/A

Issues: None

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

3.1.1 Control Plane Configuration Module

Definition:
  The control protocols enabled for the Accelerated Life Test.

Discussion:
  Control Plane Configuration Module is divided into three
  Configuration Sets as shown in Figure 2. These are Routing
  Protocol, Multicast, and MPLS. These can be enabled or
  disabled for a benchmark test. For example, a network operator
  that operates a network with BGP and an IGP without Multicast
  and MPLS protocols can execute a benchmark test with the
  Routing Protocol Configuration Set enabled and the Multicast
  and MPLS Configuration Sets disabled. Configuration Sets are
  further explained in the next section.

Measurement units: Enabled/Disabled

Issues:None

```
    _____               _____              _____
   | Routing    |             | Multicast  |            |    MPLS    |
   | Protocol   |___          | Protocol   |          __| Protocol   |
   | Config Set |  |          | Config Set |         |  | Config Set |
    ------------   |           ------------          |   ------------
                   |                |                |
                   |                |                |
                   |               \/                |
                   |           _____           |
                   |          |           |          |
                   |-------->|    DUT      |<------|
                             |            |
                              -----------
```
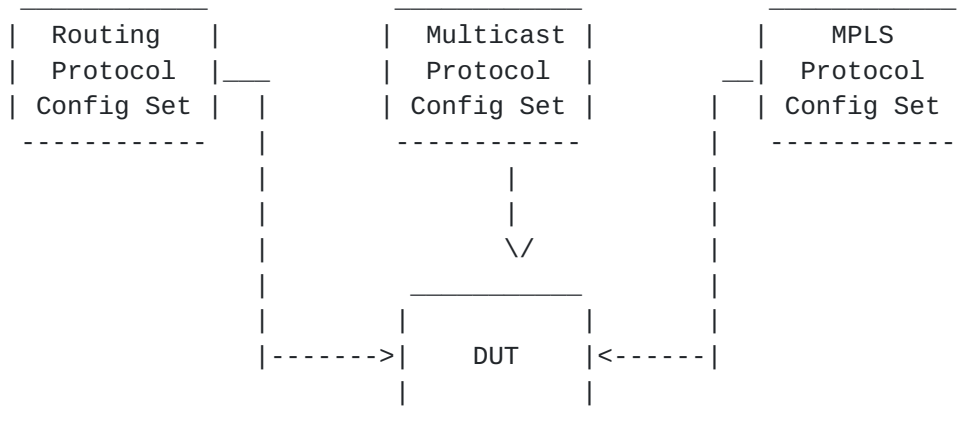
        Figure 2. Control Plane Configuration Module

        See Also:
          Routing Protocol Configuration Set
          Multicast Protocol Configuration Set
          MPLS Protocol Configuration Set

    3.1.2 Data Plane Configuration Module

        Definition:
            The data traffic and interfaces enabled for the Accelerated
            Life Test.

        Discussion:
          Accelerated Life Testing includes protocols, as defined by the
          Control Plane Configuration Module, and data forwarding, as
          defined by the Data Plane Configuration Module. As shown in
          Figure 3, the Data Plane Configuration Module has a
          corresponding Traffic Profile Configuration Set.

```
         _____
        |  Traffic  |
        |  Profile  |___
        | Config Set|   |
         -----------    |
                       \/
                  _____
                 |           |
                 |   DUT     |
                 |           |
                  -----------
```
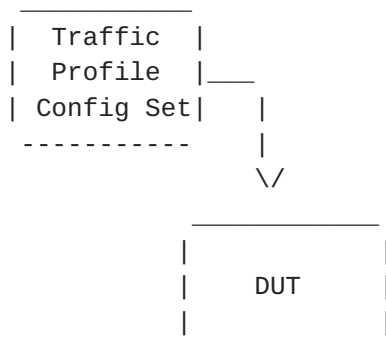
        Measurement Units:
          Enabled/Disabled

See Also:
          Traffic Profile Configuration Set
          System Configuration Set

   3.1.3 Management Configuration Module

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

      Discussion:
        A key component of the Accelerated Life Test is the
        Management Configuration Module to assess manageability
        of the router under stress. The Management Configuration
        Module can be divided into User Access Configuration Set,
        SNMP Configuration Set, Logging/Debug Configuration Set,
        and Packet Statistics Collector Configuration Set as
        shown in Figure 4.

```
         _____       _____       _____
        |    User     |     |             |     |  Logging/   |
        |   Access    |     |    SNMP     |   __|   Debug     |
        | Config Set  |     | Config Set  |  |  | Config Set  |
         ------------         ------------   |   ------------
              |                    |          |
              |                    |          |
              |                    \/         |
              |                _____   |
              |          |                |   |
              |-------->|     DUT      |<-----|
                        |              |
                         -----------
                              |
                              |
                              \/
                         _____
                        |   Packet    |
                        | Statistics  |
                        | Collector   |
                        | Config Set  |
                         -----------
```

        Figure 4. Management Configuration Module

      Measurement units:
        Enabled/Disabled

      Issues:
        None

      See Also:
        User Access Configuration Set

SNMP Configuration Set
          Logging/Debug Configuration Set
          Packet Statistics Collector Configuration Set

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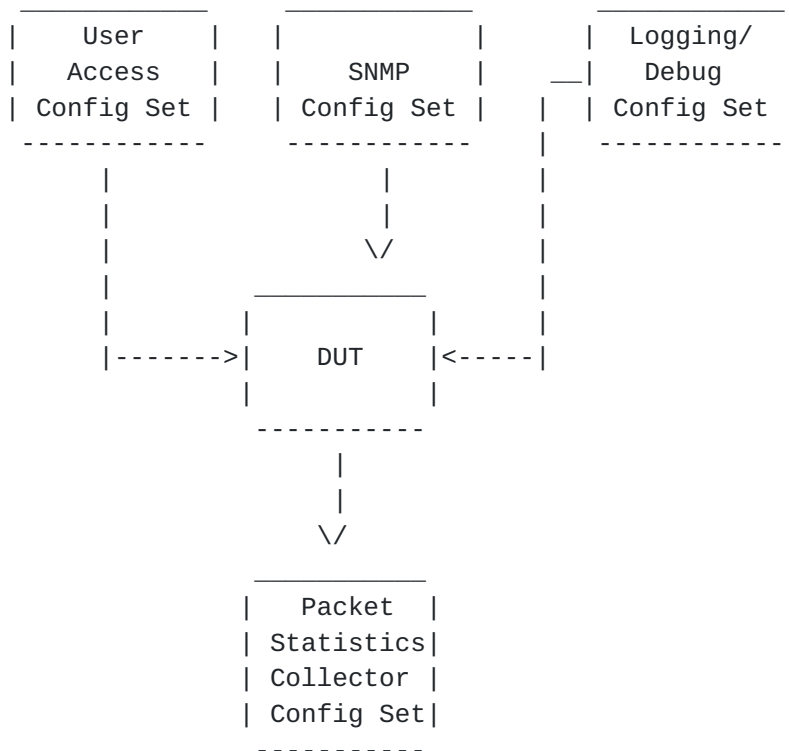   3.1.4 Security Configuration Module

      Definition:
        Security features enabled for the Accelerated Life Test.

      Discussion:
        Accelerated Life Testing of Core Router can include
        configuration of Security features. The Security
        Configuration Module includes the ACL Configuration
        Set, Secure Protocol Configuration Set, and User Login
        Configuration Set as shown in Figure 5.

```
          _____        _____        _____
         |            |      |   Secure   |      |   User     |
         |    ACL     |      |  Protocol  |    __|   Login    |
         | Config Set |      | Config Set |   |  | Config Set |
          ------------        ------------    |   ------------
               |                   |          |
               |                   |          |
               |                  \ /         |
               |             _____     |
               |            |            |    |
               |-------->   |    DUT     |<--------|
                            |            |
                             -----------
```
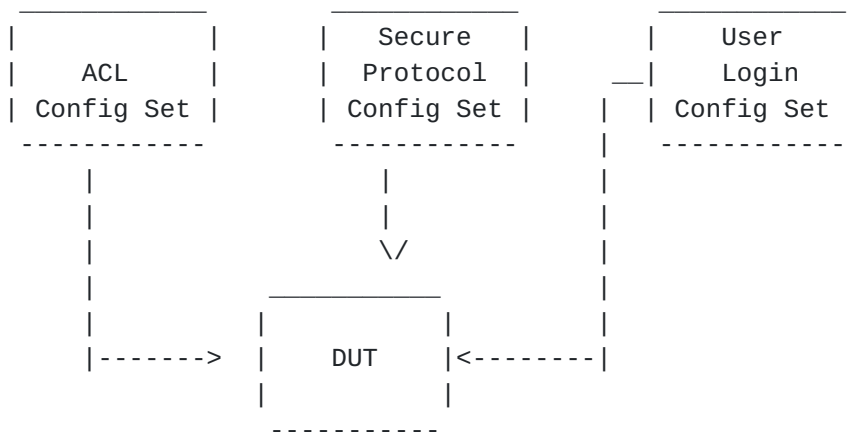   Figure 5. Security Configuration Module

      Measurement units:
        Enabled/Disabled

      Issues:
          None

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

   3.2 Configuration Sets

   3.2.1 Control Plane Configuration Sets
   3.2.1.1 Routing Protocol Configuration Set

      Definition:
          Table of Routing Protocols configuration for Accelerated
          Life Test.

      Discussion:
          The Routing Protocol Configuration Set is one of the

Control Plane Configuration Sets BGP, MBGP, ISIS, OSPF are
the routing protocols that can be enabled or disabled in
any combination. The specific protocol parameters used to

          establish the test conditions are also provided in the table.

     Measurement units:
          PARAMETER   UNITS
          BGP   Enabled/Disabled
          Number of EBGP Peers   Peers
          Number of IBGP Peers   Peers
          Number of BGP Route Instances   Routes
          Number of BGP Installed Routes   Routes

          MBGP   Enabled/Disabled
          Number of MBGP Route Instances   Routes
          Number of MBGP Installed Routes   Routes

          ISIS   Enabled/Disabled
          ISIS-TE   Enabled/Disabled
          Number of ISIS Adjacencies   Adjacencies
          Number of ISIS Routes   Routes
          Number of Nodes per Area   Nodes

          OSPF   Enabled/Disabled
          OSPF-TE   Enabled/Disabled
          Number of OSPF Adjacencies   Adjacencies
          Number of OSPF Routes   Routes
          Number of Nodes per Area   Nodes

     Issues:
          None

     See Also:
          Control Plane Configuration Module
          Multicast Protocol Configuration Set
          MPLS Protocol Configuration Set

   3.2.1.2 Multicast Protocol Configuration Set

     Definition:
       Table of Multicast Protocols configuration for Accelerated
       Life Test.

     Discussion:
          The Multicast Protocol Configuration Set is one of the
          Control Plane Configuration Sets PIM-SM and MSDP are
          the routing protocols that can be enabled or disabled in
          any combination. The specific protocol parameters used to
          establish the test conditions are also provided in the table.

     Measurement units:
          PARAMETER   UNITS

```
PIM-SM                          Enabled/Disabled
RP                              Enabled/Disabled
Number of Multicast Groups      Groups
```

          MSDP   Enabled/Disabled

     Issues:
          None

     See Also:
          Control Plane Configuration Module
          Routing Protocol Configuration Set
          MPLS Protocol Configuration Set

   3.2.1.3 MPLS Protocol Configuration Set

     Definition:
       Table of MPLS Protocols configuration for Accelerated Life Test.

     Discussion:
       The MPLS Protocol Configuration Set is one of the Control Plane
       Configuration Sets MPLS-TE (RSVP-TE, ISIS-TE, OSPF-TE) and LDP
       are the routing protocols that can be enabled or disabled in any
       combination. The specific protocol parameters used to establish
       the test conditions are also provided in the table.

     Measurement units:

PARAMETER	UNITS
MPLS-TE	
Number of Ingress Tunnels	Tunnels
Number of Mid-Point Tunnels	Tunnels
Number of Egress Tunnels	Tunnels
LDP	
Number of Sessions	Sessions
Number of FECs	FECs

     Issues:
          None

     See Also:
          Control Plane Configuration Module
          Routing Protocol Configuration Set
          Multicast Protocol Configuration Set

   3.2.2 Data Plane Configuration Sets

   3.2.2.1 Data Plane Configuration Set

     Definition:
       Table of Forwarded Traffic configuration for Accelerated Life
       Test.

Discussion:

Measurement units:

```
     PARAMETER                         UNITS
     Traffic Forwarding                Enabled/Disabled
     Packet Size                       Byte Size Distribution
     Number of Flows                   Flows
     Offered Load                      bps (or pps) Aggregate
     Number of Interfaces              Interfaces
```

   Issues:
     None

   See Also:
     Data Plane Configuration Module

3.2.3 Management Configuration Sets
3.2.3.1 User Access Configuration Set

   Definition:
     Table of User Access methods during Accelerated Life Test.

   Discussion:

   Measurement units:
```
     PARAMETER                         UNITS
     Telnet Rate                       Sessions/Hour
     FTP Rate                          Sessions/Hour
     Concurrent Telnet Sessions        Sessions
     Concurrent FTP Session            Sessions
     SSH                               Enabled/Disabled
     RADIUS                            Enabled/Disabled
     TACACS                            Enabled/Disabled
```

   Issues:
     None

   See Also:
     Management Configuration Module
     SNMP Configuration Set
     Logging/Debug Configuration Set
     Packet Statistics Collector Configuration Set

3.2.3.2 SNMP Configuration Set

   Definition:
     Table of SNMP Configuration for the Accelerated Life Test.

   Discussion:

   Measurement units:
```
     SNMP GET Rate                         SNMP Gets/minute
```

Issues:
    None

      See Also:
        Management Configuration Module
        User Access Configuration Set
        Logging/Debug Configuration Set
        Packet Statistics Collector Configuration Set

   3.2.3.3 Logging/Debug Configuration Set

      Definition:
        Table of Logging and Debug configuration for the
        Accelerated Life Test.

      Discussion:

      Measurement units:
        Logging   Enabled/Disabled
        Protocol Debug   Enabled/Disabled

       Issues:
         None

      See Also:
        Management Configuration Module
        User Access Configuration Set
        SNMP Configuration Set
        Packet Statistics Collector Configuration Set

   3.2.3.4 Packet Statistics Collector Configuration Set

       Definition:
         Table of Packet Statistics Collection for the
         Accelerated Life Test.

       Discussion:

       Measurement units:
         Packet Statistics Collector   Enabled/Disabled
         Sampling Rate   X:1 packets

       Issues:
         None

       See Also:
         Management Configuration Module
         User Access Configuration Set
         SNMP Configuration Set
         Logging/Debug Configuration Set

3.2.4 Security Configuration Sets

  3.2.4.1 ACL Configuration Set

       Definition:
         Table of ACL configuration for the Accelerated Life Test

       Discussion:

       Measurement units:
         Access-Control Lists   Enabled/Disabled
         Number of ACLs   ACLs
         ACL Depth   ACEs

       Issues:
         None

       See Also:
         Security Configuration Module

   3.3 Instability Conditions

       Definition:
         Test conditions that occur during the Accelerated Life Test
         that are typical of instability in an operational network.
         These conditions occur at a much greater rate during the
         test.

       Discussion:
         Configuration Modules and Configuration Sets establish the
         configuration of the DUT for the Accelerated Life Test.
         Instability Conditions are events that occur during the
         Accelerated Life Test to stress the router.

       Measurement units:
         N/A

       Issues:
         None

       See Also:
         Interface Shutdown Cycling Rate
         BGP Route Flap Rate
         IGP Route Flap Rate
         Route Convergence Due to Better Next-Hop
         LSP Reroute Rate
         Target Run Time

    3.3.1 Interface Shutdown Rate

       Definition:

The rate at which physical interfaces are shutdown on the DUT.

Discussion:

Router Software Accelerated Life Testing
  This instability condition is an administrative shutdown or remote
  loss of carrier for every interface of the DUT. This produces great
instability on the DUT due to continuous protocol session loss and
  convergence.

Measurement units:
  number of interface shutdowns per minute

Issues:
  None

See Also:
  Instability Conditions
  Route Flap Rate
  Target Run Time

3.3.2 BGP Route Flap Rate

Definition:
  The rate at which BGP routes installed in the route table are
  flapped.

Discussion:
  This instability condition defines the rate of repeated
  installation, withdrawal,and installation of routes installed in
  the route table. This produces great instability on the DUT due
  to continuous changes to the forwarding table.

Measurement units:
  routes flapped per second

Issues:
  None

See Also:
  Instability Conditions
  Interface Shutdown Cycling Rate
  Target Run Time

3.3.3 IGP Route Flap Rate

Definition:
  The rate at which IGP routes installed in the route table are
  flapped.

Discussion:
  This instability condition defines the rate of repeated

installation, withdrawal,and installation of routes installed in
the route table. This produces great instability on the DUT due
to continuous changes to the forwarding table.

       Measurement units:
         routes flapped per second

       Issues:
         None

       See Also:
         Instability Conditions
         Interface Shutdown Cycling Rate
         Target Run Time

  3.3.4 Route Convergence Due to Better Next-Hop

       Definition:
         The rate at which routes in the FIB are replaced by a route
         instance in the RIB with a different next-hop becoming more
         preferred.

       Discussion:
         The route changes are due to attribute and TLV changes. RIB
         contains routes matching those in the FIB. Convergence due
         to better path can occur for BGP and IGP routes.

       Measurement units:
         more preferred routes per second

       Issues:
         None

       See Also:
         Instability Conditions
         Interface Shutdown Cycling Rate
         Target Run Time

   3.3.5 LSP Reroute Rate

     Definition:
        The rate at which established LSPs experience a failure condition
        and are forced to reroute.

     Discussion:
        This instability condition defines the rate of repeated LSP
        reroutes. This produces great instability on the DUT due to
        continuous tunnel path calculations and changes to the
        forwarding table. Rerouting can be performed with Headend
        Reroute, Standby LSP, or Fast Reroute.

     Measurement units:
        routes flapped per second

Issues:
         None

     See Also:
       Instability Conditions
       Interface Shutdown Cycling Rate
       Target Run Time

   3.3.6 Intended Test Duration

     Definition:
       The maximum targetted run time for Accelerated Life Test.

     Discussion:
       This is an instability condition because the protocol sessions
       and scaling values must be maintained for this specified time with
       interfaceshutdowns and route flapping. The test may be halted
       upon reaching the Intended Test Duration.

     Measurement units:
       Hours

     Issues:
       None

     See Also:
       Instability Conditions
       Interface Shutdown Cycling Rate
       Route Flap Rate

   3.4 Evaluation Benchmarks

   3.4.1 Run-Time without Error

     Definition:
       The run-time for the Accelerated Life Test without the DUT
       exhibiting an error in the control plane, data plane, management
       plane, or security plane.

     Discussion:
       For a successful test, the Run-Time Without Error will equal the
       Intended Test Duration. In the event of any failure, the Run-Time
       Without Error is less than the Intended Test Duration and will equal
       the maximum of the Run-Time without Control Plane Error, Run-Time
       without Data Plane Error, Run-Time without Management Plane Error,
       and Run-Time without Security Plane Error.

     Measurement units:
       Hours and Minutes

     Issues:

None

        See Also:

Poretsky, Rao, Piatt

        Intended Test Duration
        Run-Time without Control Plane Error
        Run-Time without Data Plane Error
        Run-Time without Management Plane Error
        Run-Time without Security Plane Error

   3.4.2 Run-Time without Control Plane Error

      Definition:
        The run-time for the Accelerated Life Test without the DUT
        exhibiting an error in the control plane to Routing, Multicast,
        and MPLS Protocol.

      Discussion:
        For a successful test, the Run-Time Without Control Plane Error
        will equal the Run-Time without Error. In the event of a Control
        Plane failure, the Run-Time Without Control Plane Error is less
        than the Run-Time without Error.

      Measurement units:
        Hours and Minutes

      Issues:
        None

      See Also:
        Intended Test Duration
        Run-Time without Error
        Run-Time without Data Plane Error
        Run-Time without Management Plane Error
        Run-Time without Security Plane Error

   3.4.3 Run-Time without Data Plane Error

       Definition:
        The run-time for the Accelerated Life Test without the DUT
        exhibiting an error in the Data Plane for traffic forwarding
        or DUT interfaces.

      Discussion:
        For a successful test, the Run-Time Without Data Plane Error
        will equal the Run-Time without Error. In the event of a Data
        Plane failure, the Run-Time Without Data Plane Error is less
        than the Run-Time without Error.

      Measurement units:
        Hours and Minutes

      Issues:

None

   See Also:

Poretsky, Rao, Piatt

          Intended Test Duration
          Run-Time without Error
          Run-Time without Control Plane Error
          Run-Time without Management Plane Error
          Run-Time without Security Plane Error

   3.4.4 Run-Time without Management Plane Error

      Definition:
        The run-time for the Accelerated Life Test without the DUT
        exhibiting an error in the Management Plane to User Access,
        SNMP, or Logging/Debug.

      Discussion:
        For a successful test, the Run-Time Without Management Plane
        Error will equal the Run-Time without Error. In the event of
        a Management Plane failure, the Run-Time Without Management
        Plane Error is less than the Run-Time without Error.

      Measurement units:
        Hours and Minutes

      Issues:
        None

      See Also:
        Intended Test Duration
        Run-Time without Error
        Run-Time without Control Plane Error
        Run-Time without Data Plane Error
        Run-Time without Security Plane Error

   3.4.5 Run-Time without Security Plane Error

      Definition:
        The run-time for the Accelerated Life Test without the DUT
        exhibiting an error in the Security Plane to ACLs.

      Discussion:
        For a successful test, the Run-Time Without Security Plane
        Error will equal the Run-Time without Error. In the event
        of a Security Plane failure, the Run-Time Without Control
        Plane Error is less than the Run-Time without Error.

      Measurement units:
        Hours and Minutes

      Issues:
        None

See Also:
          Intended Test Duration

           Run-Time without Error
           Run-Time without Control Plane Error
           Run-Time without Data Plane Error
           Run-Time without Management Plane Error

    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.

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  7. Full Copyright Statement

   Appendix 1. White Box Benchmarking Terminology
   Appendix 1.1   Minimum Available Memory

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

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

      Measurement units:
        bytes

      Issues:
        None

See Also:
         Maximum CPU Utilization

Appendix 1.2 Maximum CPU Utilization

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

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

Measurement units:
   %

Issues:
   None

See Also:
   Minimum Available Memory