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### Methodology Guidelines for Accelerated Stress Benchmarking <draft-ietf-bmwg-acc-bench-meth-08.txt>

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### ABSTRACT

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 the router in a lab environment under accelerated conditions, which is known as Stress Testing. This document provides the Methodology Guidelines for performing Accelerated Stress Benchmarking of networking devices. The methodology is to be used with the companion terminology document [4]. These guidelines can be used as the basis for additional methodology documents that benchmark stress conditions for specific network technologies.

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### **1**. Introduction

Router testing benchmarks have consistently been made in a monolithic fashion wherein a single protocol or behavior is measured in an isolated environment. It is important to know the limits for a networking device's behavior for each protocol in isolation, however this does not produce a reliable benchmark of the device's behavior in an operational network. 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 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 with Instability Conditions [4] so that the networking devices are stress tested.

This document provides the Methodology for performing Stress Benchmarking of networking devices. Descriptions of Test Topology, Benchmarks and Reporting Format are provided in addition to procedures for conducting various test cases. The methodology is to be used with the companion terminology document [4].

Stress Testing of networking devices 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 buffer overflow conditions
- 5. Identification of software coding bugs such as: a. Memory leaks

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- b. Suboptimal CPU utilization
- c. Coding logic

These benefits produce significant advantages for network operations:

- 1. Increased stability of routers and protocols
- 2. Hardened routers to DoS attacks
- 3. Verified manageability under stress
- 4. Planning router resources for growth and scale

### **2**. Existing definitions

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 <u>BCP 14</u>, <u>RFC 2119</u> [5]. <u>RFC 2119</u> 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, this document is not a standards track document.

Terms related to Accelerated Stress Benchmarking are defined in  $[\underline{4}]$ .

### 3. Test Setup

### 3.1 Test Topologies

Figure 1 shows the physical configuration to be used for the methodologies provided in this document. The number of interfaces between the tester and DUT will scale depending upon the number of control protocol sessions and traffic forwarding interfaces. A separate device may be required to externally manage the device in the case that the test equipment does not support such functionality. Figure 2 shows the logical configuration for the stress test methodologies. Each plane MAY be emulated by single or multiple test equipment.

### 3.2 Test Considerations

The Accelerated Stress Benchmarking test can be applied in service provider test environments to benchmark DUTs under stress in an environment that reflects conditions found in an operational network. A particular Configuration Set is defined and the DUT is benchmarked using this configuration set and the Instability Conditions. Varying Configuration Sets and/or Instability Conditions applied in an iterative fashion can provide an accurate characterization of the DUT to help determine future network deployments.

For the management plane SNMP Gets SHOULD be performed continuously. Management sessions SHOULD be open simultaneously and be repeatedly open and closed using access protocols such as telnet and SSH. Open management sessions SHOULD have valid and invalid configuration and show commands entered. For the security plane, tunnels for protocols such as IPsec SHOULD be established and flapped. Policies for Firewalls and ACLs SHOULD be repeatedly added and removed via management sessions.

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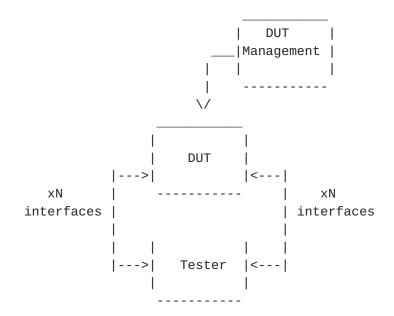


Figure 1. Physical Configuration

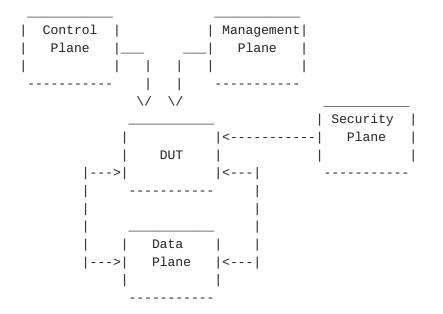


Figure 2. Logical Configuration

# 3.3 Reporting Format

Each methodology requires reporting of information for test repeatability when benchmarking the same or different devices. The information that are the Configuration Sets, Instability Conditions, and Benchmarks, as defined in [4]. Example

reporting formats for each are provided below. Benchmarks MUST be reported as provided below.

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### 3.3.1 Configuration Sets

The minimum Configuration Set that MUST be used is as follows: PARAMETER UNITS Number of IGP Adjacencies Adjacencies Number of IGP Routes Routes Number of Nodes per Area Nodes Number of Areas per Node Areas SNMP GET Rate SNMP Gets/minute Telnet Establishment Rate Sessions/Hour Concurrent Telnet Sessions Sessions FTP Establishment Rate Sessions/Hour Concurrent FTP Session Sessions SSH Establishment Rate Sessions/Hour Concurrent SSH sessions Sessions DATA TRAFFIC Traffic Forwarding Enabled/Disabled Aggregate Offered Load bps (or pps) Number of Ingress Interfaces interfaces Number of Egress Interfaces interfaces Packet Size(s) bytes Offered Load (interface) array of bps Number of Flows flows Encapsulation(flow) array of encapsulation types Configuration Sets MAY include and are not limited to the following examples. Example Routing Protocol Configuration Set-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 TGP Enabled/Disabled IGP-TE Enabled/Disabled Number of IGP Adjacencies Adjacencies Number of IGP Routes Routes Number of Nodes per Area Nodes Number of Areas per Node Areas Example MPLS Protocol Configuration Set-PARAMETER UNITS Enabled/Disabled MPLS-TE Number of Tunnels as Ingress Tunnels

Number of Tunnels as Mid-Point Number of Tunnels as Egress LDP Number of Sessions Number of FECs

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Tunnels Tunnels Enabled/Disabled Sessions FECs

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Methodology Guidelines INTERNET-DRAFT July 2007 for Accelerated Stress Benchmarking Example Multicast Protocol Configuration Set-PARAMETER UNITS PIM-SM Enabled/Disabled Enabled/Disabled RP Number of Multicast Groups Groups MSDP Enabled/Disabled Example Data Plane Configuration Set-PARAMETER UNITS Enabled/Disabled Traffic Forwarding Aggregate Offered Load bps (or pps) Number of Ingress Interfaces interfaces Number of Egress Interfaces interfaces TRAFFIC PROFILE Packet Size(s) bytes Offered Load (interface) array of bps Number of Flows flows Encapsulation(flow) array of encapsulation type Example Management Configuration Set-PARAMETER UNITS SNMP GET Rate SNMP Gets/minute Enabled/Disabled Logging Protocol Debug Enabled/Disabled Telnet Establishment Rate Sessions/Hour Concurrent Telnet Sessions Sessions FTP Establishment Rate Sessions/Hour Concurrent FTP Session Sessions SSH Establishment Rate Sessions/Hour Concurrent SSH sessions Sessions Packet Statistics Collector Enabled/Disabled Statistics Sampling Rate X:1 packets Example Security Configuration Set -PARAMETER UNITS Packet Filters Enabled/Disabled Number of Filters For-Me filters Number of Filter Rules For-Me rules Number of Traffic Filters filters Number of Traffic Filter Rules rules IPsec tunnels tunnels Enabled/Disabled RADIUS TACACS Enabled/Disabled Example SIP Configuration Set -PARAMETER UNITS Session Rate Sessions per Second Media Streams per Session Total Sessions

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Streams per session Sessions

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Methodology Guidelines INTERNET-DRAFT July 2007 for Accelerated Stress Benchmarking 3.3.2 Startup Conditions Startup Conditions MAY include and are not limited to the following examples: PARAMETER UNITS EBGP peering sessions negotiated Total EBGP Sessions IBGP peering sessions negotiated Total IBGP Sessions ISIS adjacencies established Total ISIS Adjacencies ISIS routes learned rate ISIS Routes per Second IPsec tunnels negotiated Total IPsec Tunnels IPsec tunnel establishment rate IPsec tunnels per second 3.3.3 Instability Conditions Instability Conditions MAY include and are not limited to the following examples: PARAMETER UNITS Interface Shutdown Cycling Rate interfaces per minute ISIS Route Flap Rate routes per minutes LSP Reroute Rate LSP per minute Overloaded Links number Amount Links Overloaded % of bandwidth FTP Rate Mb/minute IPsec Tunnel Flap Rate tunnels per minute Filter Policy Changes policies per hour SSH Session Rate SSH sessions per hour Telnet Session Rate Telnet session per hour Commands per Hour Command Entry Rate Message Flood Rate Messages 3.3.4 Benchmarks Benchmarks are as defined in [4] and MUST be reported as follow: PARAMETER UNITS PHASE Stable Aggregate Forwarding Rate pps Startup Stable Latency seconds Startup Stable Session Count sessions Startup Unstable Aggregate Forwarding Rate Instability pps Degraded Aggregate Forwarding Rate pps Instability Ave. Degraded Aggregate Forwarding Rate pps Instability Unstable Latency seconds Instability Unstable Uncontrolled Sessions Lost sessions Instability Recovered Aggregate Forwarding Rate pps Recovery Recovered Latency seconds Recovery Recovery Time seconds Recovery Recovered Uncontrolled Sessions sessions Recovery

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### <u>4</u>. Stress Test Procedure

4.1 General Methodology with Multiple Instability Conditions

Objective

To benchmark the DUT under accelerated stress when there are multiple instability conditions.

### Procedure

- 1. Report Configuration Set
- 2. Begin Startup Conditions with the DUT
- 3. Establish Configuration Sets with the DUT
- 4. Report Stability Benchmarks
- 5. Apply Instability Conditions
- 6. Apply Instability Condition specific to test case.
- 7. Report Instability Benchmarks
- 8. Stop applying all Instability Conditions
- 9. Report Recovery Benchmarks
- 10. Optional Change Configuration Set and/or Instability Conditions for next iteration

### Expected Results

Ideally the Forwarding Rates, Latencies, and Session Counts will be measured to be the same at each phase. If no packet or session loss occurs then the Instability Conditions MAY be increased for a repeated iteration (step 10 of the procedure).

Example Procedure

1. Report Configuration Set

BGP Enabled 10 EBGP Peers 30 IBGP Peers 500K BGP Route Instances 160K BGP FIB Routes

ISIS Enabled ISIS-TE Disabled 30 ISIS Adjacencies 10K ISIS Level-1 Routes 250 ISIS Nodes per Area

MPLS Disabled IP Multicast Disabled

IPsec Enabled 10K IPsec tunnels 640 Firewall Policies 100 Firewall Rules per Policy

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Methodology Guidelines INTERNET-DRAFT July 2007 for Accelerated Stress Benchmarking Traffic Forwarding Enabled Aggregate Offered Load 10Gbps 30 Ingress Interfaces 30 Egress Interfaces Packet Size(s) = 64, 128, 256, 512, 1024, 1280, 1518 bytes Forwarding Rate[1..30] = 1Gbps 10000 Flows Encapsulation[1..5000] = IPv4Encapsulation[5001.10000] = IPsec Logging Enabled Protocol Debug Disabled SNMP Enabled SSH Enabled **10 Concurrent SSH Sessions** FTP Enabled **RADIUS Enabled** TACACS Disabled Packet Statistics Collector Enabled 2. Begin Startup Conditions with the DUT 10 EBGP peering sessions negotiated 30 EBGP peering sessions negotiated 1K BGP routes learned per second 30 ISIS Adjacencies 1K ISIS routes learned per second 10K IPsec tunnels negotiated 3. Establish Configuration Sets with the DUT 4. Report Stability Benchmarks as follow: Stable Aggregate Forwarding Rate Stable Latency Stable Session Count It is RECOMMENDED that the benchmarks be measured and recorded at one-second intervals. 5. Apply Instability Conditions Interface Shutdown Cycling Rate = 1 interface every 5 minutes BGP Session Flap Rate = 1 session every 10 minutes BGP Route Flap Rate = 100 routes per minute ISIS Route Flap Rate = 100 routes per minute IPsec Tunnel Flap Rate = 1 tunnel per minute Overloaded Links = 5 of 30

```
Amount Links Overloaded = 20%
SNMP GETs = 1 per sec
SSH Session Rate = 6 sessions per hour
SSH Session Duration = 10 minutes
Command Rate via SSH = 20 commands per minute
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Methodology Guidelines INTERNET-DRAFT July 2007 for Accelerated Stress Benchmarking FTP Restart Rate = 10 continuous transfers (Puts/Gets) per hour FTP Transfer Rate = 100 Mbps Statistics Sampling Rate = 1:1 packets RADIUS Server Loss Rate = 1 per Hour RADIUS Server Loss Duration = 3 seconds 6. Apply Instability Condition specific to test case. 7. Report Instability Benchmarks as follow: Unstable Aggregate Forwarding Rate Degraded Aggregate Forwarding Rate Ave. Degraded Aggregate Forwarding Rate Unstable Latency Unstable Uncontrolled Sessions Lost It is RECOMMENDED that the benchmarks be measured and recorded at one-second intervals. 8. Stop applying all Instability Conditions 9. Report Recovery Benchmarks as follow: Recovered Aggregate Forwarding Rate Recovered Latency Recovery Time Recovered Uncontrolled Sessions Lost It is RECOMMENDED that the benchmarks be measured and recorded at one-second intervals. 10. Optional - Change Configuration Set and/or Instability Conditions for next iteration 4.2 General Methodology with a Single Instability Condition **Objective** To benchmark the DUT under accelerated stress when there is a single instability conditions. Procedure 1. Report Configuration Set 2. Begin Startup Conditions with the DUT 3. Establish Configuration Sets with the DUT

- 4. Report Stability Benchmarks
- 5. Apply single Instability Condition
- 6. Report Instability Benchmarks
- 7. Stop applying all Instability Condition

- 8. Report Recovery Benchmarks
- 9. Optional Change Configuration Set and/or Instability Conditions for next iteration

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Expected Results

Ideally the Forwarding Rates, Latencies, and Session Counts will be measured to be the same at each phase. If no packet or session loss occurs then the Instability Conditions MAY be increased for a repeated iteration (step 10 of the procedure).

### 5. IANA Considerations

This document requires no IANA considerations.

### <u>6</u>. 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.

### 7. Normative References

- [1] Bradner, S., Editor, "Benchmarking Terminology for Network Interconnection Devices", <u>RFC 1242</u>, October 1991.
- [2] Mandeville, R., "Benchmarking Terminology for LAN Switching Devices", <u>RFC 2285</u>, October 1998.
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