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Scott Poretsky  
Reef Point Systems

Shankar Rao  
Qwest Communications

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**Methodology Guidelines for  
Accelerated Stress Benchmarking**  
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**ABSTRACT**

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 that the router be tested in these simultaneous operational conditions, which is known as Stress Testing. This document provides the Methodology Guidelines 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 [\[4\]](#). These guidelines can be used as the basis for additional methodology documents that benchmark specific network technologies under accelerated stress.

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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 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 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
  - b. Suboptimal CPU Utilization



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 [BCP 14](#), [RFC 2119](#) [6]. [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, this document is not a standards track document.

Terms related to Accelerated Stress Benchmarking are defined in [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 is reflective of 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.



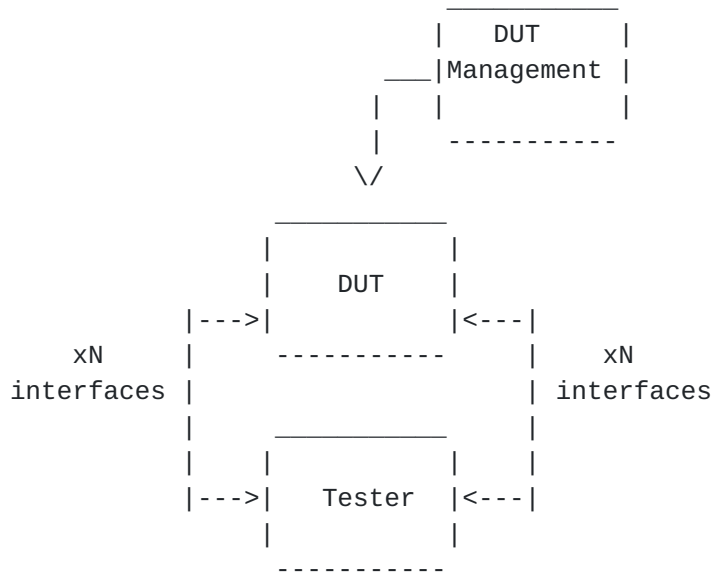


Figure 1. Physical Configuration

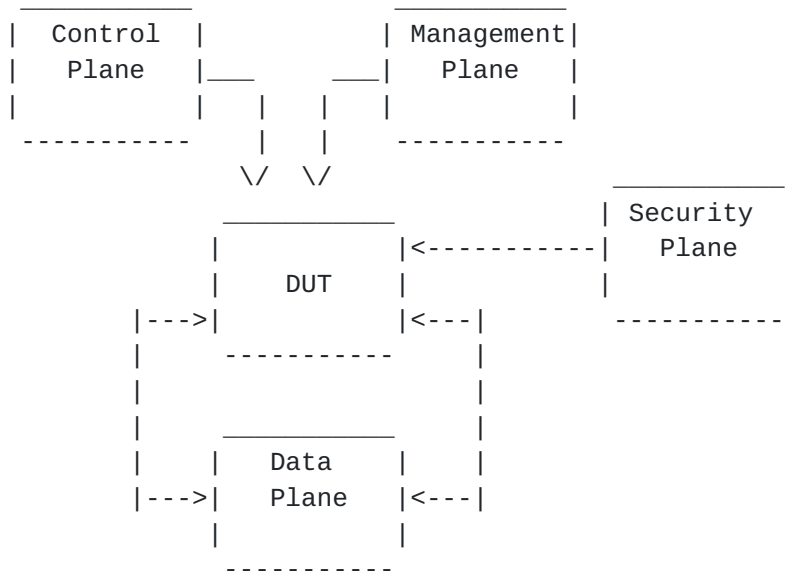


Figure 2. Logical Configuration

### 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.

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### 3.3.1 Configuration Sets

Configuration Sets may include and are not limited to the following examples.

#### Example Routing Protocol Configuration Set-

| PARAMETER                       | UNITS            |
|---------------------------------|------------------|
| BGP                             | Enabled/Disabled |
| Number of EBGPeers              | 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           |
| IGP                             | Enabled/Disabled |
| IGP-TE                          | Enabled/Disabled |
| Number of IGP Adjacencies       | Adjacencies      |
| Number of IGP Routes            | Routes           |
| Number of Nodes per Area        | Nodes            |

#### Example MPLS Protocol Configuration Set-

| PARAMETER                   | UNITS            |
|-----------------------------|------------------|
| MPLS-TE                     | Enabled/Disabled |
| Number of Ingress Tunnels   | Tunnels          |
| Number of Mid-Point Tunnels | Tunnels          |
| Number of Egress Tunnels    | Tunnels          |
| LDP                         | Enabled/Disabled |
| Number of Sessions          | Sessions         |
| Number of FECs              | FECs             |

#### Example Multicast Protocol Configuration Set-

| PARAMETER                  | UNITS            |
|----------------------------|------------------|
| PIM-SM                     | Enabled/Disabled |
| RP                         | Enabled/Disabled |
| Number of Multicast Groups | Groups           |
| MSDP                       | Enabled/Disabled |

#### Example Data Plane Configuration Set-

| PARAMETER                    | UNITS            |
|------------------------------|------------------|
| Traffic Forwarding           | Enabled/Disabled |
| Aggregate Offered Load       | bps (or pps)     |
| Number of Ingress Interfaces | number           |
| Number of Egress Interfaces  | number           |
| TRAFFIC PROFILE              |                  |
| Packet Size(s)               | bytes            |
| Offered Load (interface)     | array of bps     |
| Number of Flows              | number           |

Encapsulation(flow)

array of encapsulation type

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#### Management Configuration Set-

| PARAMETER                   | UNITS            |
|-----------------------------|------------------|
| SNMP GET Rate               | SNMP Gets/minute |
| Logging                     | Enabled/Disabled |
| Protocol Debug              | Enabled/Disabled |
| Telnet Rate                 | Sessions/Hour    |
| FTP Rate                    | Sessions/Hour    |
| Concurrent Telnet Sessions  | Sessions         |
| Concurrent FTP Session      | Sessions         |
| Packet Statistics Collector | Enabled/Disabled |
| Statistics Sampling Rate    | X:1 packets      |

#### Security Configuration Set -

| PARAMETER                           | UNITS            |
|-------------------------------------|------------------|
| Packet Filters                      | Enabled/Disabled |
| Number of Filters For-Me            | number           |
| Number of Filter Rules For-Me       | number           |
| Number of Traffic Filters           | number           |
| Number of Traffic Filter Rules      | number           |
| IPsec tunnels                       | number           |
| SSH                                 | Enabled/Disabled |
| Number of simultaneous SSH sessions | number           |
| RADIUS                              | Enabled/Disabled |
| TACACS                              | Enabled/Disabled |

#### 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      |
| BGP routes learned rate          | BGP Routes per Second    |
| 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 |
| BGP Session Flap Rate           | sessions per minute   |
| BGP Route Flap Rate             | routes per minutes    |
| IGP 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  
Filter Policy Changes  
SSH Session Restart  
Telnet Session Restart

tunnels per minute  
policies per hour  
SSH sessions per hour  
Telnet session per hour

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### 3.3.4 Benchmarks

Benchmarks are as defined in [1] and listed as follow:

| PARAMETER                               | UNITS    | PHASE       |
|---|----------|-------------|
| Stable Aggregate Forwarding Rate        | pps      | Startup     |
| Stable Latency                          | seconds  | Startup     |
| Stable Session Count                    | sessions | Startup     |
| Unstable Aggregate Forwarding Rate      | pps      | Instability |
| 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 Lost    | sessions | Recovery    |

## 4. Example Test Case 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

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] = IPv4

Encapsulation[5001.10000] = IPsec

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- Logging Enabled
- Protocol Debug Disabled
- SNMP Enabled
- SSH Enabled
- 20 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 Restart Rate = 10 sessions per hour
- FTP Restart Rate = 10 transfers per hour
- FTP Transfer Rate = 100 Mbps
- Statistics Sampling Rate = 1:1 packets

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

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. Normative References

- [1] Bradner, S., Editor, "Benchmarking Terminology for Network Interconnection Devices", [RFC 1242](#), July 1991.
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- [3] Bradner, S. and McQuaid, J., "Benchmarking Methodology for Network Interconnect Devices", [RFC 2544](#), March 1999.
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- [IEEECQR] "Router Stress Testing to Validate Readiness for Network Deployment", Scott Poretsky, IEEE CQR 2003.
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## 8. Author's Address

Scott Poretsky  
Reef Point Systems  
8 New England Executive Park  
Burlington, MA 01803  
USA  
Phone: + 1 781 395 5090  
EMail: sporetsky@reefpoint.com

Shankar Rao  
1801 California Street  
8th Floor  
Qwest Communications  
Denver, CO 80202  
USA  
Phone: + 1 303 437 6643  
Email: shankar.rao@qwest.com



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