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Scott Poretsky
Quarry Technologies

Brent Imhoff

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Terminology for Benchmarking IGP Data Plane Route Convergence

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Status of this Memo

ABSTRACT
This draft describes the terminology for benchmarking IGP Route Convergence as described in Applicability document [1] and Methodology document [2]. The methodology and terminology is to be used for benchmarking Route Convergence and can be applied to any link-state IGP such as ISIS [3] and OSPF [4]. The data plane is measured to obtain the convergence benchmarking metrics described in [2].

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1. Introduction

This draft describes the terminology for benchmarking IGP Route Convergence. The motivation and applicability for this benchmarking is provided in [1]. The methodology to be used for this benchmarking is described in [2]. The methodology and terminology to be used for benchmarking Route Convergence can be applied to any link-state IGP such as ISIS [3] and OSPF [4]. The data plane is measured to obtain black-box (externally observable) convergence benchmarking metrics. The purpose of this document is to introduce new terms required to complete execution of the IGP Route Convergence Methodology [2].

An example of Route Convergence as observed and measured from the data plane is shown in Figure 1. The graph in Figure 1 shows Forwarding Rate versus Time. Time 0 on the X-axis is on the far right of the graph. The components of the graph and metrics are defined in the Term Definitions section.

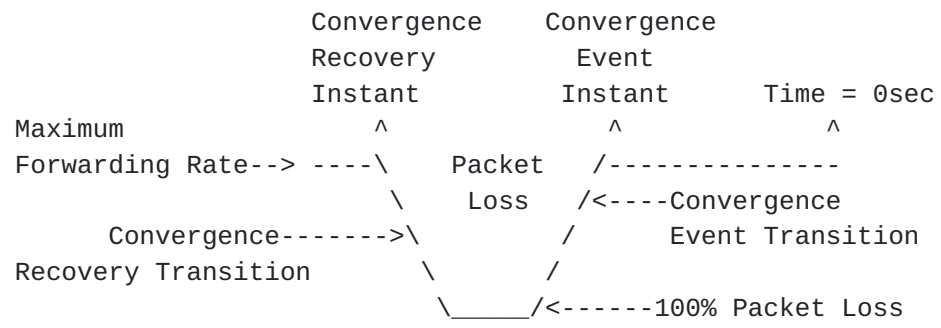

Figure 1. Convergence Graph

2. Existing definitions

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 Convergence Event

Definition:
The occurrence of a planned or unplanned action in the network that results in a change in the egress interface of the DUT for routed packets.

Discussion:
Convergence Events include link loss, routing protocol session loss, router failure, configuration change, and better next-hop learned via a routing protocol.

Measurement Units:
N/A

Issues:
None

See Also:
Convergence Packet Loss
Convergence Event Instant

3.2 Route Convergence

Definition:
Recovery from a Convergence Event indicated by the DUT forwarding rate equal to the offered load.

Discussion:
Route Convergence is the action of all components of the router being updated with the most recent route change(s) including the RIB and FIB, along with software and hardware tables. Route Convergence can be observed externally by the rerouting of data Traffic to a new egress interface.

Measurement Units:
N/A

Issues:
None

See Also:
Network Convergence
Full Convergence
Convergence Event

3.3 Network Convergence

Definition:
The completion of updating of all routing tables, including the FIB, in all routers throughout the network.

Discussion:
Network Convergence is bounded by the sum of Route Convergence for all routers in the network. Network Convergence can be determined by recovery of the forwarding rate to equal the offered load, no Stale Forwarding, and no blenders[5][6].

Measurement Units:
N/A

Issues:
None

See Also:
Route Convergence
Stale Forwarding

3.4 Full Convergence

Definition:
Route Convergence for an entire FIB.

Discussion:
When benchmarking convergence it is useful to measure the time to converge an entire route table. For example,

a Convergence Event can be produced for an OSPF table of 5000 routes so that the time to converge routes 1 through 5000 is measured.

Measurement Units:
N/A

Issues:
None

See Also:
Network Convergence
Route Convergence
Convergence Event

3.5 Convergence Packet Loss

Definition:
The amount of packet loss produced by a Convergence Event until Route Convergence occurs.

Discussion:
Packet loss can be observed as a reduction of forwarded traffic from the maximum forwarding rate. Convergence Packet Loss include packets that were lost and packets that were delayed due to buffering.

Measurement Units:
number of packets

Issues:
None

See Also:
Route Convergence
Convergence Event
Rate-Derived Convergence Time
Loss-Derived Convergence Time

3.6 Convergence Event Instant

Definition:
The time instant that a Convergence Event becomes observable in the data plane.

Discussion:
Convergence Event Instant is observable from the data plane as the precise time that the device under test begins to exhibit packet loss.

Measurement Units:
hh:mm:ss:uuu

Issues:
None

See Also:
Convergence Event
Convergence Packet Loss
Convergence Recovery Instant

3.7 Convergence Recovery Instant

Definition:
The time instant that Full Convergence is measured and maintained for at least an additional five seconds.

Discussion:
Convergence Recovery Instant is measurable from the data plane as the precise time that the device under test achieves Full Convergence. Convergence Recovery Instant is externally observable from the data plane when the forwarding rate on the Next-Best Egress Interface equals the offered rate.

Measurement Units:
hh:mm:ss:uuu

Issues:
None

See Also:
Convergence Packet Loss
Convergence Event Instant

3.8 Rate-Derived Convergence Time

Definition:
The amount of time for Convergence Packet Loss to persist upon occurrence of a Convergence Event until occurrence of Route Convergence.

Discussion:

Rate-Derived Convergence Time can be measured as the time difference from the Convergence Event Instant to the Convergence Recovery Instant, as shown with Equation 1.

(eq 1) Rate-Derived Convergence Time =
Convergence Recovery Instant - Convergence Event Instant.

Rate-Derived Convergence Time should be measured at the maximum forwarding rate. Failure to achieve Full Convergence results in a Rate-Derived Convergence Time benchmark of infinity.

Measurement Units:
seconds/milliseconds

Issues:
None

See Also:
Convergence Packet Loss
Convergence Recovery Instant
Convergence Event Instant
Full Convergence

3.9 Convergence Event Transition

Definition:
The characteristic of a router in which forwarding rate gradually reduces to zero after a Convergence Event.

Discussion:
The Convergence Event Transition is best observed for Full Convergence.

Measurement Units:
seconds/milliseconds

Issues:
None

See Also:
Convergence Event
Rate-Derived Convergence Time

Convergence Packet Loss
Convergence Recovery Transition

3.10 Convergence Recovery Transition

Definition:
The characteristic of a router in which forwarding rate gradually increases to equal the offered load.

Discussion:
The Convergence Recovery Transition is best observed for Full Convergence.

Measurement Units:
seconds/milliseconds

Issues:
None

See Also:
Full Convergence
Rate-Derived Convergence Time
Convergence Packet Loss
Convergence Event Transition

3.11 Loss-Derived Convergence Time

Definition:
The amount of time it takes for Route Convergence to to be achieved as calculated from the Convergence Packet Loss.

Discussion:
Loss-Derived Convergence Time can be calculated from Convergence Packet Loss that occurs due to a Convergence Event and Route Convergence, as shown with Equation 2.

(eq 2) Loss-Derived Convergence Time =
Convergence Packets Loss / Forwarding Rate

NOTE: Units for this measurement are
packets / packets/second = seconds

Measurement Units:
seconds/milliseconds

Issues:
Loss-Derived Convergence Time gives a better than actual result when converging many routes simultaneously. Rate-Derived Convergence Time takes the Convergence Recovery Transition into account, but Loss-Derived Convergence Time ignores the Route Convergence Recovery Transition because

it is obtained from the measured Convergence Packet Loss.
Ideally, the Convergence Event Transition and Convergence

Recovery Transition are instantaneous so that the
Rate-Derived Convergence Time = Loss-Derived Convergence Time.
However, router implementations are less than ideal.
For these reasons the preferred reporting benchmark for IGP
Route Convergence is the Rate-Derived Convergence Time.
Guidelines for reporting Loss-Derived Convergence Time are
provided in [2].

See Also:
Route Convergence
Convergence Packet Loss
Rate-Derived Convergence Time
Convergence Event Transition
Convergence Recovery Transition

3.12 Sustained Forwarding Convergence Time

Definition:
The amount of time for Route Convergence to be achieved for
cases in which there is no packet loss.

Discussion:
Sustained Forwarding Convergence Time is the IGP Route Convergence
benchmark to be used for Convergence Events that produce
a change in next-hop without packet loss.

Measurement Units:
seconds/milliseconds

Issues:
None

See Also:
Route Convergence
Rate-Derived Convergence Time
Loss-Derived Convergence Time

3.13 Restoration Convergence Time

Definition:
The amount of time for the router under test to restore
traffic to the original outbound port after recovery from
a Convergence Event.

Discussion:
Restoration Convergence Time is the amount of time to
Converge back to the original outbound port. This is achieved
by recovering from the Convergence Event, such as restoring
the failed link. Restoration Convergence Time is measured

using the Rate-Derived Convergence Time calculation technique, as provided in Equation 1. It is possible, but not desired

to have the Restoration Convergence Time differ from the Rate-Derived Convergence Time.

Measurement Units:
seconds or milliseconds

Issues:
None

See Also:
Convergence Event
Rate-Derived Convergence Time

3.14 Packet Sampling Interval

Definition:
The interval at which the tester (test equipment) polls to make measurements for arriving packet flows.

Discussion:
Metrics measured at the Packet Sampling Interval may include Forwarding Rate and Convergence Packet Loss.

Measurement Units:
seconds or milliseconds

Issues:
Packet Sampling Interval can influence the Convergence Graph. This is particularly true as implementations achieve Full Convergence in less than 1 second. The Convergence Event Transition and Convergence Recovery Transition can become exaggerated when the Packet Sampling Interval is too long. This will produce a larger than actual Rate-Derived Convergence Time. The recommended value for configuration of the Packet Sampling Interval is provided in [2].

See Also:
Convergence Packet Loss
Convergence Event Transition
Convergence Recovery Transition

3.15 Local Interface

Definition:
An interface on the DUT.

Discussion:
None

Measurement Units:
N/A

Issues:
None

See Also:
Neighbor Interface
Remote Interface

3.16 Neighbor Interface

Definition:
The interface on the neighbor router or tester that is directly linked to the DUT's Local Interface.

Discussion:
None

Measurement Units:
N/A

Issues:
None

See Also:
Local Interface
Remote Interface

3.17 Remote Interface

Definition:
An interface on a neighboring router that is not directly connected to any interface on the DUT.

Discussion:
None

Measurement Units:
N/A

Issues:
None

See Also:
Local Interface
Neighbor Interface

3.18 Preferred Egress Interface

Definition:
The outbound interface from the DUT for traffic routed to the

preferred next-hop.

Discussion:
Preferred Egress Interface is the egress interface prior to a Convergence Event

Measurement Units:
N/A

Issues:
None

See Also:
Next-Best Egress Interface

3.19 Next-Best Egress Interface

Definition:
The outbound interface from the DUT for traffic routed to the second-best next-hop.

Discussion:
Next-Best Egress Interface is the egress interface after a Convergence Event.

Measurement Units:
N/A

Issues:
None

See Also:
Preferred Egress Interface

3.20 Stale Forwarding

Definition:
Forwarding of traffic to route entries that no longer exist or to route entries with next-hops that are no longer preferred.

Discussion:
Stale Forwarding can be caused by a Convergence Event and is also known as a "black-hole" since it may produce packet loss. Stale Forwarding exists until Network Convergence is achieved.

Measurement Units:
N/A

Issues:
None

See Also:
Network Convergence

4. Security Considerations

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

5. References

[1] Poretsky, S., "Benchmarking Applicability for IGP Data Plane Route Convergence", draft-ietf-bmwg-igp-dataplane-conv-app-03, work in progress, July 2004.

[2] Poretsky, S., "Benchmarking Methodology for IGP Data Plane Route Convergence", draft-ietf-bmwg-igp-dataplane-conv-meth-03, work in progress, July 2004.

[3] Callon, R., "Use of OSI IS-IS for Routing in TCP/IP and Dual Environments", RFC 1195, December 1990.

[4] Moy, J., "OSPF Version 2", RFC 2328, IETF, April 1998.

[5] S. Casner, C. Alaettinoglu, and C. Kuan, "A Fine-Grained View of High Performance Networking", NANOG 22, May 2001.

[6] L. Ciavattone, A. Morton, and G. Ramachandran, "Standardized Active Measurements on a Tier 1 IP Backbone", IEEE Communications Magazine, pp90-97, June, 2003.

6. Author's Address

Scott Poretsky
Quarry Technologies
8 New England Executive Park
Burlington, MA 01803
USA
Phone: + 1 781 395 5090
EMail: sporetsky@quarrytech.com

Brent Imhoff
USA
EMail: bimhoff@planetspork.com

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