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Methodology for Forwarding Information Base (FIB) based Router Performance
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Abstract

The forwarding performance of an IP router is highly dependent on the information in its forwarding information base. This document

describes the methodology to be used to determine the IP packet forwarding performance of an IP router as a function of the routers ability to properly form and optimize its forwarding information base.

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 Error! Reference source not found..

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Introduction

This document covers the measurement of the IP packet forwarding performance of IP routers on the basis of the routers ability to properly form and optimize its forwarding information base (FIB). [FIB-TERM] describes the terminology associated with this document.

This version of the document describes a more general approach to the determination of router performance than previous versions. As a result, it is the intent of the authors that this document serves as a catalyst for further discussions concerning the approach outline in this draft. The purpose of this document is to describe a methodology for measuring the impact of FIB generation from a given routing information base (RIB) on the forwarding performance of a router. The objective is to determine whether a router can maintain performance levels as the RIB grows in size and complexity.

This document utilizes the methodology described in [METHOD] for measuring the FIB-dependent throughput, FIB-dependent latency and FIB-dependent frame loss rate of IP packets as they traverse the router under test. The forwarding performance of a router should be observed under different RIB sizes and compositions.

Terms of Reference

This document utilizes the methodologies for packet throughput, latency and loss measurements described in [METHOD].

Definitions unique to this test methodology are covered in [FIB-TERM].

The application of methodologies described in this document is not limited to IP forwarding; however, it is beyond the scope of this document to explicitly describe their application. In this document, use of the term IP is protocol version independent. Traffic, RIB and FIB may be IPv4, IPv6 or both.

1. Overview

The methodology described in this document is based on the precept that the FIB is formed from information in the RIB and, possibly, other configured variables. The methodology is independent of the particulars associated with populating the RIB or setting these variables; however, this SHOULD be done using routing protocols, e.g., OSPF [OSPF]. RIB and FIB contents MAY be determined either through observing traffic forwarding or management information base (MIB) queries. For completeness, this determination SHOULD be made using both. Generation of the FIB from the RIB based on three major components:

o Interface Identifier

o Route Optimization

o Routing Policies

The following three sub-sections describe these components and their effect on FIB generation.

1.1. Interface Identifier

The interface identifier entry in the FIB establishes the physical path for datagram forwarding. If the interface not active or down, the path is no longer available and the entry SHOULD be removed from the FIB. Descriptions of interface identifiers are contained in [MIB-BGP] and [MIB-OSPF].

1.2. Route Optimization

Route optimization seeks to minimize the overall effort on the part of the router to forward datagrams. Optimization has three basic components:

o Route Aggregation

o Route Flap Damping

o Route Metrics

Route aggregation seeks to minimize the number of entries in the FIB corresponding to a set of reachable address prefixes. These

prefixes could be contiguous or overlapping. Methods for route aggregation are described in [IDR].

Route flap damping seeks to minimize unnecessary re-generation of the FIB based on unstable routing information. Methods for route flap damping are described in [BGP-FLAP].

Route metrics assign a relative weight or merit to a particular routed path. Descriptions of these metrics are found in [MIB-BGP] and [MIB-OSPF].

1.3. Routing Policies

Routing policies are administrative restrictions or requirements on the FIB. The take three major forms:

o Access Control Lists

o Route Filters

o Static Routes

Access control lists can be used to explicitly allow or deny access to physical interfaces of network prefixes. This can be done either on the basis of individual protocol addresses or entire prefixes.

Route filters are a set of protocol addresses or prefixes against which a given route will be matched. The resulting action of a match will depend on the use of the route filter; however, it is usually an allow or deny action.

Static routes are lists of protocol addresses explicitly associated with a given interface. All datagrams with protocol addresses in these lists are automatically routed to the specified address.

2. Base Methodology

The test methodologies described in this document are grouped according to a hierarchy based on the effects of routing updates. This test hierarchy and nomenclature follow the ISO 9646 [ISO9646] formalism. The basic test hierarchy is:

1. Control Plane Group

a. Interface Identifier Group

b. Route Optimization Group

c. Routing Policies Group

2. Data Plane Group

a. Interface Identifier Group

b. Route Optimization Group

c. Routing Policies Group

Each test group or case MUST contain a test purpose. Test cases MUST specify the SUT state, series of stimuli to bring it to that state, stimulating datagram and expected datagram. All required field in all datagrams MUST be specified. Verdicts are PASS, FAIL and INCONCLUSIVE. All verdicts MUST have the associated responses explicitly specified. The entirety constitutes a test suite.

2.1. Verdict Definitions

- PASS û The required datagram was detected within the required time period.
- FAIL û The required datagram was not detected within the required time period.
- INCONCLUSIVE _ The SUT could not be brought into the specified state.

2.2. Basic Test Types

This methodology employees three basic test types:

- Route Addition
- Route Deletion
- Route Change

2.2.1. Route Addition

A route addition test case involves advertising a route to the SIT not contained in the RIB or FIB. The test case produces a PASS verdict when the advertised route is reflected in the SUTÆs processing of data and control plane datagrams.

2.2.2. Route Deletion

A route addition test case involves ceasing to advertise a route to the SIT contained in the RIB or FIB. The test case produces a PASS verdict when the deleted route is reflected in the SUTÆs processing of data and control plane datagrams.

2.2.3. Route Addition

A route addition test case involves advertising a route to the SIT contained in the RIB or FIB and associated with a different interface. The test case produces a PASS verdict when the advertised route is reflected in the SUTÆs processing of data and control plane datagrams.

2.3. Baseline Tests

Given a FIB in a steady state and populated to a specified percentage of its maximum size, a measure of the maximum throughput [RFC 1242] constitutes a baseline for all additional measurements.

3. Test Suite Definition

Test Suite Purpose: Determine the effect of route advertisements on the data and control plane responses of the SUT.

3.1. Control Plane Test Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages.

3.1.1. Interface Identifier Test Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages to the appropriate interface.

3.1.2. Route Optimization Test Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating route optimization.

3.1.2.1. Route Aggregation Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating route aggregation has been applied to FIB.

3.1.2.2. Route Flap Damping Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating route flap damping has been applied to FIB.

3.1.2.3. Route Metrics Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating route metrics have been applied to FIB.

3.1.3. Routing Policies Test Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages based on routing policies.

3.1.3.1. Access Control Lists Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating access control lists have been applied to FIB.

3.1.3.2. Route Filters Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages indicating route filters have been applied to FIB.

3.1.3.3. Static Routes Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates with the appropriate control plane messages static routes have been applied to FIB.

3.2. Data Plane Test Group

Test Group Purpose: Determine whether the SUT responds to route updates by appropriately handling IP datagrams.

3.2.1. Interface Identifier Test Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface.

3.2.2. Route Optimization Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface after the specified period of time.

3.2.2.1. Route Aggregation Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the aggregated appropriate interface.

3.2.2.2. Route Flap Damping Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface based on the damping period.

3.2.2.3. Route Metrics Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface.

3.2.3. Routing Policies Test Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface based on routing policies.

3.2.3.1. Access Control Lists Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface based on routing policies.

3.2.3.2. Route Filters Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface based on routing policies.

3.2.3.3. Static Routes Test Sub-Group

Test Group Purpose: Determine whether the SUT responds to route updates by routing data to the appropriate interface based on routing policies.

4. Security Considerations

As this document is solely for the purpose of providing performance methodologies and describes neither a protocol nor a protocol's implementation; therefore, there are no security considerations associated with this document.

5. Acknowledgments

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6. References

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