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Updates for the Back-to-back Frame Benchmark in RFC 2544  
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Abstract

Fundamental Benchmarking Methodologies for Network Interconnect Devices of interest to the IETF are defined in RFC 2544. This memo updates the provisions of the test to measure the Back-to-back frames Benchmark of RFC 2544, based on further experience.

This memo updates Section 26.4 of RFC 2544.

Requirements Language

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 [RFC2119].

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## 1. Introduction

The IETF's fundamental Benchmarking Methodologies are defined in[RFC2544], supported by the terms and definitions in [RFC1242], and [RFC2544] actually obsoletes an earlier specification, [RFC1944]. Over time, the benchmarking community has updated [RFC2544] several times, including the Device Reset Benchmark [RFC6201], and the important Applicability Statement [RFC6815] concerning use outside the Isolated Test Environment (ITE) required for accurate benchmarking. Other specifications implicitly update [RFC2544], such as the IPv6 Benchmarking Methodologies in [RFC5180].

Recent testing experience with the Back-to-back Frame test and Benchmark in Section 26.4 of [RFC2544] indicates that an update is warranted [OPNFV-2017] [VSPERF-b2b]. This memo describes the rationale and provides the updated method.

[RFC2544] provides its own Requirements Language consistent with [RFC2119], since [RFC1944] predates [RFC2119]. Thus, the requirements presented in this memo are expressed in [RFC2119] terms, and intended for those performing/reporting laboratory tests to improve clarity and repeatability, and for those designing devices that facilitate these tests.

## 2. Scope and Goals

The scope of this memo is to define an updated method to unambiguously perform tests, measure the benchmark(s), and report the results for Back-to-back Frames (presently described Section 26.4 of [RFC2544]).

The goal is to provide more efficient test procedures where possible, and to expand reporting with additional interpretation of the results.

[RFC2544] Benchmarks rely on test conditions with constant frame sizes, with the goal of understanding what network device capability has been tested. Tests with the smallest size stress the header processing capacity, and tests with the largest size stress the overall bit processing capacity. Tests with sizes in-between may determine the transition between these two capacities. However, conditions simultaneously sending multiple frame sizes, such as those described in [RFC6985], MUST NOT be used in Back-to-back Frame testing.

## 3. Motivation

Section 3.1 of [RFC1242] describes the rationale for the Back-to-back Frames Benchmark. To summarize, there are several reasons that devices on a network produce bursts of frames at the minimum allowed spacing, and it is therefore worthwhile to understand the Device Under Test (DUT) limit on the length of such bursts in practice. Also, [RFC1242] states:

"Tests of this parameter are intended to determine the extent of data buffering in the device."

After this test was defined, there have been occasional discussions of the stability and repeatability of the results, both over time and across labs. Fortunately, the Open Platform for Network Function Virtualization (OPNFV) VSPERF project's Continuous Integration (CI) testing routinely repeats Back-to-back Frame tests to verify that test functionality has been maintained through development of the test control programs. These tests were used as a basis to evaluate

stability and repeatability, even across lab set-ups when the test platform was migrated to new DUT hardware at the end of 2016.

When the VSPERF CI results were examined [VSPERF-b2b], several aspects of the results were considered notable:

1. Back-to-back Frame Benchmark was very consistent for some fixed frame sizes, and somewhat variable for others.
2. The Back-to-back Frame length reported for large frame sizes was unexpectedly long, and no explanation or measurement limit condition was indicated.
3. Calculation of the extent of buffer time in the DUT helped explain the results with all frame sizes (some frame sizes cannot exceed the frame header processing rate of the DUT, and therefore no buffering occurs).
4. It was observed that the actual buffer time in the DUT could be estimated using results from the Throughput tests conducted according to Section 26.1 of [RFC2544].

Further, if the Throughput tests of Section 26.1 of [RFC2544] are conducted as a pre-requisite test, the number of frame sizes required for Back-to-back Frame Benchmarking can be reduced to one or more of the small frame sizes, or results for large frame sizes can be noted as invalid in the results.

[VSPERF-b2b] provides the details of the calculation to estimate the actual buffer time available in the DUT, using results from the Throughput tests for each frame size, and the maximum theoretical frame rate for the DUT links (which constrain the minimum frame spacing).

#### 4. Pre-Requisites

The Test Setup MUST be consistent with Figure 1 of [RFC2544], or Figure 2 when the tester's sender and receiver are different devices. Other mandatory testing aspects described in [RFC2544] MUST be included, unless explicitly modified in the next section.

The ingress and egress link speeds and link layer protocols MUST be specified and used to compute the maximum theoretical frame rate when respecting the minimum inter-frame gap.

The test results for the Throughput Benchmark conducted according to Section 26.1 of [RFC2544] for all [RFC2544]-RECOMMENDED frame sizes MUST be available to reduce the tested frame size list, or to note

invalid results for individual frame sizes (because the burst length may be infinite for large frame sizes).

Note that:

- o the Throughput and the Back-to-back Frame measurement configuration traffic characteristics (unidirectional or bi-directional) MUST match.
- o the Throughput measurement MUST be under zero-loss conditions, according to Section 26.1 of [RFC2544].

The Back-to-back Benchmark described in Section 3.1 of [RFC1242] MUST be measured directly by the tester. Additional measurement requirements are described below in Section 5.

## 5. Back-to-back Frames

Objective: To characterize the ability of a DUT to process back-to-back frames as defined in [RFC1242].

The Procedure follows.

### 5.1. Preparing the list of Frame sizes

From the list of RECOMMENDED Frame sizes (Section 9 of [RFC2544]), select the subset of Frame sizes whose measured Throughput was less than the maximum theoretical Frame Rate. Only these Frame sizes make it possible to produce a burst of frames that cause the DUT buffers to fill and eventually overflow, producing one or more discarded frames.

### 5.2. Test for a Single Frame Size

Each trial in the test requires the tester to send a burst of frames (after idle time) with the minimum inter-frame gap, and to count the frames forwarded by the DUT.

The duration of the trial MUST be at least 2 seconds, to allow DUT buffers to deplete.

If all frames have been received, the tester increases the length of the burst and performs another trial.

If the received frame count is less than the number of frames in the burst, then the limit of DUT processing and buffering may have been exceeded, and the burst length is reduced for the next trial.

@@@ Should a particular search algorithm be included?

The Back-to-back Frame value is the longest burst of frames that the DUT can successfully process and buffer without frame loss, as determined from the series of trials. The tester may impose a (configurable) minimum step size for burst length, and the step size MUST be reported with the results (as this influences the accuracy and variation of test results).

### 5.3. Test Repetition

The test MUST be repeated N times for each frame size in the subset list, and each Back-to-back Frame value made available for further processing (below).

### 5.4. Benchmark Calculations

For each Frame size, calculate the following summary statistics for Back-to-back Frame values over the N tests:

- o Average (Benchmark)
- o Minimum
- o Maximum
- o Standard Deviation

Further, calculate the Implied DUT Buffer Time and the Corrected DUT Buffer Time in seconds, as follows:

Implied DUT Buffer Time =

Average Back-to-back Frames / Max Theoretical Frame Rate

Corrected DUT Buffer Time =

Implied DUT Buffer Time \*  $\frac{\text{Measured Throughput}}{\text{Max Theoretical Frame Rate}}$

## 6. Reporting

The back-to-back results SHOULD be reported in the format of a table with a row for each of the tested frame sizes. There SHOULD be columns for the frame size and for the resultant average frame count for each type of data stream tested.

The number of tests Averaged for the Benchmark, N, MUST be reported.

The Minimum, Maximum, and Standard Deviation across all complete tests SHOULD also be reported.

The Corrected DUT Buffer Time SHOULD also be reported.

If the tester operates using a maximum burst length in frames, then this maximum length SHOULD be reported.

Frame Size, octets	Ave B2B Length, frames	Min,Max,StdDev	Corrected Buff Time, Sec
64	26000	25500,27000,20	0.00004

#### Back-to-Back Frame Results

Static and configuration parameters:

Number of test repetitions, N

Minimum Step Size (during searches), in frames.

#### 7. Security Considerations

Benchmarking activities as described in this memo are limited to technology characterization using controlled stimuli in a laboratory environment, with dedicated address space and the other constraints [RFC2544].

The benchmarking network topology will be an independent test setup and MUST NOT be connected to devices that may forward the test traffic into a production network, or misroute traffic to the test management network.

Further, benchmarking is performed on a "black-box" basis, relying solely on measurements observable external to the DUT/SUT.

Special capabilities SHOULD NOT exist in the DUT/SUT specifically for benchmarking purposes. Any implications for network security arising from the DUT/SUT SHOULD be identical in the lab and in production networks.

## 8. IANA Considerations

This memo makes no requests of IANA.

## 9. Acknowledgements

Thanks to Trevor Cooper, Sridhar Rao, and Martin Klokik of the VSPERF project for many contributions to the testing [VSPERF-b2b].

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