Benchmarking Methodology for IPv6 Transition Technologies
draft-georgescu-bmwg-ipv6-tran-tech-benchmarking-01

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23 Jul. 2015
DRAFT OVERVIEW

- RFC2544\textsuperscript{1} and RFC5180\textsuperscript{2} address both IPv4 and IPv6 performance benchmarking, but IPv6 transition technologies are outside their scope.

- This draft provides complementary guidelines for evaluating the performance of IPv6 transition technologies.
  - generic classification on IPv6 transition technologies $\rightarrow$ associated test setups
  - calculation formula for the maximum frame rate according to the frame size overhead

- Includes a tentative metric for benchmarking scalability
  - scalability as performance degradation under the stress of multiple network flows

- Proposes supplementary benchmarking tests for stateful IPv6 transition technologies in accordance with RFC3511\textsuperscript{3}


Production networks generic design

- Customer Edge (CE) segment
- Core network segment
- Provider Edge (PE) segment
**IPv6 transition technologies generic categories**

1. **Single-stack**: either IPv4 or IPv6 is used to traverse the core network and translation is used at one of the edges.

2. **Dual-stack**: the core network devices implement both IP protocols.

3. **Encapsulation-based**: an encapsulation mechanism is used to traverse the core network; CE nodes encapsulate the IPvX packets in IPvY packets, while PE nodes are responsible for the decapsulation process.

4. **Translation-based**: a translation mechanism is employed for the traversal of the network core; CE nodes translate IPvX packets to IPvY packets and PE nodes translate the packets back to IPvX.
TEST ENVIRONMENT SETUP

Single-stack transition technologies

```
+-----------------------------+
|                            |
+-----------------------------+
| IPvX tester IPvY            |
|                            |
+-----------------------------+
| (translator)                |
+-----------------------------+
+-----------------------------+
|                            |
+-----------------------------+
| IPvX DUT IPvY               |
| (translator)                |
+-----------------------------+
```
Test environment setup (contd.)

Encapsulation/Translation-based transition technologies

```
+---------------------------------+ 
|                                 | IPvX tester IPvX|<------------------| 
|                                 +-------------------| 
|                                 |                    | 
| +--------------------------------+
|                                 |
|                                 |
|                                 +-------------------|
|                                 |                    |
| +--------------------------------+
|                                 |
|                                 |
| +--------------------------------+
|                                 |
|                                 |
| +--------------------------------+
|                                 |
+---------------------------------+ 
|                                 |
```

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EMPIRICAL RESULTS

SCALABILITY BENCHMARKING

Benchmarking Scalability through **performance degradation**

**Objective**: To quantify the performance degradation introduced by n parallel network flows.

**Procedure**: First the benchmarking tests have to be performed for one network flow. The same tests have to be repeated for n-network flows. The performance degradation of the X benchmarking dimension SHOULD be calculated as relative performance change between the 1-flow results and the n-flow results, using the following formula:

**Reporting format**: relative performance change between the 1-flow results $x_1$ and the n-flow results $x_n$

$$X_{pd} = \frac{x_n - x_1}{x_1} \times 100 \quad (1)$$
SCALABILITY TEST SETUP

Single-stack transition technologies

```
+-------------------------+
| +--------|NF1|<--------+
| | NF2 tester NF2|<-------+ |
| | ...| | | |
| | NFn NFn|<---+ | |
| | +-------------------------+ | | |
| | | | |
| | +->|NFn|----+ | |
| | ... DUT | | |
| +------->|NF2 (translator) NF2|--------+ |
+---------->|NF1 NF1|-----------+
+-------------------------+
```
SCALABILITY TEST SETUP (CONTD.)
Encapsulation/Translation-based transition technologies

+-------------------------+
|                        |                        +-------------------------+
|                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        |                        |                        +-------------------------+
|                        |                        |                        |                        |                        |                        |                        |                        |                        +-------------------------+

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SCALABILITY EMPIRICAL RESULTS

Throughput UDP (Mbps) vs Frame size (bytes)

asamape
asamape10

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Update 01 Overview

- Recommended dynamic routing as the only option for the test setups
- Added benchmarking tests for Packet Delay variation
  - SHOULD measure PDV as defined by RFC5481
  - MAY measure IPDV as defined by RFC5481

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Update: Routing Recommendations

Text modified in Section 3:

For the test setups presented in this memo dynamic routing SHOULD be employed. However, the presence of routing and management frames can represent unwanted background data that can affect the benchmarking result. To that end, the procedures defined in [RFC2544] (Sections 11.2 and 11.3) related to routing and management frames SHOULD be used here as well. Moreover, the “Trial description” recommendations presented in [RFC2544] (Section 23) are valid for this memo as well.

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6 following the comment from Scott Bradner.
UPDATE: PACKET DELAY VARIATION - CALCULATION FORMULA

Metric 1: Packet Delay Variation (PDV) - Formula

\[ PDV_i = D_i - D_{\text{min}} \]
\[ D_i - \text{One-Way-Delay of } i\text{-th frame} \]
\[ D_{\text{min}} - \text{The minimum One-Way-Delay of the frame stream} \]  

Metric 2: Inter Packet Delay Variation (IPDV) - Formula

\[ IPDV_i = D_i - D_{i-1} \]
\[ D_i - \text{One-Way-Delay of } i\text{ th frame} \]
\[ D_{i-1} - \text{The One-Way-Delay of the } i\text{-1 th frame} \]  

\footnote{following the comments from Al Morton and Bhuvan Vengainathan and the discussion in IETF92.}
UPDATE: PACKET DELAY VARIATION - SUMMARIZATION

Metric1: Packet Delay Variation (PDV) - Single number summarization

\[ PDV = \text{Avg}(D_i - D_{\text{min}}) \]

- \( D_i \) - One-Way-Delay of i-th frame
- \( D_{\text{min}} \) - The minimum One-Way-Delay of the frame stream

(4)

Metric2: Inter Packet Delay Variation (IPDV) - 3 numbers summarization

\[ IPDV_{\text{min}} = \text{Min}(D_i - D_{i-1}) \]
\[ IPDV_{\text{avg}} = \text{Avg}(D_i - D_{i-1}) \]
\[ IPDV_{\text{max}} = \text{Max}(D_i - D_{i-1}) \]

(5)
UPDATE: ERROR EXPRESSION

Margin of Error (MoE) expression

\[ MoE = z_{\alpha/2} \frac{\sigma}{\sqrt{n}} \]

\( \sigma \) - standard deviation, \( n \) - sample size
\( z_{\alpha/2} \) - critical value
\( z_{\alpha/2} = 2.576 \) for 99% level of confidence

(6)
COMMENTS NOT COVERED YET

- The comment from Nalini Elkins related to DNS resolution
  - *Still Considering a DNS Resolution Performance metric: Number of processed DNS requests/sec*\(^7\)
  - Planning to include it in *version 02* feat. Prof. Gábor Lencse [RG profile link]

- Many comments received from Al Morton on the ML
  - Planning to address them in *version 02*

Next steps

- Propose solutions for DNS Resolution Performance
- Continue the revisions

★ Question for BMWG:
- Were the comments covered well enough?
- How adoption-ready is the draft?
Contact

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