IPv6 Transition Technologies Benchmarking Methodology

draft-georgescu-ipv6-transition-tech-benchmarking-00

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IPv6 TRANSITION

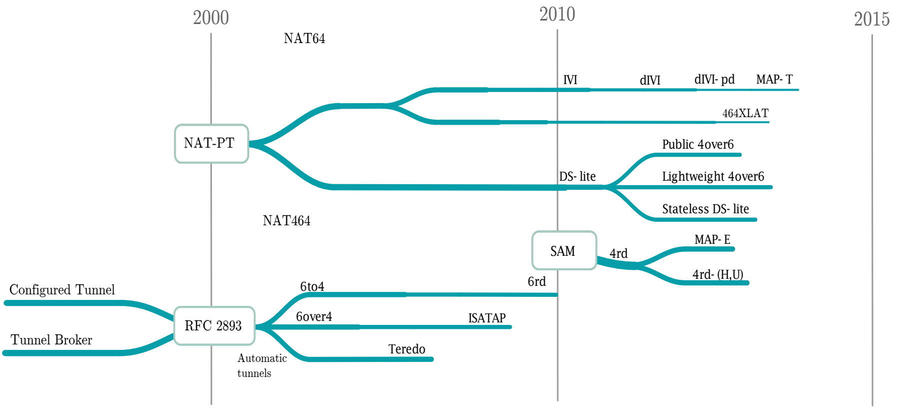
- IPv6 is not backwards compatible
- The Internet will undergo a period through which both protocols will coexist
- Currently only 2 % of worldwide Internet users have IPv6 connectivity [1]

[2]

[1] APNIC. *IPv6 measurements for The World*. Asia-Pacific Network Information Centre, Oct. 2014. URL: http://labs.apnic.net/ipv6-measurement/Regions/.

[2] **Original drawing by Andrew Bell @ www.creaturesinmyhead.com** .

IPv6 transition technologies evolution



[3]

[3] inspired by the APNIC35 presentation "The evolution of IPv6 transition technologies" by Jouni Korhonen.

Draft contribution

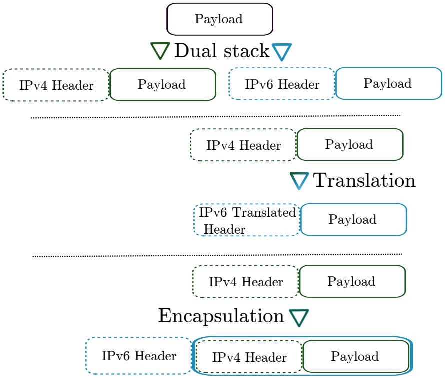
- RFC2544[4]and RFC5180[5]address both IPv4 and IPv6 performance benchmarking, but IPv6 transition technologies are outside their scope
- This draft provides complementary guidelines for evaluating the performance of IPv6 transition technologies
  - generic classification on IPv6 transition technologies → 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*

[6] S. Bradner and J. McQuaid. *Benchmarking Methodology for Network Interconnect Devices*. United States, 1999.

[7] A. Hamza C. Popoviciu, G. Van de Velde, and D. Dugatkin. *IPv6 Benchmarking Methodology for Network Interconnect Devices*. RFC 5180. Internet Engineering Task Force, 2008.

Basic transition technologies

- Dual Stack [8]
  - Host side and edge nodes
  - A base for other transition technologies
- Translation
  - Achieves direct communication
  - Breaks the end-to-end model
- Tunneling
  - heterogeneous environments traversal

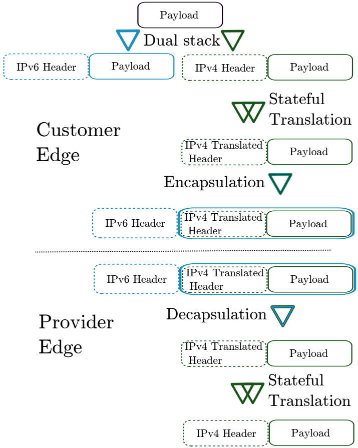


[8] E. Nordmark and R. Gilligan. *Basic Transition Mechanisms for IPv6 Hosts and Routers*. RFC 4213 (Proposed Standard). Internet Engineering Task Force, Oct. 2005. URL: `http://www.ietf.org/rfc/rfc4213.txt`.

MAP

Mapping of Address and Port with Encapsulation [9] building blocks:

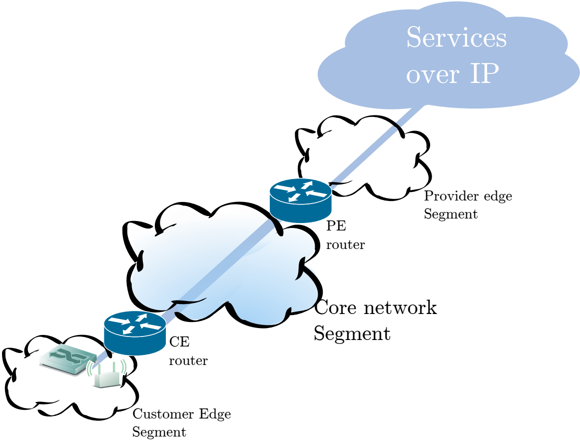
- MAP domain
- Customer Edge (CE) router
- Boarder Relay (BR) router
- MAP rule
  - IPv4 prefix
  - IPv6 prefix
  - Embedded Address (EA) bits



[9] O. Troan et al. *Mapping of Address and Port with Encapsulation (MAP)*. draft-ietf-softwire-map-10. Internet Engineering Task Force, Jan. 2014. URL: `http://tools.ietf.org/html/draft-ietf-softwire-map-10`.

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

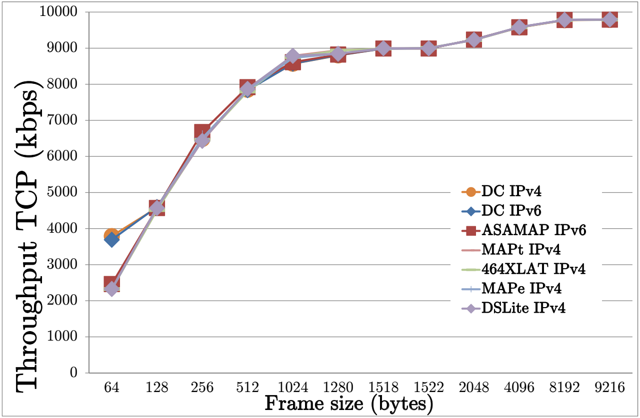
```
             +---------------------+
             |                     |
+------------|IPvX   tester    IPvY|<-------------+
|            |                     |              |
|            +---------------------+              |
|                                                 |
|            +---------------------+              |
|            |                     |              |
+----------->|IPvX     DUT     IPvY|--------------+
             |     (translator)    |
             +---------------------+
```

Test environment setup (contd.)

Encapsulation/Translation-based transition technologies

```
                      +---------------------+
                      |                     |
+---------------------|IPvX   tester    IPvX|<--------------------+
|                     |                     |                     |
|                     +---------------------+                     |
|                                                                 |
|      +---------------------+      +---------------------+      |
|      |                     |      |                     |      |
+----->|IPvX    DUT CE   IPvY|----->|IPvY   DUT PE    IPvX|------+
       |    trans/encaps     |      |    trans/decaps     |
       +---------------------+      +---------------------+
```

EMPIRICAL RESULTS



[10]

[10] M. Georgescu et al. "Empirical analysis of IPv6 transition technologies using the IPv6 Network Evaluation Testbed". In: *9th International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities*. Guangzhou, China, 2014.

Frame size overhead - Ethernet

- **X** - frame size
- **O** - the frame size overhead created by the encapsulation or the translation process

The maximum theoretical frame rate for Ethernet

$$FR_{max} = \frac{LineRate(bps)}{(8bits/byte)*(\mathbf{X}+\mathbf{O}+20)bytes/frame} \quad (1)$$

Example for 6in4[11] and 10Mb/s Ethernet in the case of 64byte frames

$$\frac{10{,}000{,}000(bps)}{(8bits/byte)*(\mathbf{64}+\mathbf{20}+20)bytes/frame} = 12,019\ fps \quad (2)$$

[10] Nordmark and Gilligan, see n. 8.

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

$$X_{pd} = \frac{x_n - x_1}{x_1} \times 100 \qquad (3)$$

SCALABILITY TEST SETUP

Single-stack transition technologies

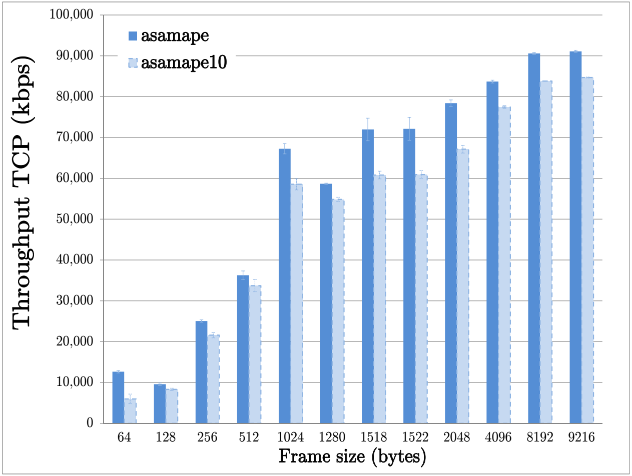
```
            +-------------------------+
+-----------|NF1                   NF1|<----------+
|  +--------|NF2      tester       NF2|<-------+  |
|  |     ...|                         |        |  |
|  |   +----|NFn                   NFn|<---+   |  |
|  |   |    +-------------------------+    |   |  |
|  |   |                                   |   |  |
|  |   |    +-------------------------+    |   |  |
|  |   +--->|NFn                   NFn|----+   |  |
|  |     ...|           DUT           |        |  |
|  +------->|NF2    (translator)   NF2|--------+  |
+---------->|NF1                   NF1|-----------+
            +-------------------------+
```

Scalability test setup (contd.)

Encapsulation/Translation-based transition technologies

```
                  +-------------------------+
+-----------------|NF1                   NF1|<---------------+
|  +--------------|NF2      tester       NF2|<-----------+   |
|  |           ...|                         |            |   |
|  |   +----------|NFn                   NFn|<--------+  |   |
|  |   |          +-------------------------+         |  |   |
|  |   |                                              |  |   |
|  |   |    +-----------------+    +--------------+   |  |   |
|  |   +--->|NFn  DUT CEn  NFn|--->|NFn        NFn|---+  |   |
|  |        +-----------------+    |              |      |   |
|  |     ...                       |              |      |   |
|  |        +-----------------+    |    DUT PE    |      |   |
|  +------->|NF2  DUT CE2  NF2|--->|NF2        NF2|------+   |
|           +-----------------+    |              |          |
|           +-----------------+    |              |          |
+---------->|NF1  DUT CE1  NF1|--->|NF1        NF1|----------+
            +-----------------+    +--------------+
```

Scalability empirical results



Next steps

- Continue revising the draft according to received comments in IETF91
- Feedback in general would be very much appreciated, an in particular:
  - Section 1.1 - IPv6 transition technologies generic classification
  - Section 7 - Scalability benchmarking
- Is the draft ready to be adopted as BMWG draft ?

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