Chair of Network Architectures and Services
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Revisiting Benchmarking Methodology for Interconnect Devices

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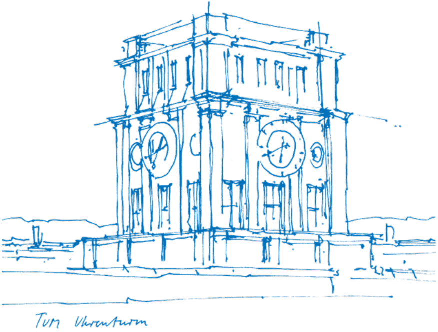
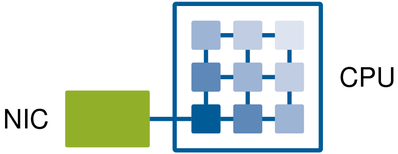
July 16, 2016



Contents

Why to revisit benchmarking state of the art?

- Numerous standards, recommendations, best practices
  - Well-known benchmarking definition RFC 2544
  - Various extensions
  - Divergence of benchmarks
- New class of devices
  - High speed network IO frameworks
  - Virtual switching
  - Many core CPU architectures:

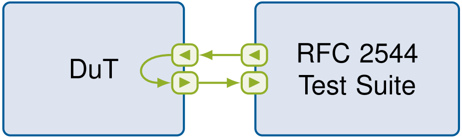


Common metrics

- Throughput: highest rate that the devices under test (DuT) can serve without loss.
- Back-to-Back frame burst size: longest duration (in frames) without loss.
- Frame loss rate: percentage of dropped frames under a given load.
- Latency: average duration a packet stays within the DuT.

- … extended metrics, e.g., FIB-dependent performance
- … additional SHOULDs, rarely measured

Case study: RFC 2544 benchmarks

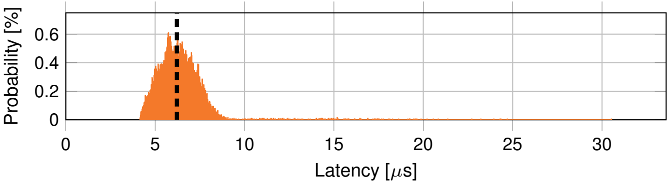


Three different DuTs

- Linux router
- FreeBSD router
- MikroTik router

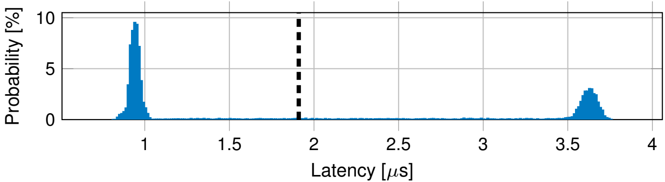
Flaws of benchmarks: selected examples

Meaningful latency measurements: case study



- FreeBSD, 64-byte packets
- Average does not reflect long tail distribution

Meaningful latency measurements: 2nd example

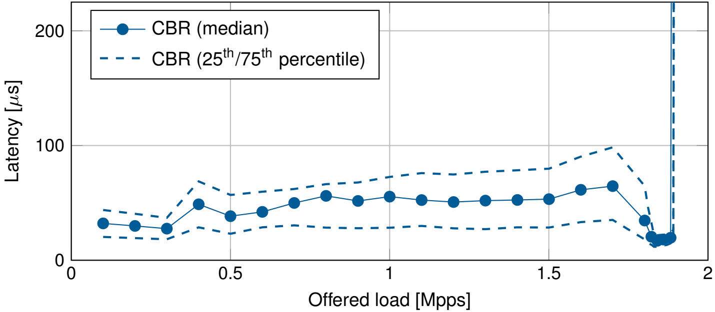


- Pica8 switch tested in [IFIP NETWORKING 16]
- Different processing paths through a device
- Bimodal distribution
- Average latency is misleading

→ Extensive reports: histograms for visualization

→ Short reports: percentiles (25th, 50th, 75th, 95th, 99th, and 99.9th)

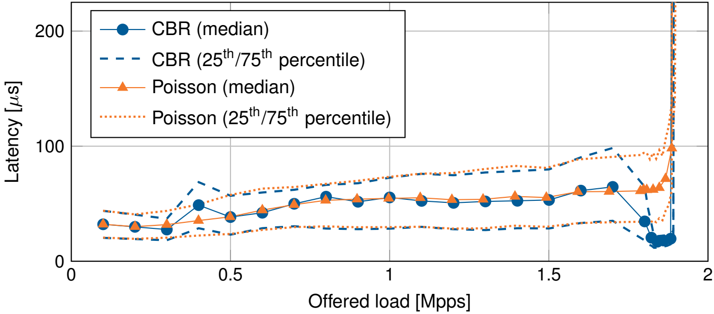
Latency under load



- Open vSwitch (Linux NAPI & ixgbe) [IMC15]
- Latency at maximum throughput is not worst case

→ Measurements at different loads (10, 20, ..., 100% max. throughput)

Traffic pattern & latency

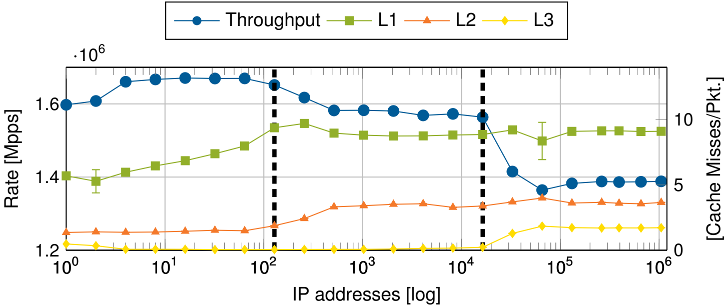


- Open vSwitch (NAPI + ixgbe) [IMC15]
- Different behavior for different traffic patterns

→ Tests with different traffic patterns

→ Poisson process to approximate real world traffic

Omitted tests



- CPU caches affect the performance

→ Additional tests for certain device classes

→ Functionality dependent tests

Reproducibility of configurations

- Manual device configuration is error prone
- Device configuration is hard to reproduce

→ Reproducible configuration of DuT via scripts

→ Configuration scripts executed by benchmarking tool

Conclusion

- Novel class of devices requires additional tests
- There are arguments for reconsidering best practice:
  - Average latency may be misleading
    $\rightarrow$ Histograms / percentiles
  - Latency is load dependent
    $\rightarrow$ Measure 10, 20, ..., 100% of max. throughput
  - CBR traffic is a unrealistic test pattern
    $\rightarrow$ Poisson process
  - Device specific functionality
    $\rightarrow$ Perform device specific benchmarks
  - Manual configuration is error prone
    $\rightarrow$ Automatic configuration by benchmark tool

Novelty: RFC 2544 test suite on commodity hardware

- MoonGen [IMC15] is a fast software packet generator
- Hardware-assisted latency measurements (misusing PTP support)
- Precise software rate control and traffic patterns

- http://net.in.tum.de/pub/router-benchmarking/
- RFC 2544 benchmark reports for Linux, FreeBSD, and MikroTik
- Early version of the MoonGen RFC 2544 module