Test on Forwarding Latency v.s Queuing Length

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Motivation

- In order to figure out:
  - How buffer queuing affects the performance of latency-sensitive apps
  - How queuing feedback/control mechanisms in various layers can help
- We need to understand
  - How the switch's buffer queuing contributes to the E2E latency
- The test uses commercial products
  - We use COTS switches instead of simulation

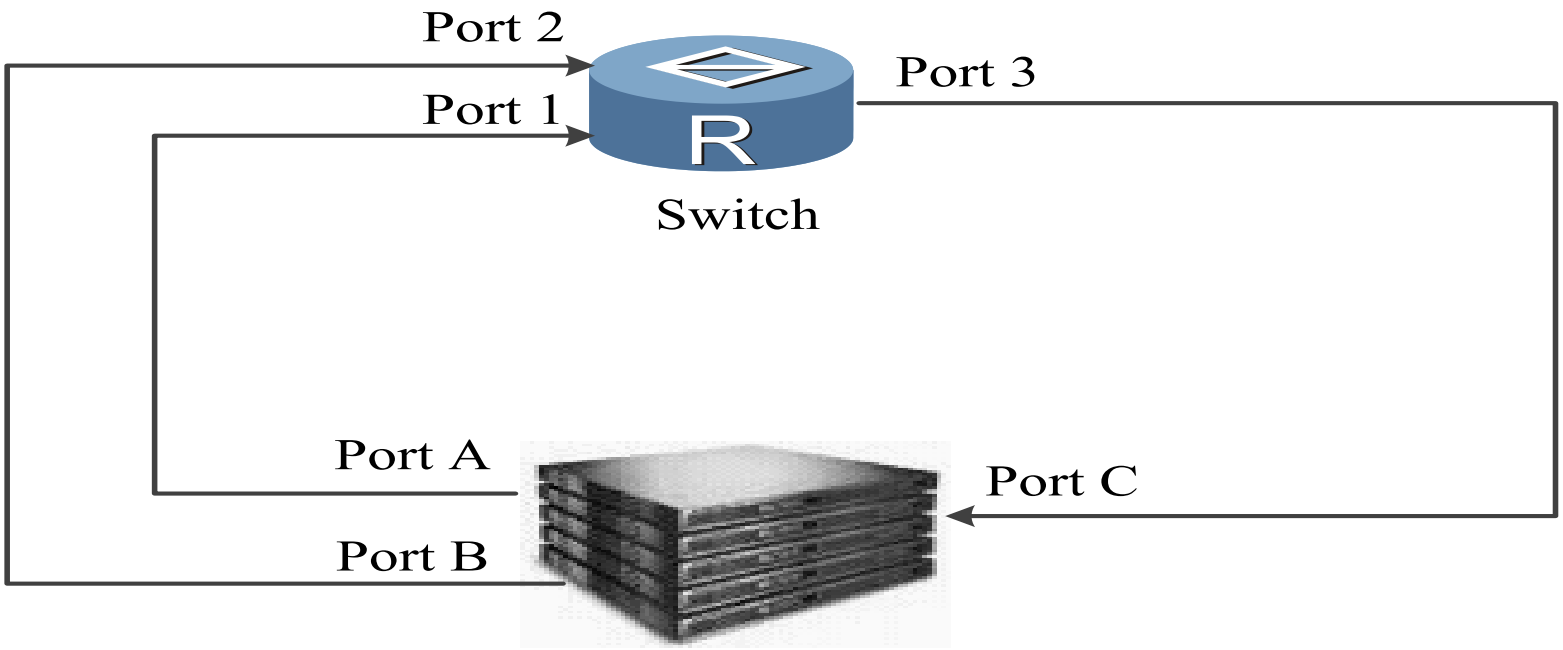
Measurement Goals

- The E2E latency consists of:
  - Propagation latency on the wire
  - Forwarding latency at the switch
  - Transceiving latency at both end points
- In physical DCs, forwarding latency dominates the E2E latency
- In virtual DCs, transceiving latency may become another major contributor of E2E latency
- In this draft, we focus on forwarding latency test

Test Setup

- DUT and test device:
  - ToR switch
  - Spirent TesterCenter
- Test Procedure
  - 1) Investigate buffer configuration of the switch
    - Switch buffer size
    - How the buffer space is shared
  - 2) Switch forwarding delay without packet loss
    - Enabling a tail drop feature on a queue
    - Configured consumption ratio (i.e. the buffer(%))
    - Test no-packet-loss forwarding delay of the switch

Test Topology



Port A→Port C: RFC 2544 TestSuit Port B→Port C : RFC 2544 TestSuit

Traffic load per port : from 49.8% to 50.2%, step 0.1% (5 rounds)

Switch Port configuration: no QoS class, no priority queue, directly discarding packet beyond the buffer(%) threshold

Switch buffer size

- Goal: Investigate the switch buffer size
- Test pattern
  - Port A→Port C: RFC 2544 TestSuit back-to-back frame test,
    Port B→Port C: RFC 2544 TestSuit back-to-back frame test,
  - Use 512-byte packets and 1024-byte packets to do the test
  - Set the buffer threshold to 50% and 100%
- Test Result
  - 50% buffer: 512-byte 3116 frames, 1024-byte 1502 frames
  - 100% buffer: 512-byte 6398 frames, 1024-byte 3116 frames
- Observation: buffer (%) configuration is working and packets of different sizes share the same queue

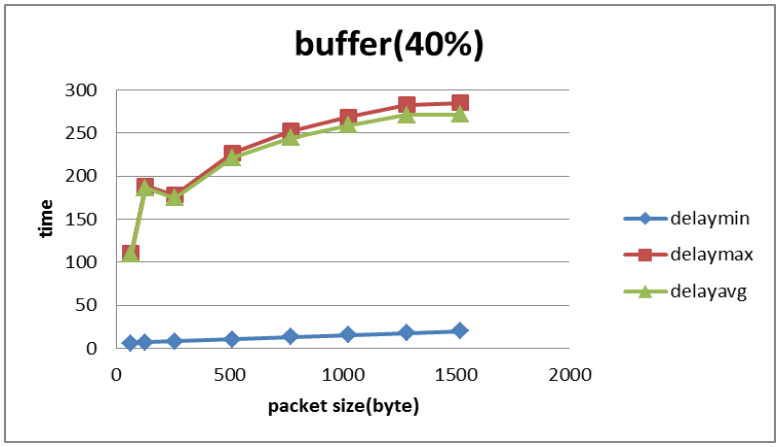
Switch Forwarding delay

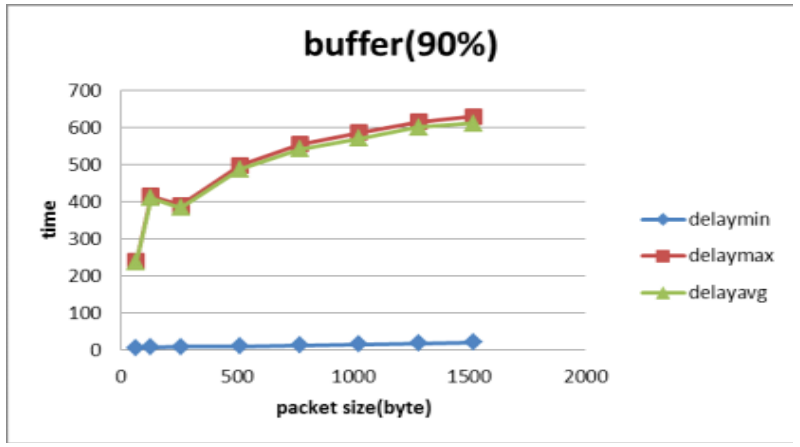
- Goal: Investigate the relation between forwarding delay and the buffer threshold
- Test Setup
  - Port A→Port C: RFC 2544 TestSuit back-to-back latency test,
    Port B→Port C : RFC 2544 TestSuit back-to-back latency test,
  - Use 64,128,256,512,1024,1280 and 1518 byte to do tests
  - Set the buffer threshold to 1%, 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%

Test Result

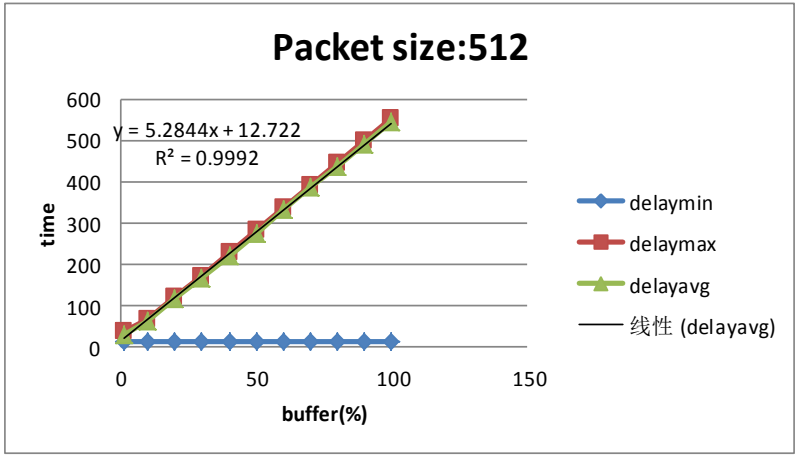
- The data were analyzed by univariate analysis first, and then by using linear regression model, we did the multivariate analysis.
- In this way, we found out that
  - when we considered the packet size and the buffer(%) as the independent variable,
  - the minimum delay time shown different relations with the variants under observation,
  - while the maximum delay time and the average delay time share very similar features.

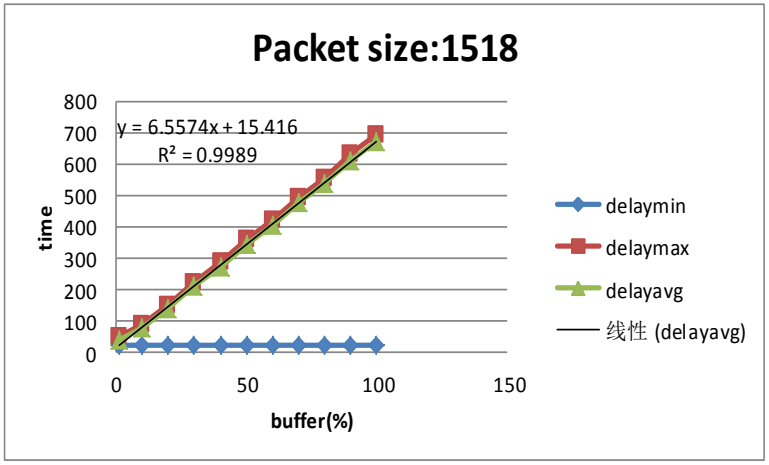
Test Result Analysis:





delay vs packet_size





delay vs buffer(%)

The Minimum Delay:

- Observation 1: when buffer(%) is fixed, the delay increases linearly with the packet size.

- Observation 2: When packet size is fixed, the buffer(%) seems has no influence on the minimum delay time.

The Maximum/Average Delay:

- Observation 1: Both the maximum and average delay have similar tendency and values.
- Observation 2: When buffer(%) is fixed, with increasing packet size, delay will also increase.
  - the maximum and average delay time have a nonlinear relationship with the packet size.
- Observation 3: When packet size is fixed, maximum and average delay increase linearly with the buffer(%).

Future work

- Test and analyze on other access switches and aggregate switches.
- Topology with multiple switches.
- Test the RTT for TCP data flow, and analyze the relationshipp between the forwarding delay and TCP RTT.

Thanks