Using Loss Pairs to Discover Network Properties

Jun Liu and Mark Crovella

Presented by: Antonio Augusto Rocha (Guto)
Motivation

- Methods for discovering network-intenal characteristics at endpoints are increasingly valuable

- Previous work has focused on:
  - Estimating bottleneck bandwidth
  - Estimating per-link bandwidth, latency, and loss

- Some others resources have not been studied:
  - The amount of buffer present in the bottleneck
  - Packet dropping scheme

- Useful information:
  - To configure simulations
  - To adapt congestion control behavior
  - To predict delay and jitter
Overview

- Packet Pair
- Loss Pair
- Estimating the buffer size
- Characterizing Packet Dropping Behavior in AQM Routers
Packet Pair

- **Method Description:**
  - From the same source
  - Two packets P1 and P2 are injected into the network
  - The time $\Delta$ between P1 and P2 must be near 0
  - P1 and P2 traverse the same path up to the collector

- **Possible results for each pair:**
  - Both packets lost
  - One of them lost
  - Both packets received correctly

- **Used to estimate bandwidth**

- The inter-packet gap is inversely proportional to the bottleneck bandwidth.

- The method may be applied in a passive way.
• Based in the Packet Pair method, is proposed the loss pair

• **Loss Pair Description:**
  - From the same source
  - Two packets P1 and P2 are injected into the network
  - The time $\Delta$ between P1 and P2 must be near 0
  - P1 and P2 traverse the same path up to the point where one of them is dropped

• **Assumptions:**
  - the path and the bottleneck do not change during the measuring
  - Most packets losses and delays happen at the bottleneck

• Packet NOT dropped may have some important informations about the network conditions close to the periods of loss.

• The method may be in a passive mode.
Model Description

- **Validation in ns-2 simulator:**
  - A set of TCP sources connected to a set of TCP sinks
  - The TCP flows traverse a single bottleneck
  - Passive way
  - RTT of OK packets
  - RTT = TCP data time + ACK time
  - Lost identified by retransmission
  - Sources alternate between transmitting and idle
  - Transmission sizes are drawn from a Pareto distribution
  - TCP traffic observable and concurrent
  - Queue length, bandwidth, and link delay
Using Loss Pair

- Figure (a) - RTT histogram of all packets
- Figure (b) - RTT histogram of loss pair packets
- Minimum RTT of all packets was 32 ms
- Peak of figure (b) is 99 ms
- 67 ms - full queue drain time
Estimating Buffer Size

- Using a tool to estimate the bottleneck capacity
- Min RTT given by min RTT of packet pair
  \[ E[B] = C(T_q - T_p) \]
- How to estimate the \( T_q \) in the presence of noises?
- Validation varying the buffer size
  - Bin of 1ms is sufficient.
Estimating Buffer Size

• To test their estimation procedure, they varied many parameters of the simulation.
  ■ Bottleneck buffer size
  ■ Capacity of the router C (bottleneck)
  ■ Amount of cross traffic

• Results:
  ■ LOW cross traffic, very accurate, relative error* <= 5%
  ■ MEDIUM cross traffic, relative error* is still under 50% for all cases
  ■ HIGH cross traffic, the relative error* may became 100%

*Relative error = (E[B] - B)/B
Estimating Buffer Size

- The accuracy of the estimation improves as the buffer size increases, and link capacity decreases.
- This corresponds to the loss drain time of the buffer.
- The figure shows this relation.
Characterizing Dropping Behavior

- Characterize Dropping Behavior in AQM Routers:
  - Plot a curve
  - Drop Rate X Queue Occupancy

- Use Loss Pair to discover such curve

- Associate Queue Occupancy "x" with a RTT "r"
  - Use the method of estimating buffer size

- Drop Rate estimation

\[ D_x = \frac{\text{# of loss pair with RTT } = "r"}{\text{# of trial (ok) pair with RTT } = "r"} \]
Characterizing RED scheme

- Function with parameters: THmin, THmax, Mp
  - If queue < THmin -> NO drop
  - If queue > THmin and < THmax -> Drop 0-Mp packets
  - If queue > THmax -> Drop all packets

- Figure (a), curve of the true dropping rate
- Figure (b), curve of the dropping rate using loss pair
- Between 9KB and 13KB, the line is quite similar
- Most samples is between 9 - 13 KB in the histogram, figure(c).
Characterizing BLUE scheme

- BLUE works with different parameters from RED
- The BLUE’s plot has the curve Packet Drop Rate X Queue Occupancy (number of packets)
- Figure (a) shows internal drop and Figure (b) shows Loss Pair curve
- As in the RED, the curve is quite similar for high histogram values figure(c).
Conclusion and Considerations

- Method seems to be valid

- It was not tested in a real network, is valid character cross traffic using many PARETO sources? What happens in the real network?

- Figure 1(b) and 2(a) should be the similar, they have the same configurations.

- The RED Dropping parameters was not estimated.

- What is the real cause for the errors in estimating buffer size?
  - Cross Traffic and Bottleneck Buffer Drain time?
  - Cross Traffic and Before bottleneck buffer time?
  - P1 and P2 take a different state in the bottleneck buffer

- Why do not try this in one-way?
  - Algorithms for solving clock problems
  - Reduce the probability lost in different bottlenecks
• Thanks!!!