Estimating Available Bandwidth using Packet Pair Probing

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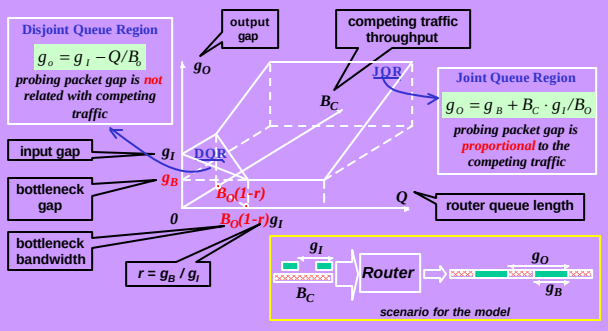
Objective

- Develop a technique to measure end-to-end available bandwidth using packet pairs
- Establish a model of packet pair dynamics
- Evaluate the accuracy of the measurement tool
- Study the potential application in the real world

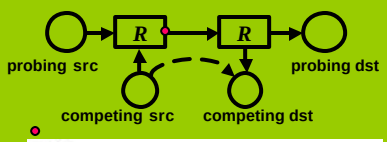
Theory Model — Single Hop Gap Model

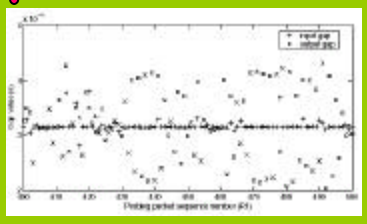
Capture the relationship between probing packet gap and competing traffic



Observation

Increased probing packet gaps capture information about competing traffic





Problem

Packet pair techniques can measure the bottleneck bandwidth using back-to-back packet pair probes

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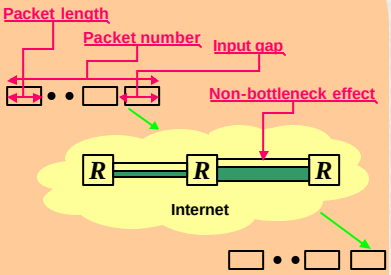
What about available bandwidth?

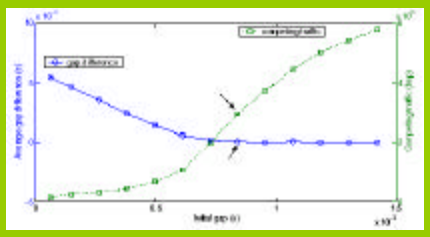
Issues



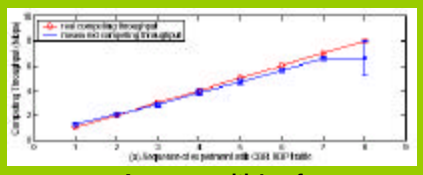
- Packet length: 500B
- Packet number: 16-64
- Input gap: dynamically change
- *Non-bottleneck effect (work in progress)*

Evaluation

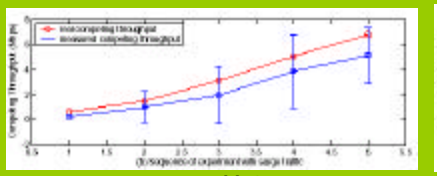
90% measurements can finish within 4-6 RTT, and 80% have error smaller than 10% of the bottleneck capacity



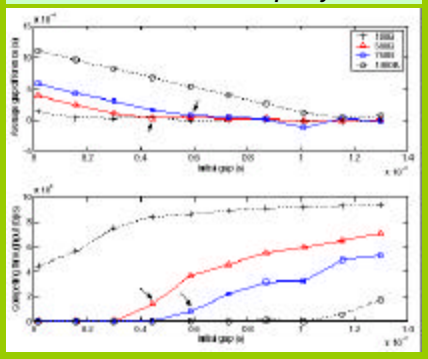
3.6Mbps Iperf competing traffic



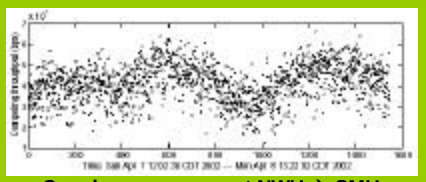
Accuracy with Iperf



Accuracy with Surge



Internet measurement CMU → OHIO



One day measurement NWU → CMU

Algorithm

Initial Gap Increasing (IGI)

Increasing input gap

Compute available bandwidth

$$A\_BW = B_O - \frac{\sum_{g_i > \max(g_B, g_I)} (B_O \times (g_i - g_B))}{\sum g_i}$$

A_BW: available bandwidth
B_o: bottleneck bandwidth
g_i: receiver side gap value
g_B: bottleneck gap
g_I : input gap value