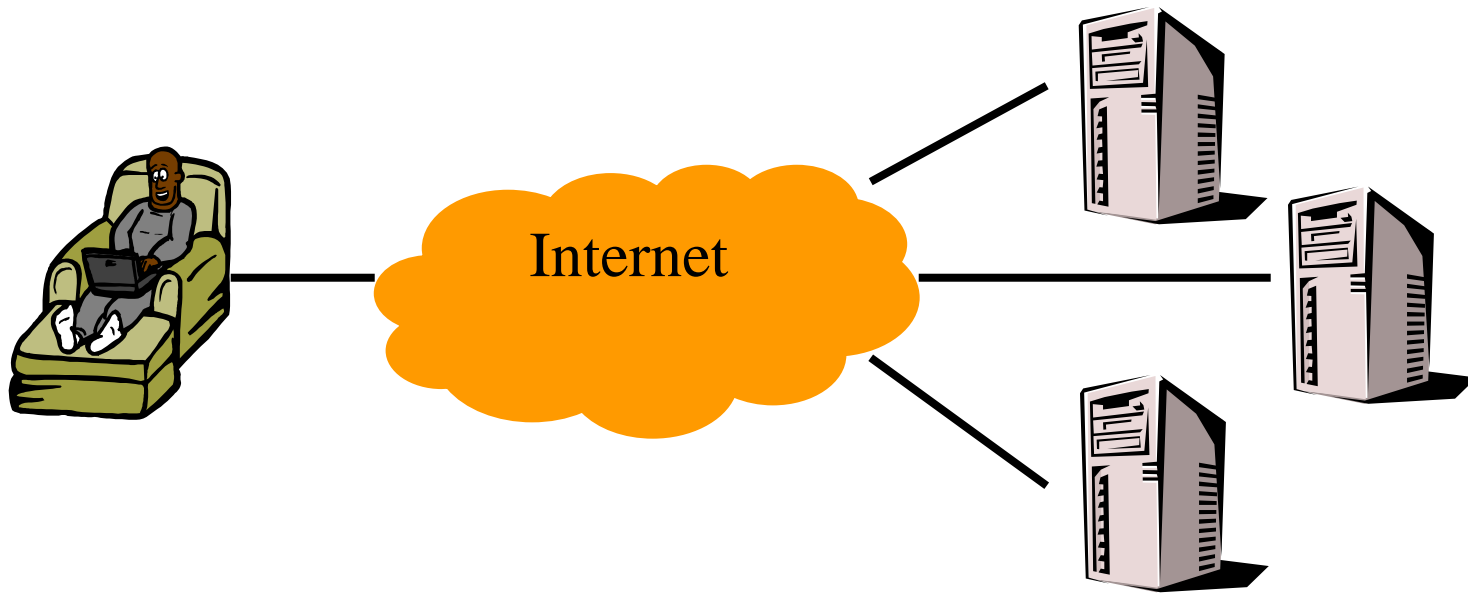# PTR: A Fast Method For Available Bandwidth Estimation

Ningning Hu, Peter Steenkiste

April 8, 2003

The Problem

- **[On P2P] Which site shall I download this movie ☺? – Available Bandwidth!**

- **Critical for the adaptation in network applications**

Available Bandwidth Measurement

- **Available bandwidth: the maximum user data flow throughput**

- **Goal – USEFUL for regular users**
  - **High accuracy**
  - **Small measurement time**
  - **Low network overhead**

Outline

- **Related Work**

- **Intuition**

- **Algorithm – PTR (Packet Transmission Rate)**

- **Evaluation**

Related Work

- ## Passive measurement
    - Recording the statistics of the network transmission
    - On ISP routers: SNMP, NetFlow
    - Research project: SPAND
   - Not available for end users

- ## Active measurement
    - Insert probing traffic into the network
    - Bottleneck link capacity: bprobe, nettimer
    - Available bandwidth: cprobe, pathload

packet train probing
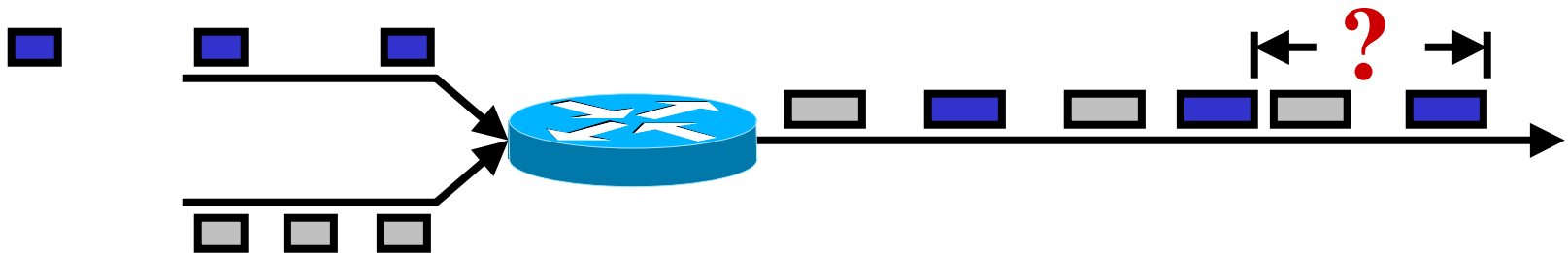
Packet Train

- **Packet train: a sequence of manually configured data packets**

- **Obtain network performance info by monitoring packet train performance**
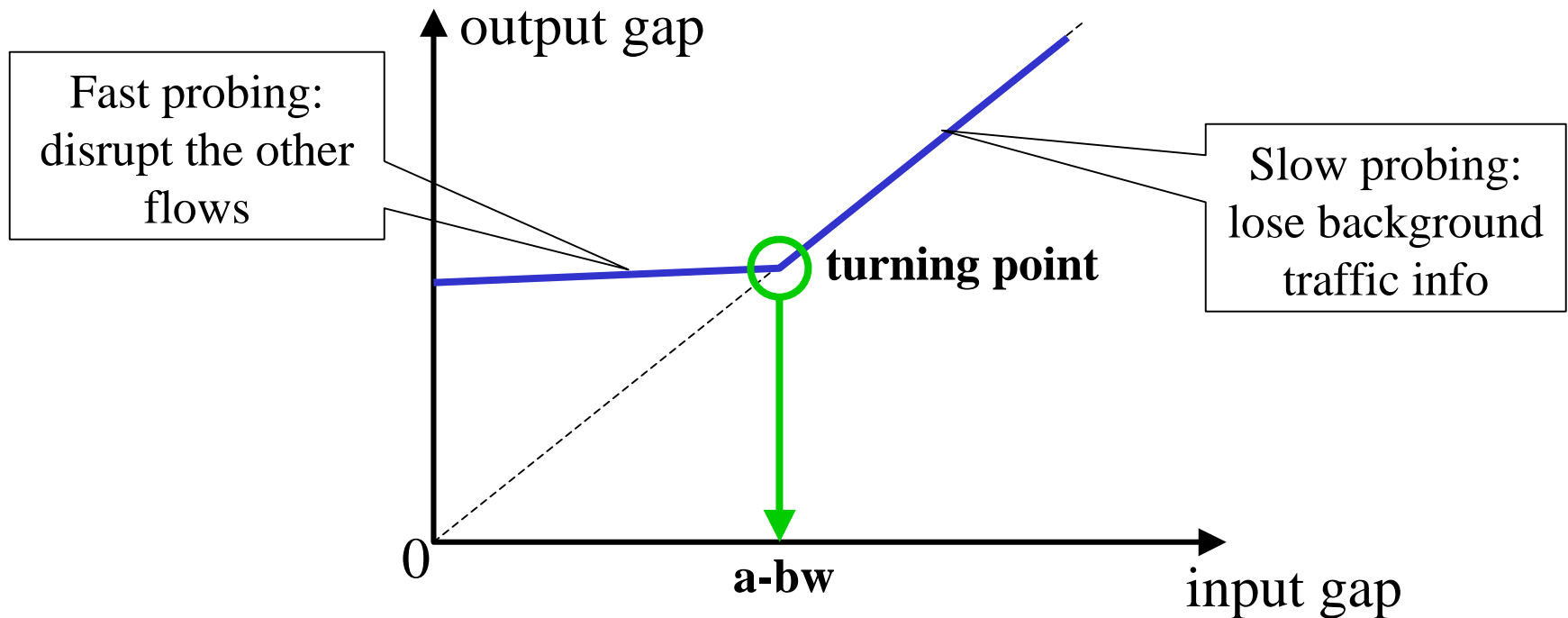

probing pkt

background pkt
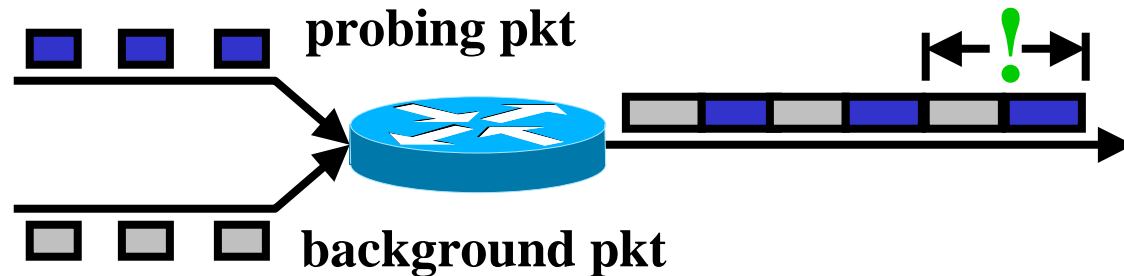
Configuration Is Important!

- **Packet train probing must be set correctly to get useful information**
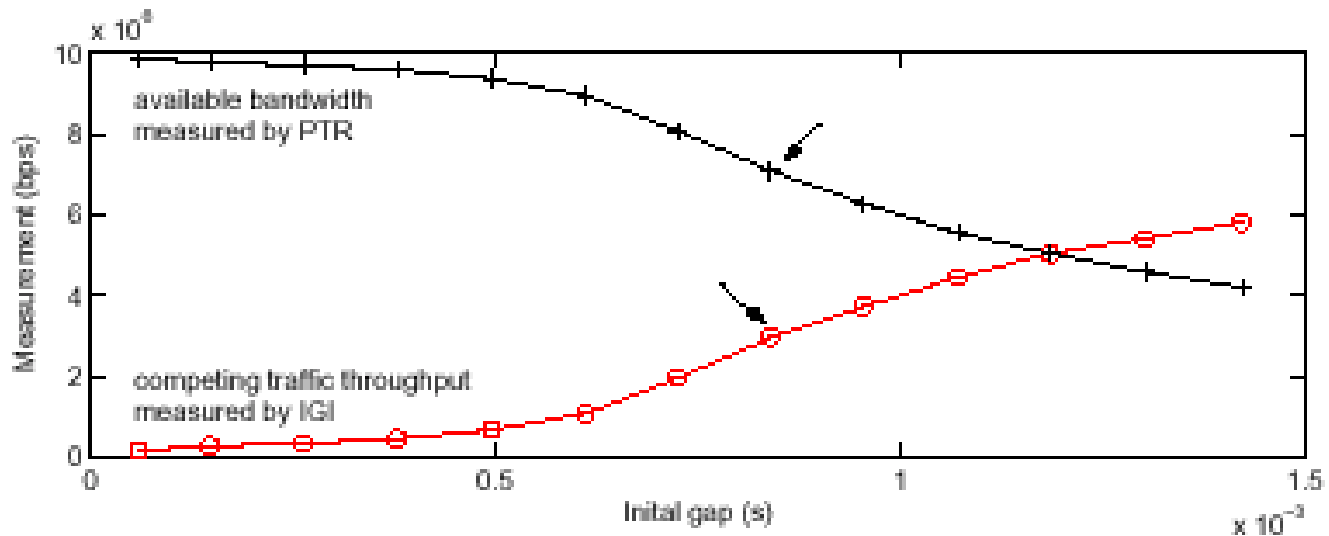 - **Otherwise, nothing can be deduced**

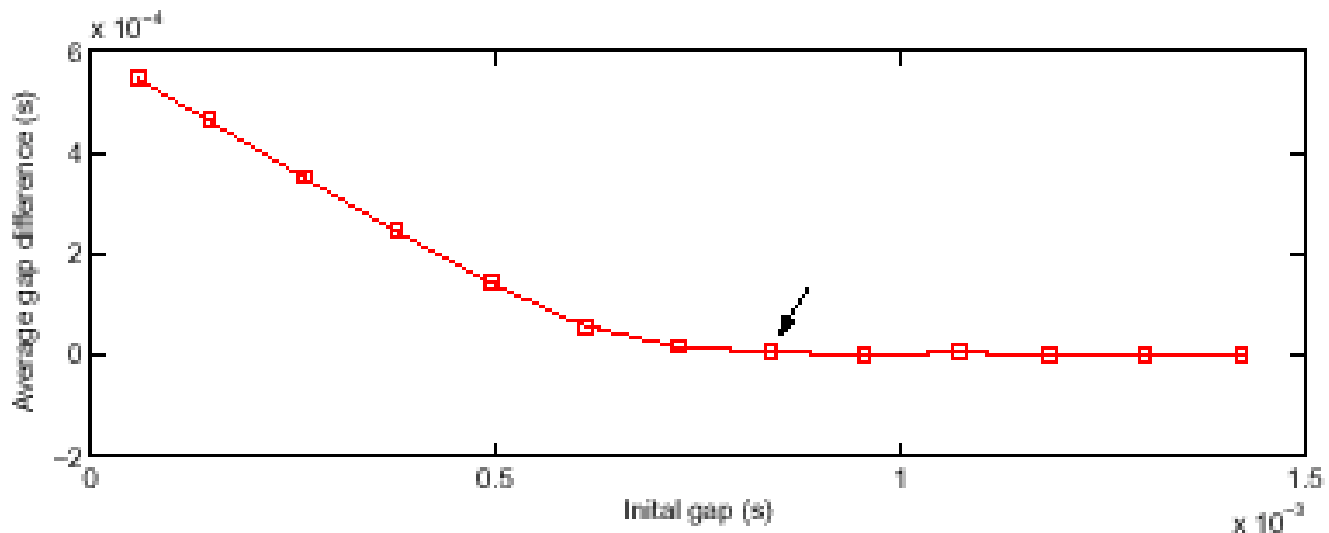# Intuition for PTR

Fast probing: disrupt the other flows

Slow probing: lose background traffic info
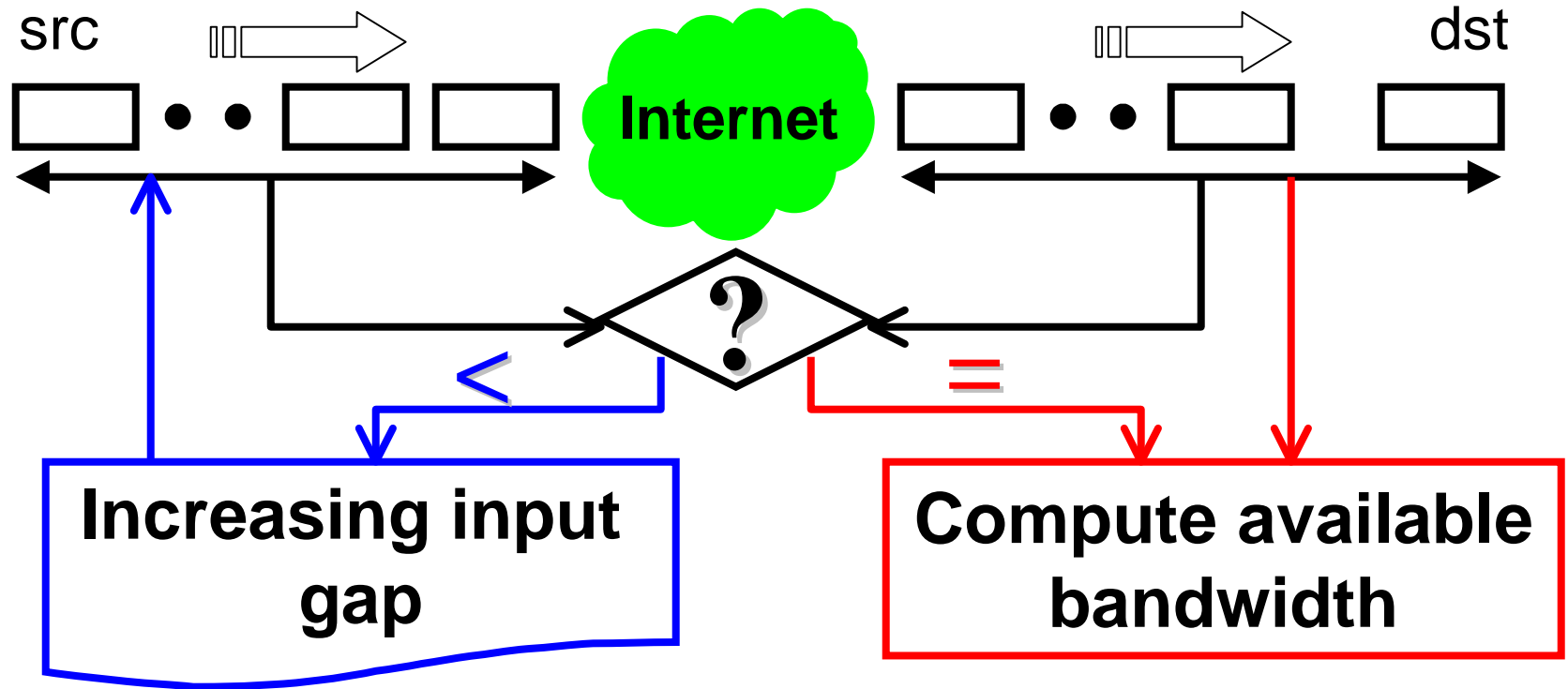
turning point

output gap

input gap

a-bw

0

- **At turning point: probing train behaves exactly like a regular user flow**

It's Real!

Algorithm

Look for the turning point

src
Internet
dst

?

<

=

Increasing input gap

Compute available bandwidth

Compute Available Bandwidth

- ## PTR (Packet Transmission Rate)
  - ### The probing rate at the turning point → available bandwidth

$$\frac{total\ data\ size\ in\ the\ packet\ train}{packet\ train\ trans.\ time}$$

Compute Available Bandwidth (cont.)

- **IGI (Initial Gap Increasing)**
  - **Packet gap $\rightarrow$ amount of background traffic $\rightarrow$ background traffic throughput $\rightarrow$ available bandwidth**

$$\textit{link capacity - } \frac{\textit{amount of competing traffic}}{\textit{packe train trans. time}}$$

Evaluation Methodology

- ## 13 Internet paths with different properties
  - ### End hosts are in US, Europe, and Asia
  - ### Path capacity: 1.5 - 100Mbps
  - ### Round trip time: 10 - 265ms

- ## Measure the available bandwidth using:
  - ### PTR (IGI)
  - ### Pathload
  - ### TCP flow(s) ← benchmark

High Accuracy
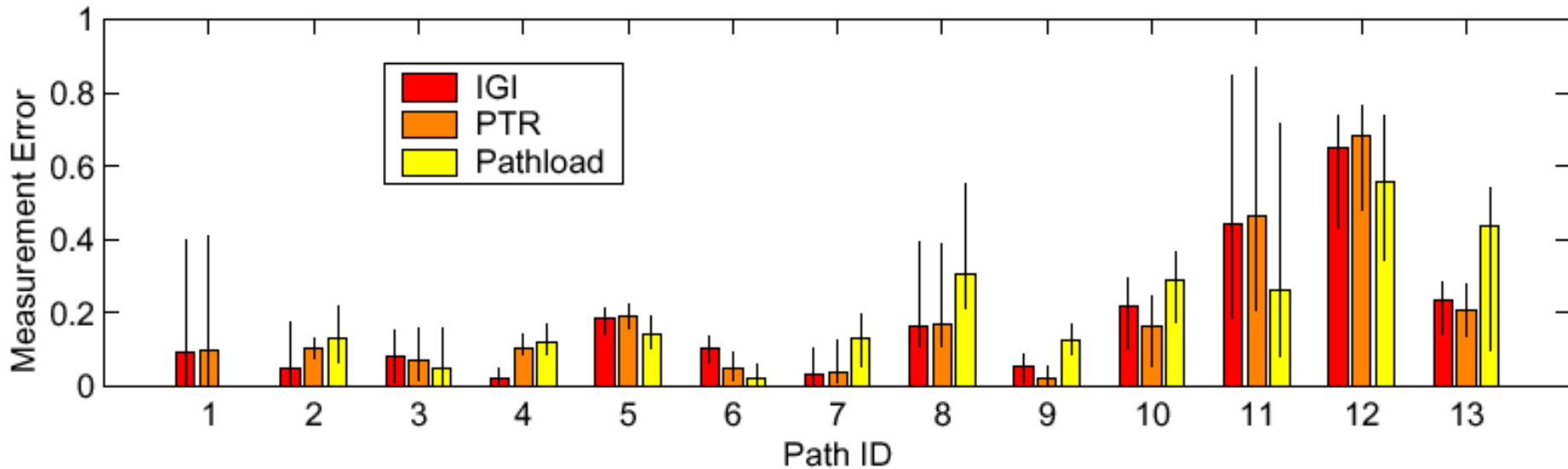
- **No one is always better → accuracy is similar**

- **Small measurement error: < 20% (path 1-10)**
  - **Path 11-13, large measurement error**

Small Measurement Time
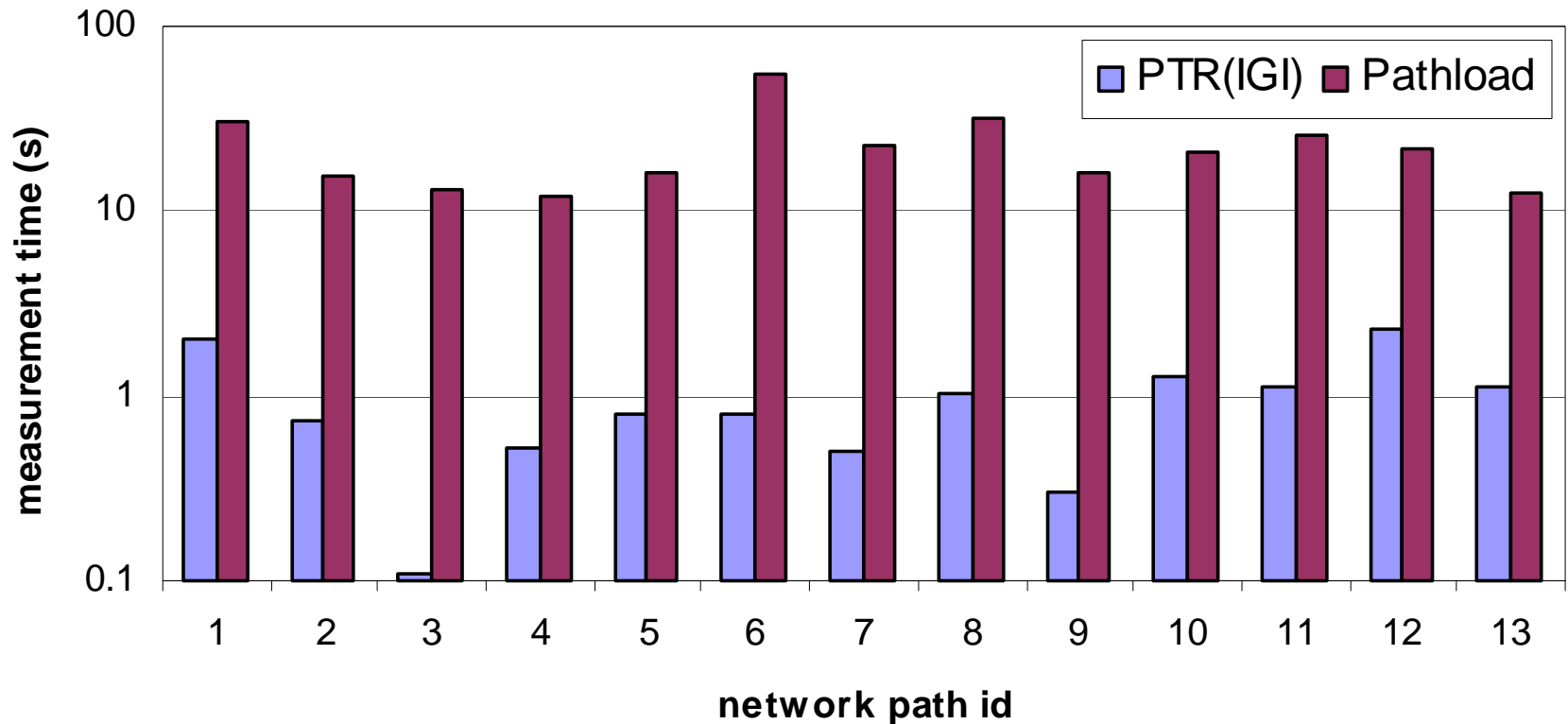
- **PTR is much faster than Pathload**
  - **Average: 26 times faster**

Low Network Overhead

- **Probing packet size**
  - **[500B, 700B] works best**

- **# of probing packets / packet train**
  - **16 – 64 packets, depends on the network path**

- **# of probing phases (# of packet trains)**
  - **Depends on the path, typically 6 rounds**

Conclusion

- **A simple active probing algorithm for available bandwidth estimation**

- **PTR <u>is</u> USEFUL for regular users**
  - **Measurement error < 20%**
  - **Very fast measurement speed**
  - **Low network overhead**

More Details See

- **Paper**
  - **Evaluation and Characterization of Available Bandwidth Techniques**. **In the** *IEEE JSAC Special Issue in Internet and WWW Measurement, Mapping, and Modeling,* **3rd Quarter, 2003.**

- **Project webpage & source code:**
  - **www.cs.cmu.edu/~hnn/igi**