Path Selection Criteria for P2P Voice

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Coming Ahead

- The Problem
  - Most time here

- Simulation Setup
  - Try to be brief

- Lessons Learned
  - The rest of the time
Motivation

Success of Skype
Secret of Success

- Codec (provided by Global IP Sound)
  - 67 bytes packet payload
  - 24 to 120 kbps
- NAT and firewall traversal
- Alternative paths!
Physical Network
Overlay Network

AS 1

AS 2

AS 3

AS 4

AS 5
Default Path

AS 1 → AS 5

default path
Default Path Not Good

AS 1
AS 2
AS 3
AS 4
AS 5

default path
Find an Alternative Path

AS 1

AS 2

default path

AS 3

alternative path

relay peer

AS 4

AS 5
Who should be the relay peer?

such that the alternative path is better than the default one…
A Fundamental Question

Which is the right path selection criteria?

Source Rate?
Congestion Level?
Delay?
Combination of the above?
Prior Work

USI = 2.15 * log(bit rate) – 1.55 * log(jitter) – 0.36 * RTT

- bit rate: data rate of voice packets
- jitter: level of network congestion
- RTT: round-trip times between two parties
Metrics for Level of Congestion

1. Delay Jitter
2. Available Bandwidth
3. Loss
Two Questions to Address

1. Does delay jitter speaks for all?
   Are the paths selected using the other two metrics the same?

2. Does average delay jitter speaks for all?
   Are the paths selected using the average, min/max, or 90% of the metrics the same?
Simulation-Based Approach

- Simulated topology
  - A number of alternative paths between the call source and destination

- Simulated background traffic
  - Different Web/P2P/other compositions on the paths

- Sending voice calls
  - Using different selection criteria

- Measure quality of the calls
  - In terms of throughput and delay jitter

If different selection criteria give different results
→ The criteria are not isomorphic (not independent)
Outline

- The Problem
  - Most time here

- Simulation Setup
  - Try to be brief

- Lessons Learned
  - Some time here
Simulation Setup

Non-congested case: 72% utilization
Congested case ~ 100% utilization

1. Background Traffic Generator
   - P2P/WEB/Poisson
     - 60%/20%/20%
     - 20%/60%/20%
     - 40%/40%/20%
   - P2P/WEB/Heavytail
     - 60%/20%/20%
     - 20%/60%/20%
     - 40%/40%/20%

2. Call Source
3. Call Destination
Background Traffic Generation

- The most time consuming part
  - Web traffic
  - P2P traffic
  - Internet traffic composition
  - Voice traffic
1. Delay jitter, available bandwidth, loss rate are not independent
2. Taking average, 0, 10%, ..., or 100% quantile does not matter
Voice Performance: Non-Congested Case

For each selection criteria,
1. run simulations 80 times
2. get average throughput and delay jitter

1. Available bandwidth and delay jitter give very similar results
2. Loss rate is different and not as good as a path selection criteria
Voice Performance: Congested Case

1. Available bandwidth and loss rate give similar results
2. Delay jitter is unique
3. Hard to say which criteria is better
**Lesson #1**

**Delay jitter, available bandwidth, loss rate are not independent**

<table>
<thead>
<tr>
<th>Quality</th>
<th>Network Load</th>
<th>Available Bandwidth</th>
<th>Delay Jitter</th>
<th>Loss Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>Non-congested</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Congested</td>
<td>O</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Delay Jitter</td>
<td>Non-congested</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td></td>
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<td>O</td>
<td>X</td>
</tr>
</tbody>
</table>
Bonus

- When the network is not congested, jitter is high $\rightarrow$ lower jitter better path
- When the network is congested, jitter is low $\rightarrow$ lower jitter not necessary better path

- Delay jitter and loss late combined will serve better as the measure of congestion
Lesson #2

Available bandwidth \(\rightarrow\) Throughput

Average, min, max, median, … no difference (if observing long enough)!
Here is Why…
Instantaneous Available BW

In very few cases, using average, min, max, or median may result in different path choices
Questions Answered

- **Good news**
  - Taking average, 0, 10%, ..., or 100% quantile does not matter

- **Bad news**
  - Delay jitter, available bandwidth, loss rate are not independent

- **Hope → robust path selection criteria for voice**
  - Delay jitter and loss rate combo
Questions?

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