

## Effectiveness of overlay routing based on delay and bandwidth information

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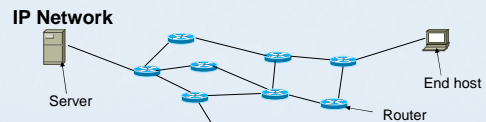
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## Overlay network

- Varied types of service-oriented overlay networks are emerging
- Overlay networks are defined as upper-layer networks that are built on the lower-layer IP network



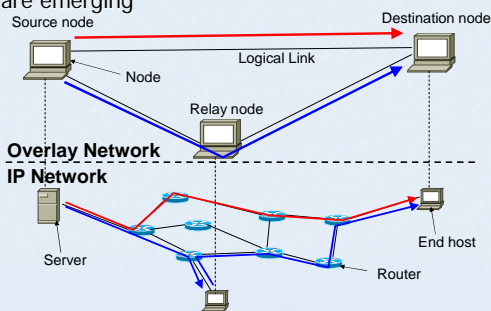
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## Overlay network

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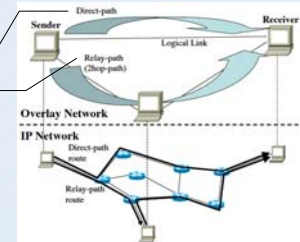
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## Overlay routing (1)

- Some overlay networks concentrate only traffic routing
- > Called overlay routing
- Improve user-perceived end-to-end performance
  - End-to-end delay
  - Throughput

Overlay routing can consider direct path, and relay path that traverses other node(s) before reaching the destination node



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## Overlay routing (2)

- Performance evaluation of overlay routing
  - Data transmission experiments in Japan [6]
    - About 28% of node pair, he can reduce latency by relaying another host, compared to direct path
  - Many evaluation based only on delay between overlay nodes
- > Bandwidth-related information is more important especially for long-lived data transmission
- Objectives
  - Evaluate the effectiveness of overlay routing using latency and available bandwidth information**

[6] S. Kamei, "Applicability of overlay routing in Japan using inter-domain measurement data," *Overlay Network Workshop*, Dec. 2006.

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## Methodology

- Measurement data
  - Network environment: PlanetLab [10]
  - Data origin: Scalable Sensing Service (S-cube) [11]
    - Full-mesh measurement datas about physical capacity, available bandwidth, end-to-end delay and packet loss rate between PlanetLab nodes
  - Measurement date: 25th Oct. 2006
  - Number of PlanetLab nodes: 588 in 179 ASes

[10] PlanetLab Web Page. available at <http://www.planet-lab.org/>.

[11] Scalable Sensing Service. available at <http://networking.hpl.hp.com/s-cube/>.

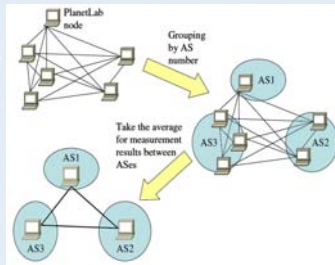
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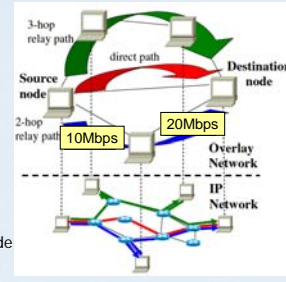
### Measurement data conversion

- Group nodes by AS number
  - Assume that each AS has only one overlay node
  - If more than one data exists between ASes, we use the average of data



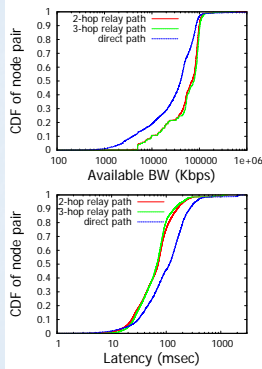
### Performance metrics

- Path candidates
  - Direct path
  - 2-hop relay path
  - 3-hop relay path
- Metrics
  - Latency and available bandwidth (BW)
  - Relay path's latency
    - Sum of latency between node pair used on the relay path
  - Relay path's available BW
    - Minimum of available BW between node pair used on the relay path
  - Improvement ratio
    - The ratio of relay path's metric with respect to direct path's metric

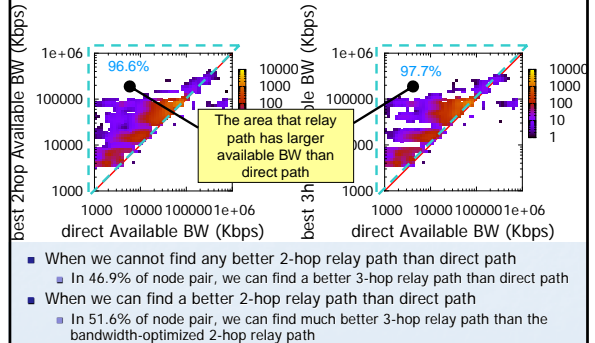


### Distribution of latency and available BW

- About 80% of direct path, available BW is between 10Mbps and 100Mbps
  - > increased to 90% by using relay paths
- About a half of direct path, latency is between 10ms and 100ms
  - > increased to 80% by using relay paths

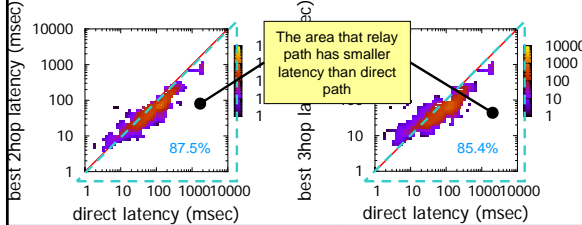


### Characteristics of relay path (available BW)



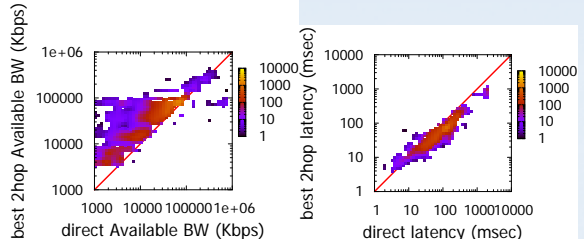
- When we cannot find any better 2-hop relay path than direct path
  - In 46.9% of node pair, we can find a better 3-hop relay path than direct path
- When we can find a better 2-hop relay path than direct path
  - In 51.6% of node pair, we can find much better 3-hop relay path than the bandwidth-optimized 2-hop relay path

### Characteristics of relay path (latency)

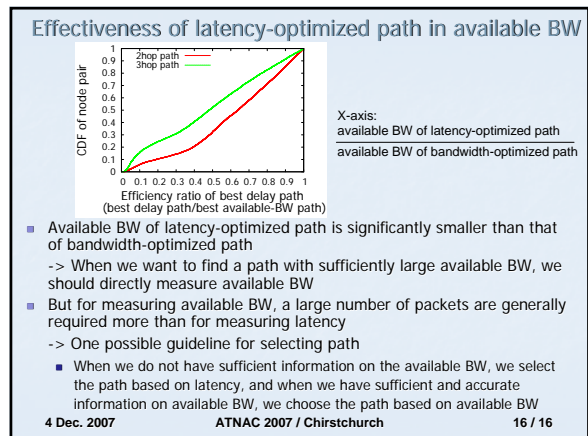
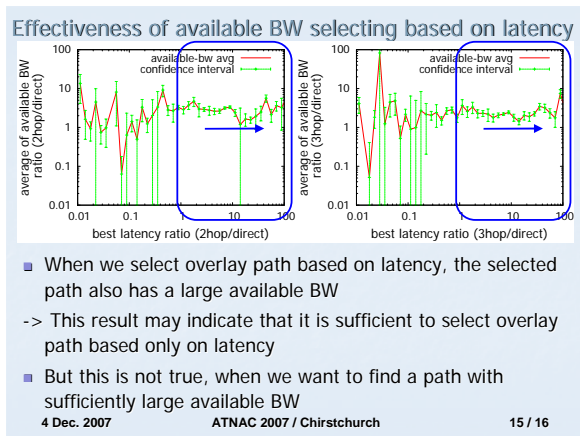
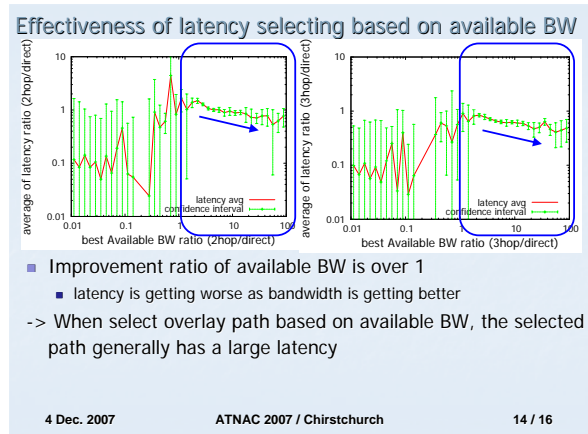
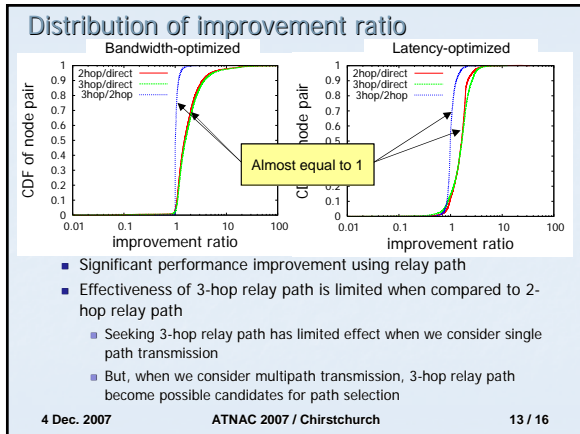


- When we cannot find any better 2-hop relay path than direct path
  - In 17.8% node pair, we can find a better 3-hop relay path than direct path
- When we can find a better 2-hop relay path than direct path
  - In 47.3% node pair, we can find much better 3-hop relay path than the latency-optimized 2-hop relay path

### Characteristics of relay path (available BW & latency)



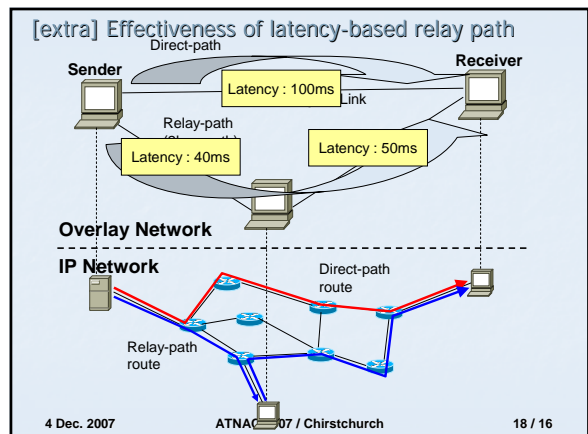
- Effectiveness of the latency-based relay path is smaller than that of the available BW-based relay path
  - <- IP routing is configured based on hop-count, which have some degree of correlation with latency



### Conclusions & Future work

- We evaluated the effectiveness of overlay routing
  - Available BW-based overlay routing provided significant gain, compared with latency-based overlay routing
  - Effectiveness of the 3-hop relay path is limited in a single transmission, but would be effective in multipath transmission with a few paths
  - Small latency relay paths generally have large available BW
  - Large available BW relay paths do not always have small latency
- Future work
  - Evaluate the effectiveness of the path selection guideline

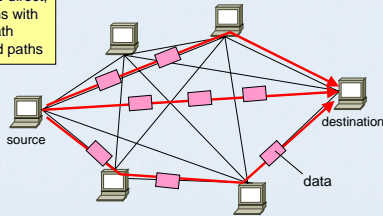
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### [extra] Multipath transmission

- Multipath transmission is data transmission using multiple paths for one data transmission between source and destination nodes

Choose the multiple paths in the best order of available BW or latency from all of the direct, 2-hop, and 3-hop paths with considering the path disjointness of selected paths

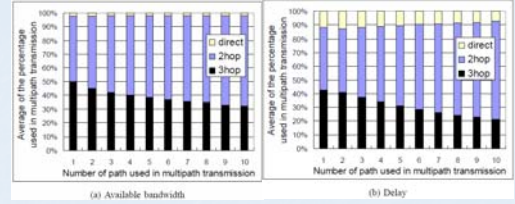


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### [extra] Effectiveness in multipath transmission



- Seeking 3-hop relay path is meaningful in multipath transmission with a few paths
- But its effectiveness decreases as the number of total using paths in multipath transmission increases

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