

# Measuring and characterizing end-to-end dynamics in the presence of load balancers

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# Our understanding of dynamics is outdated

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Understanding dynamics is important to

- Maintain an up-to-date topology map
- Select peers during overlay construction
- Direct network management efforts

First big study of routing dynamics was done by Paxson in 95-97

- Studied route persistence and route prevalence
- Only partial updates since his work

However, new networking practices have arisen since Paxson's work

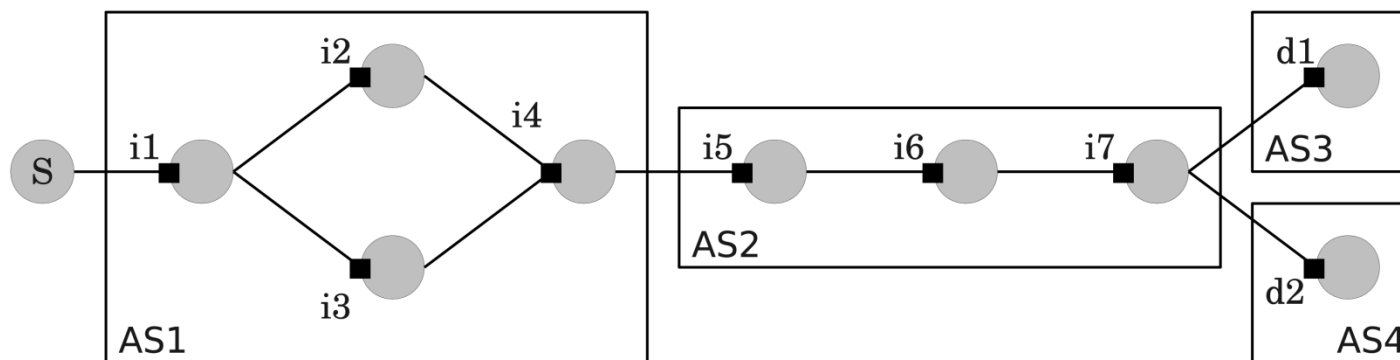
- Load balancing
- Multi-homing
- Tunneling, VPNs, NATs

# Routers perform load balancing

Load balancing improves link utilization and reliability

Routers perform load balancing among

- Multiple links between a pair of routers
- Routes with same OSPF/ISIS cost (ECMP)



# How we study route dynamics

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Obtain frequent measurements to capture dynamics

- Design FastMapping

Characterize route dynamics

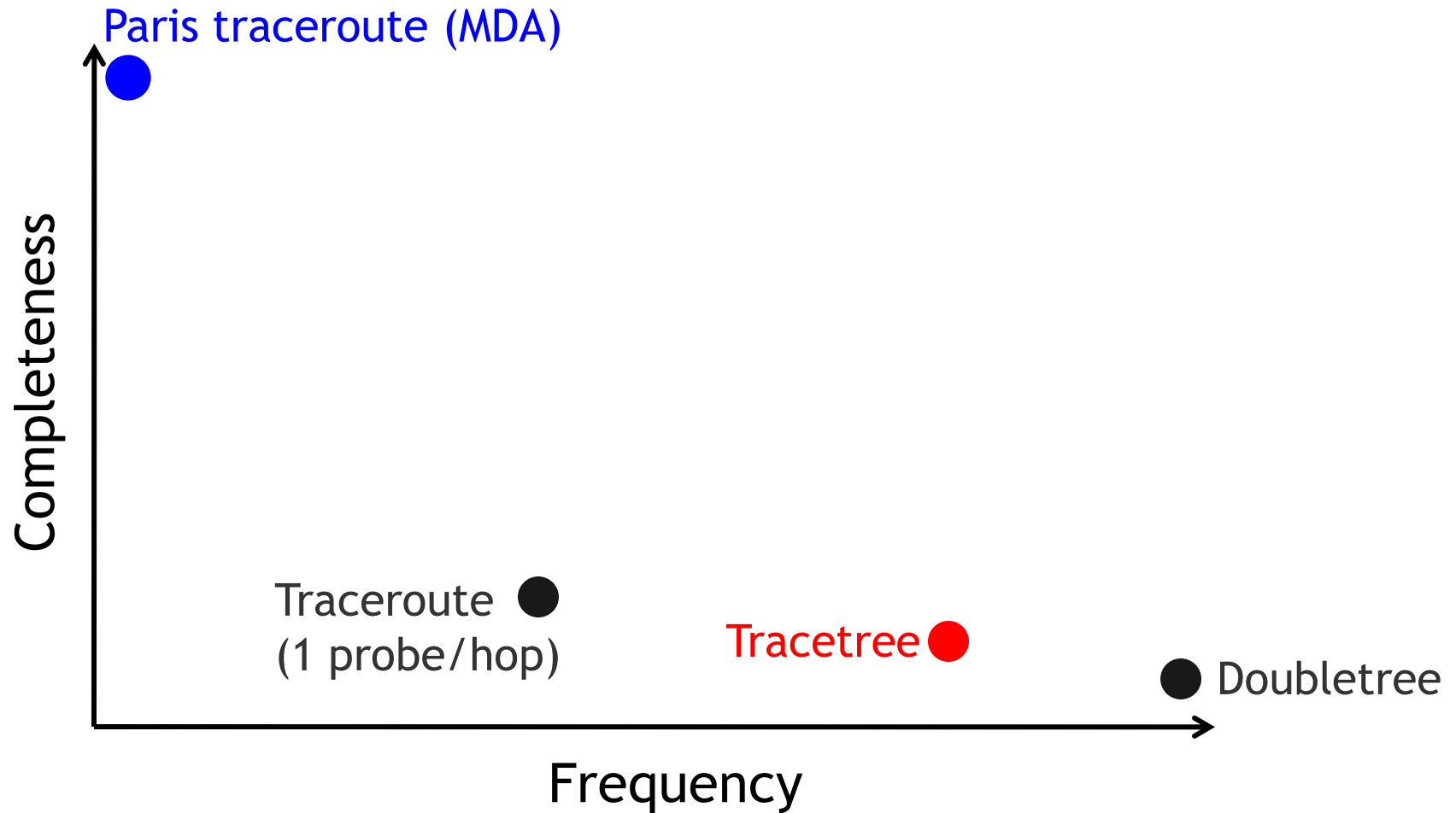
- Compare to Paxson's results

# Obtaining measurements to study path dynamics

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# Frequent versus complete measurements

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# Measurements to study route dynamics

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23 PlanetLab hosts probing 1,000 destinations

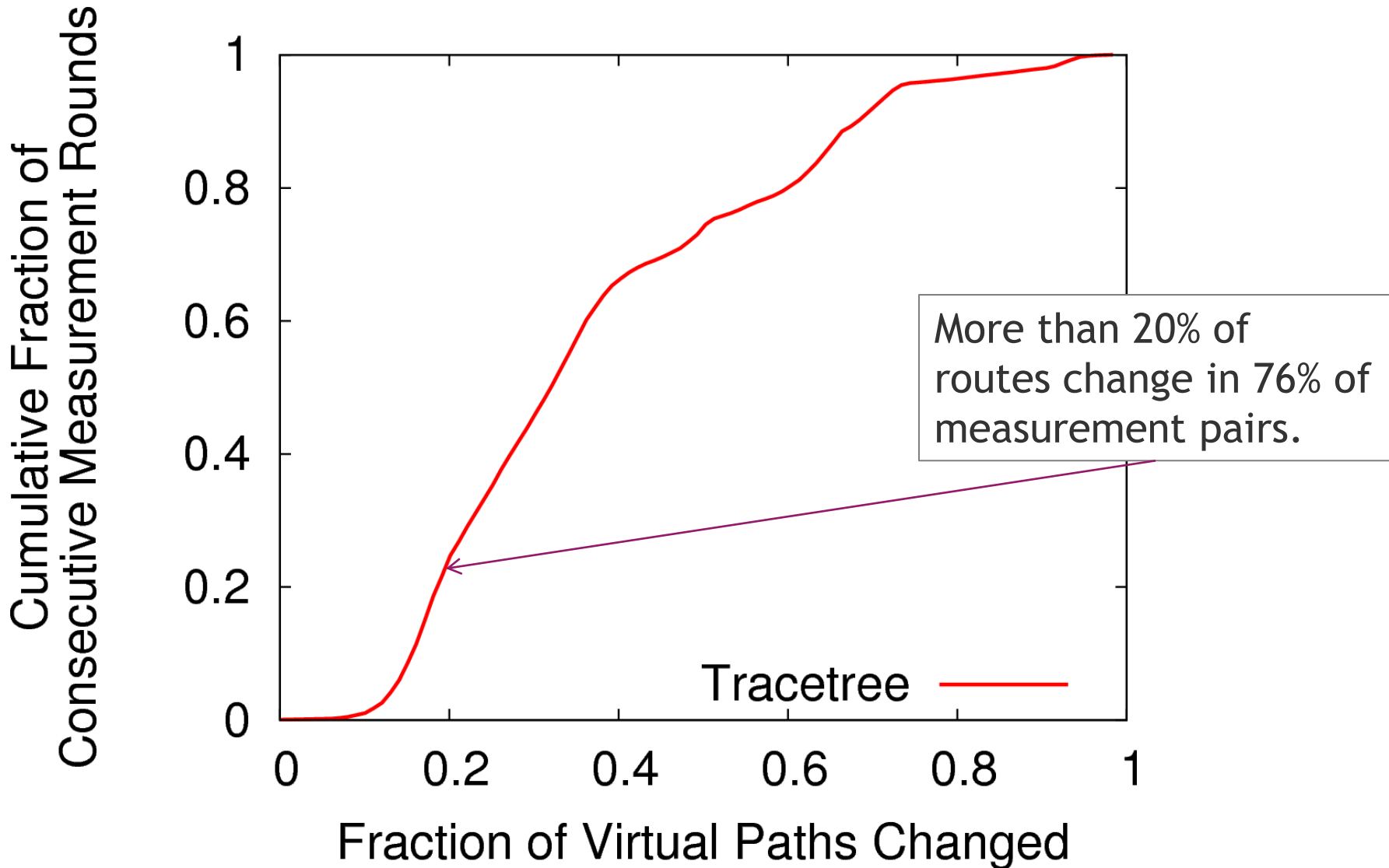
Tracetest and Paris traceroute (MDA)

1 week of data starting August 9<sup>th</sup>, 2010.

Paths measured every 28 minutes on average

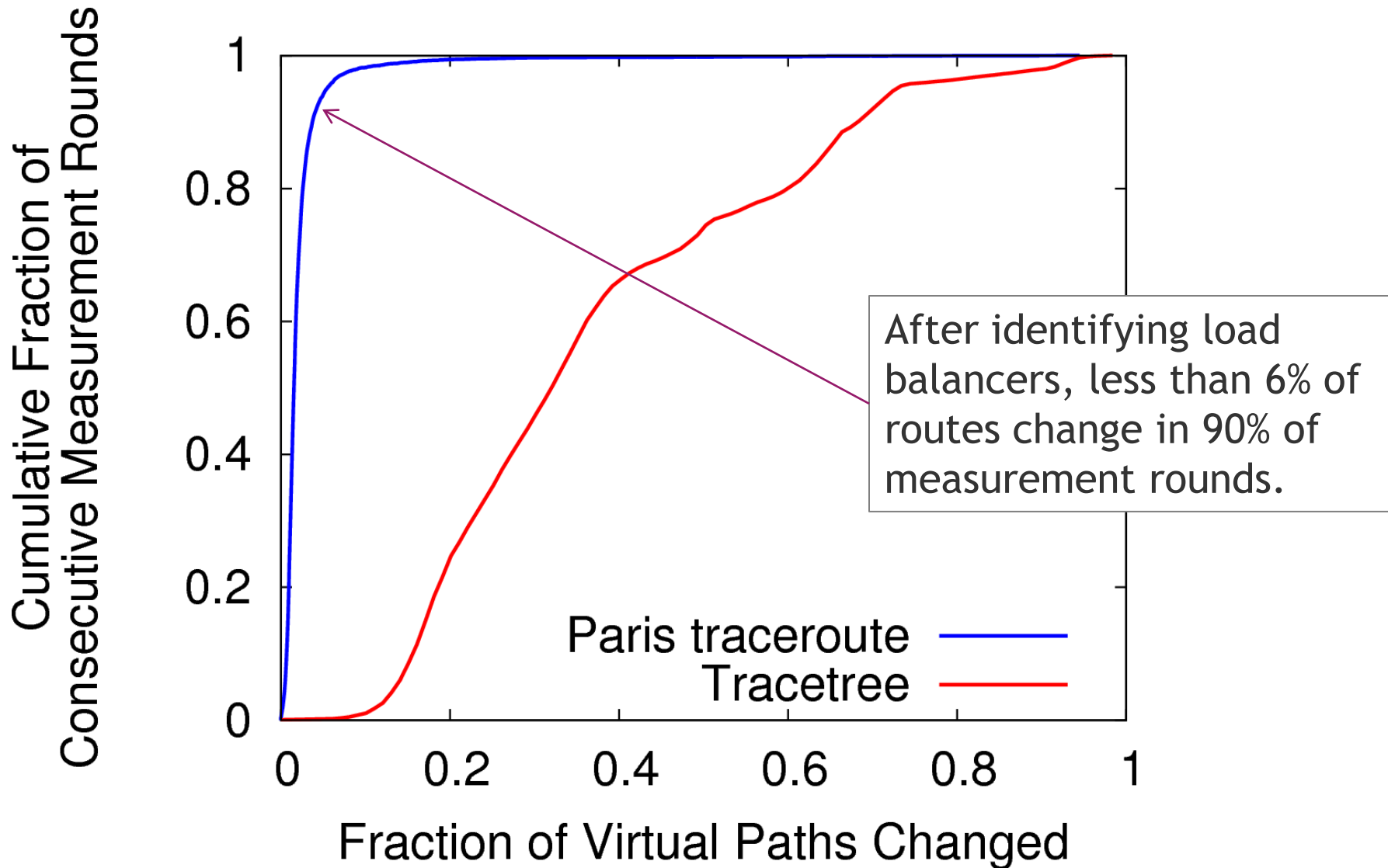
Dataset covers 5,266 ASes and 95% of the large ASes

# What's with all this path changes?

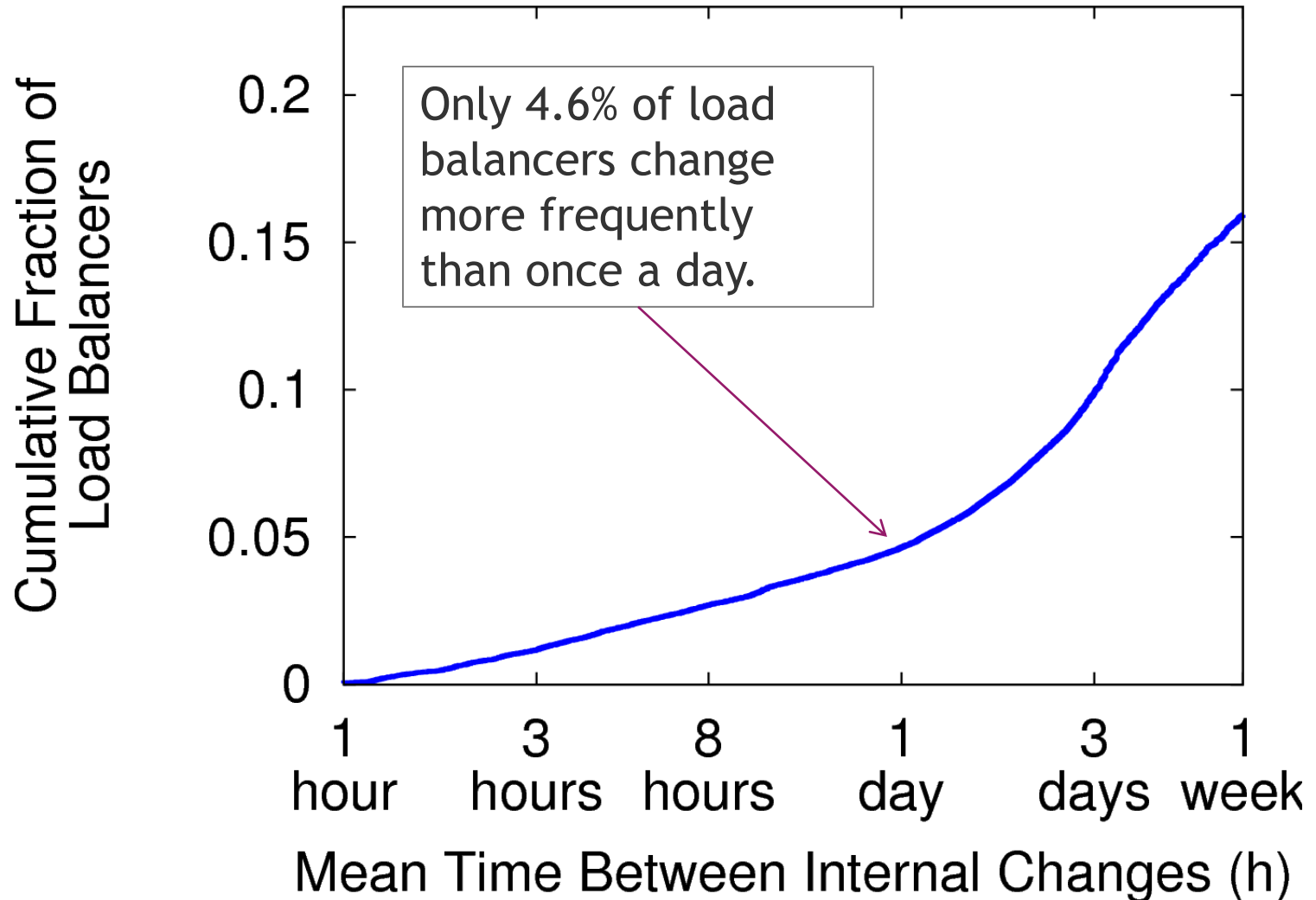




# Load balancing induces a lot of dynamics

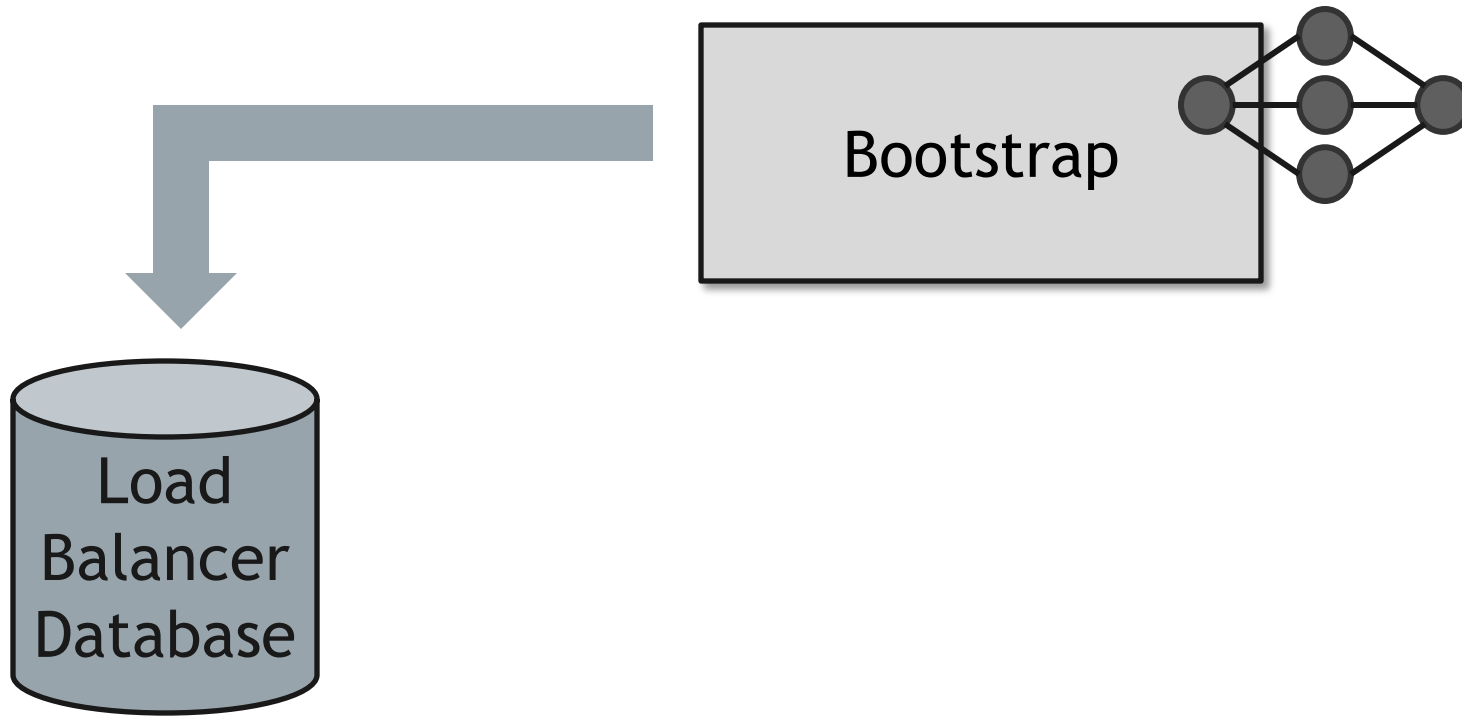


# No need to measure load balancers frequently



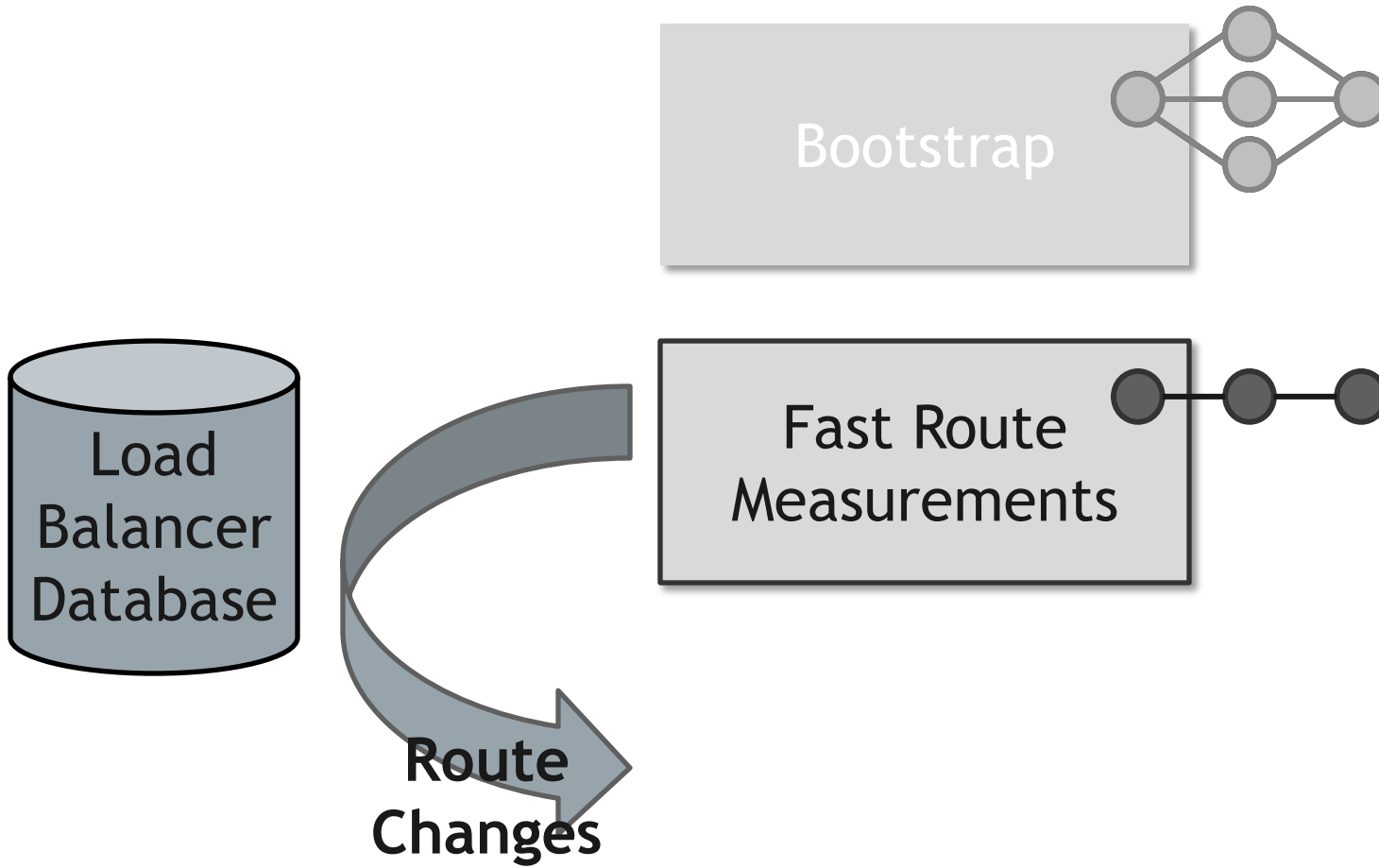
# FastMapping

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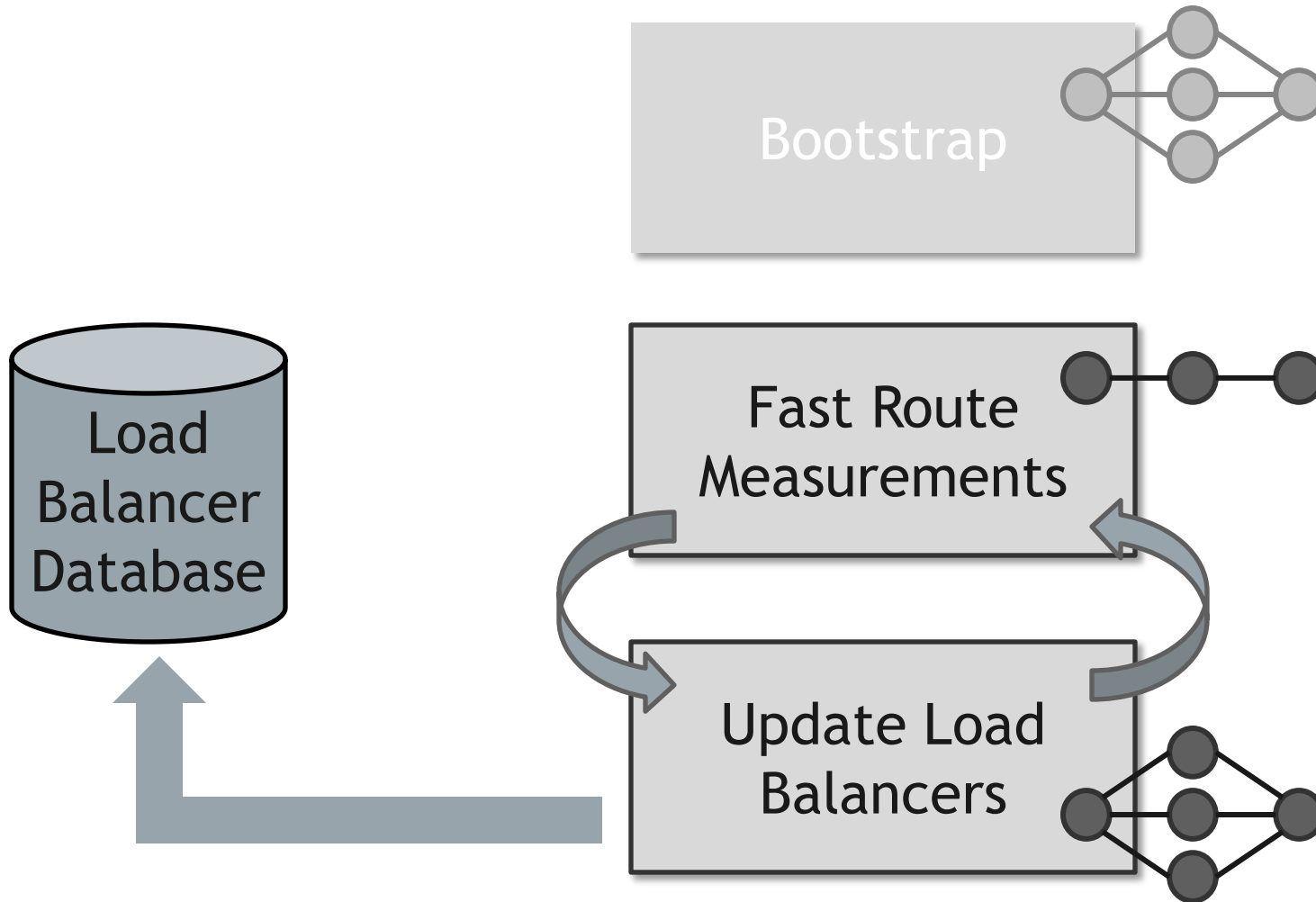
# FastMapping

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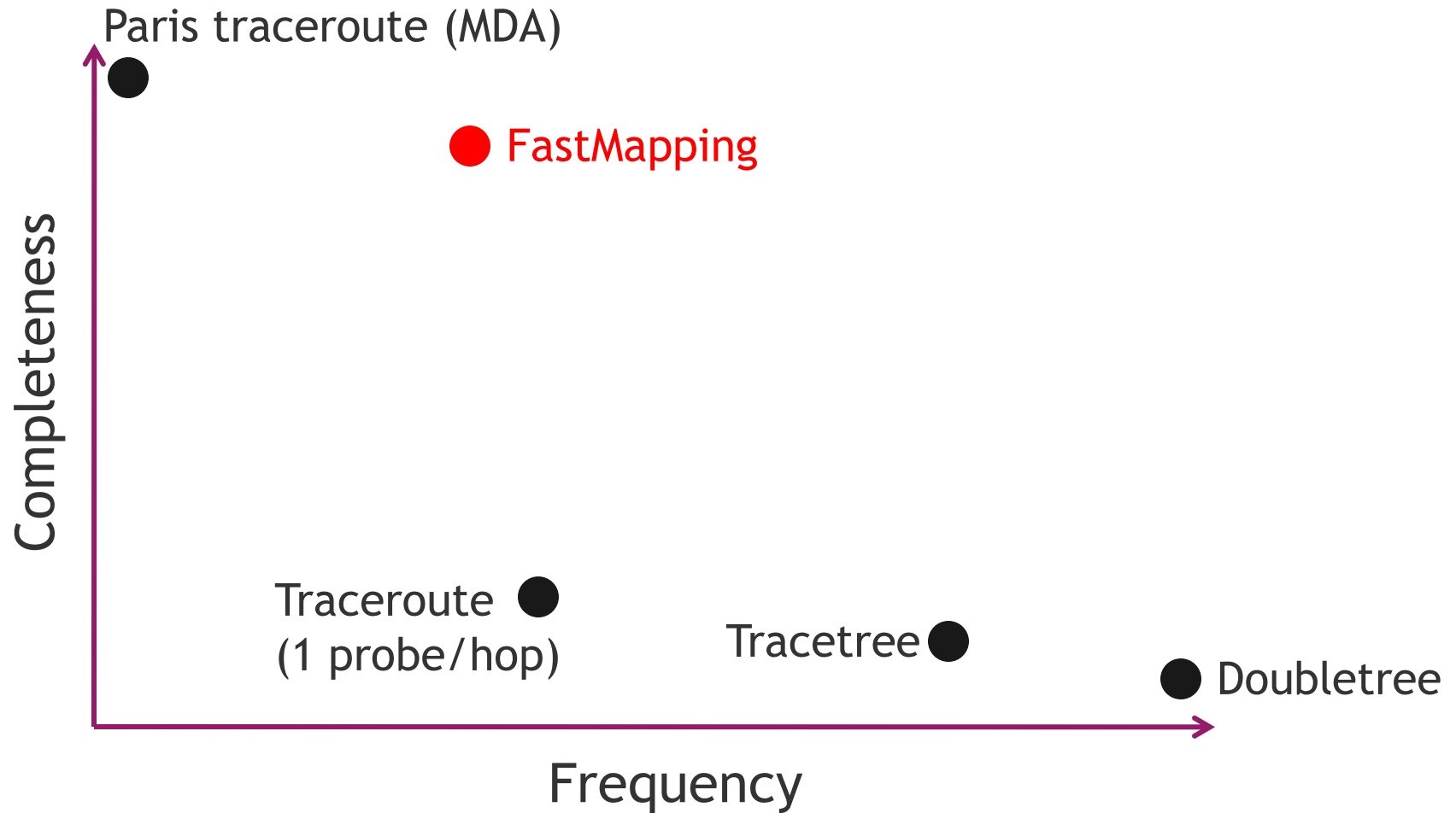


# FastMapping

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# Frequent versus complete measurements



# Characterizing path dynamics

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# FastMapping measurements

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70 PlanetLab hosts probing 1000 destinations

5 weeks of data starting September 1<sup>st</sup>, 2010.

Paths measured every 4.4 minutes on average

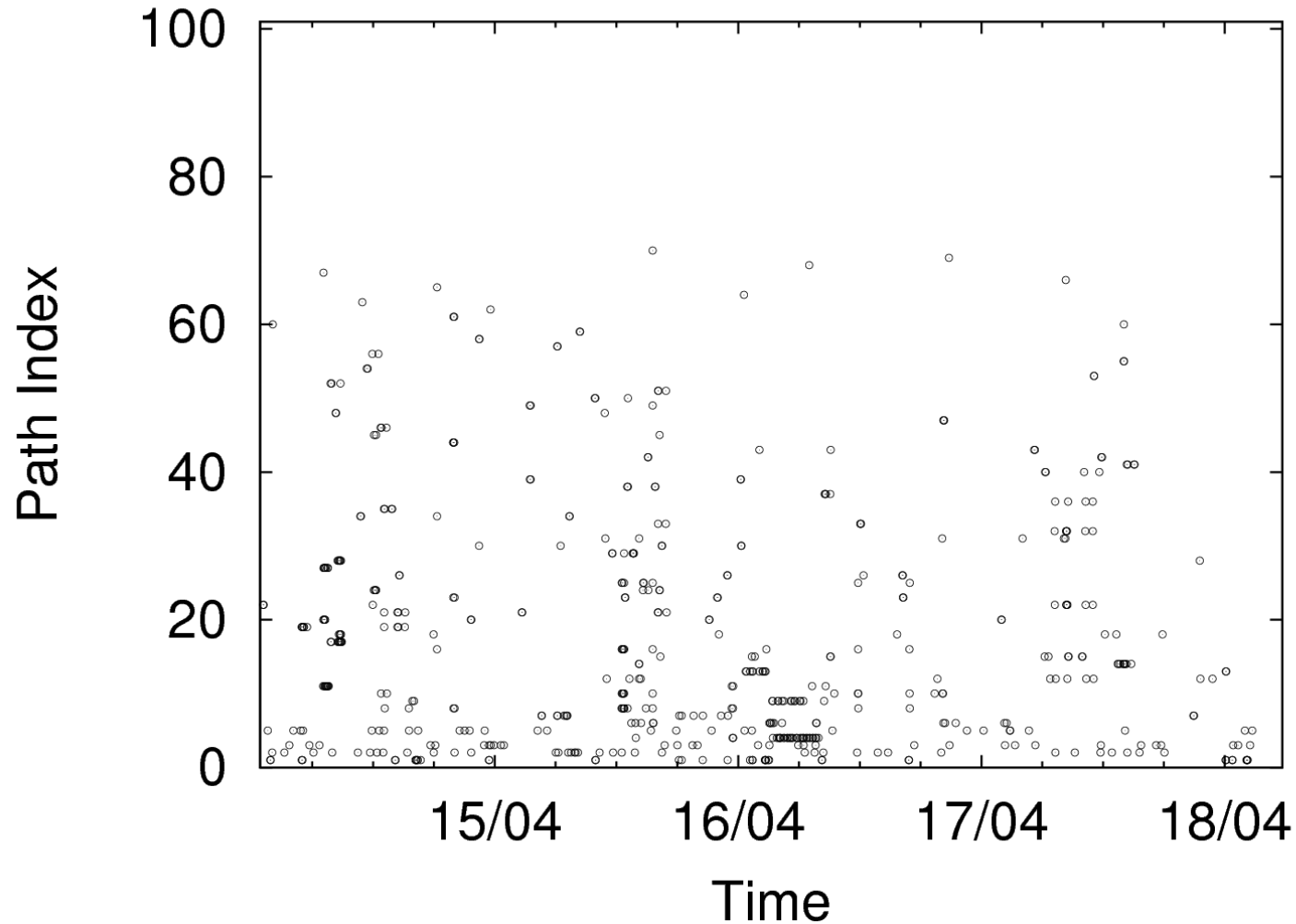
Dataset covers 7942 ASes and 97% of the large ASes



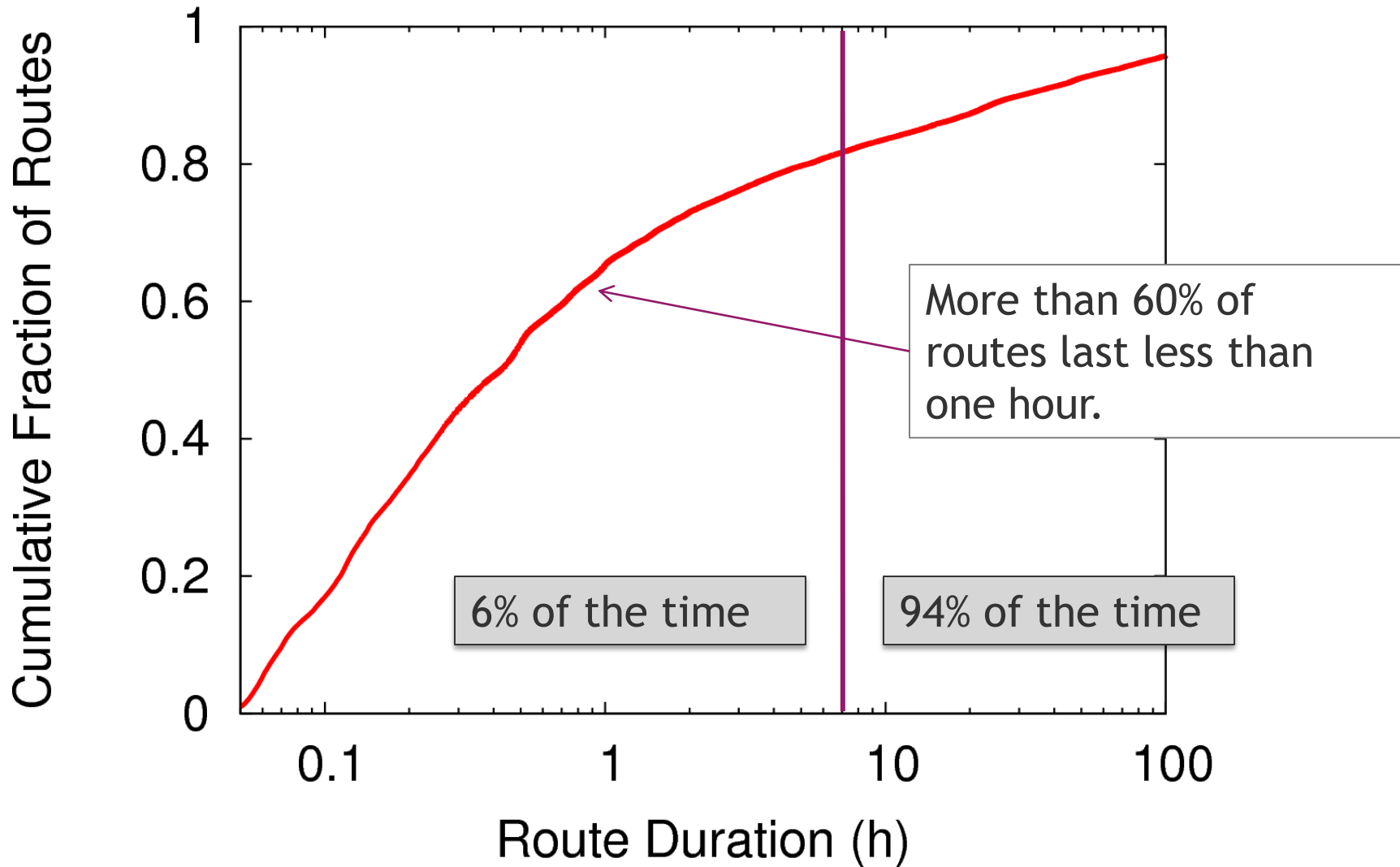
# Overview of route dynamics

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Paths are stable most of the time,  
but go through short-lived instability periods

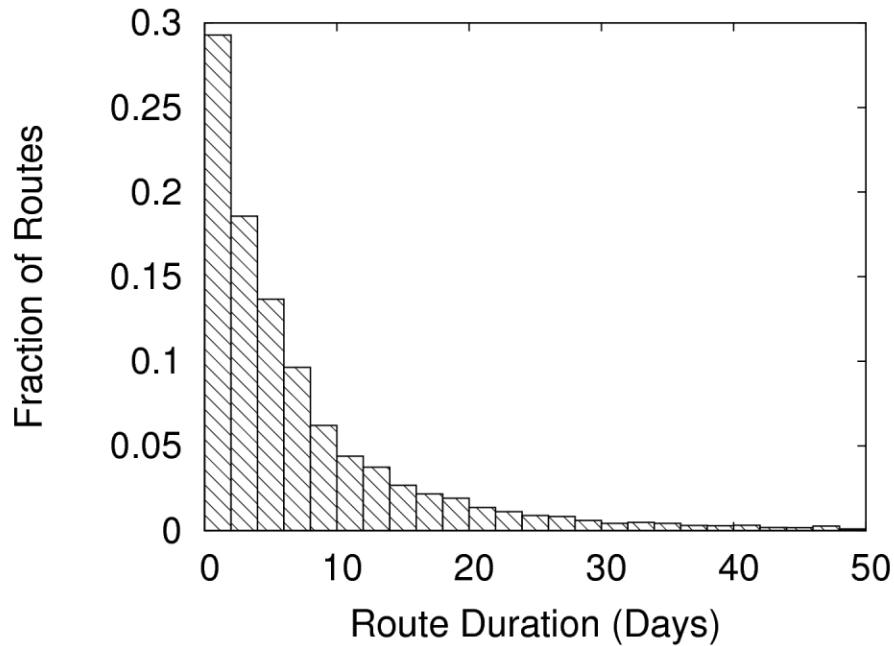


# Paths experience short instability periods

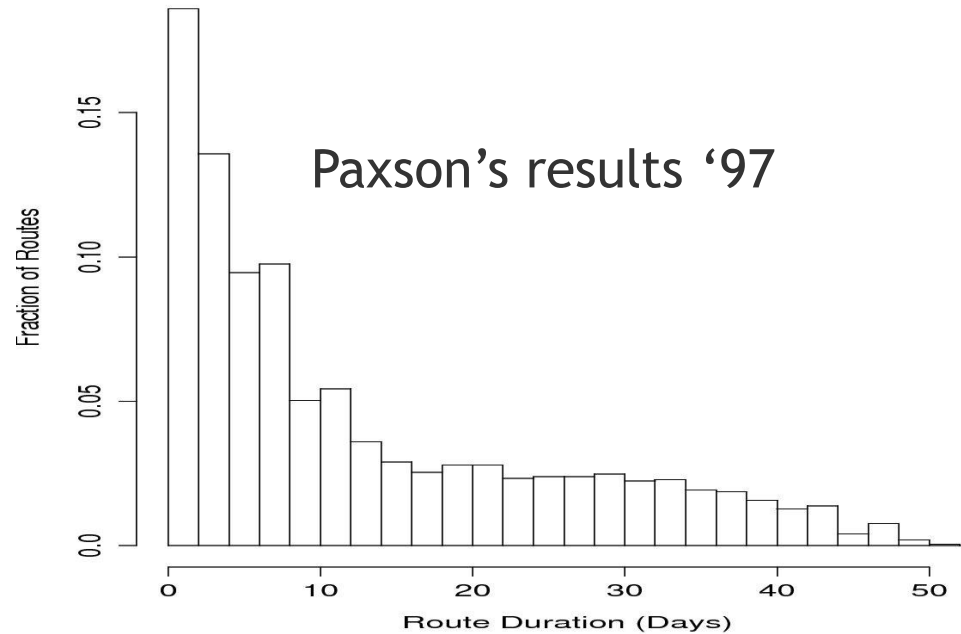


# Route stability is similar to 13 years ago

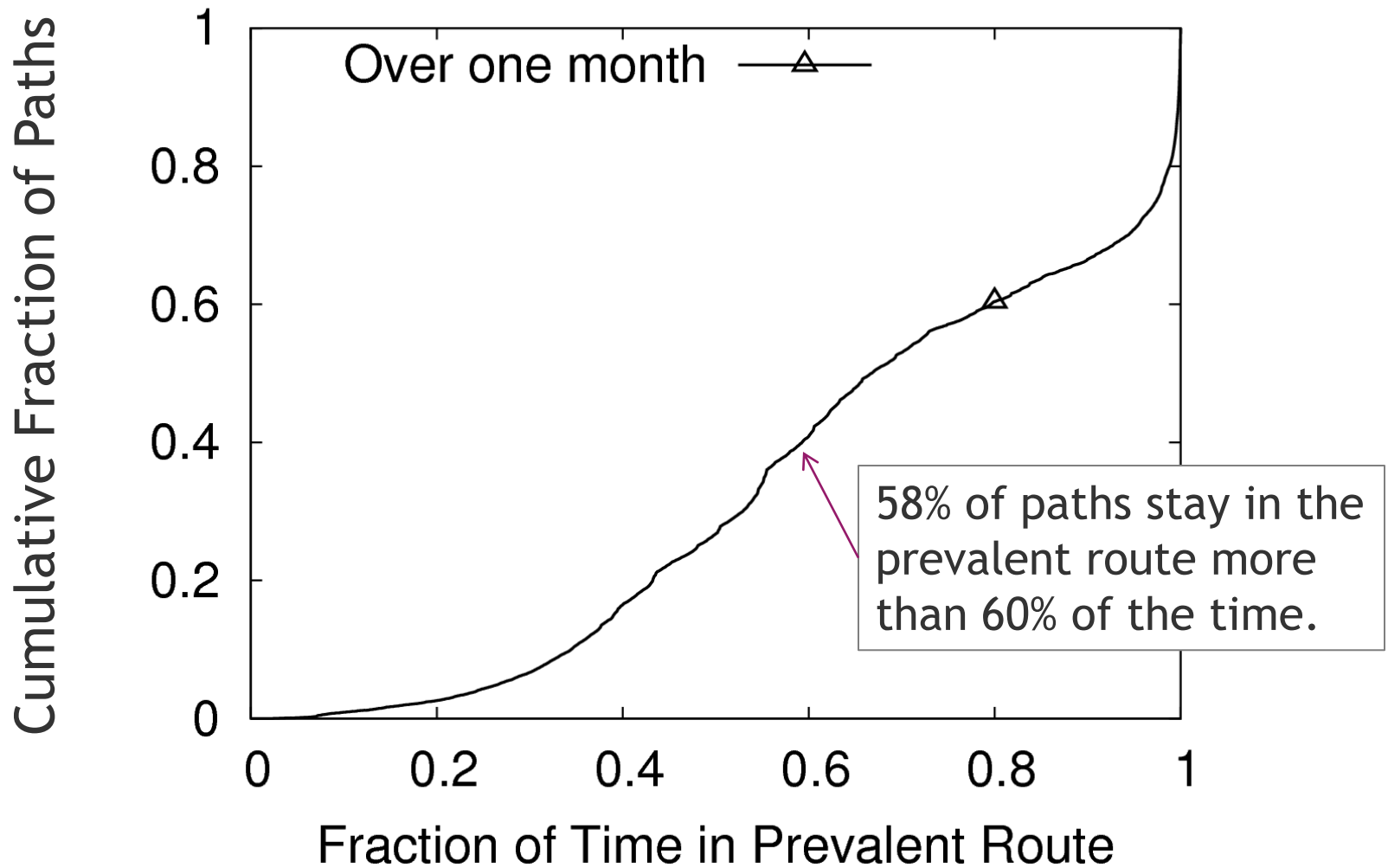
Today



Paxson's results '97

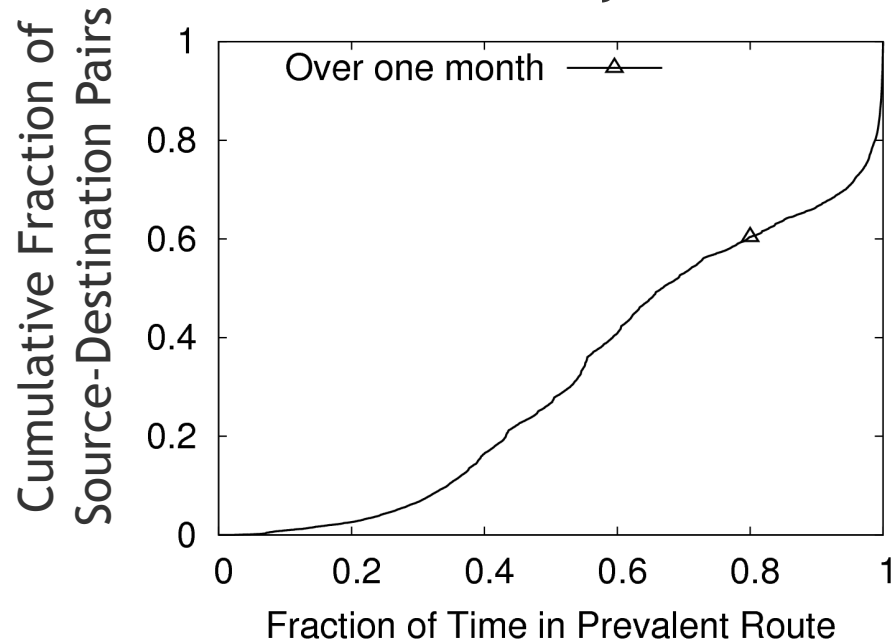


# Paths have a prevalent route

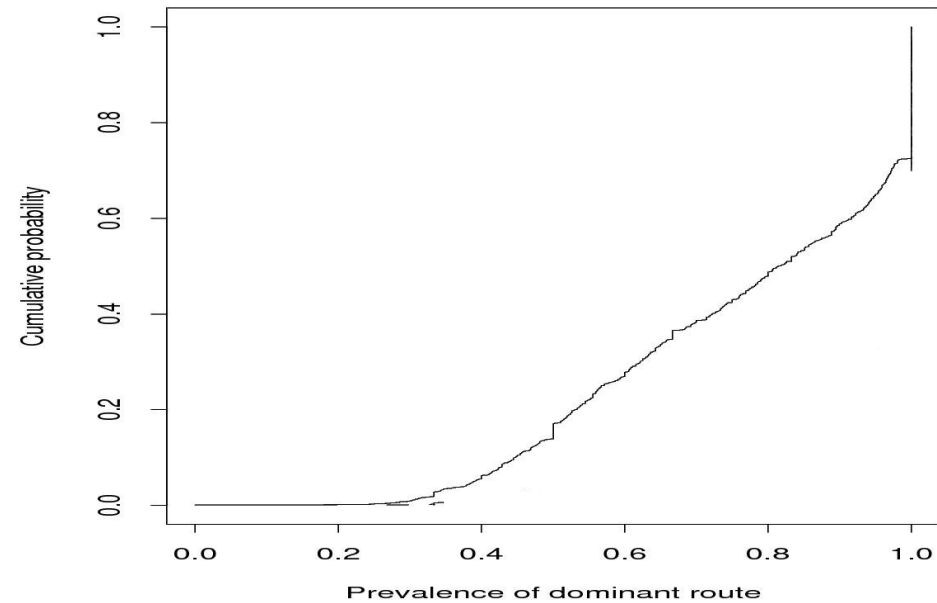


# Route prevalence also similar to 13 years ago

Today



Paxson's results '97



# Summary

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Need to filter out load balancers

- No need to measure load balancers all the time, once a day is enough

Need frequent measurements to see dynamics in instability periods

Results have not changed much since Paxson's evaluation in '97

**Thank you!**

Questions?

# Credits

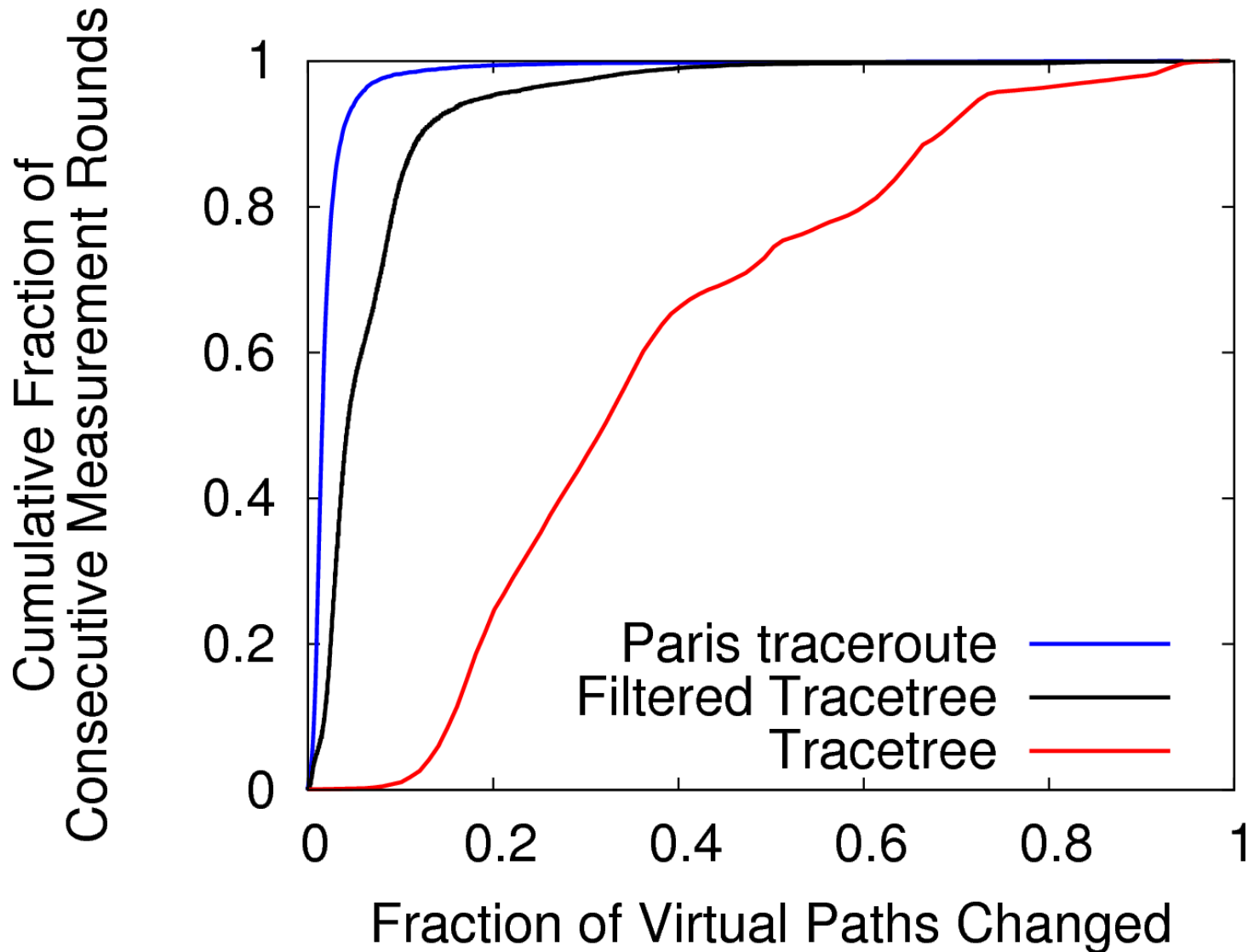
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Internet rendering on the first slide by The Opte Project.

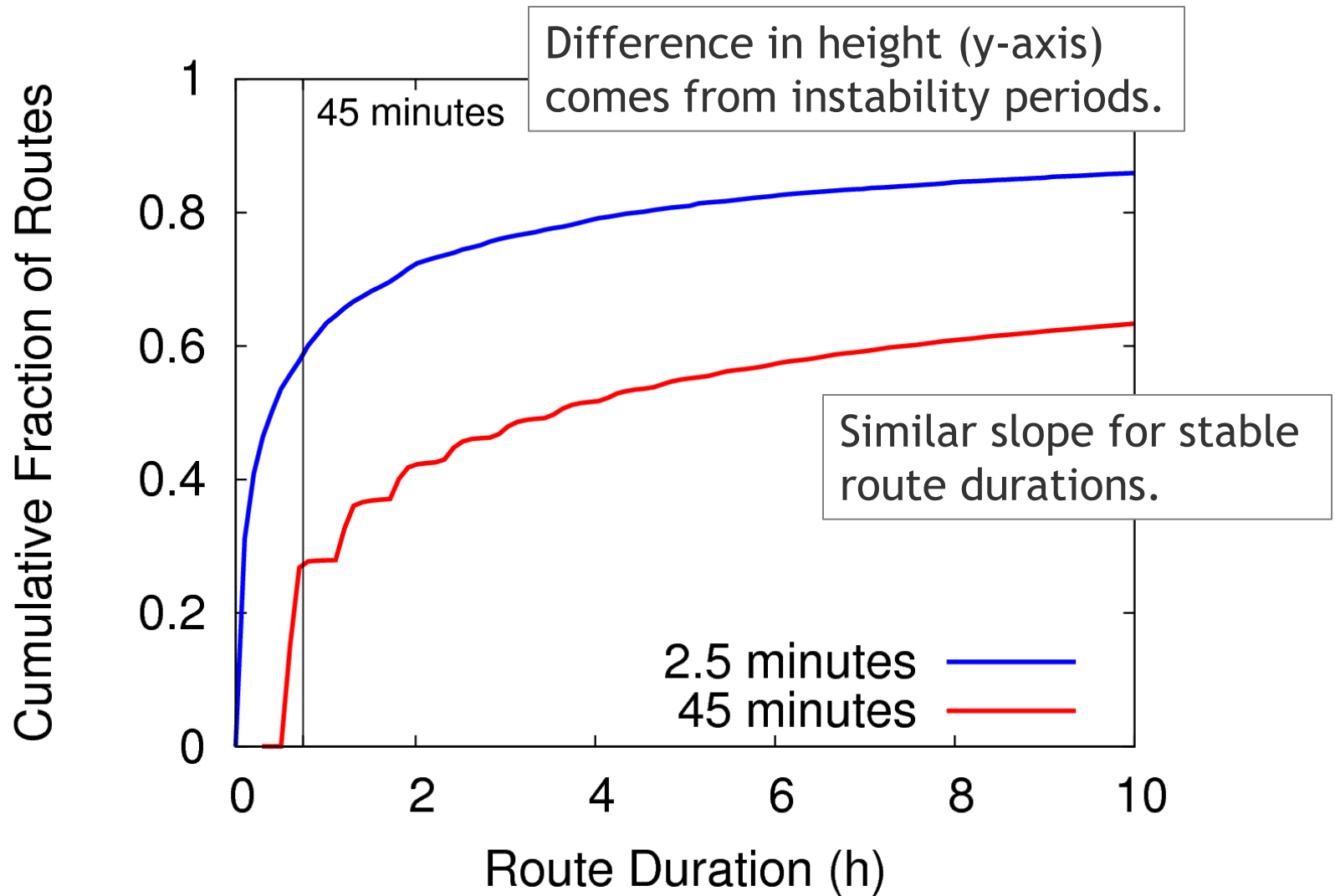




# Filtering load balancers from Tracetest



# Need frequent measurements to see dynamics



# Prevalent routes change over time

