DASU Pushing Experiments to the Internet's Edge

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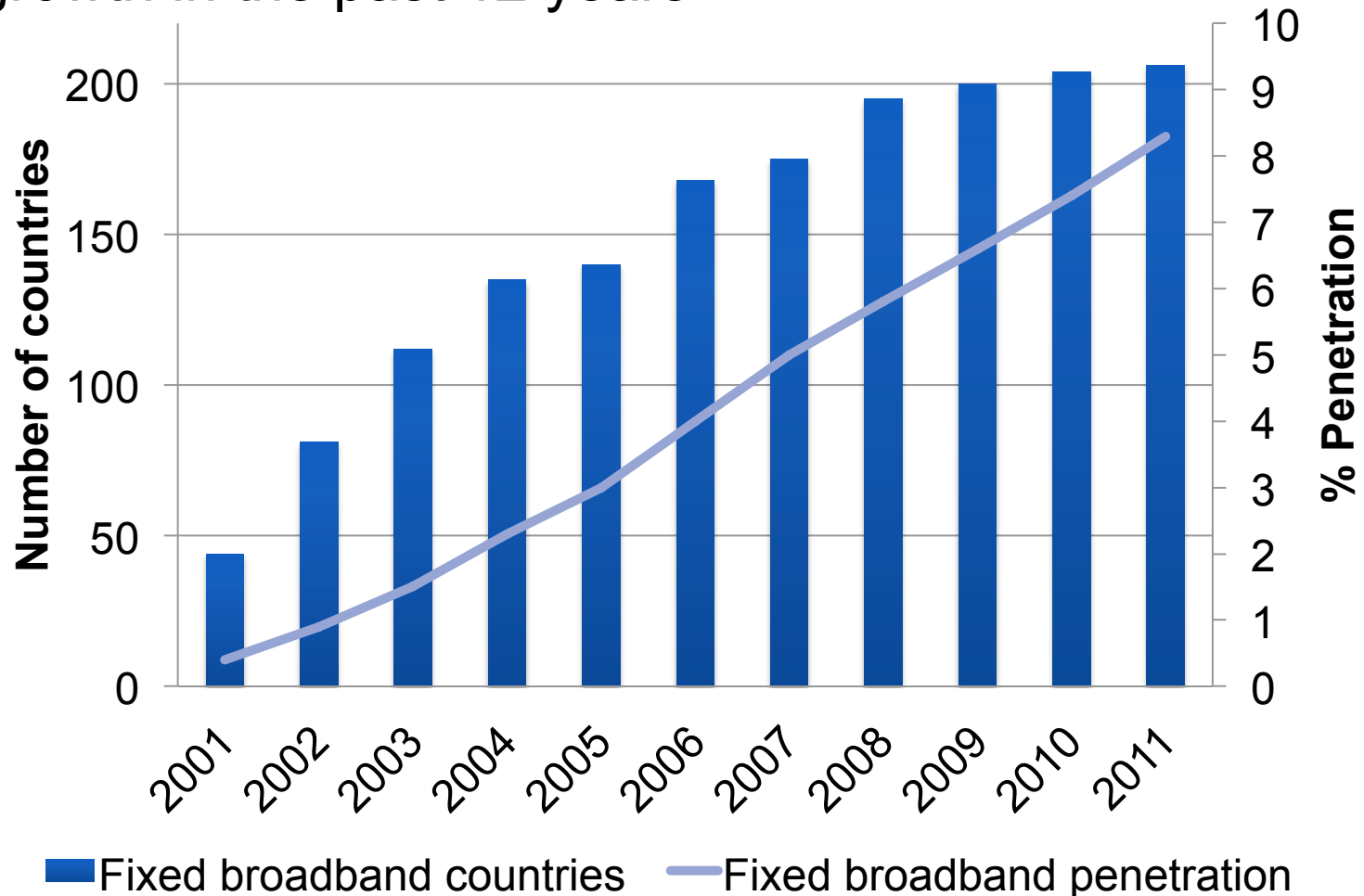
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AT&T Labs-Research

The Internet edge is exploding

34% of global population uses the Internet
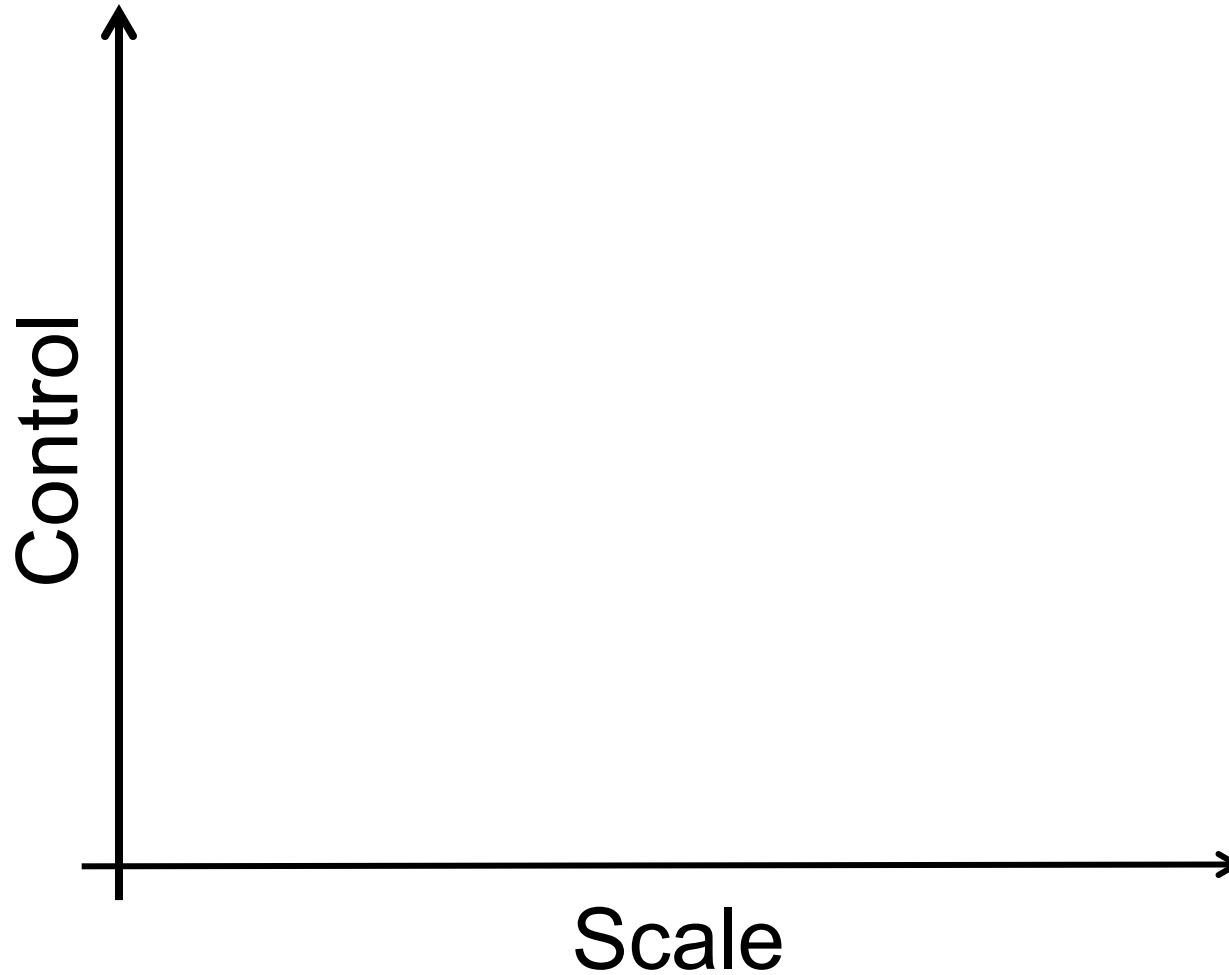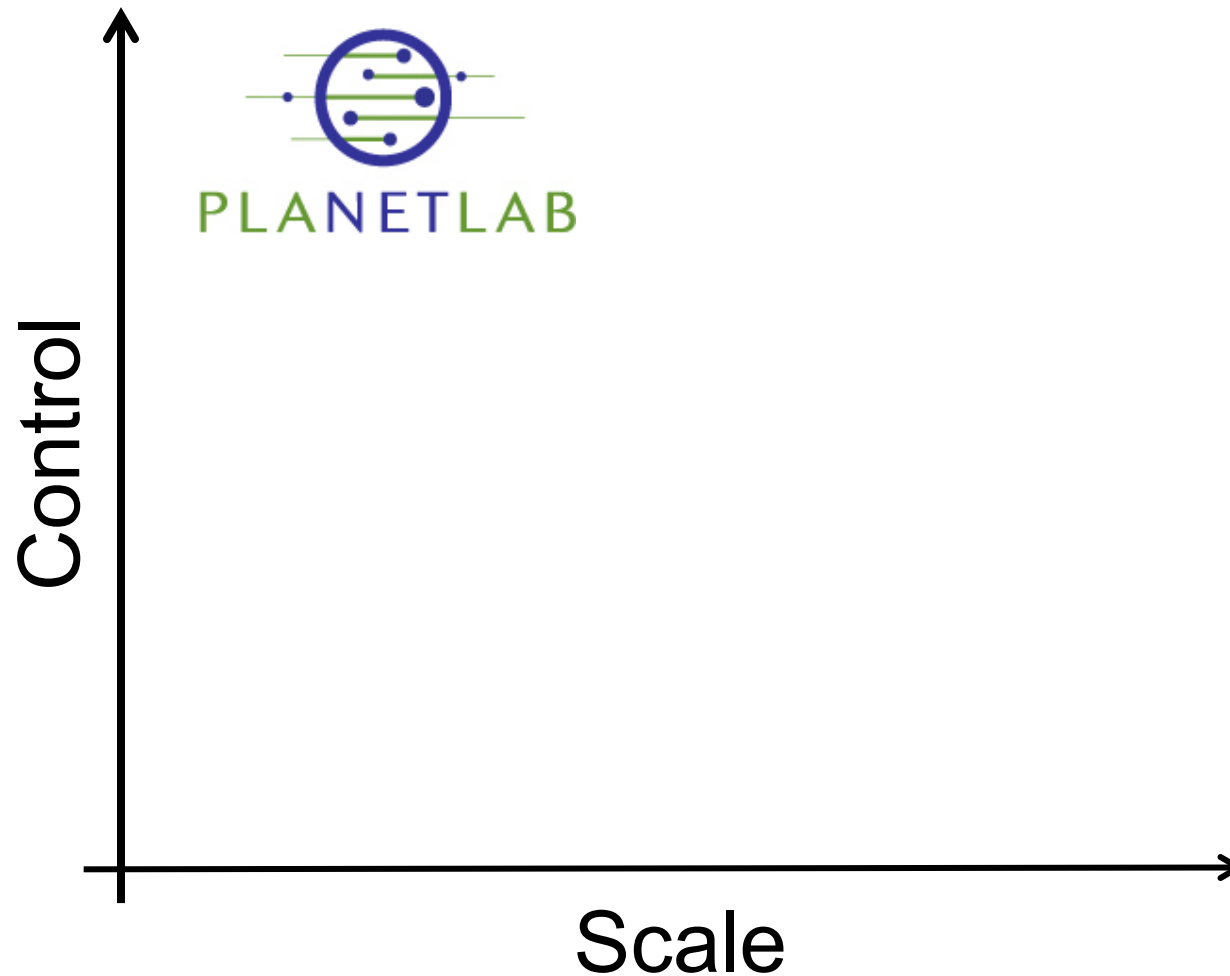
5x growth in the past 12 years

The view from the edge

Many of our systems run at the edge

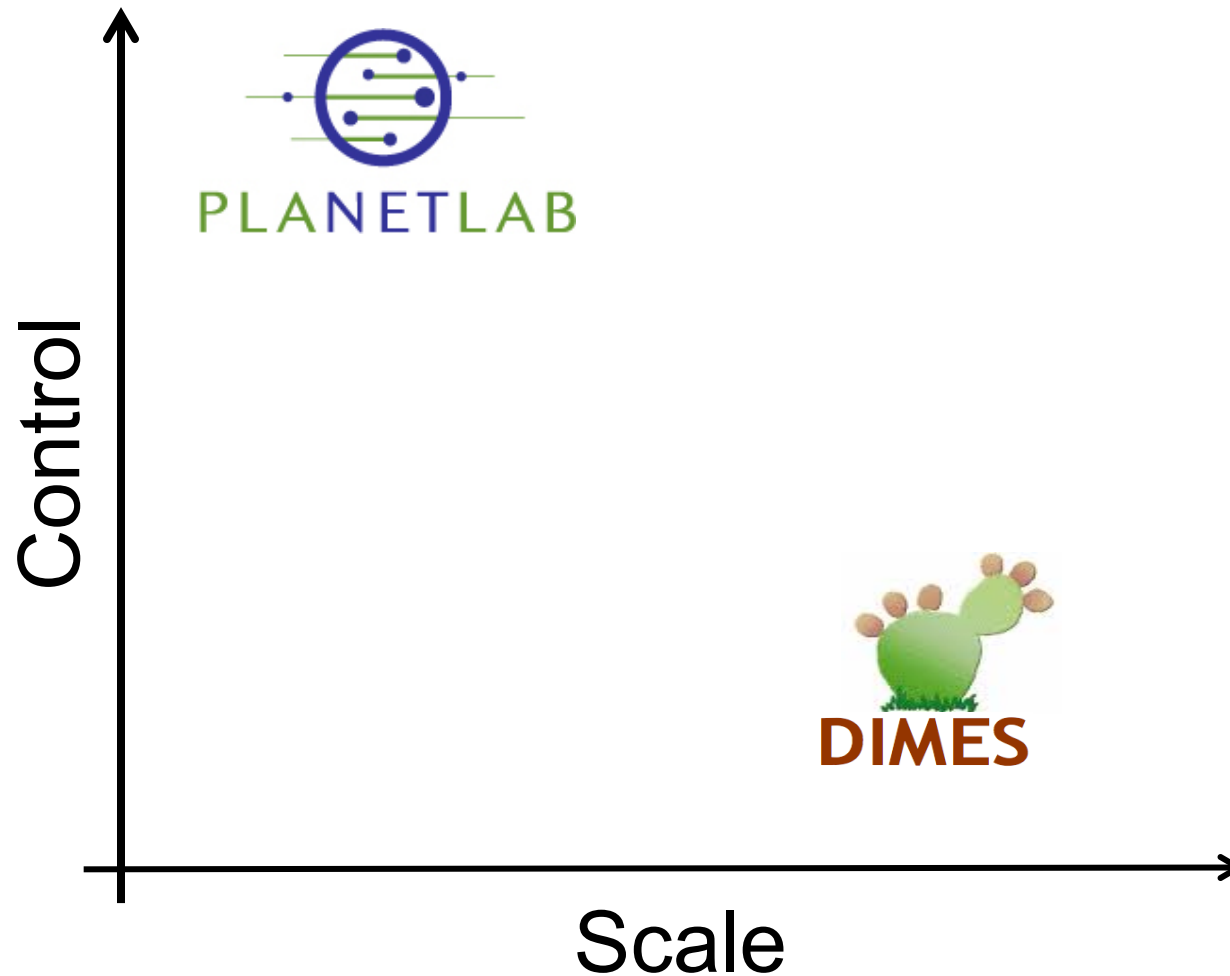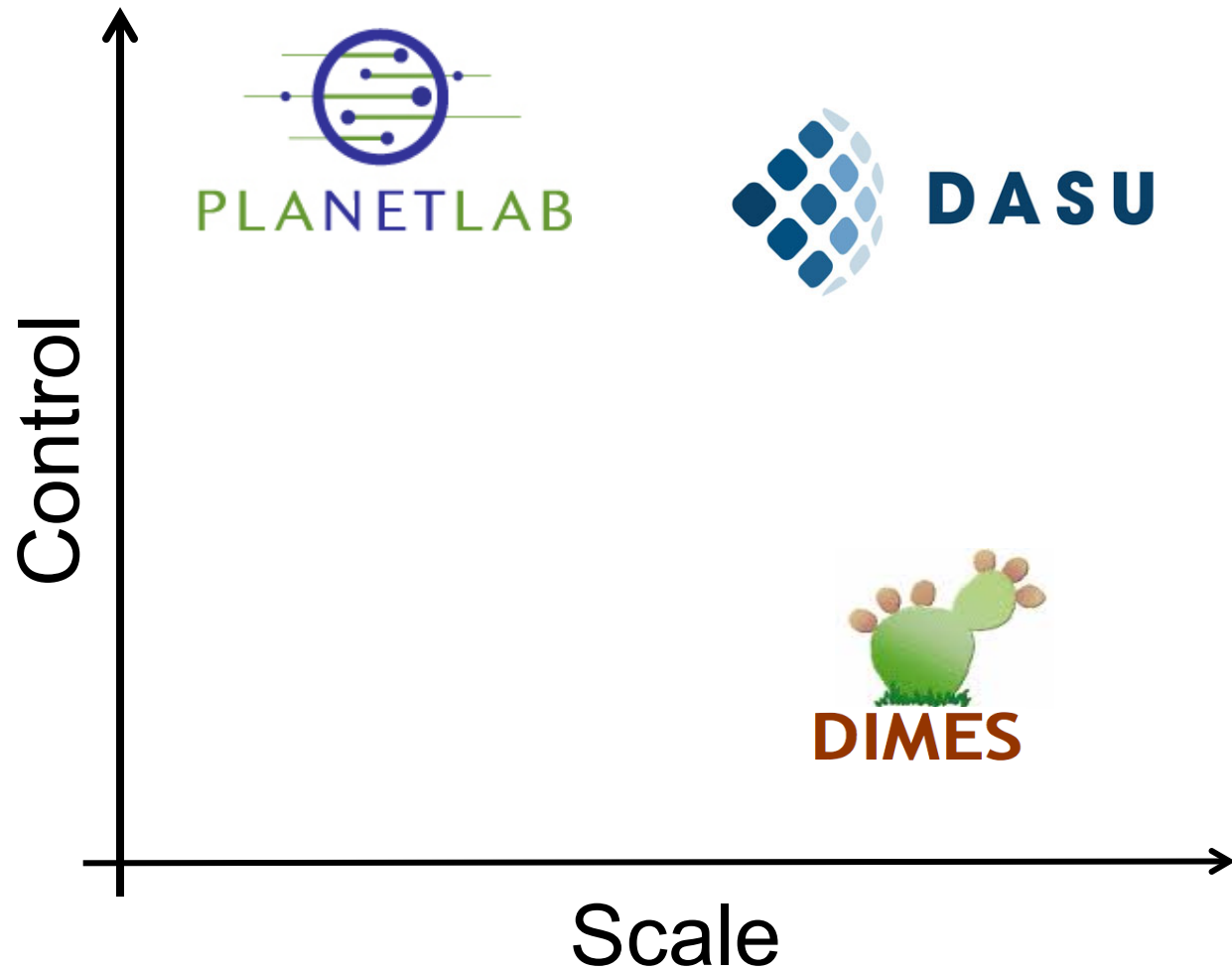Lack platforms to experiment at or even characterize the edge

The view from the edge

Control

Scale

The view from the edge

The view from the edge

The view from the edge

The view from the edge

A flexible experimentation platform hosted by end users

Our work

Hosted by end users, at scale …

Guarantees safety of participants

Controls impact of experiments on underlying network and systems

Shares platform resources among concurrent experiments
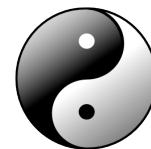
Dasu

A platform prototype

Software-based (BitTorrent ext., for now)

Hosted at the network's edge

Broadband characterization as incentive for adoption
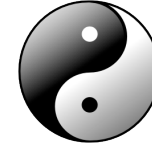
Dasu

Two purposes by design

- – Characterize users' broadband services
- – Support experimentation from the edge

Aligns objectives of end-users and experimenters

Dasu

Two purposes by design

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Aligns objectives of end-users and experimenters

	End-user	Experimenter
Coverage	✔	✔
Availability	✔	✔
At the edge	✔	✔
Extensibility	✔	✔

End-user based platform – Challenges

No dedicated resources
 – We cannot run arbitrary experiments
 – Safety of volunteer nodes is key

Large-scale platform ➔ large-scale *impact*

Highly volatile nodes
 – We cannot run at arbitrary times
 – We cannot run at arbitrary locations

Roadmap

Motivation

Design and implementation

Challenges

A unique perspective

Dasu: Current status

An extension to BitTorrent

  – Soon standalone and in a DNS resolver

Could be hosted by other long-running networked app. (e.g. Skype, IPTV)

Over 90,000 users (>150 countries)
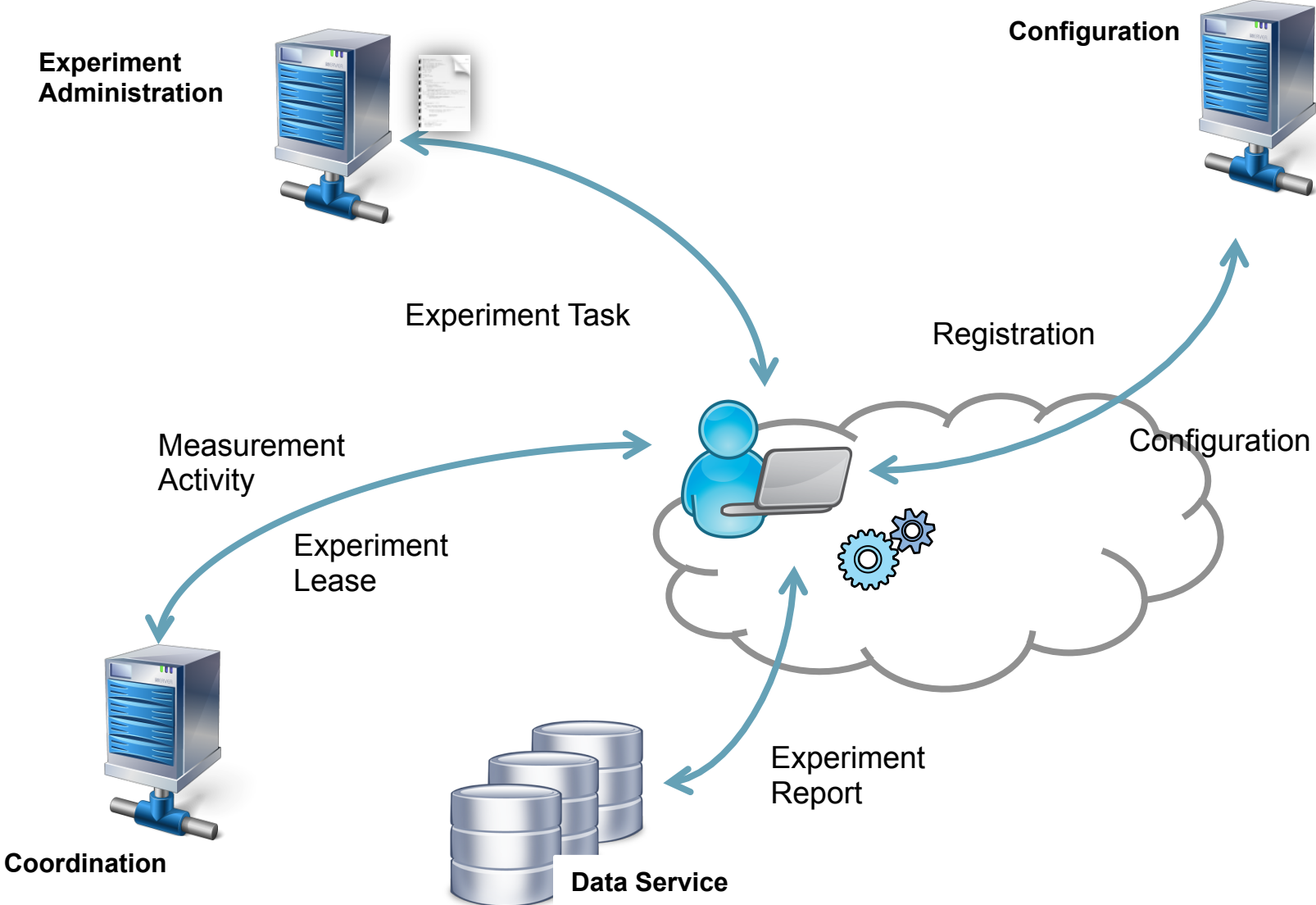*with almost no advertisement*

Guiding goals...

Programmable platform

– To run general measurement experiments

Reduce effort needed to develop/deploy large-scale measurements

Design: System components

Experiment Administration

Configuration

Experiment Task

Registration

Configuration

Measurement Activity

Experiment Lease

Coordination

Experiment Report

Data Service

Design: Experiment specification

package package-name

Imports

variable declaration

    - global

    - local

functions

rules

```
dialect "java"
package edu.northwestern.dasu.drools

import edu.northwestern.dasu.drools.*;

global FactHalt halt;

declare TestResult
    taskId : String
    todoList : List
    pingList : List
end

function void ping(String ip, int taskId)
{

  AMCoordinator.addProbeTask(
    taskId, ip, ProbeType.PING);

}
```

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Design: Experiment specification

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functions

rule "name"

    when

      ...

    then

      ...

end

```
rule "Process Probes"

    when
        $tr : TestResult();
        $ping : FactProbePingResult();
    then
        $tr.getPingList().add($ping);
        retract($ping);

        if($tr.getTodoList().size() == 0) {
          AMCoordinator.commitResult(
            "Experiment Name", $tr);
          halt.setHalt(true);
        } else {
          ping($tr.getTodoList().remove(0),
            $tr.getTaskId());
        }
end
```
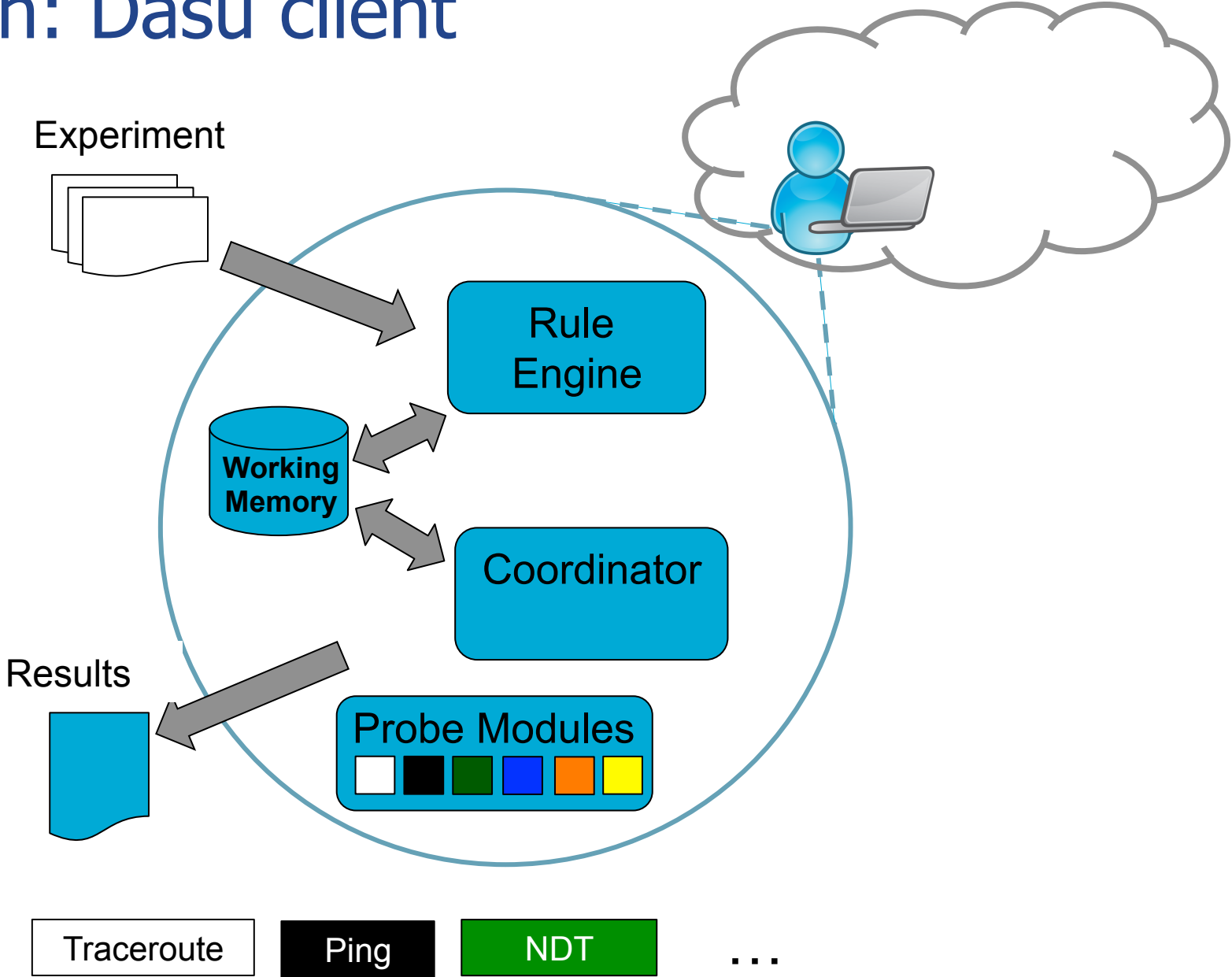
Design: Rule-based programming

Experiment as a combination of rules

Rules drive execution and flow of experiments

Benefits of a declarative model
- Clear and concise
- Easy to check
- Easy to extend

Design: Dasu client

Experiment

Rule Engine

Working Memory

Coordinator

Results

Probe Modules

Traceroute | Ping | NDT | …

Challenges: No dedicated resources

Protecting volunteer nodes

- Sandboxed

  - Import restrictions avoid arbitrary code execution

  - Resource profiler / watchdog timer

- Secure communication of configuration and experiments

Challenges: No dedicated resources

Limit resource consumption

Minimize impact on user's performance:

- Pre-defined probe rates
- Restrict aggregate bandwidth consumption
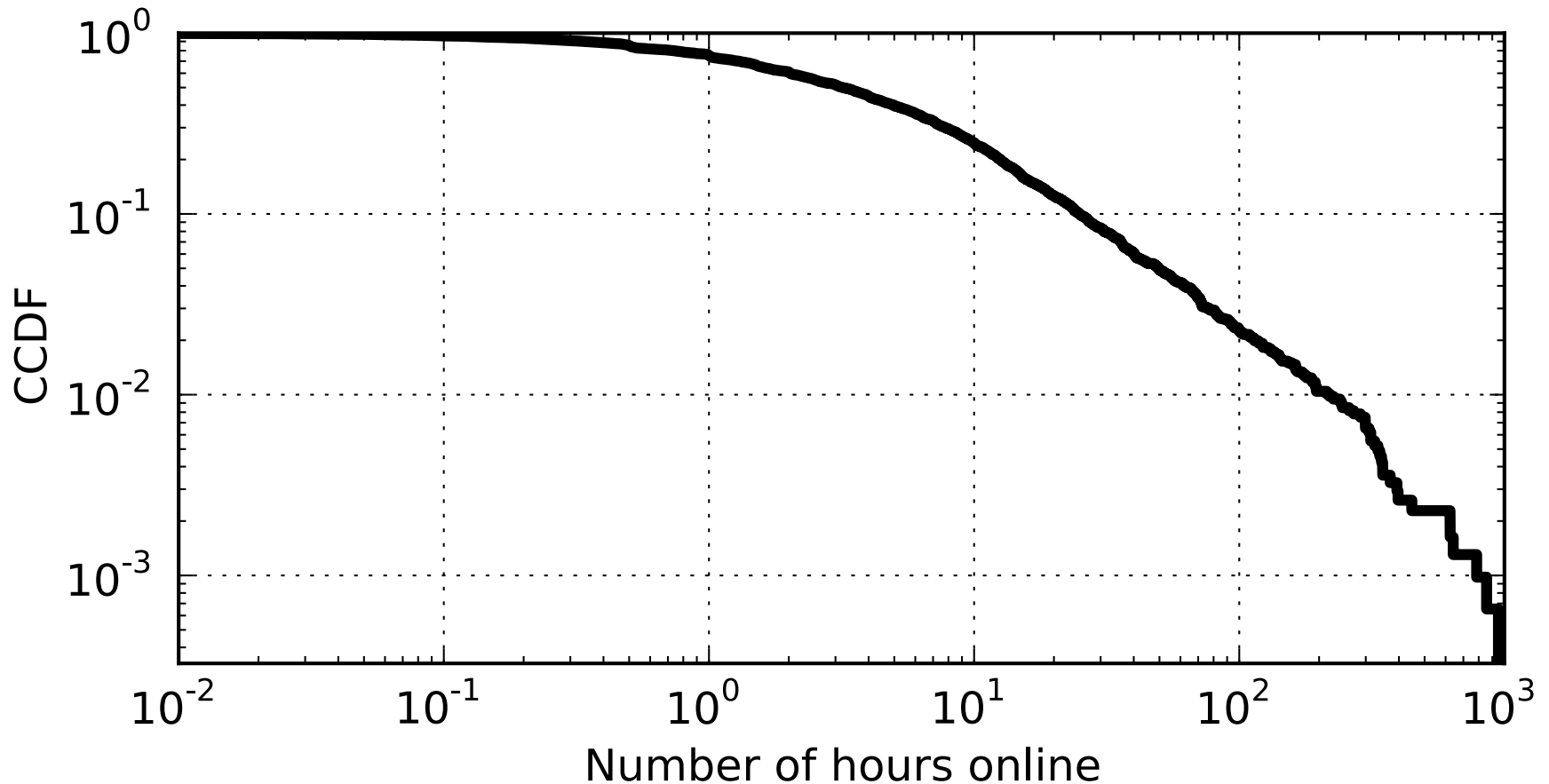- Limit probes to low-utilization periods

Challenges: Impact
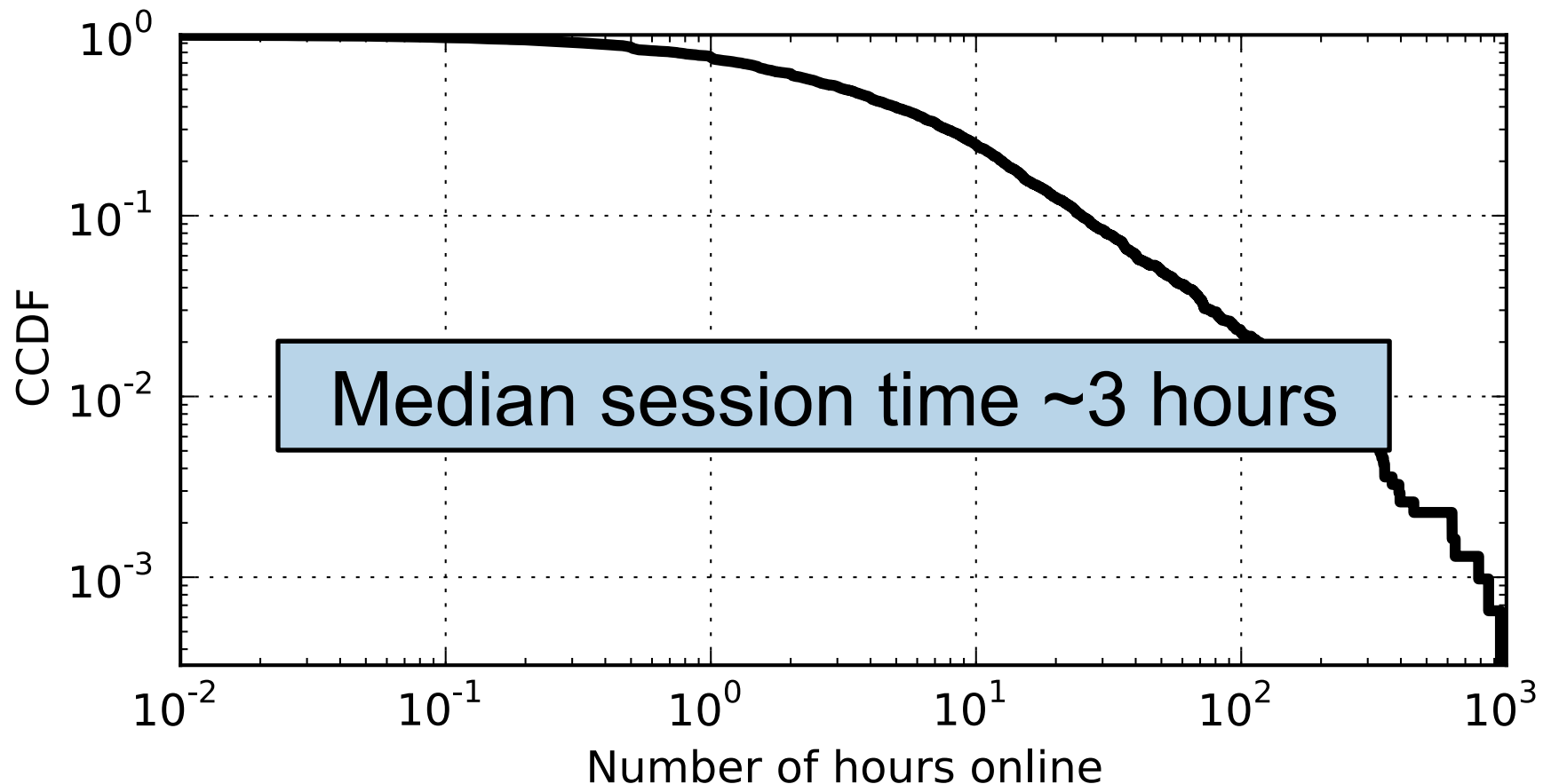
Scaling measurement coordination across participants
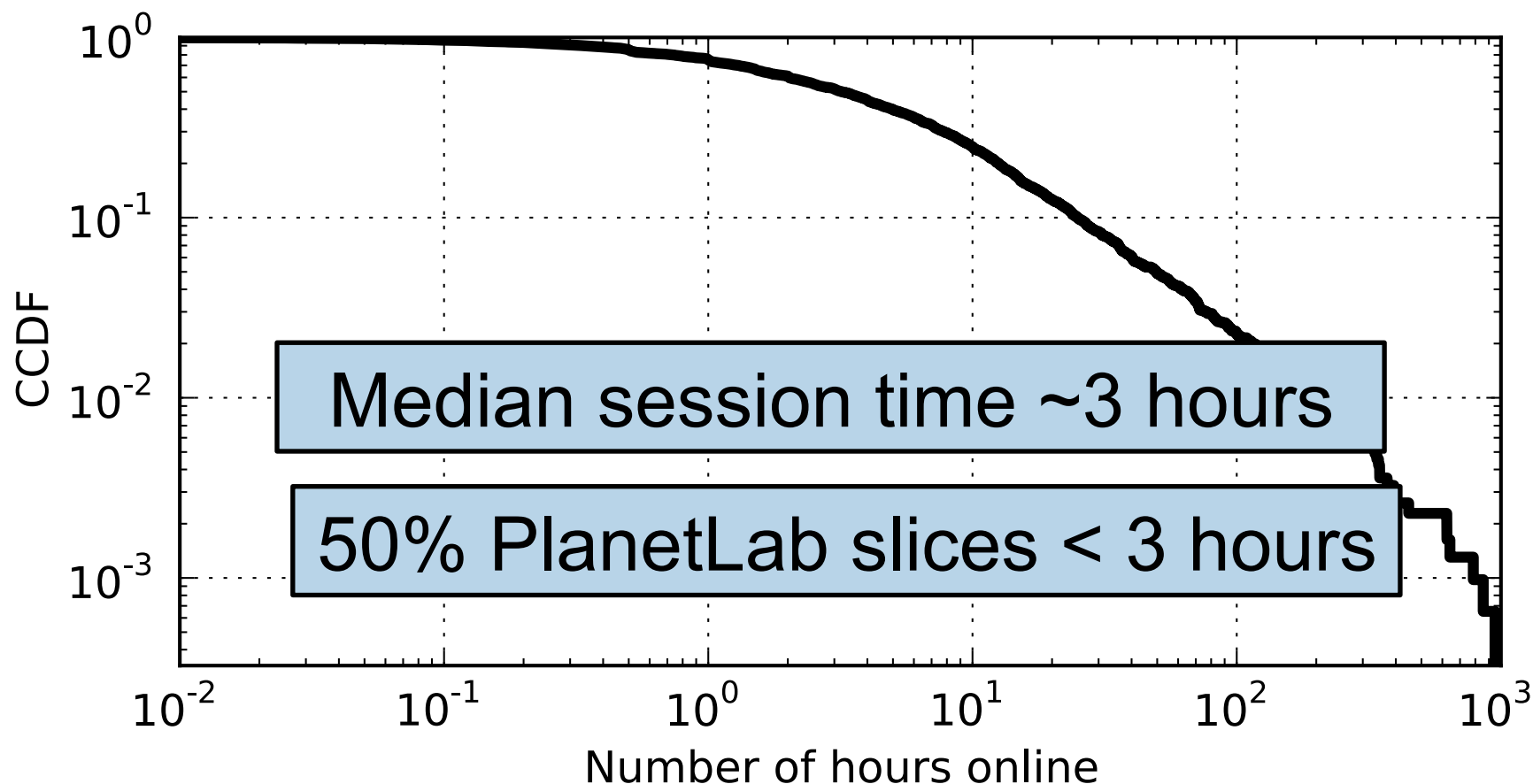
- Experiment leases
- Elastic budgets

Measurement Activity

Coordination

Aggregated Measurement Activity

Experiment Lease

Experiment Lease

Experiment Administration
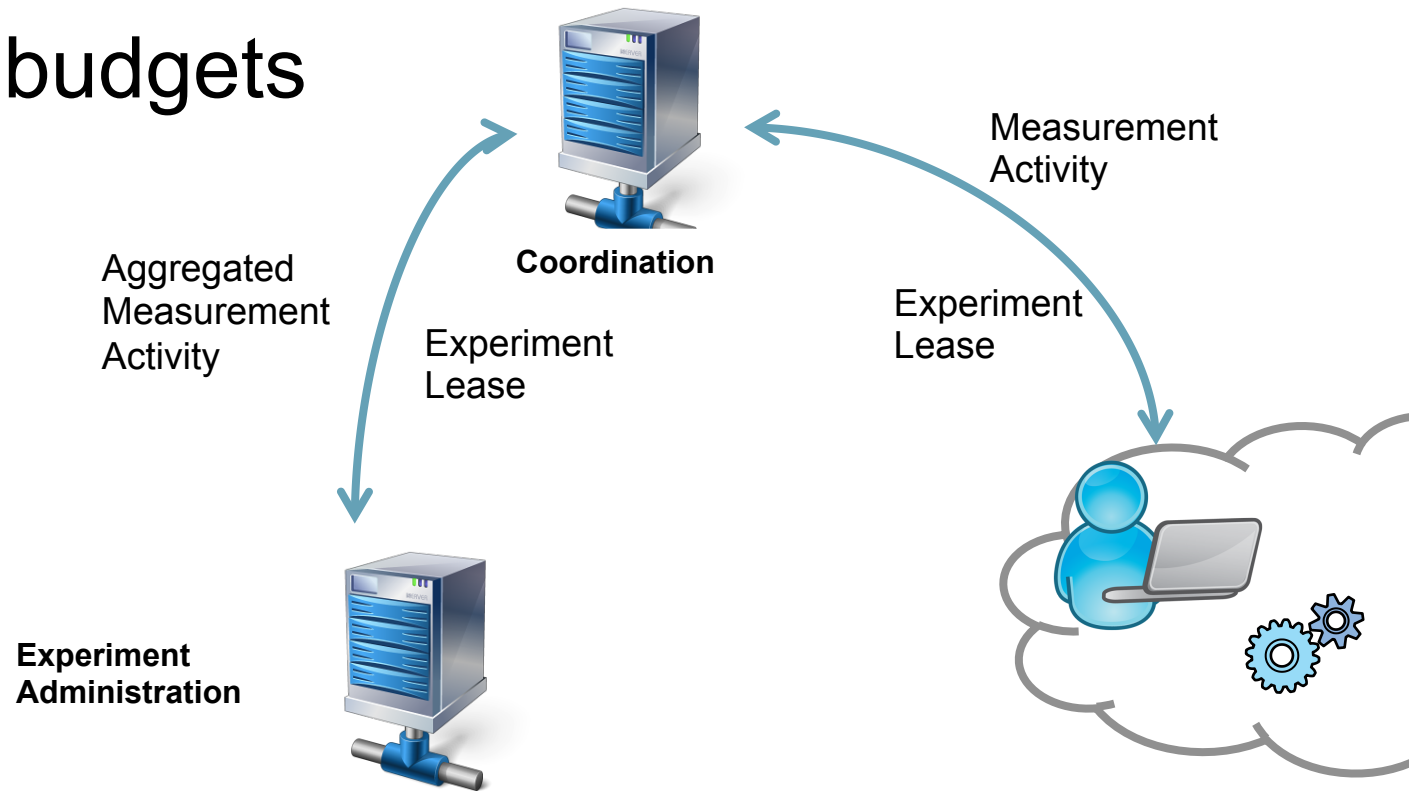
Challenges: Availability and churn

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Median session time ~3 hours

Figure: CCDF versus Number of hours online

Challenges: Availability and churn

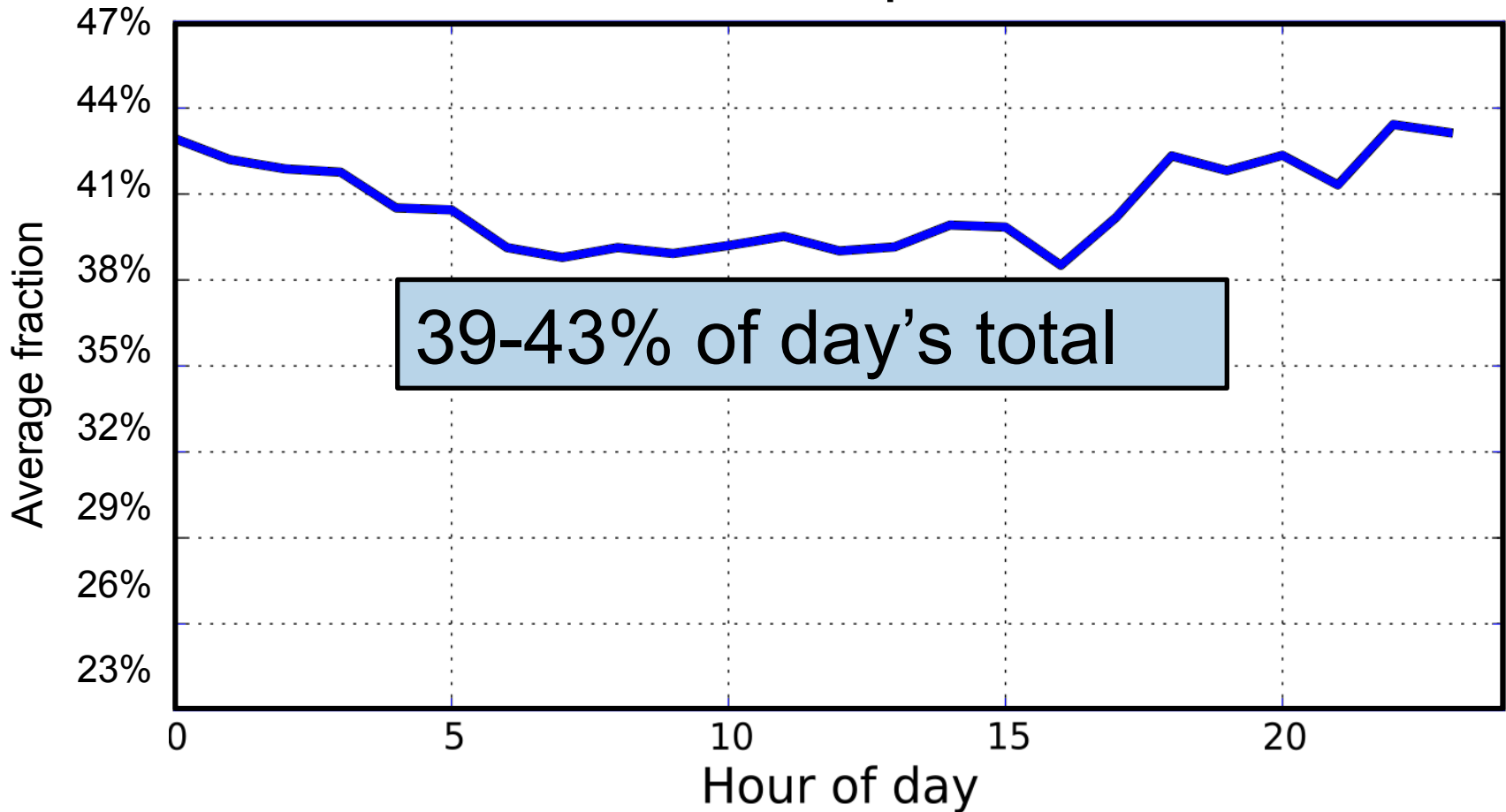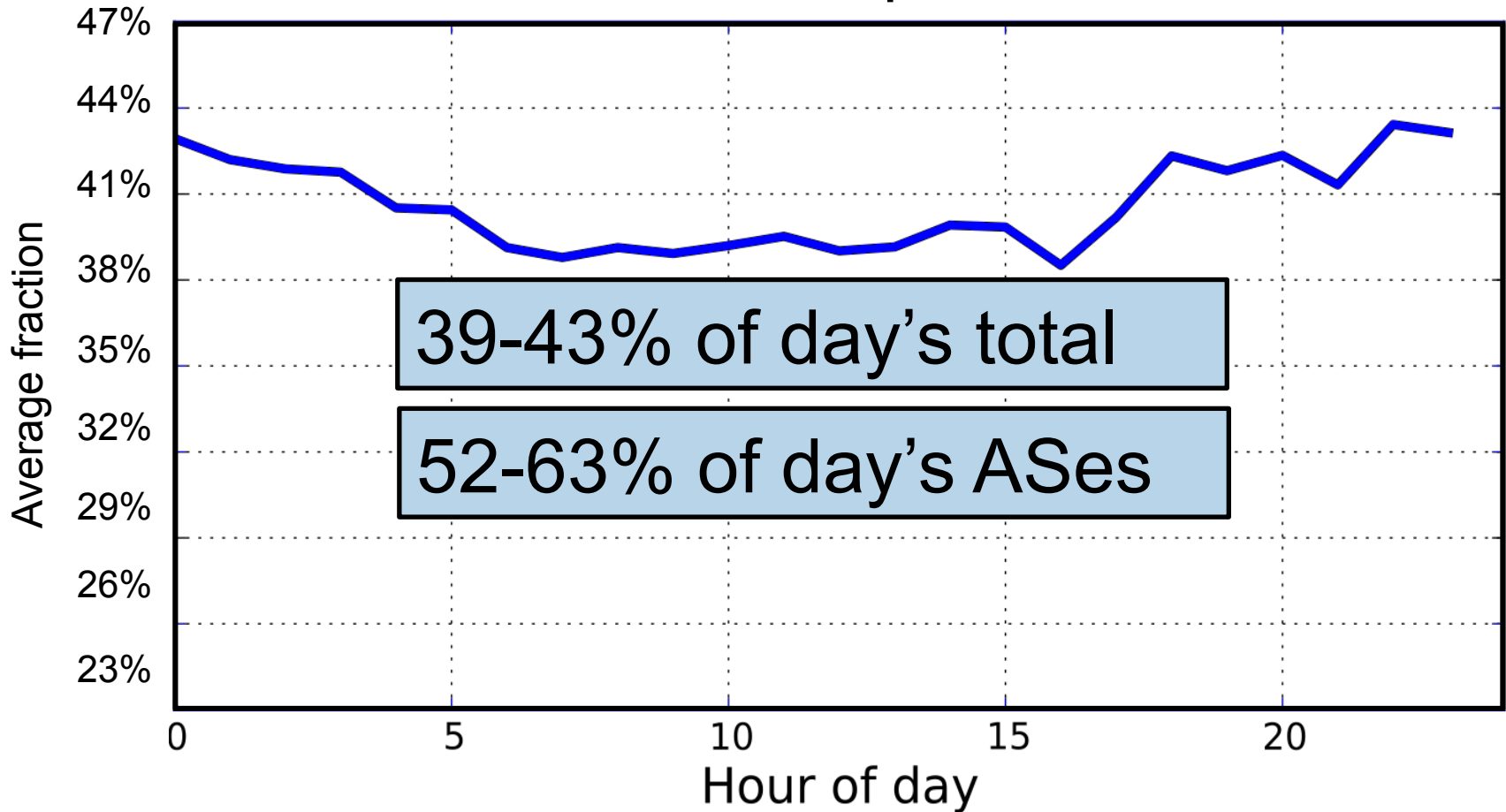CCDF vs Number of hours online

Median session time ~3 hours

50% PlanetLab slices < 3 hours
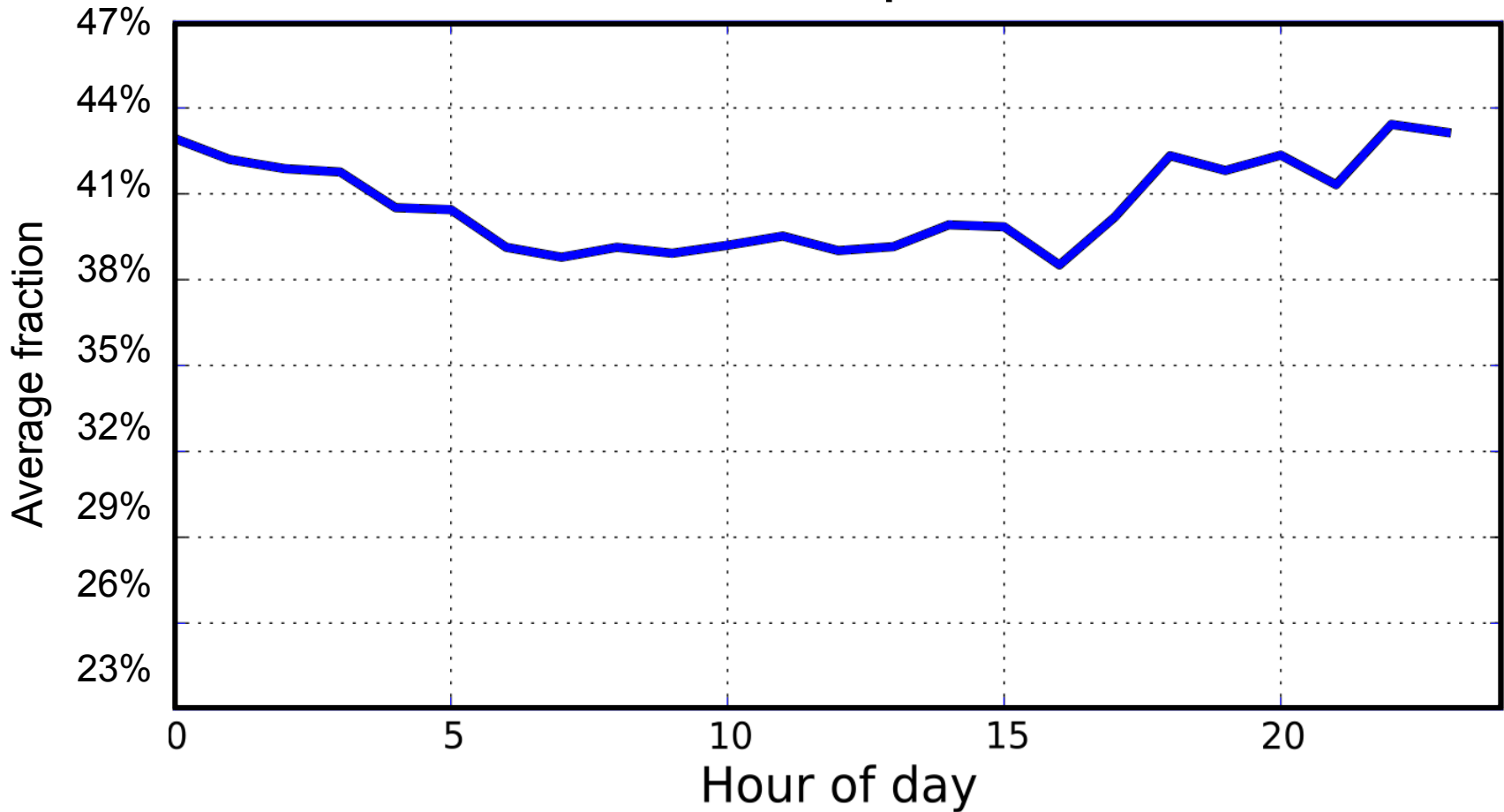
Challenges: Availability and churn

Peers online per hour

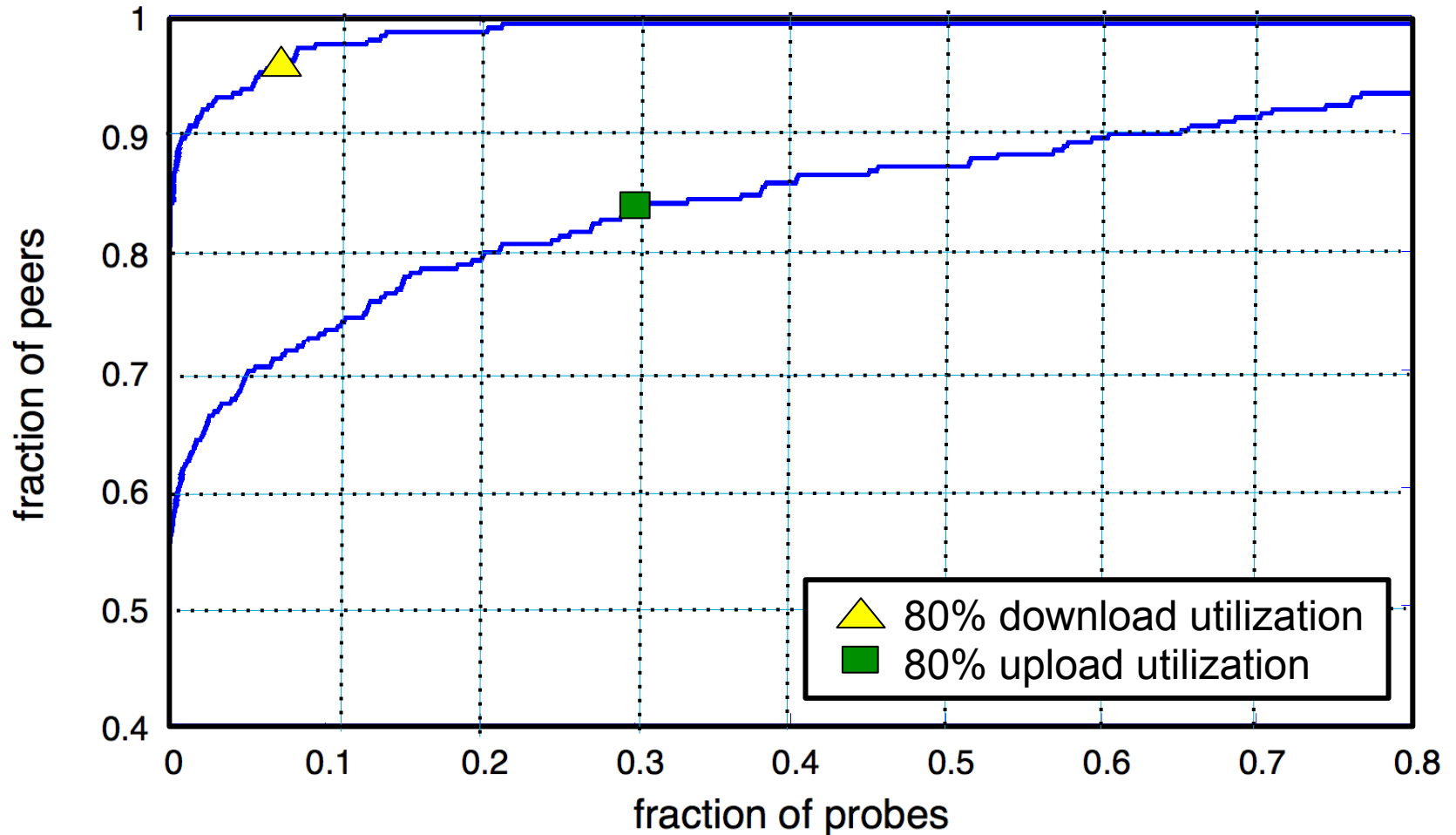# Challenges: Availability and churn

Peers online per hour

39-43% of day's total

Average fraction

Hour of day

Challenges: Availability and churn

Peers online per hour

39-43% of day's total

52-63% of day's ASes

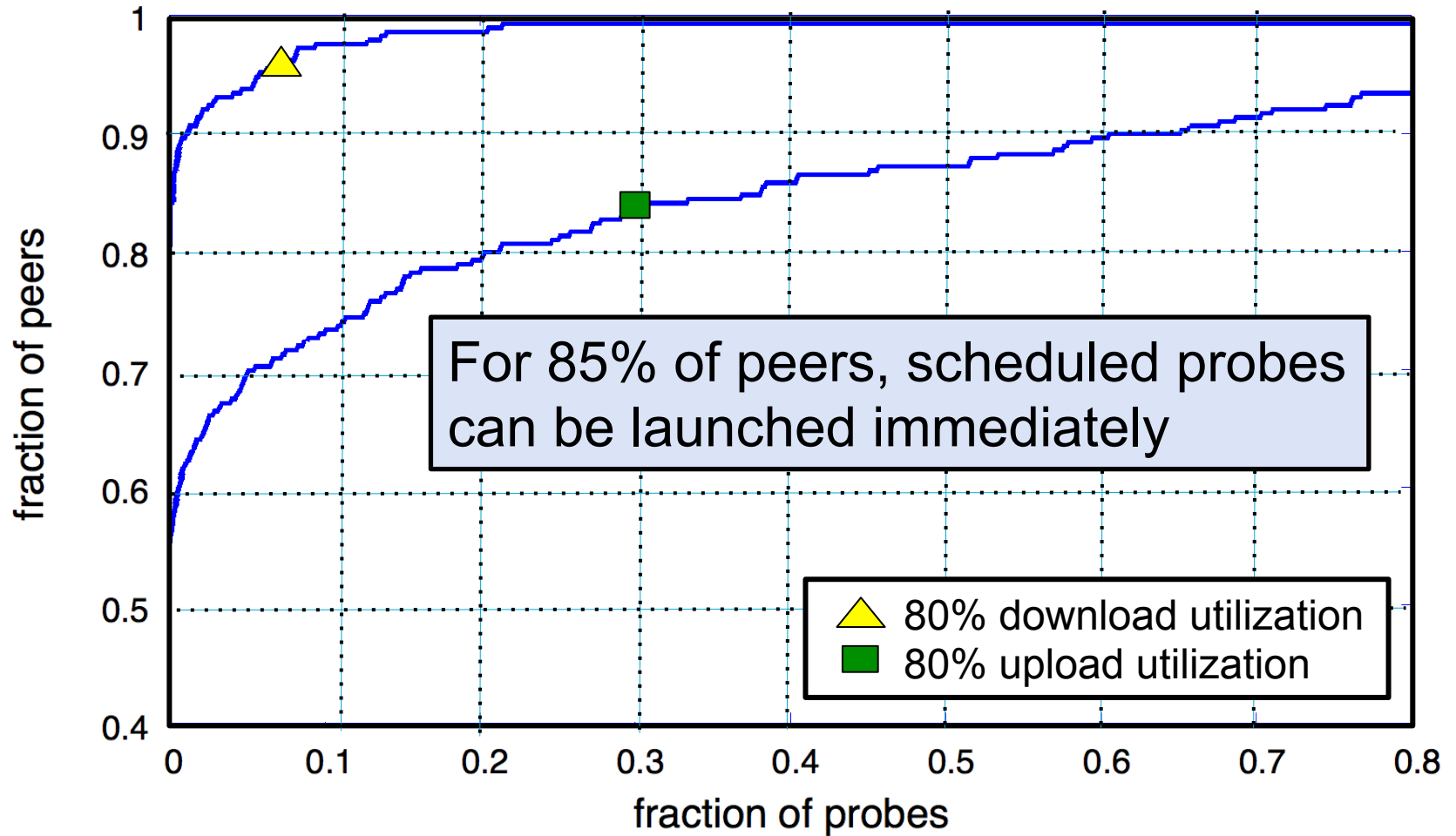# Challenges: Load-control on experiments

Delayed probes per peer

Challenges: Load-control on experiments

Delayed probes per peer

For 85% of peers, scheduled probes can be launched immediately

△ 80% download utilization
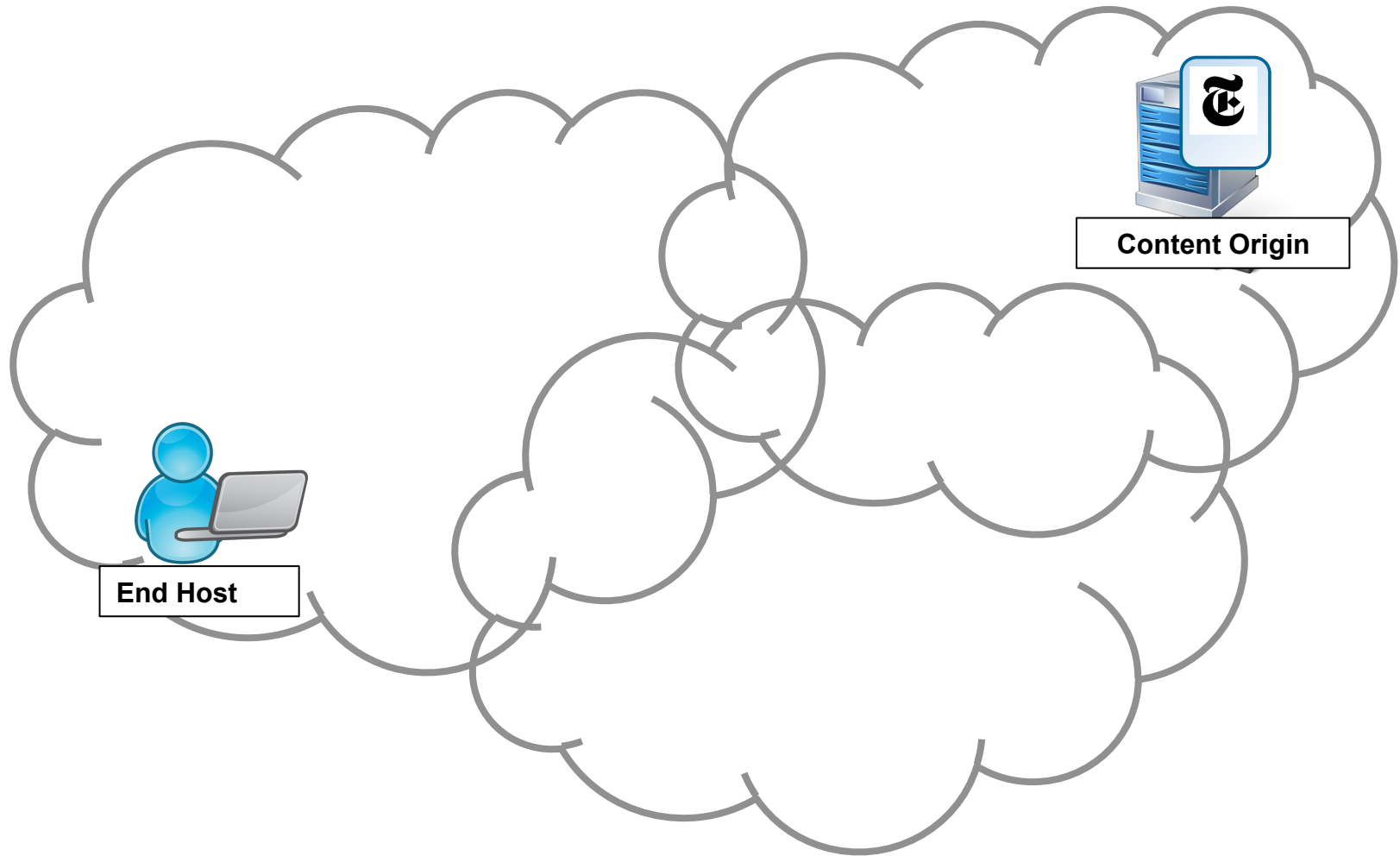■ 80% upload utilization

Illustrating its unique perspective

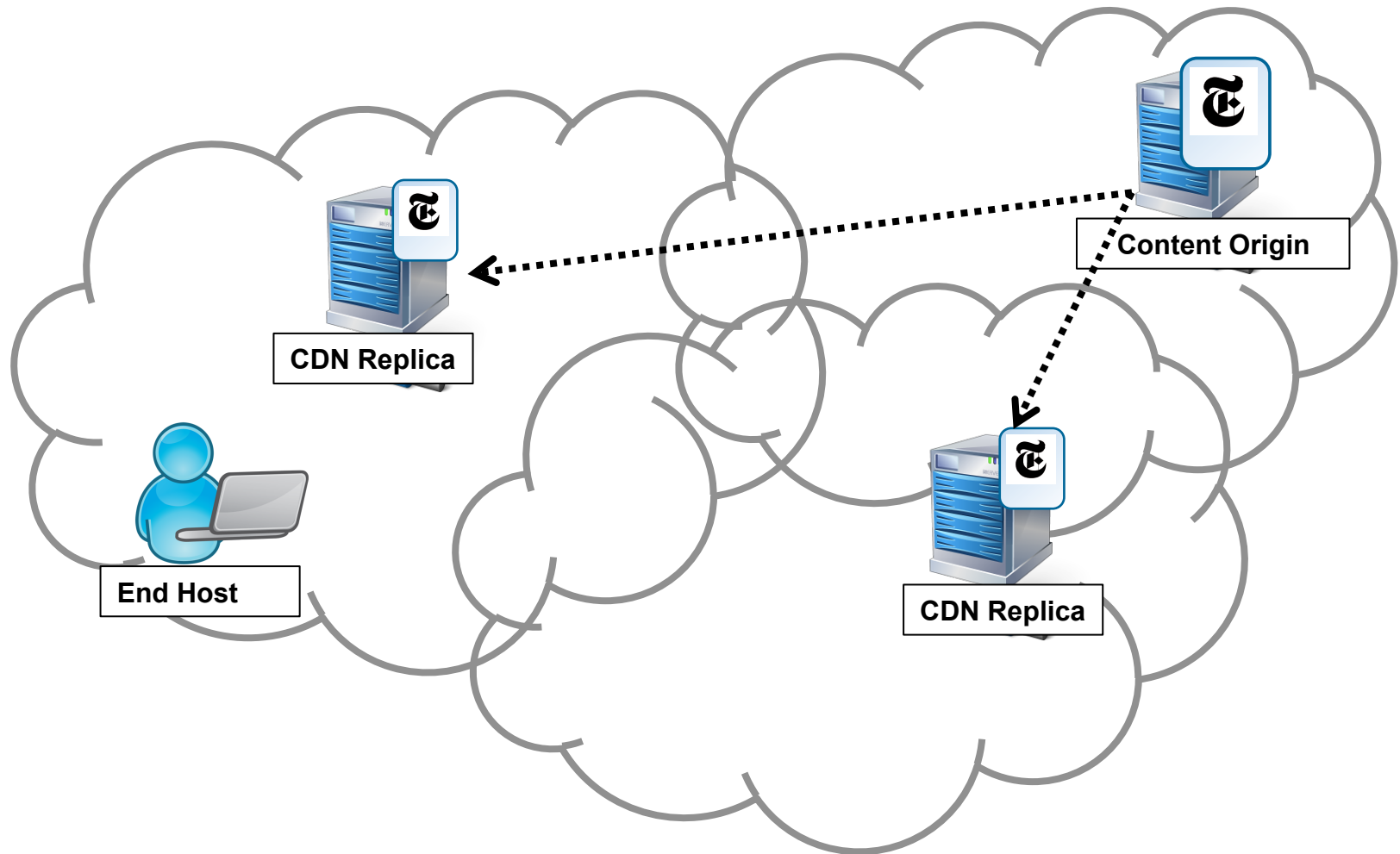Revisiting past experiments: Routing asymmetry, King

Questioning old assumptions: AS-level connectivity

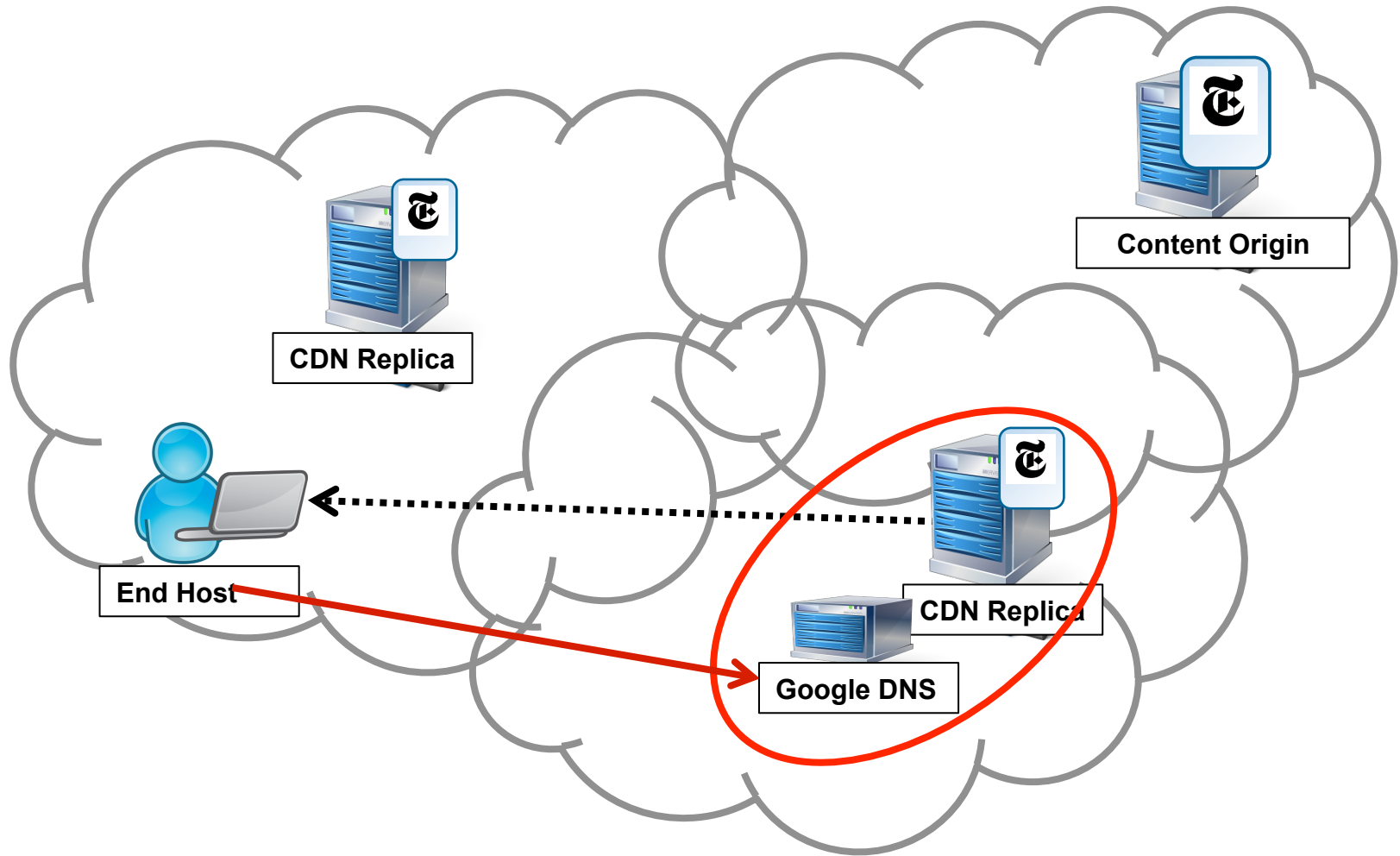**Performing novel experiments: Evaluating a recently-proposed DNS extension**
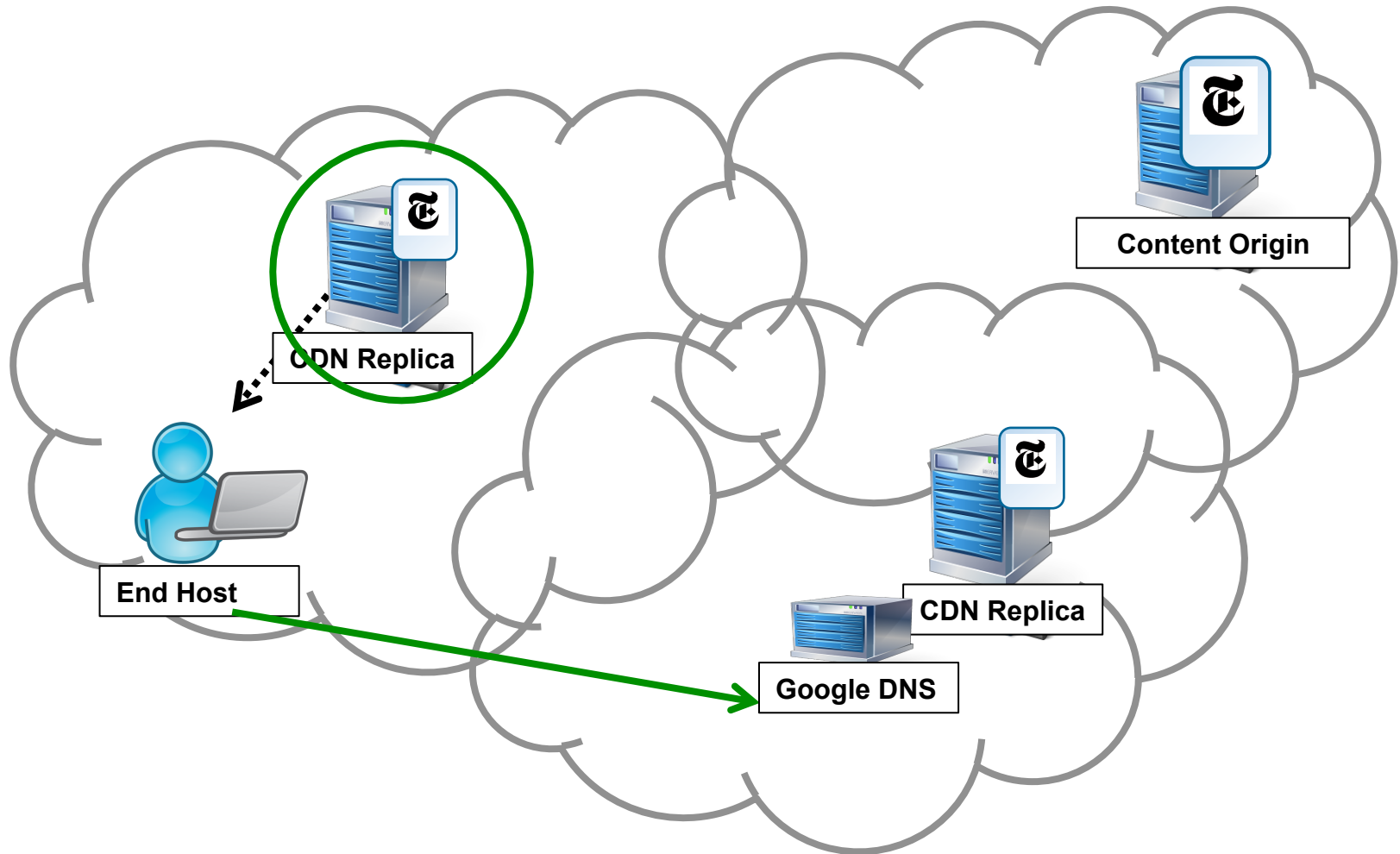
CDNs and DNS-based localization

Content Origin

End Host

CDNs and DNS-based localization

CDNs and DNS-based localization

Content Origin

CDN Replica

End Host

CDN Replica

Google DNS

CDNs and DNS-based localization

DNS extension approach

Idea: Avoid impact of remote DNS usage by directly providing *client location*

A EDNS0 extension "*edns-client-subnet*"

Resolver adds client's IP prefix to request

Is it effective?

Understanding performance benefits
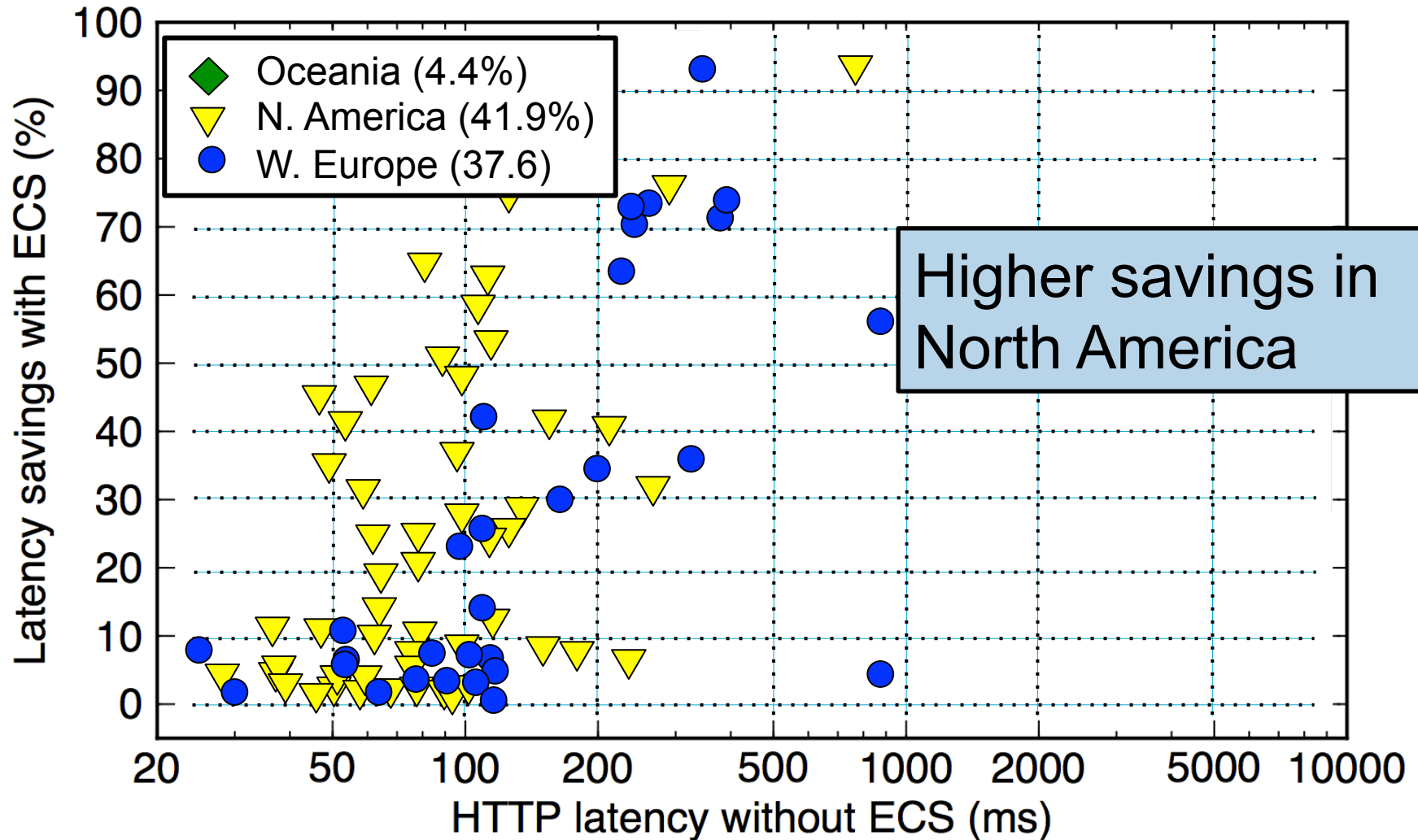
Access to large set of vantage points

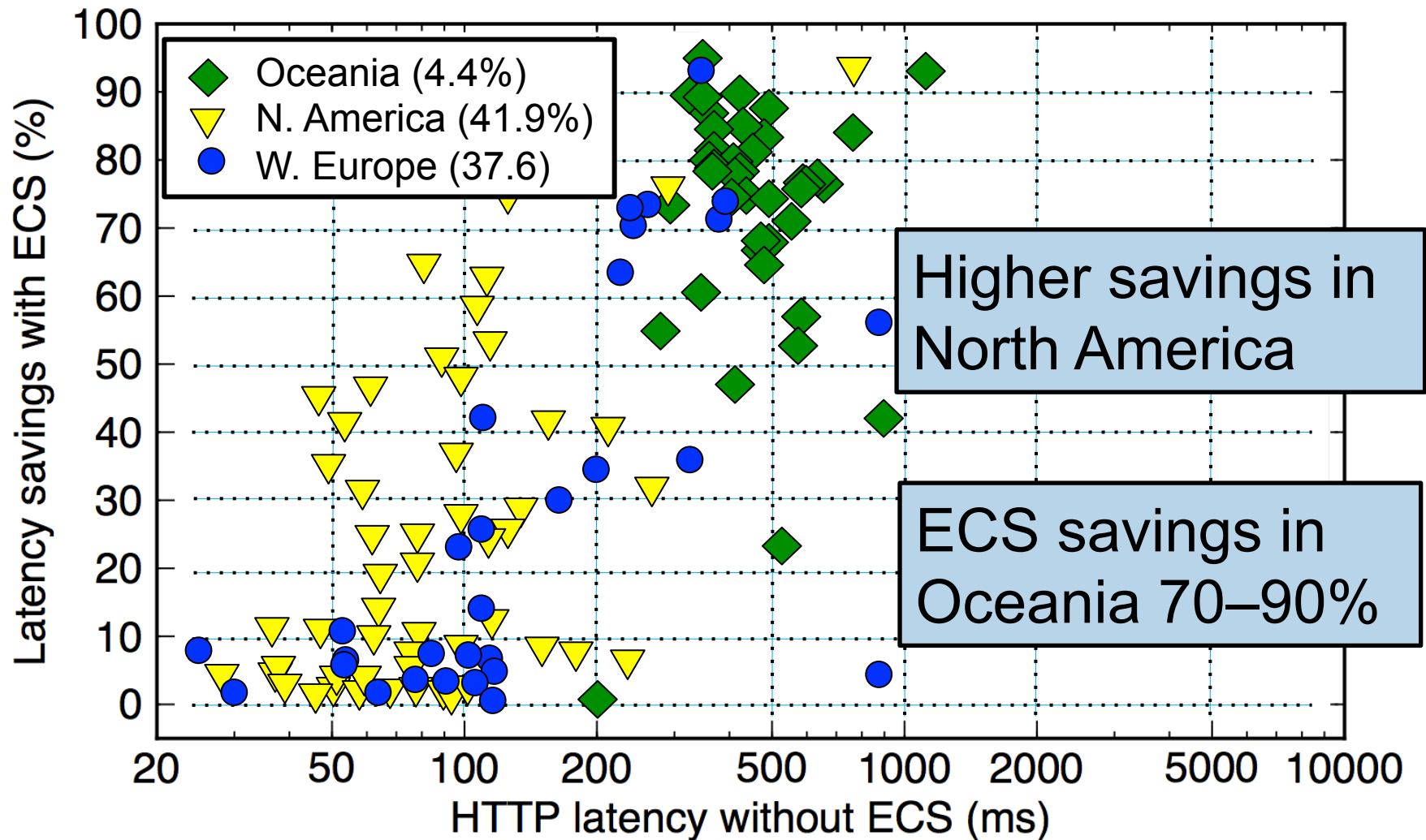Vantage points located around the world

Interrelated measurement probes

Flexible

Evaluating EDNS

Higher savings in North America

Evaluating EDNS

Dasu's first child `namehelp`

… more than *just* better CDN performance

- – Faster lookups with proactive caching
- – Automatic, personalized server selection
- – Graceful handling of DNS outages …

As of this morning – 52,800 users over 147 countries!

http://aqualab.cs.northwestern.edu/projects/namehelp

Summary

Experimental platform for the network edge

Relies on a direct incentive model for adoption
- Rather than relying on the kindness of strangers

Participants collectively offer
- Broad network coverage
- High availability
- Fine-grained control

Contact us to play with it