Columbia University Community Measurement Resources: Routing Experiments for the Cloud Era with the PEERING Testbed & A New Dataset of Packet Captures from a Residential Network

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UFMG

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Updates on two community resources — please use them!

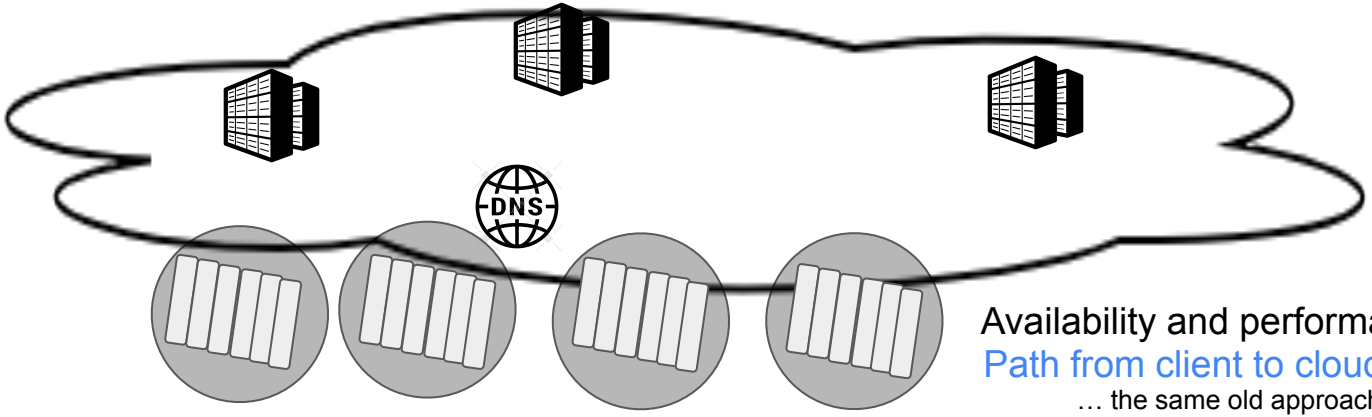
PEERING BGP testbed

- Exchange BGP routes and traffic with thousands of ASes at locations around the world

Residential traffic traces

- Packet traces from ~1000 residences
  - Plan to scale to 8000 units, 24x7

DNS + BGP determine path from client to cloud



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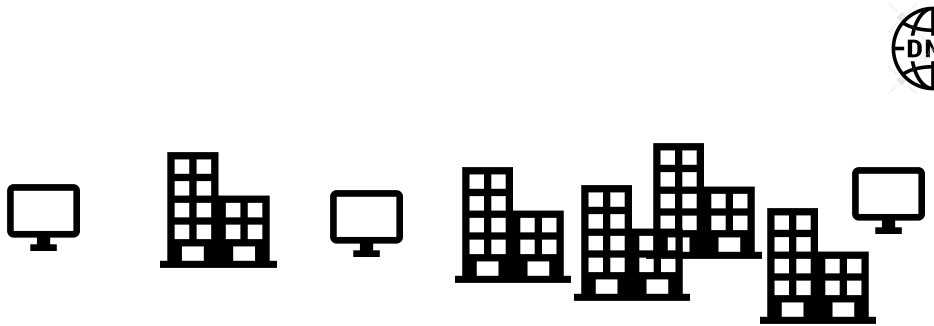

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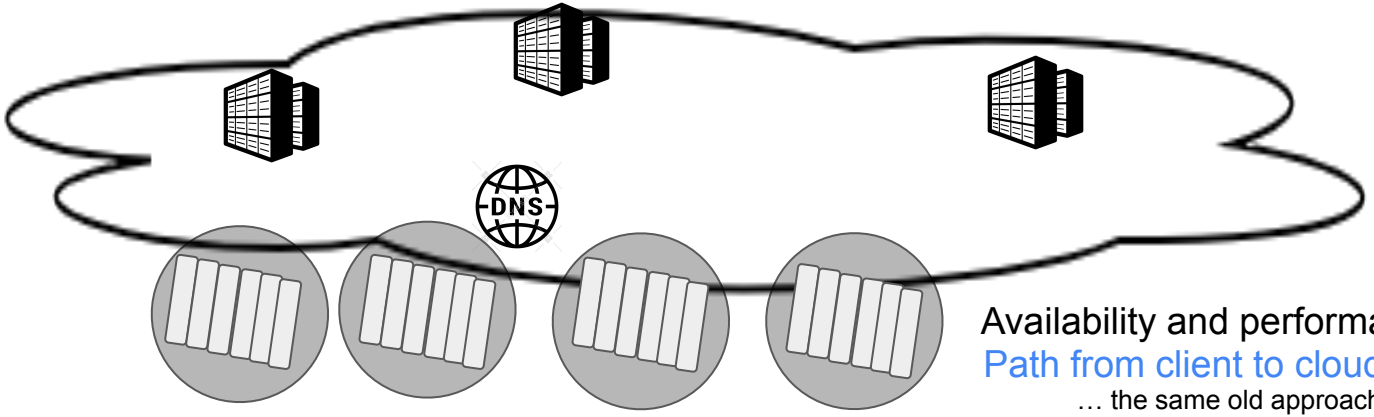

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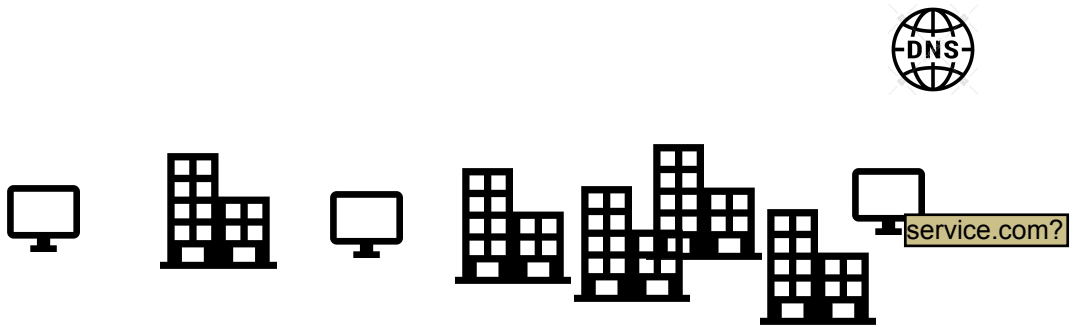

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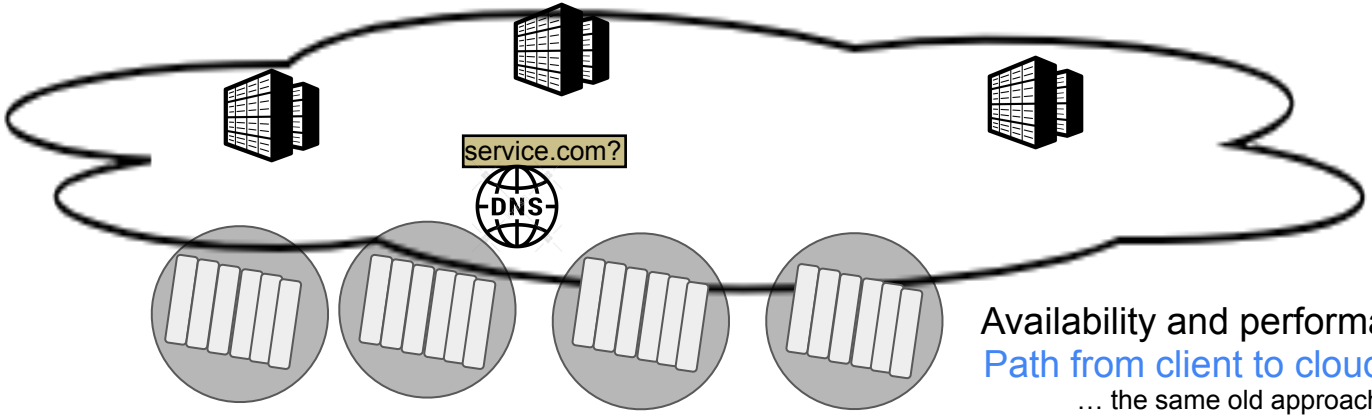

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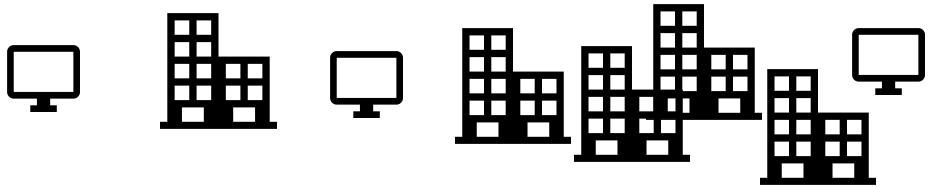

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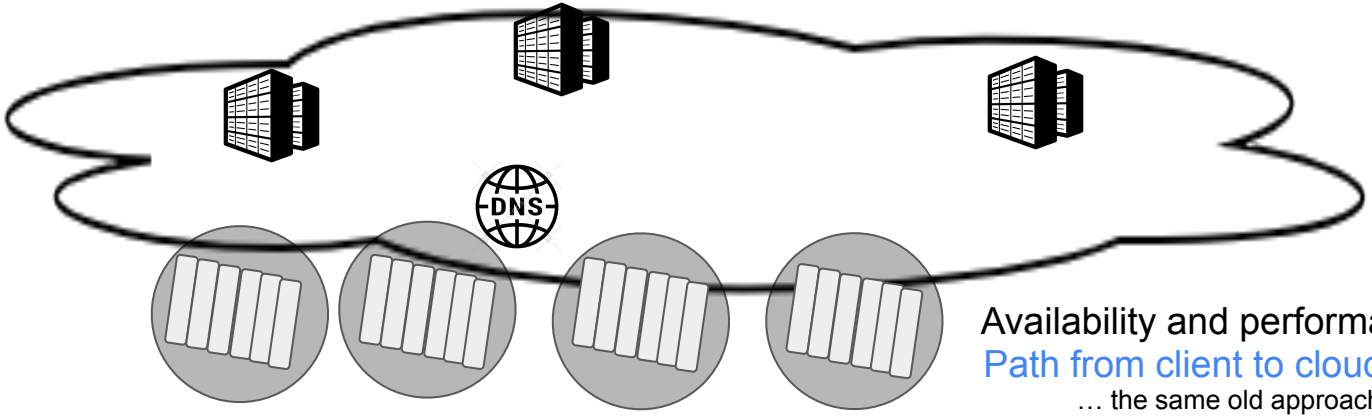

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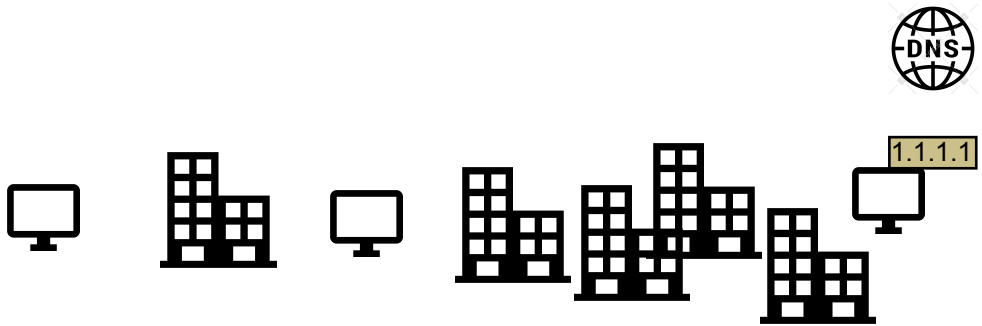

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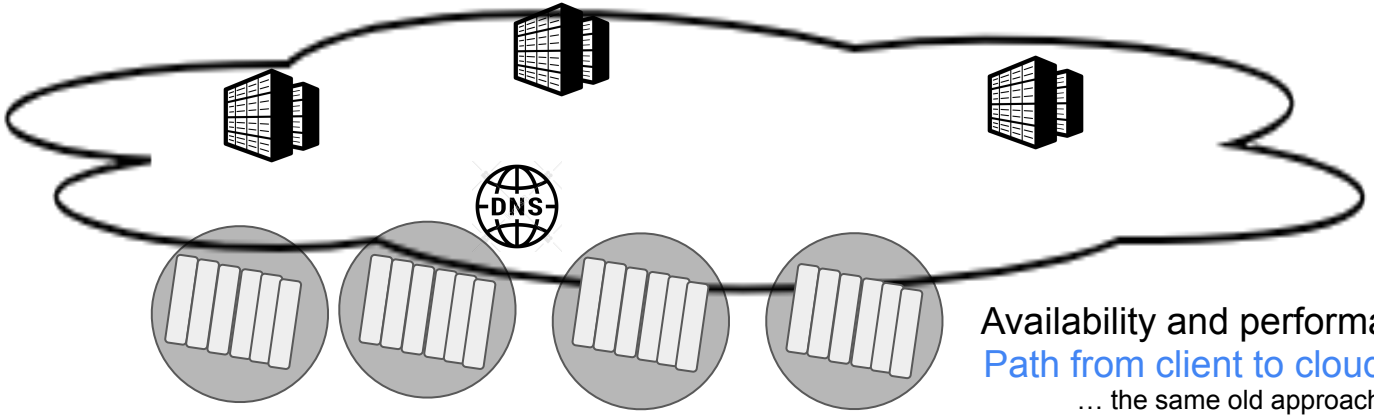

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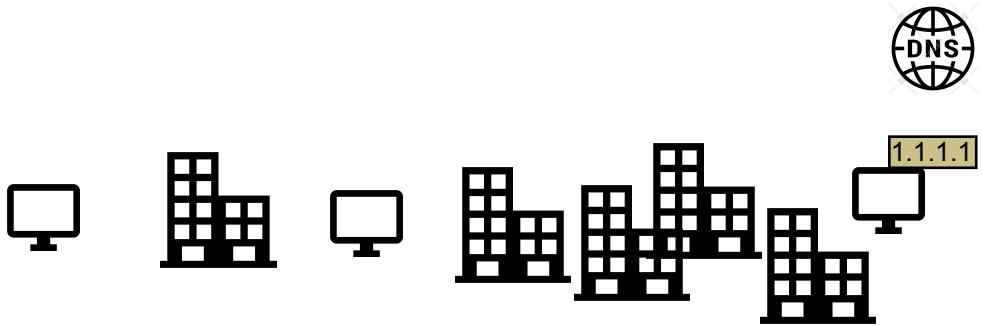

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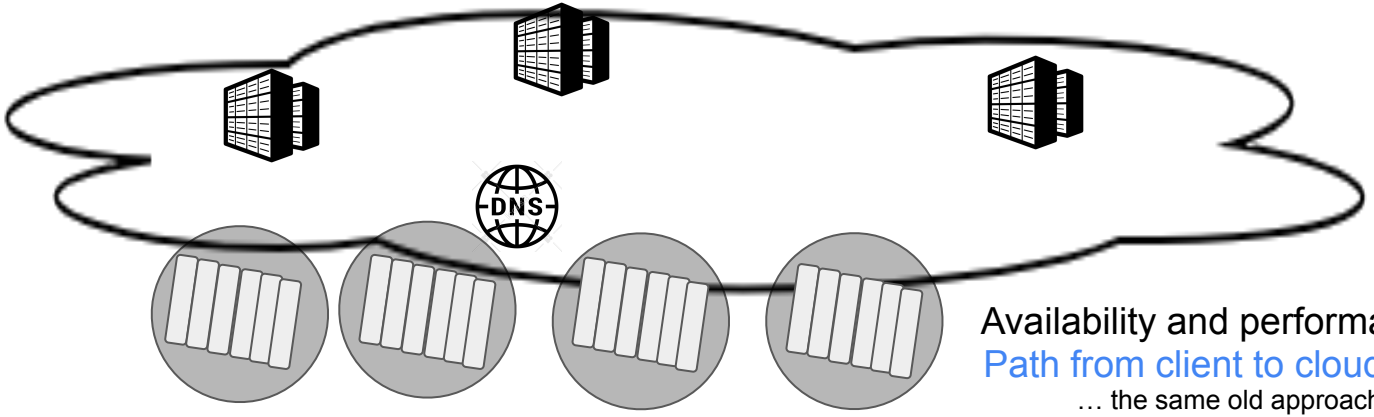

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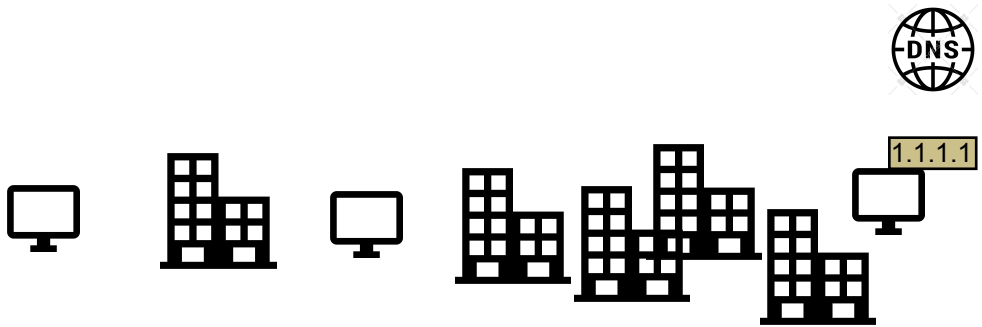

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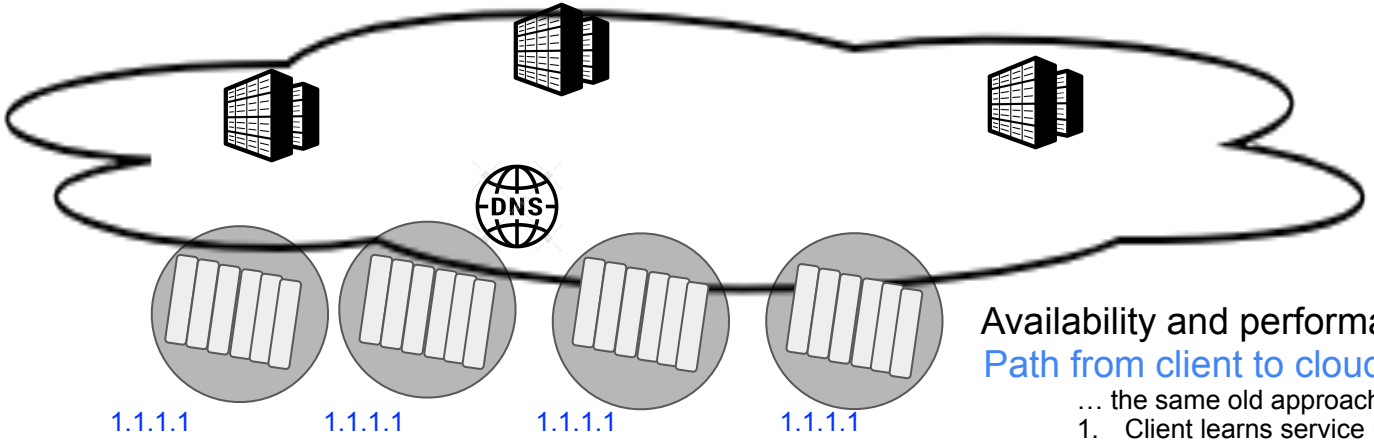

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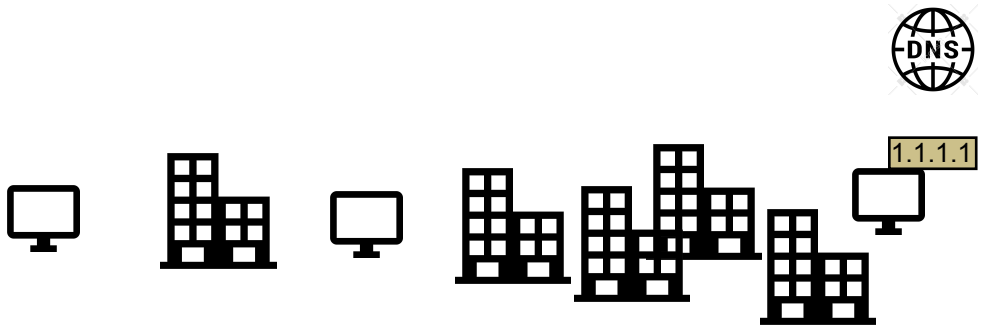

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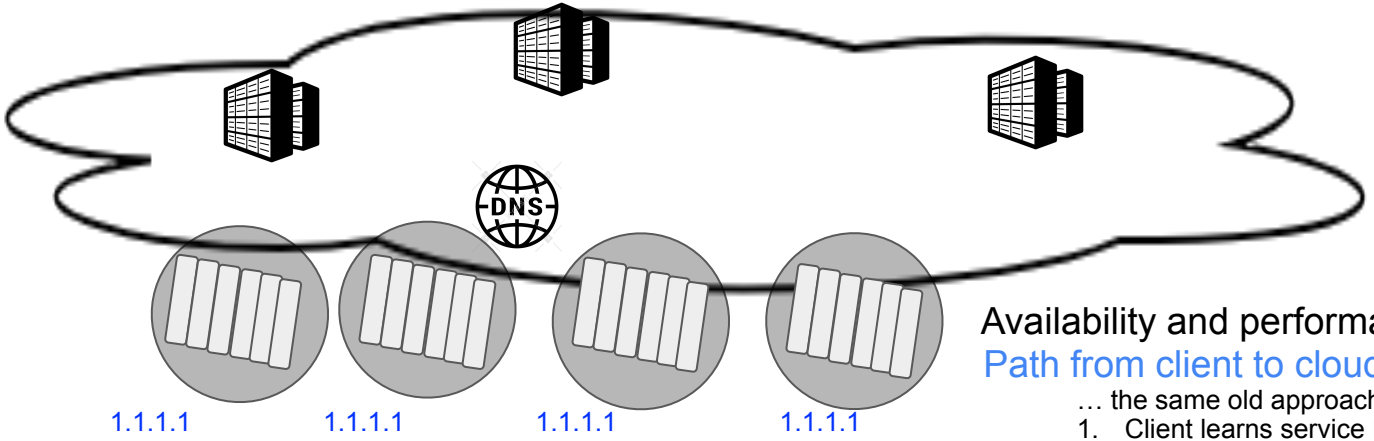

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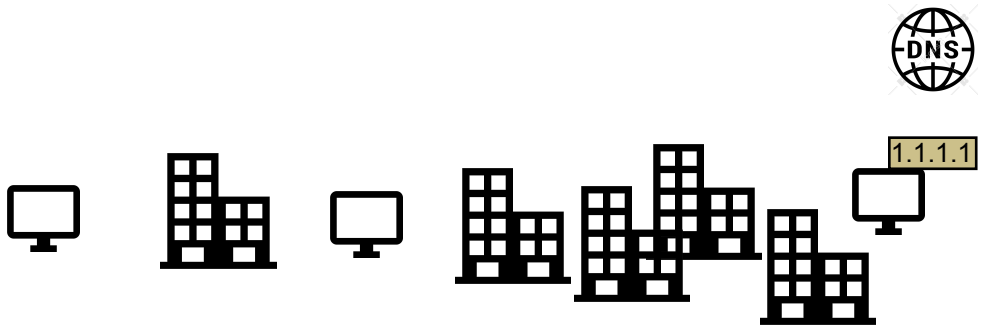

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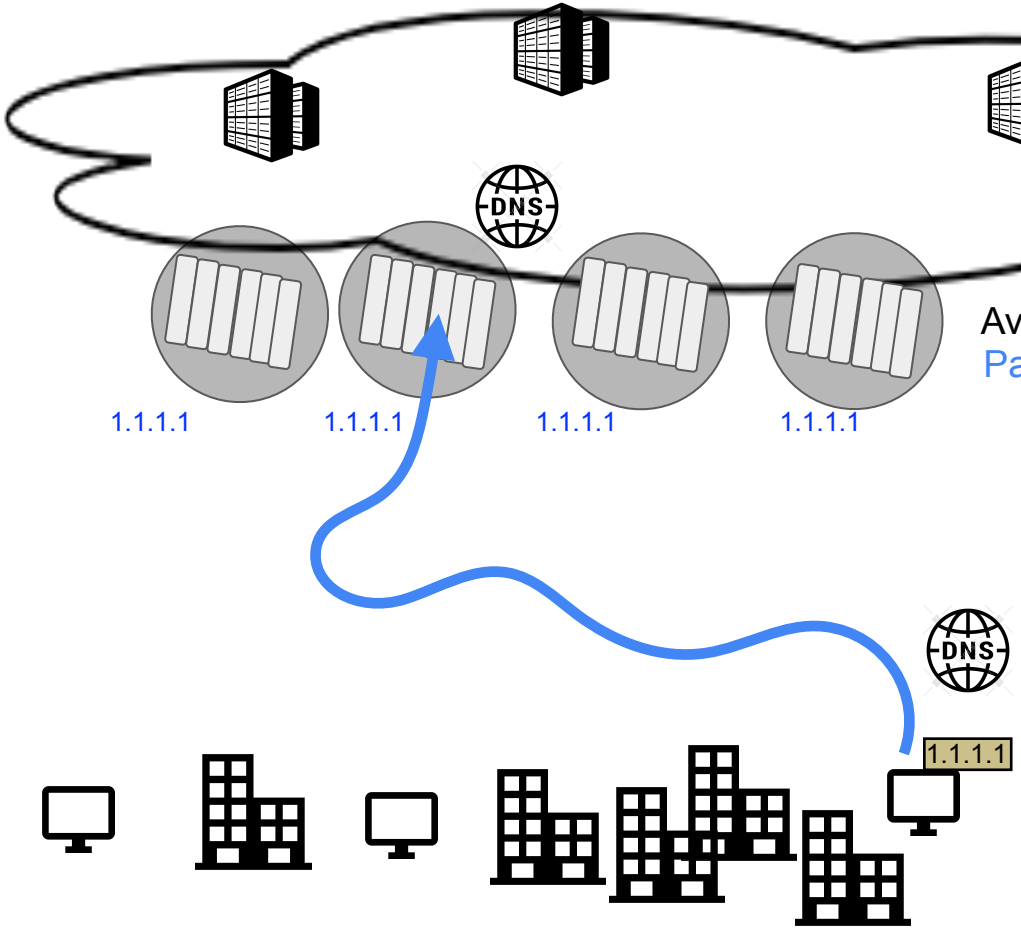

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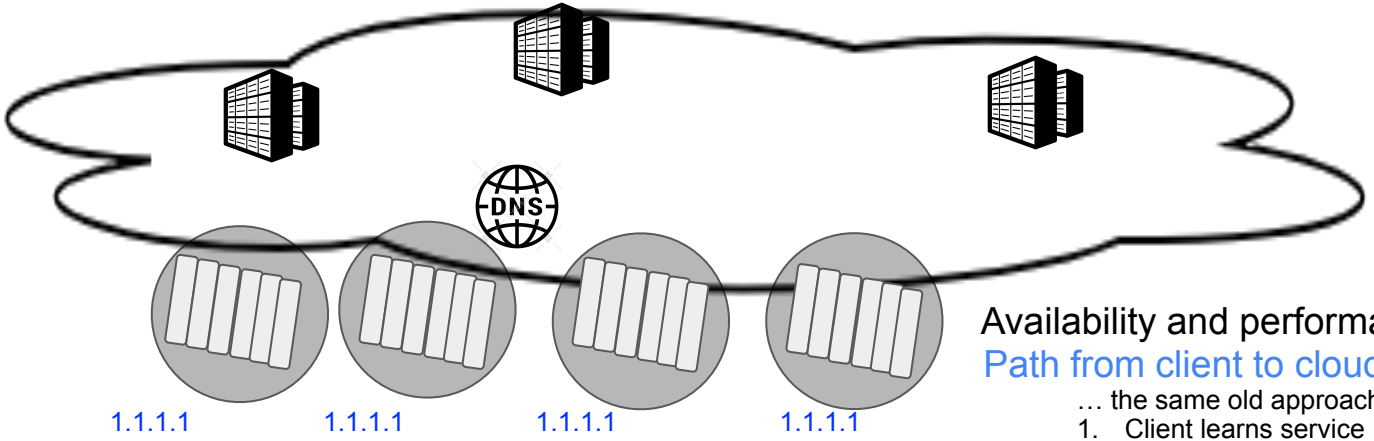

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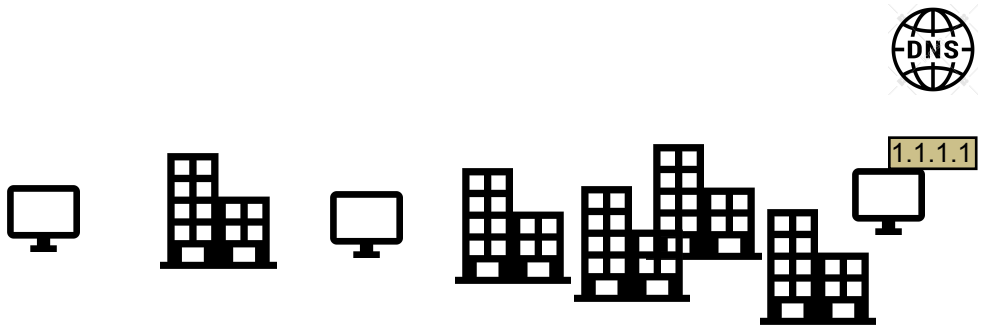

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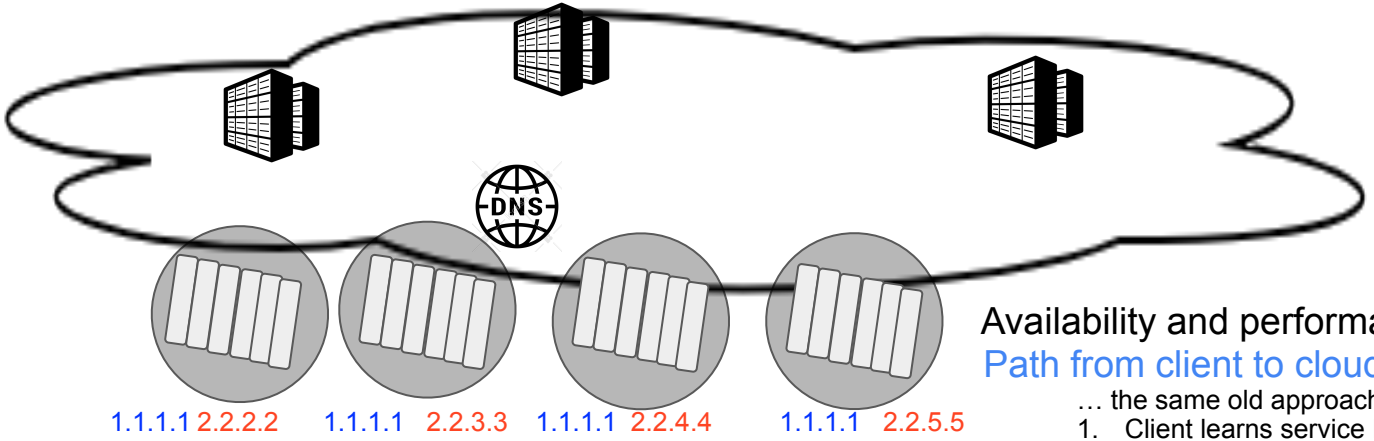

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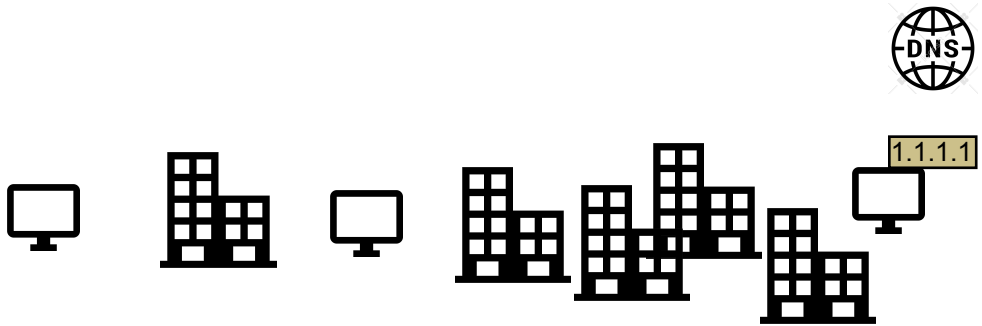

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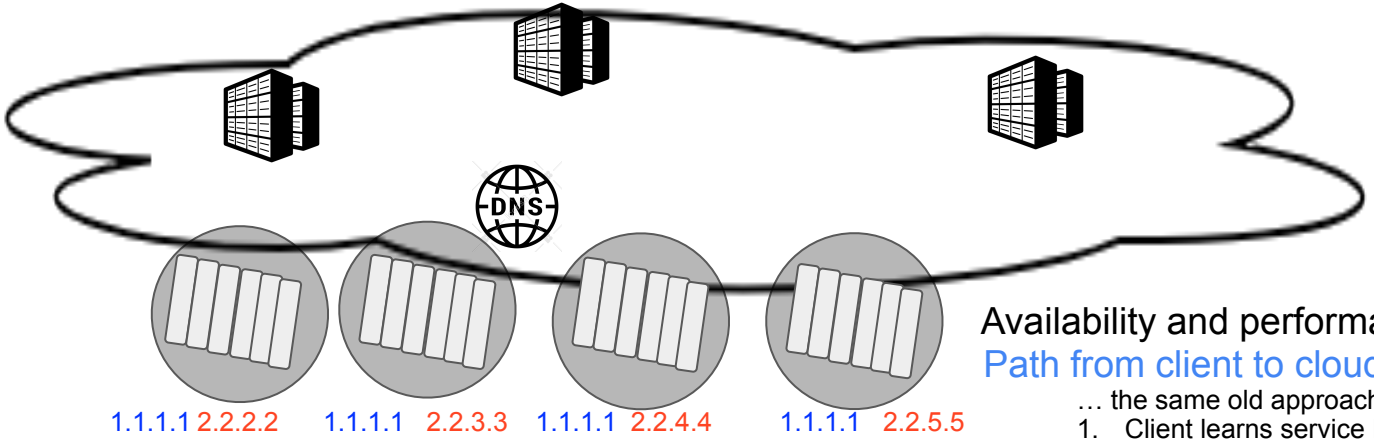

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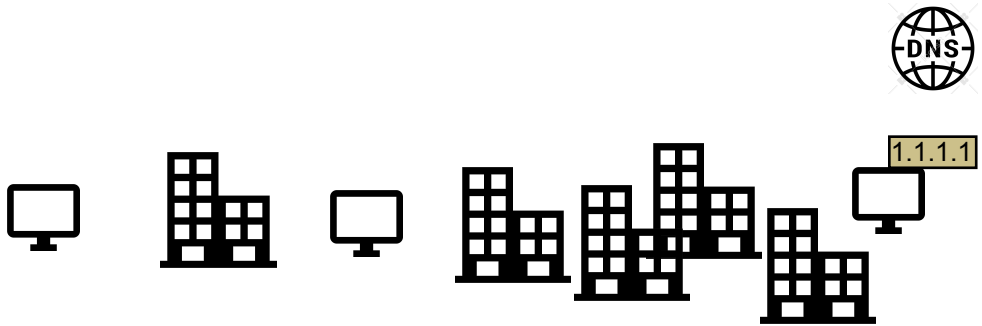

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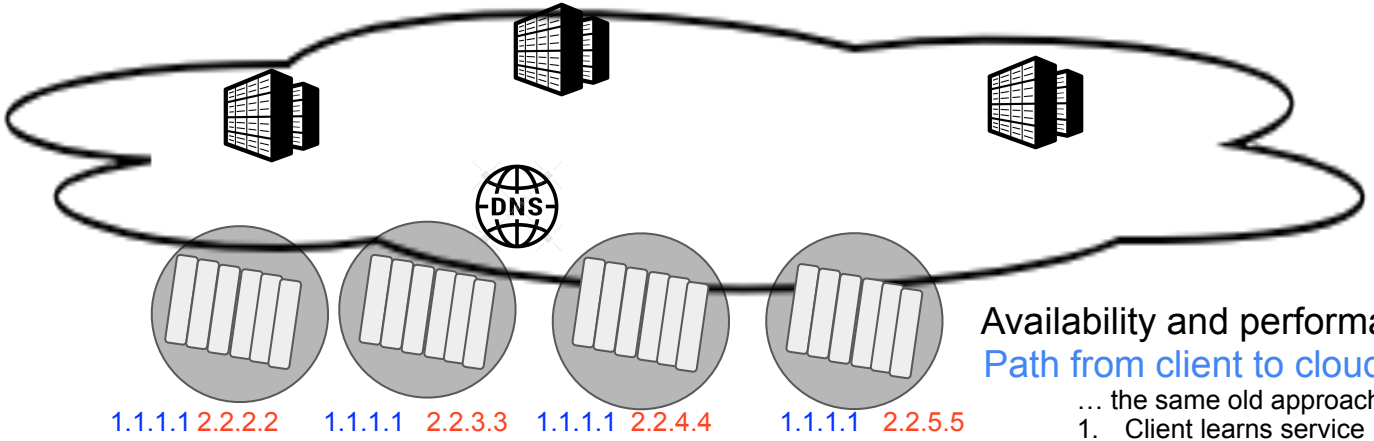

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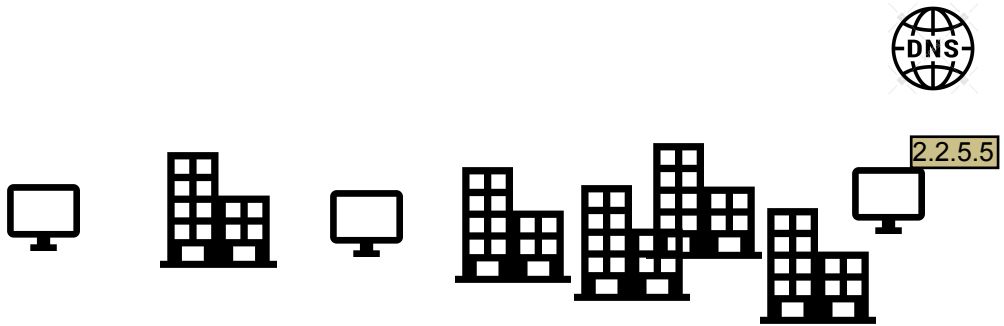

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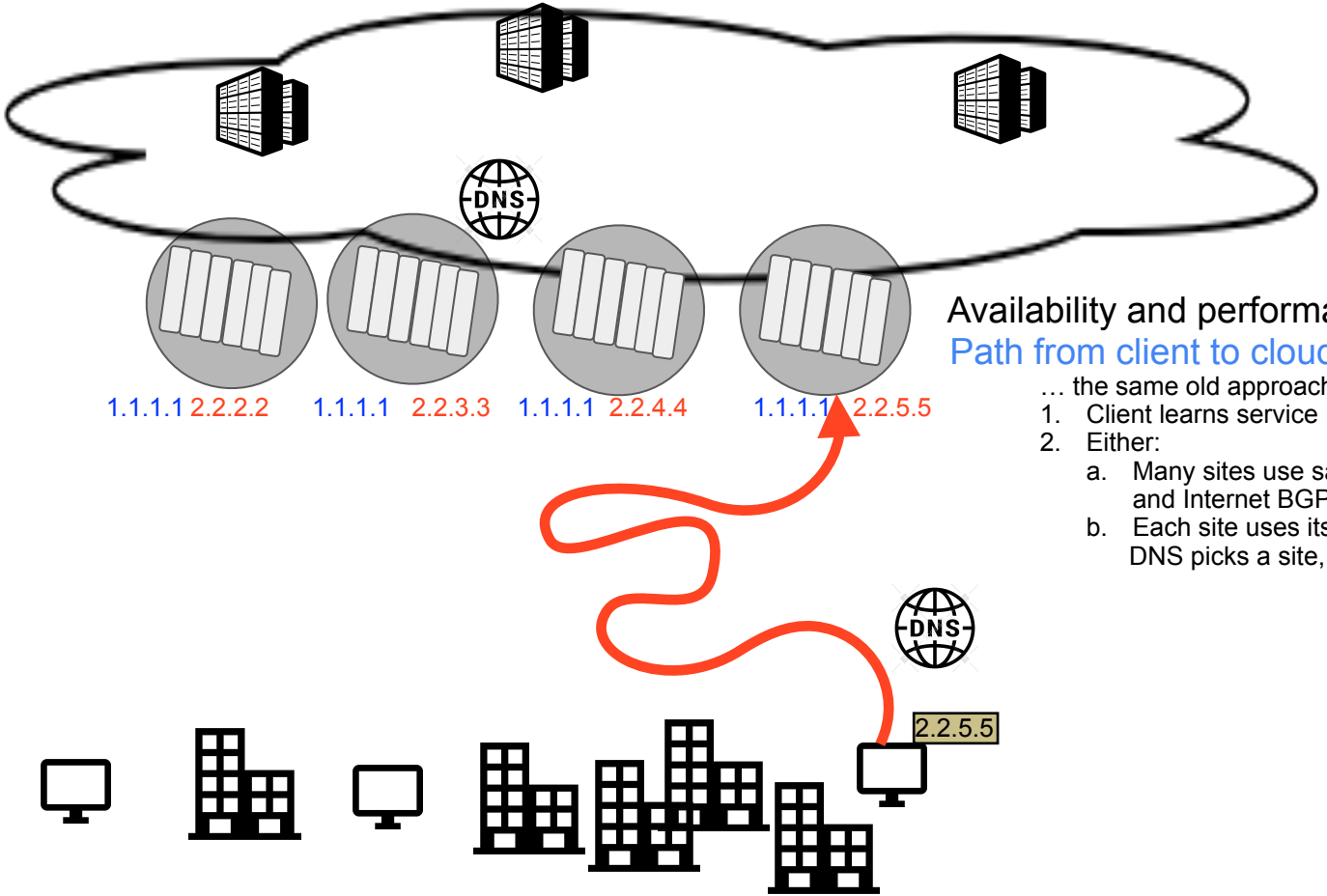

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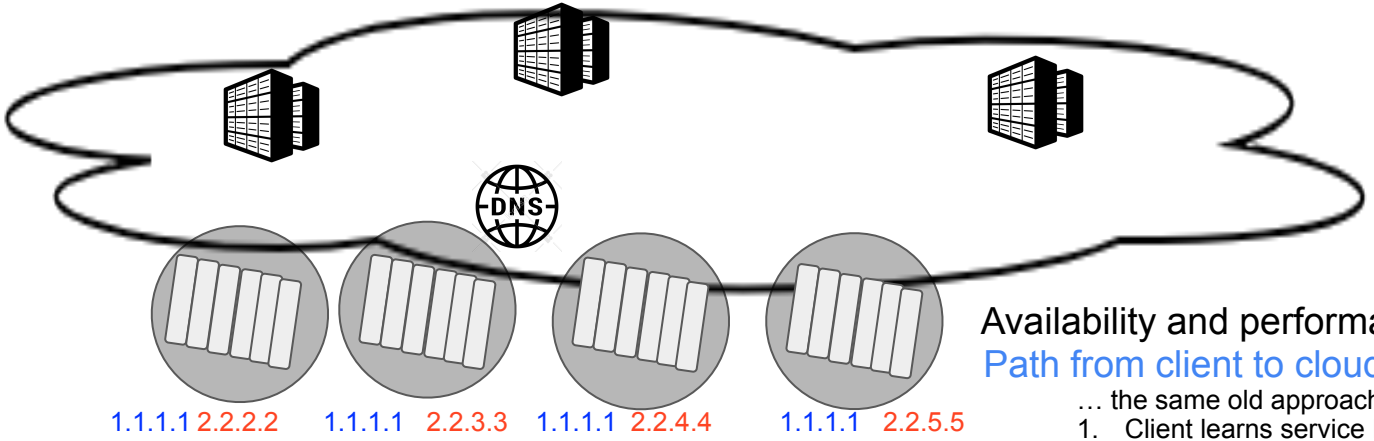

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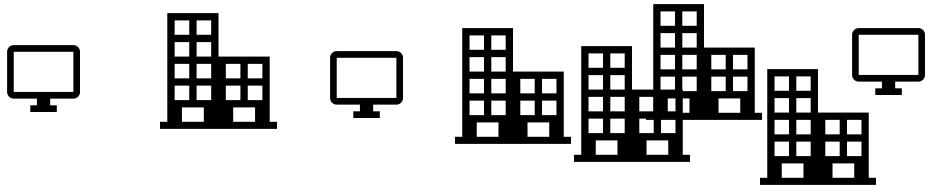

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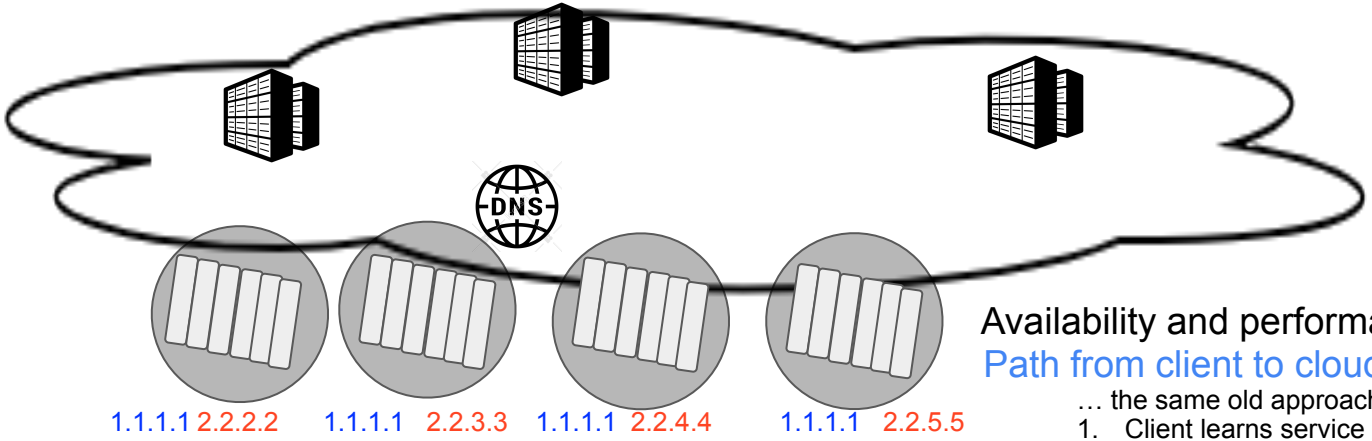

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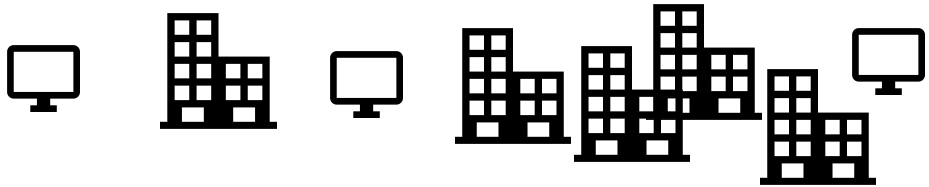

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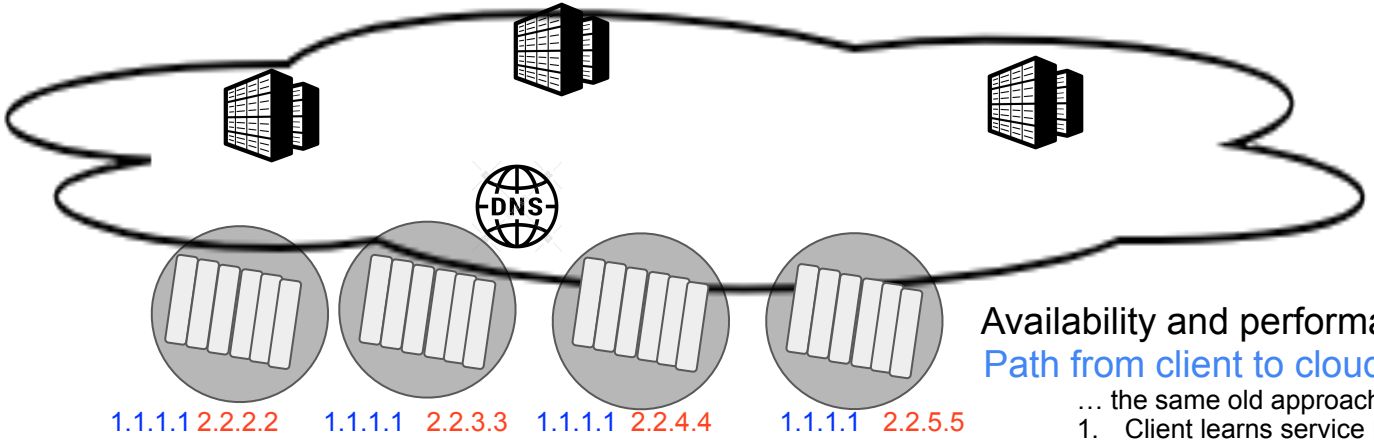

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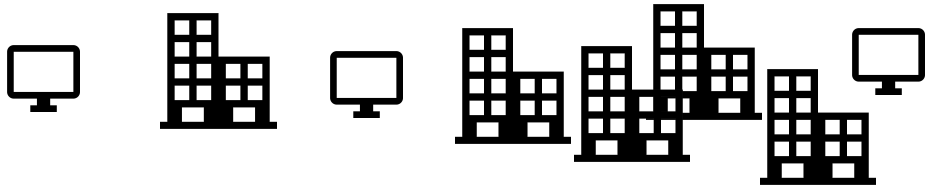
2. Difficult to conduct research in academia:
   a. Manipulate routing (at cloud scale)
   b. Observe ingress routing decisions and DNS caching behavior (at scale)



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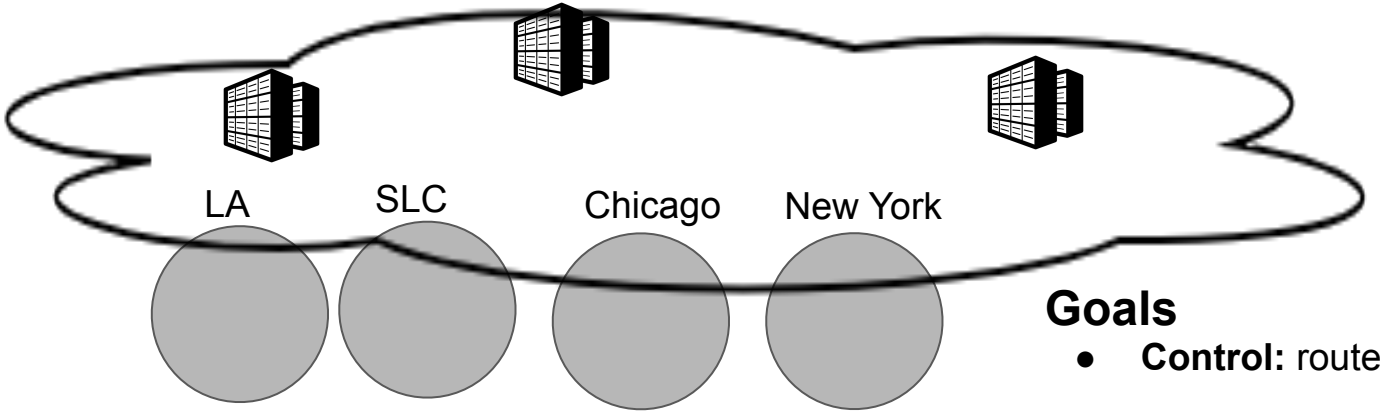

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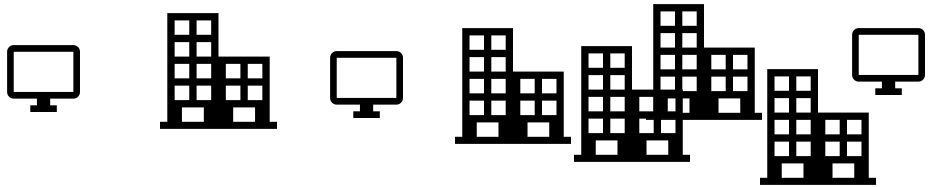

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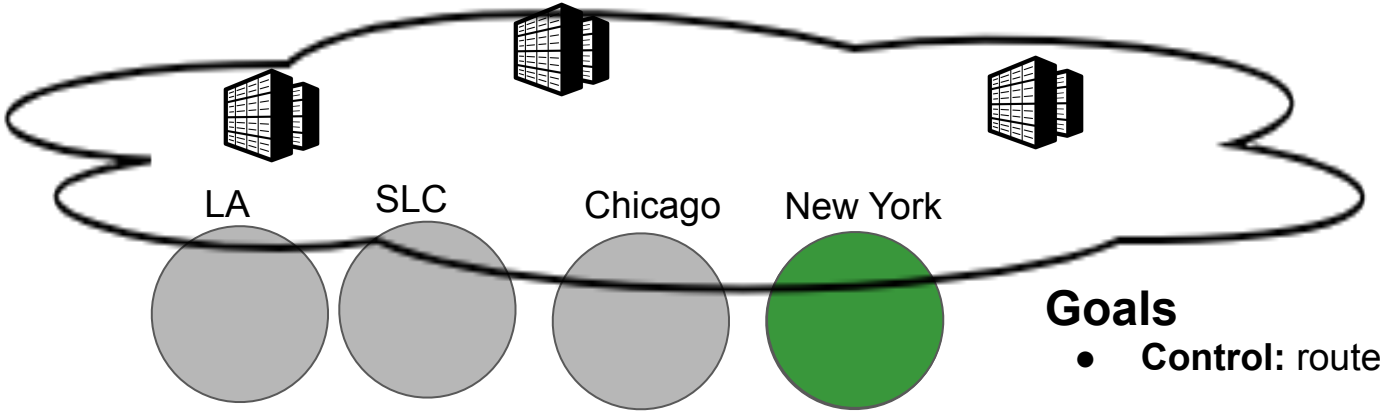

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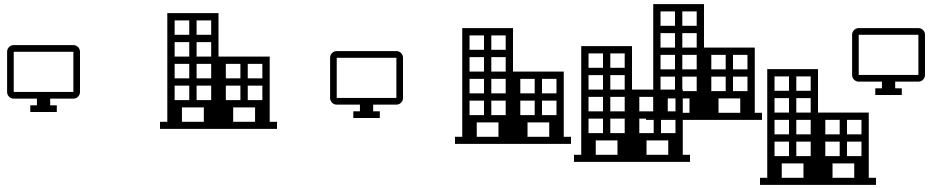

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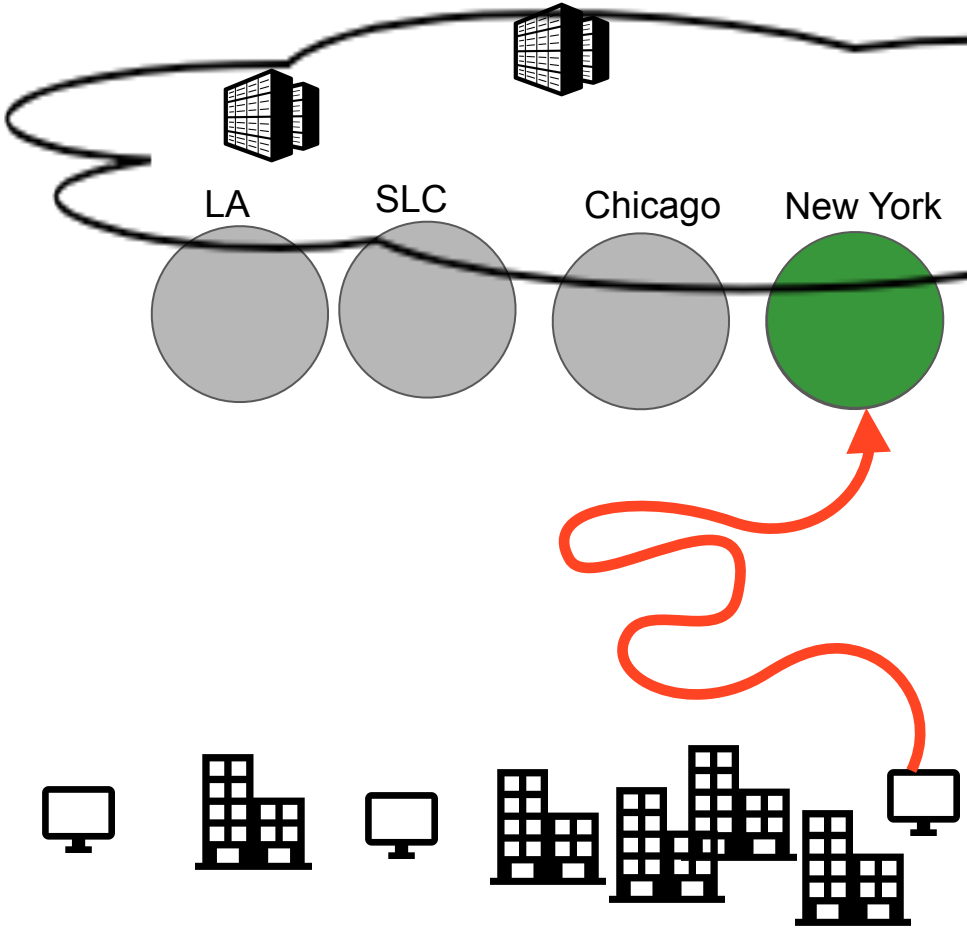

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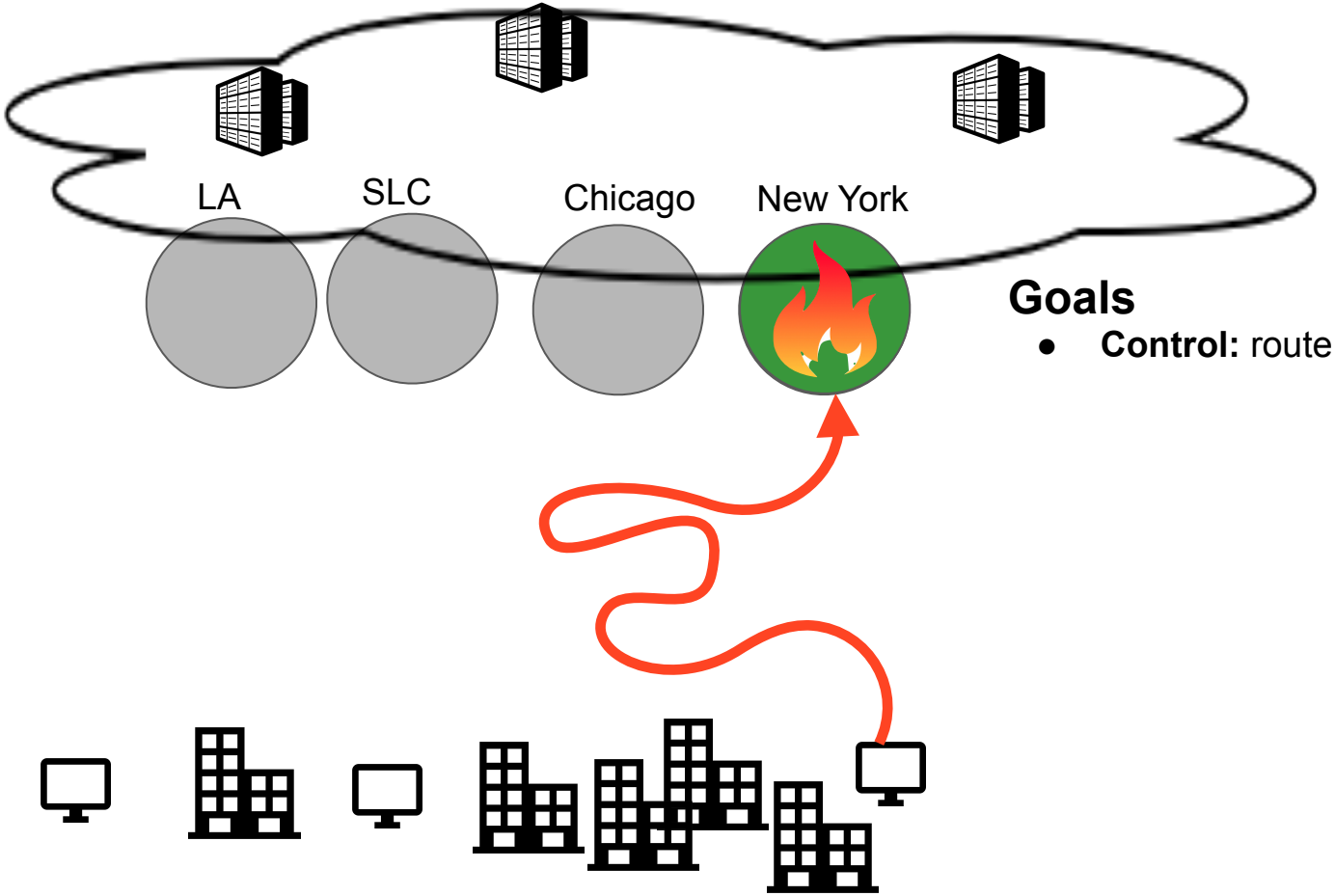

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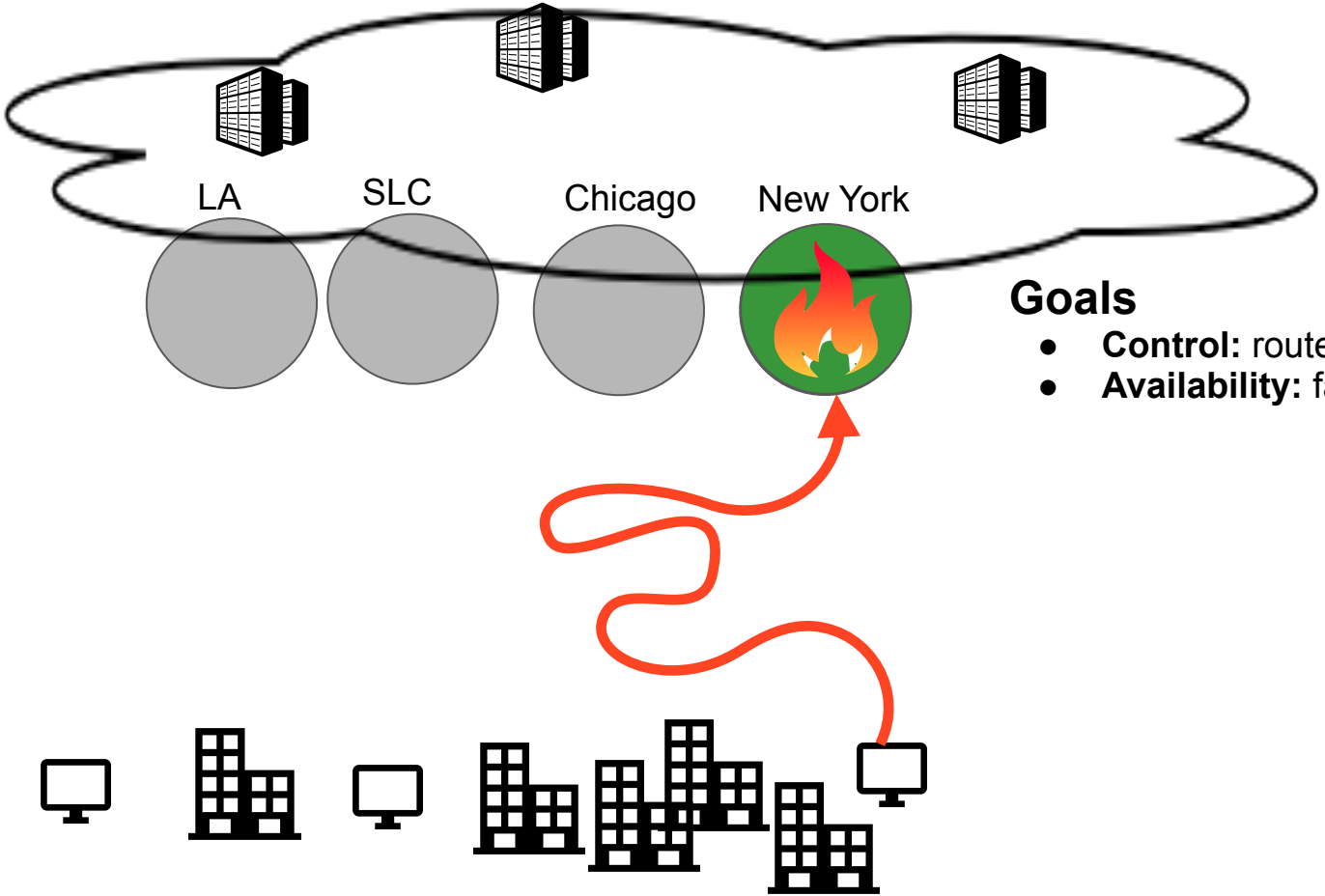

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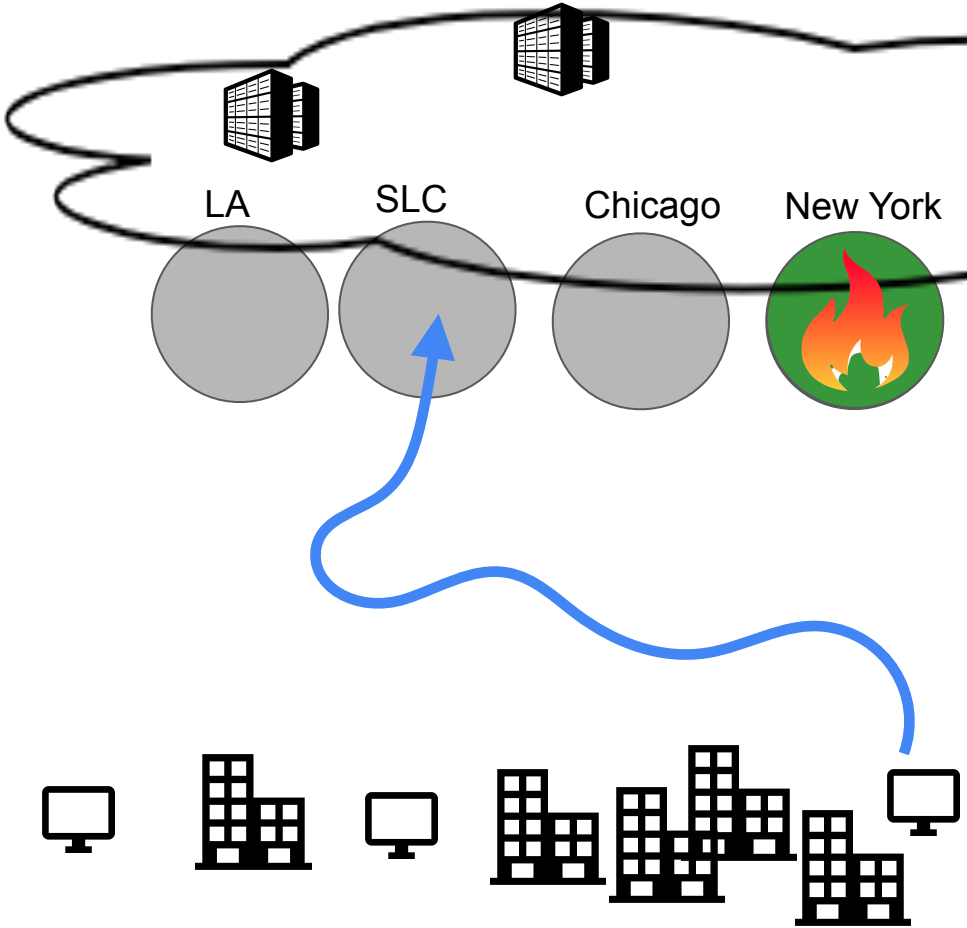

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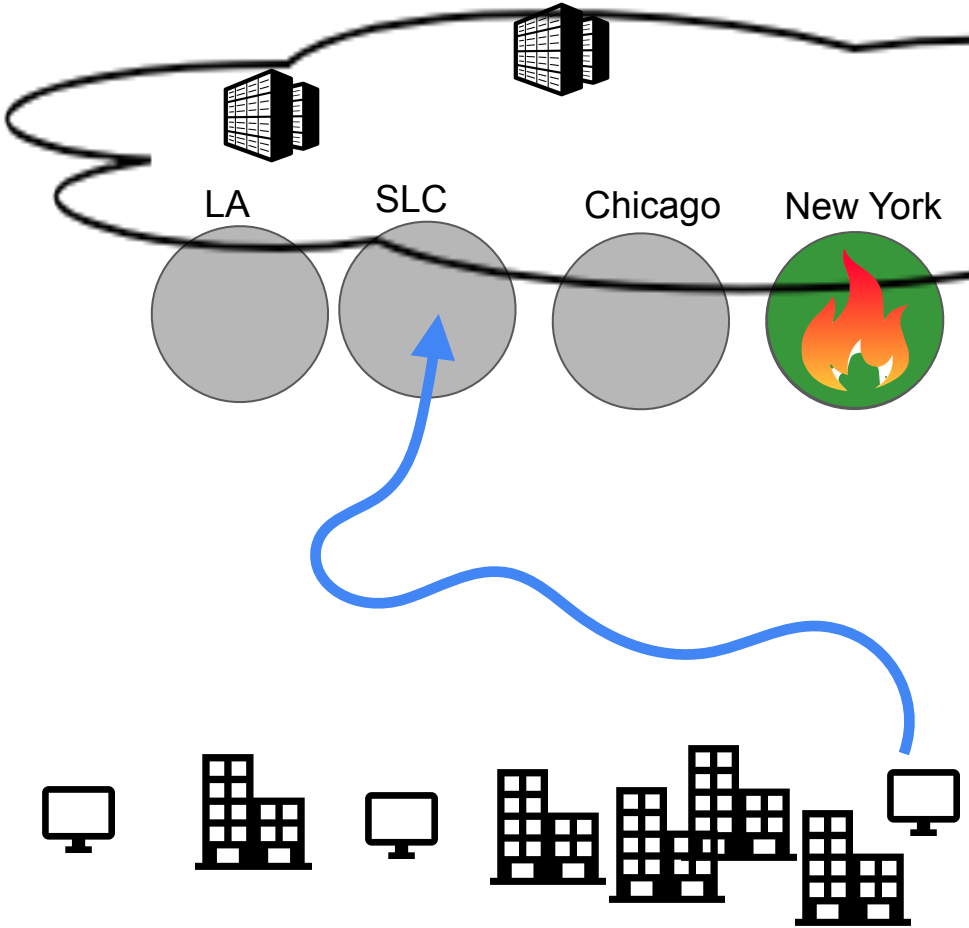

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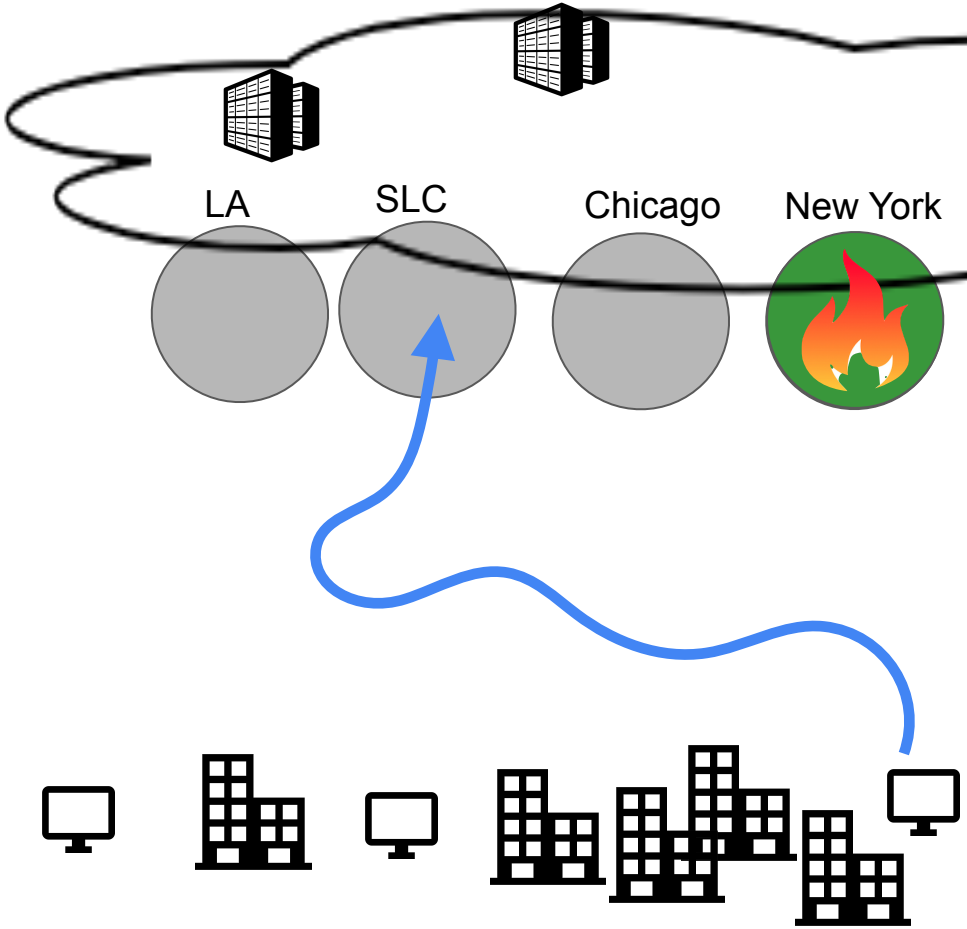

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Availability?

- Unicast failover (and hence availability) depends on DNS caching behavior, which depends on traffic patterns, OS behavior, and application behavior

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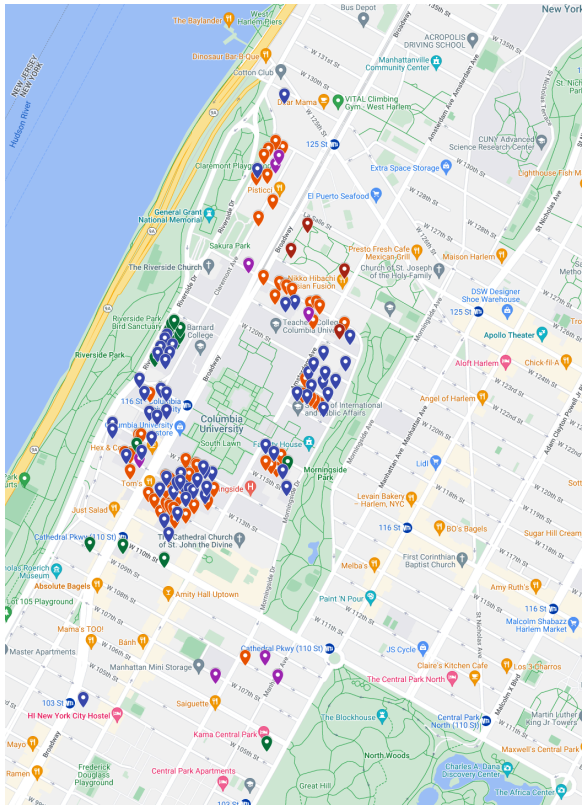
  - Plan to scale to 8000 units, 24x7

Residential traces to understand real-world behavior



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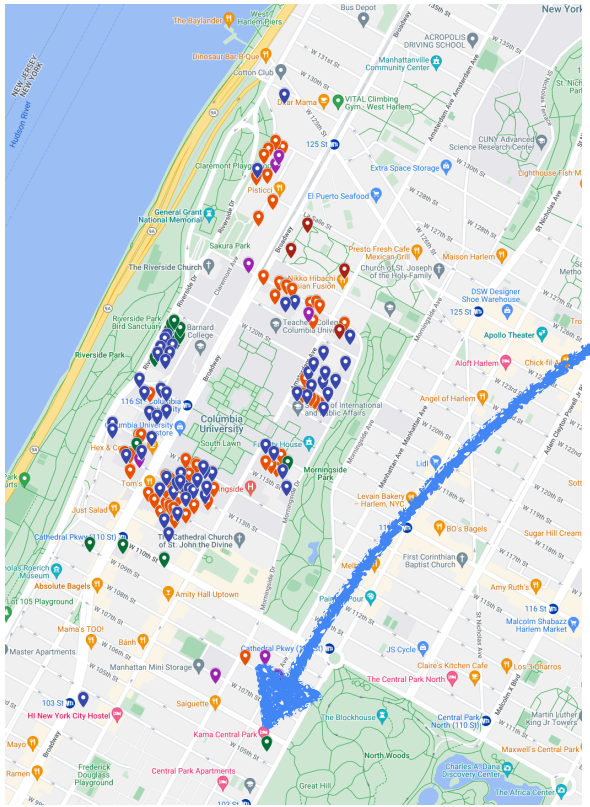

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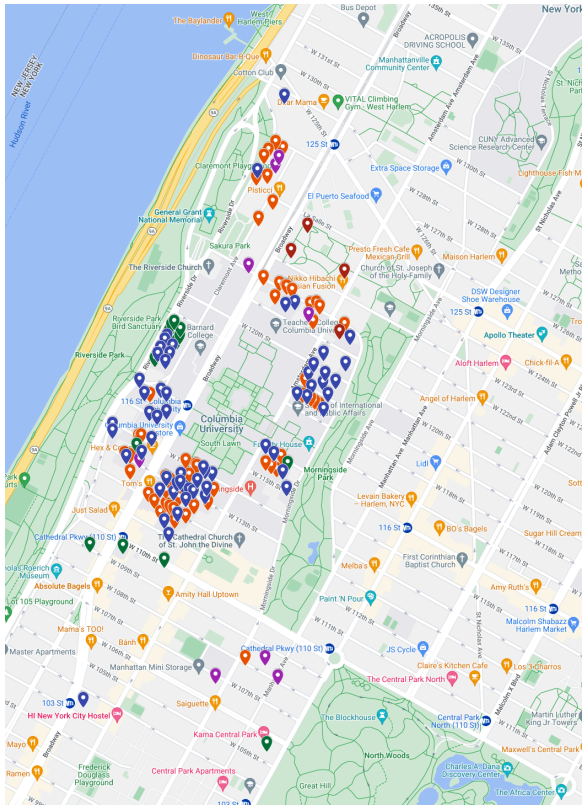

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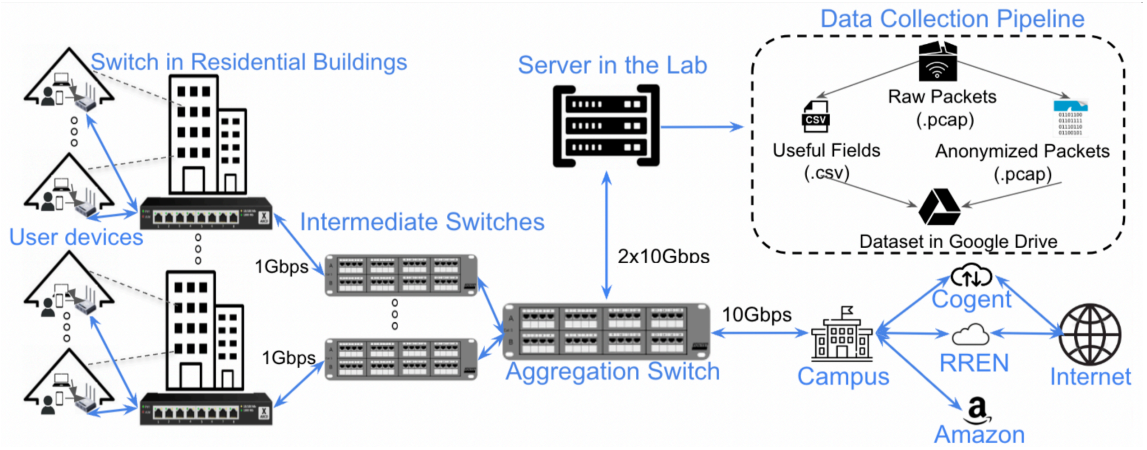

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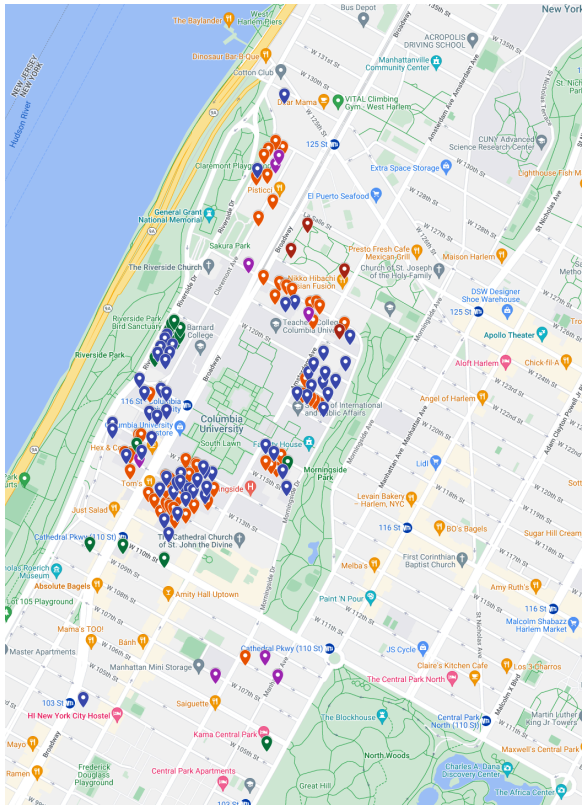

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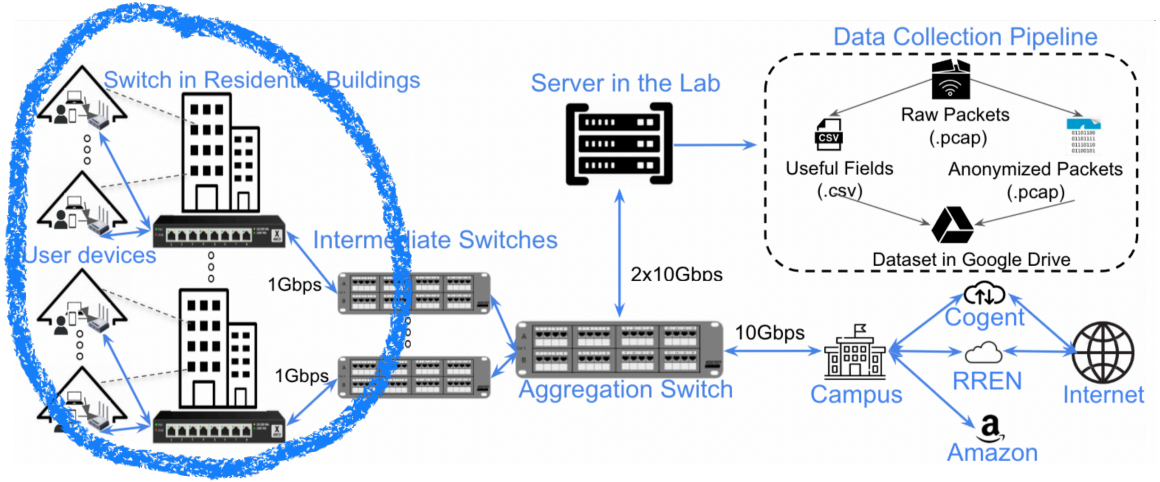

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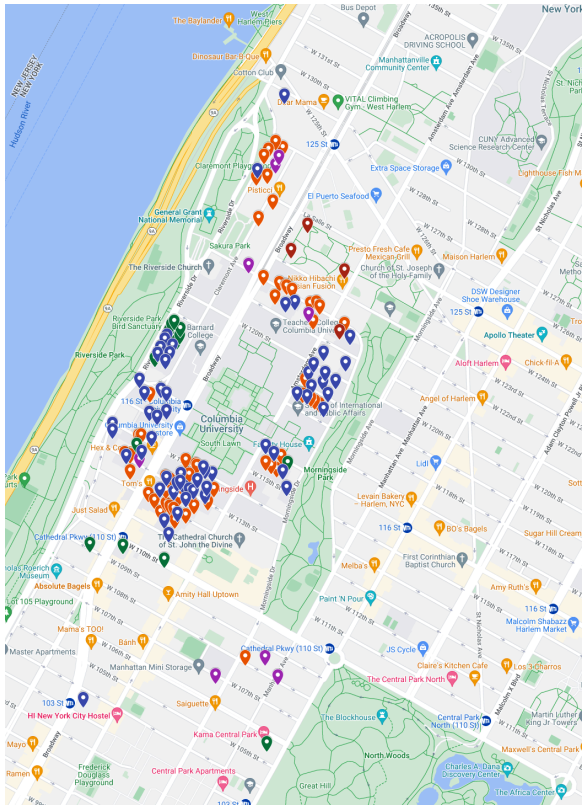

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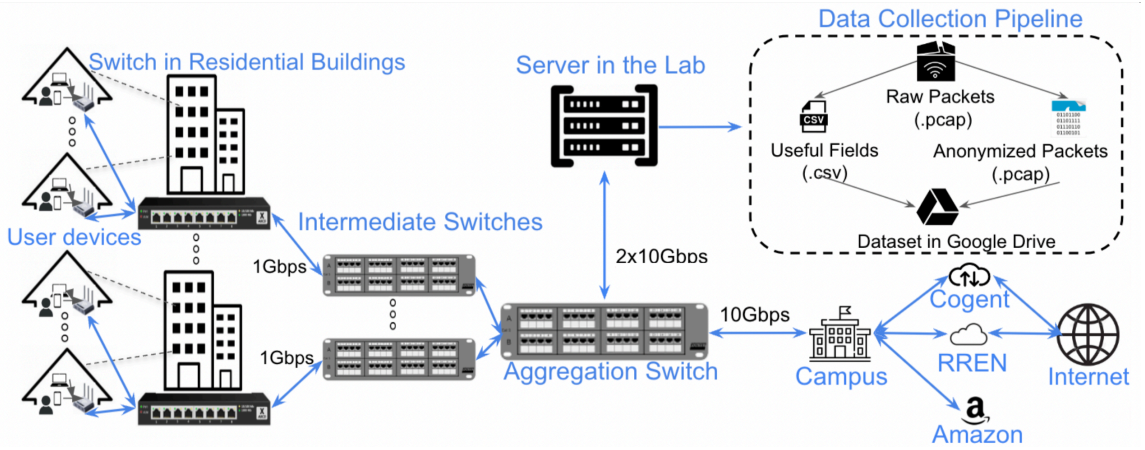

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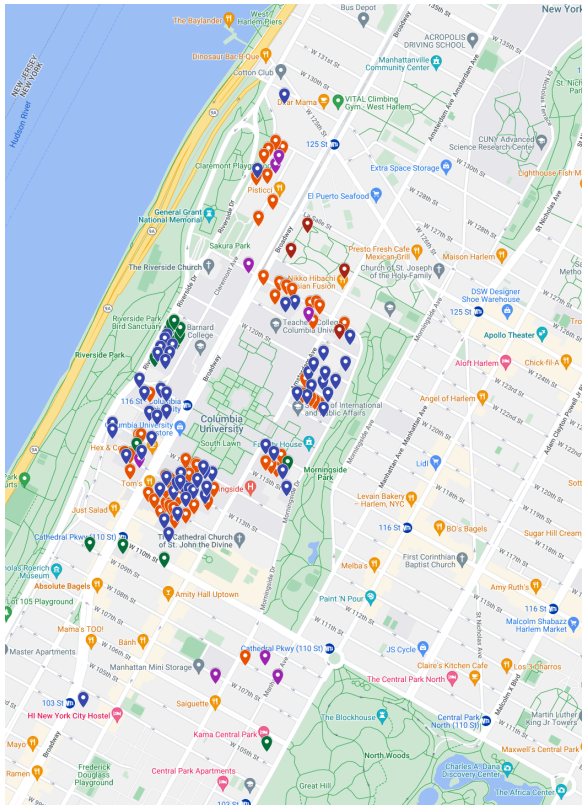

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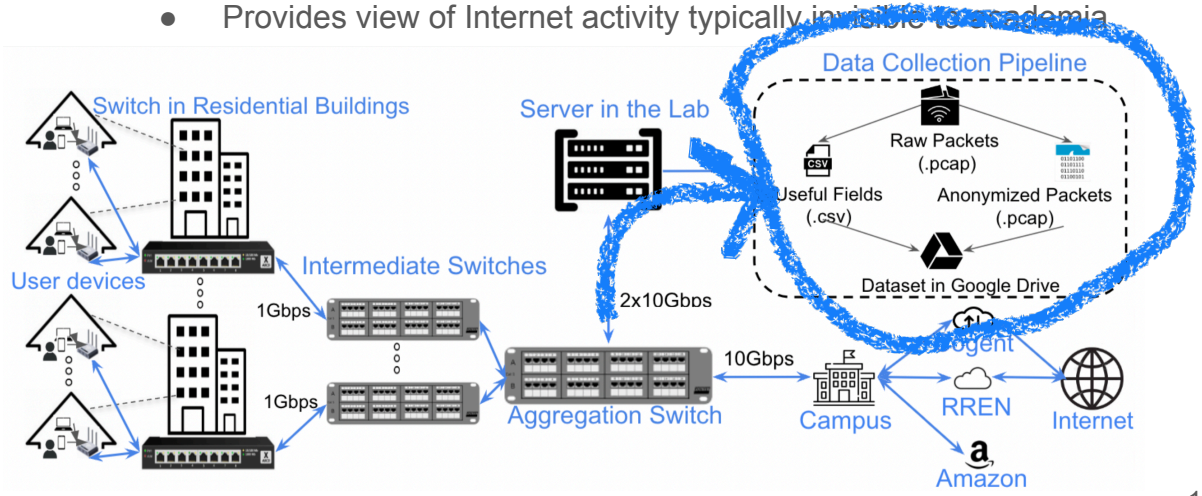

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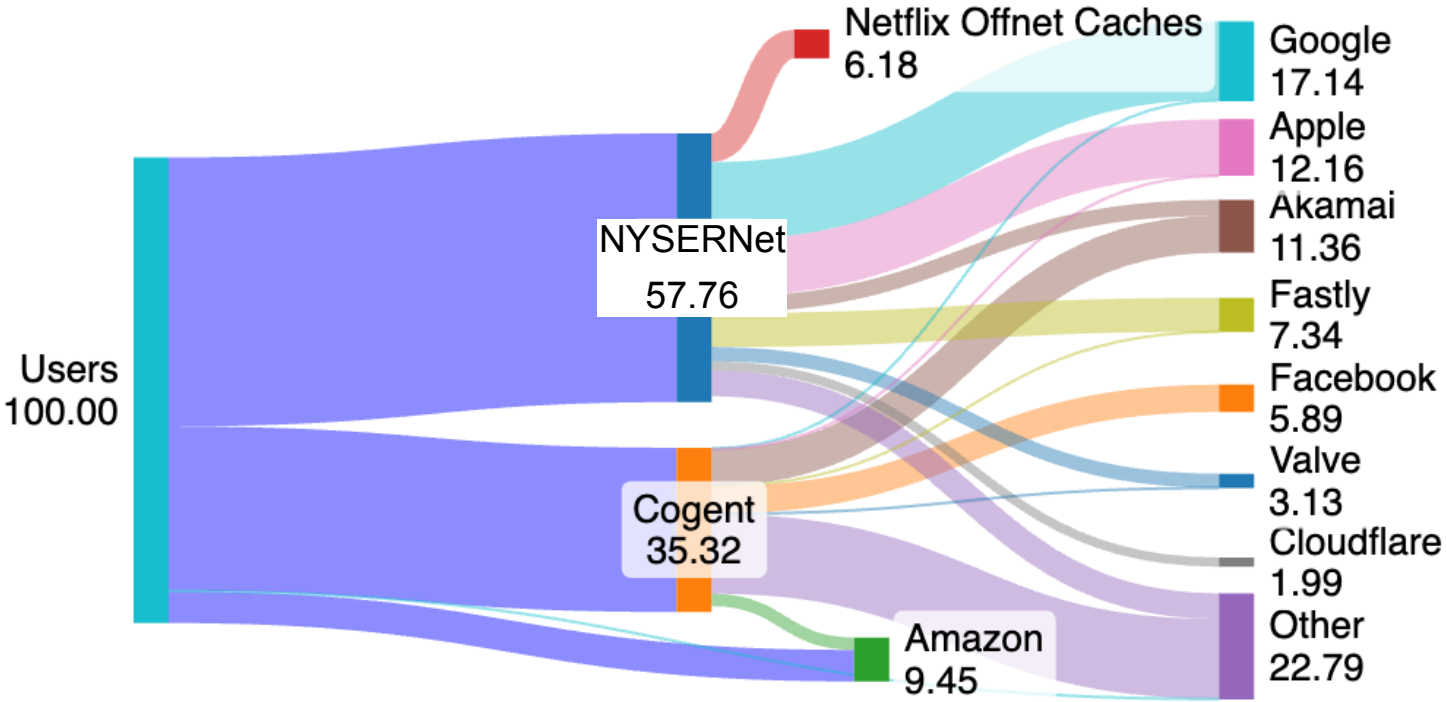

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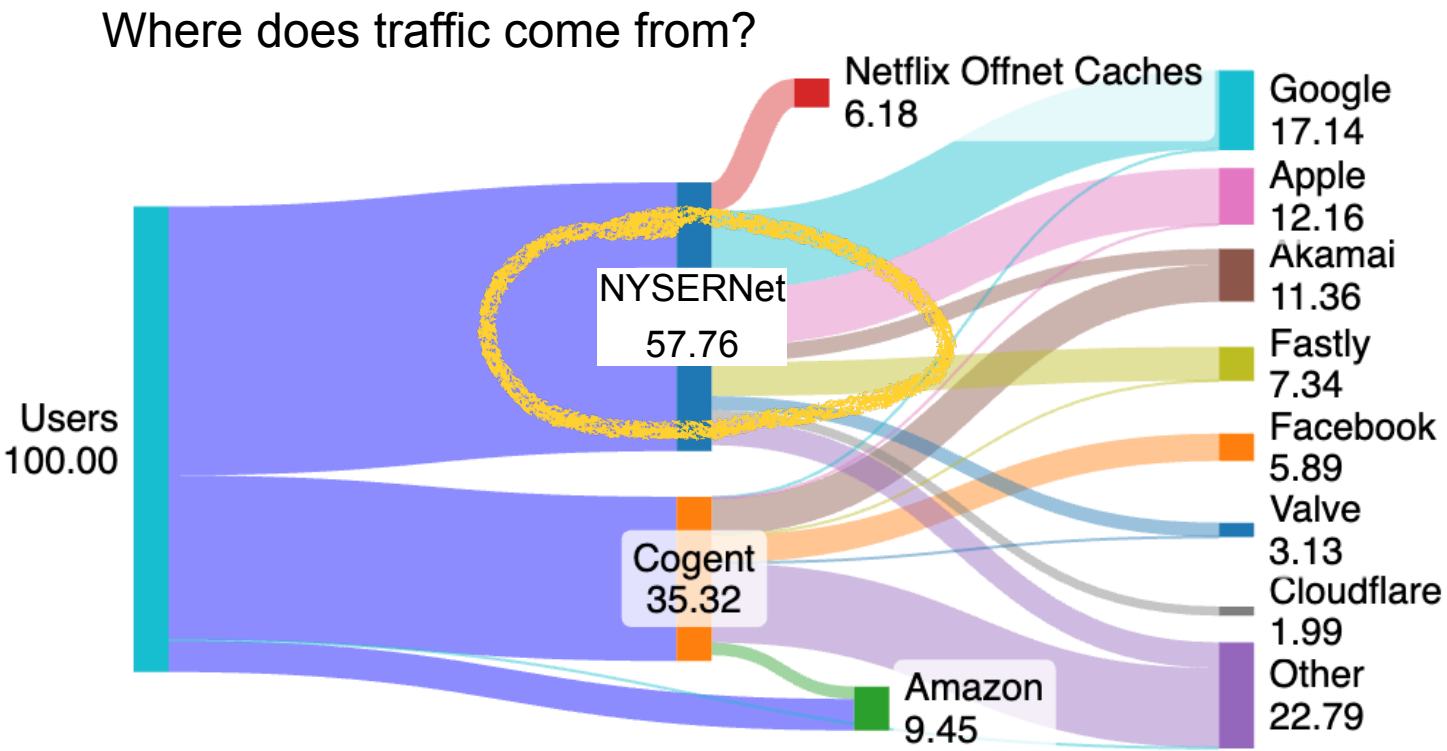

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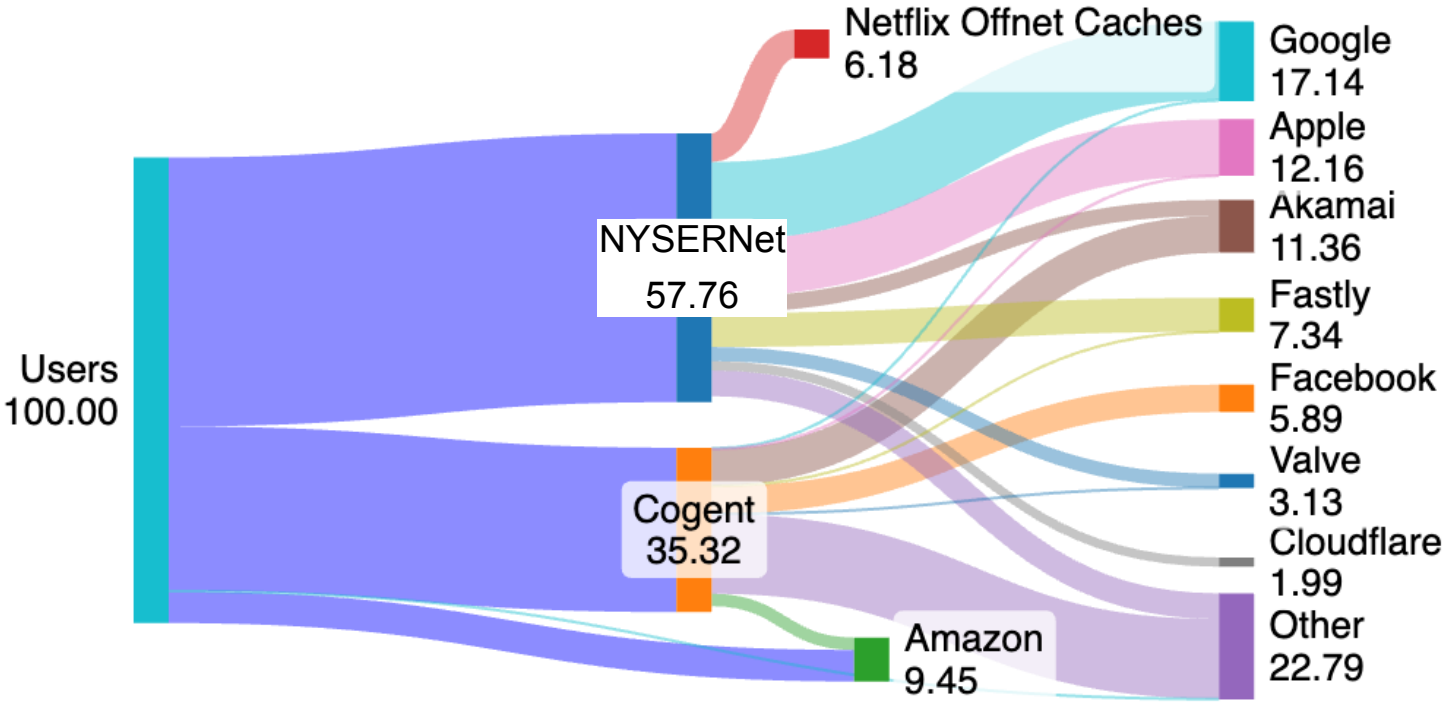

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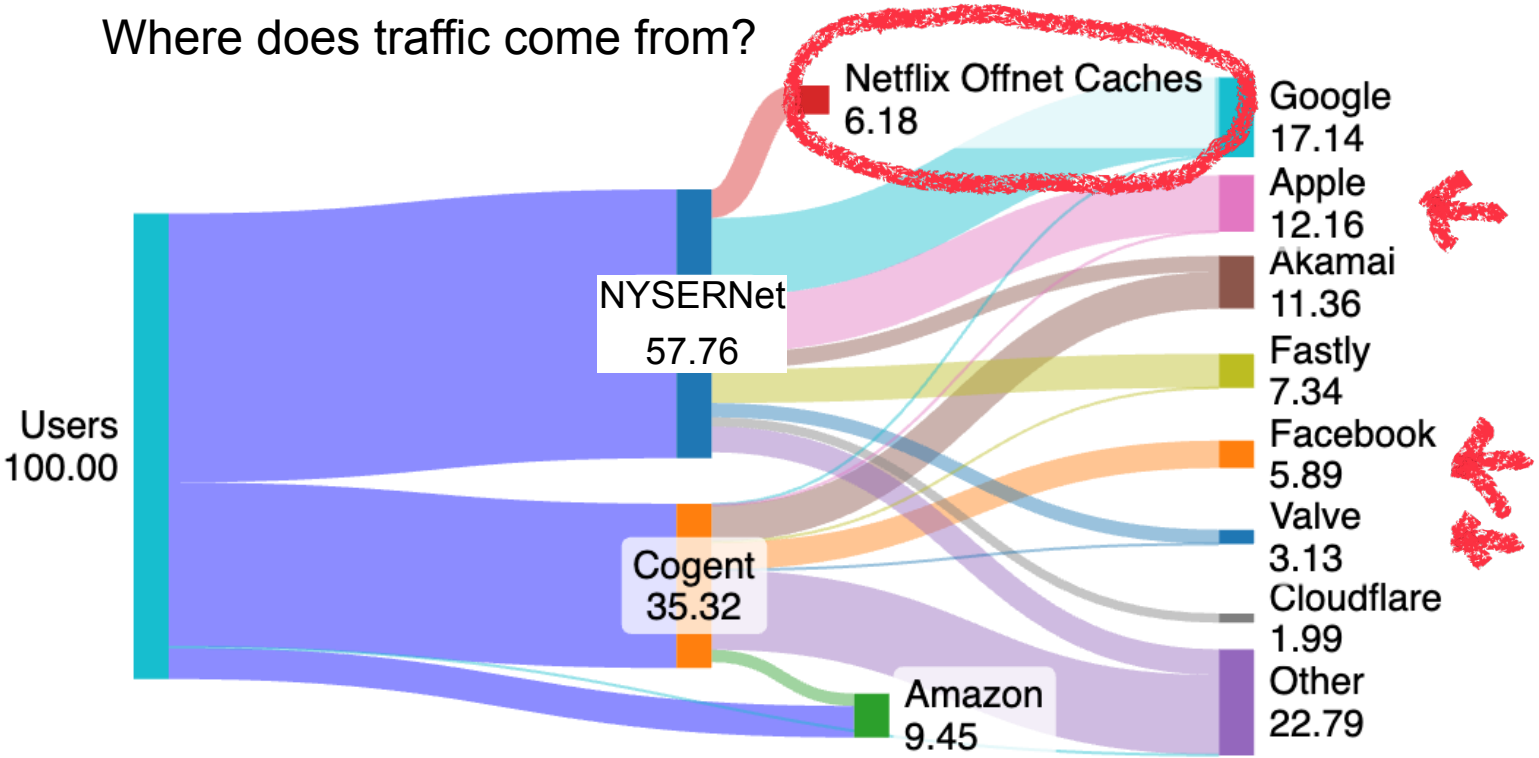

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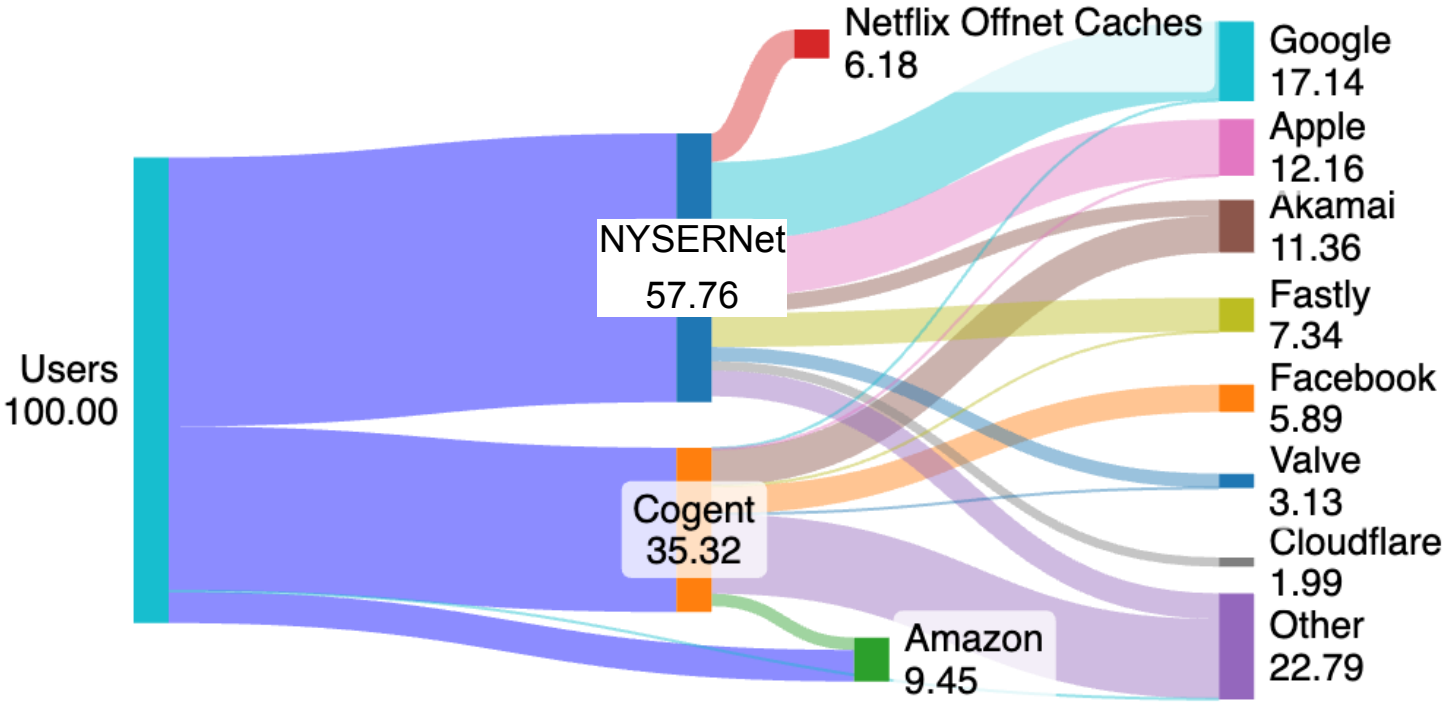

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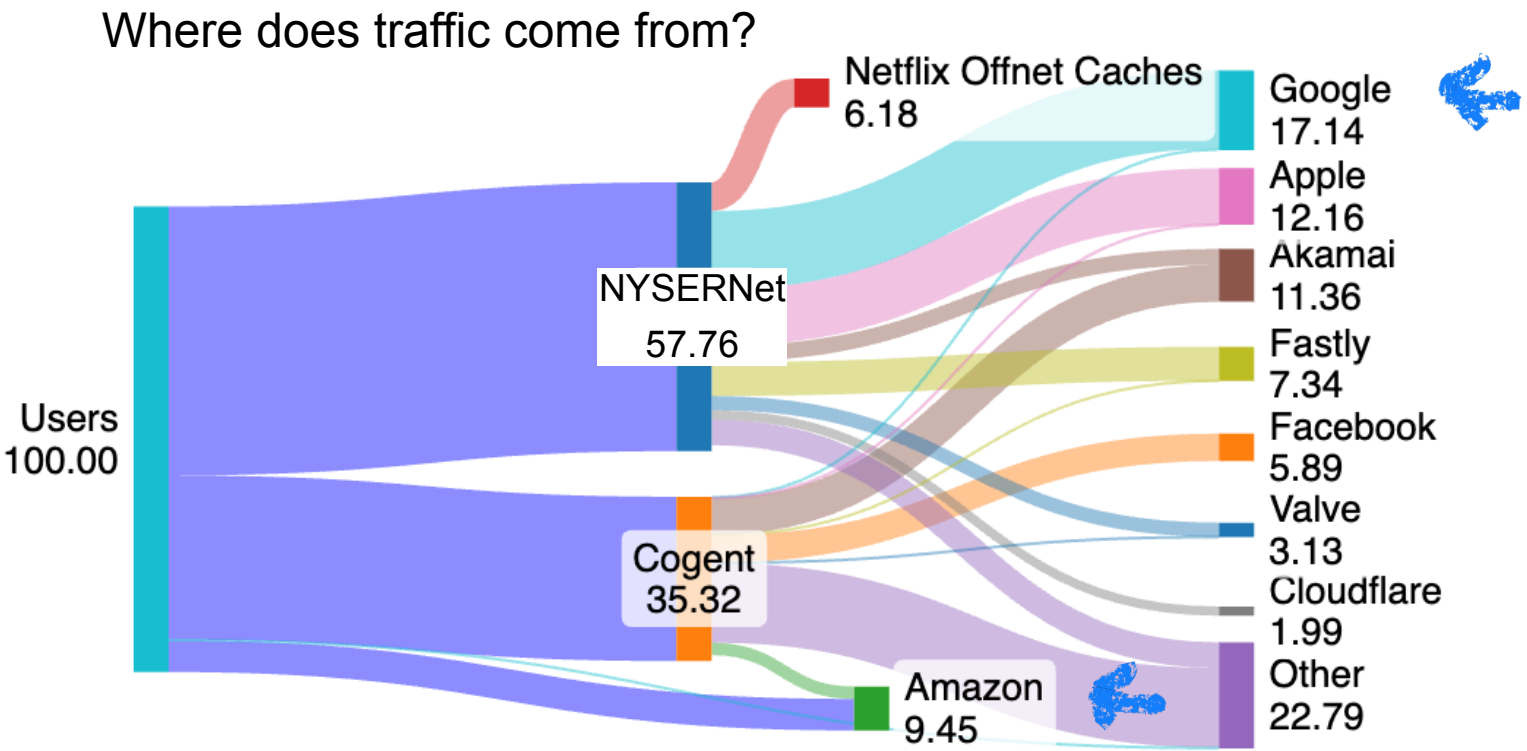

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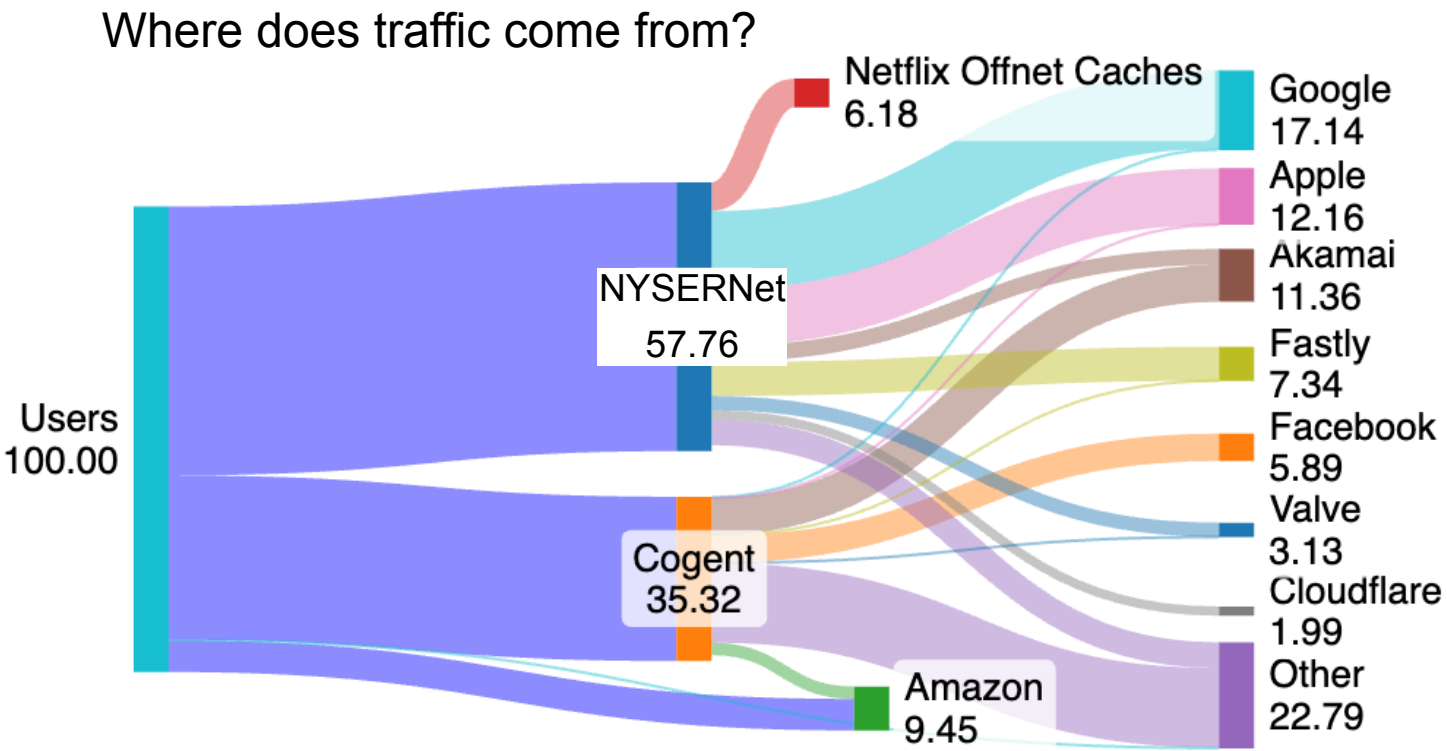

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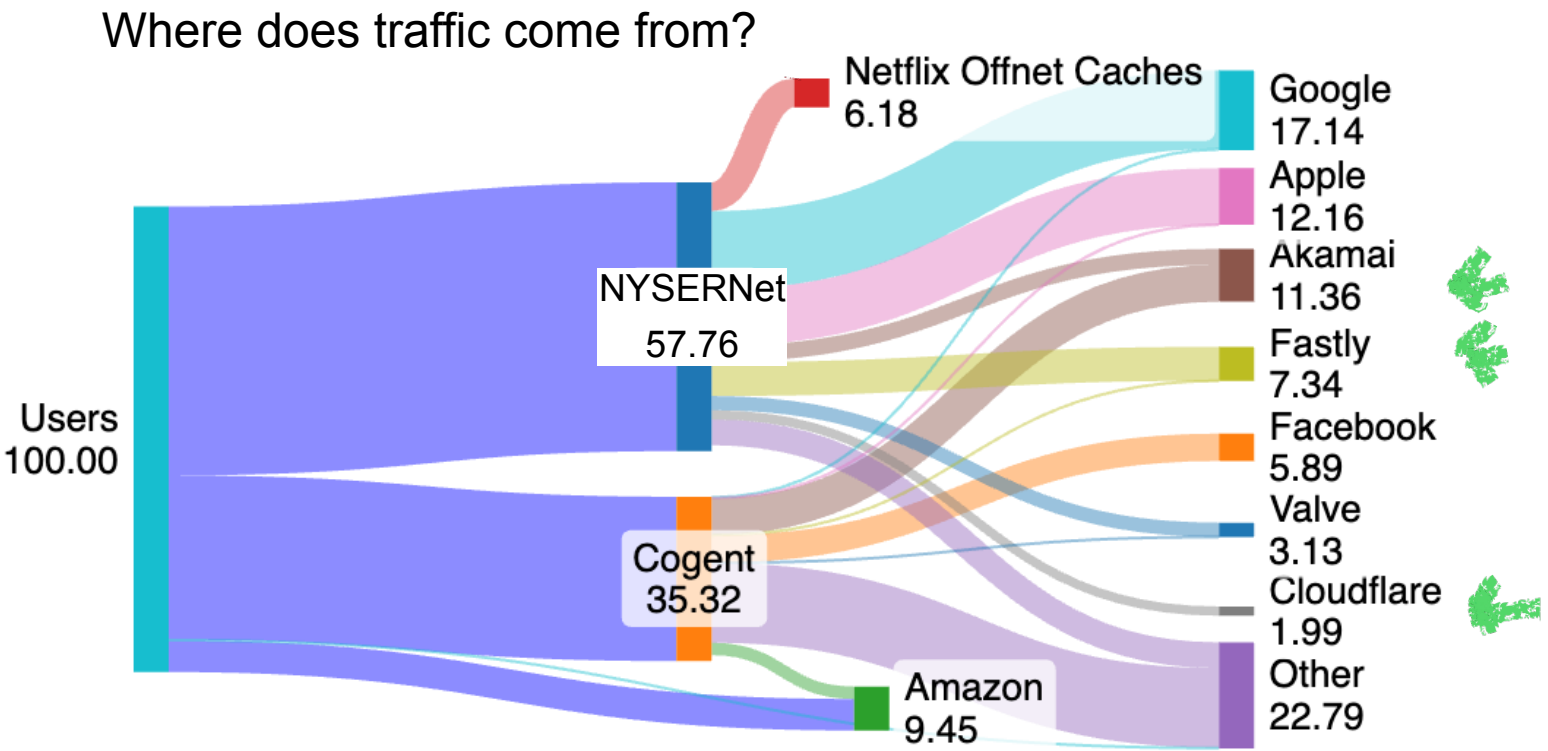
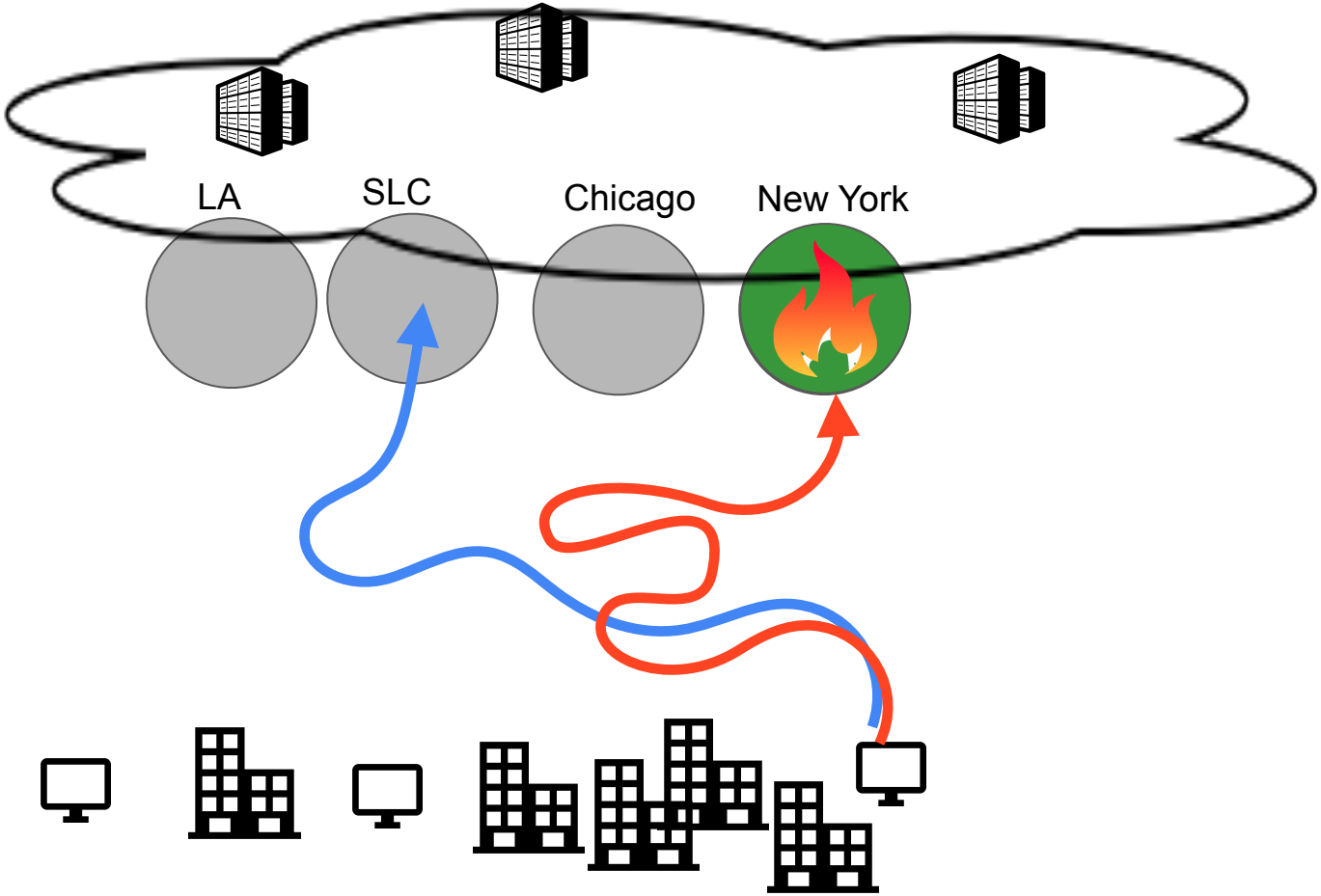
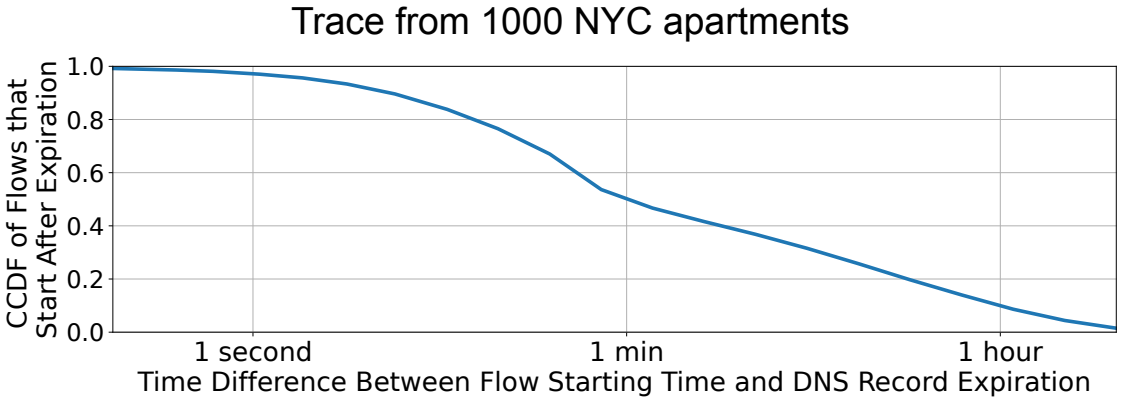


How quickly can DNS fail clients over to a new site?



Unicast lacks **availability** in site failure scenarios



- DNS **controls** client-to-site mapping
- DNS update is slow due to caching, which limits **availability.**
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    13% of flows start after TTL expired
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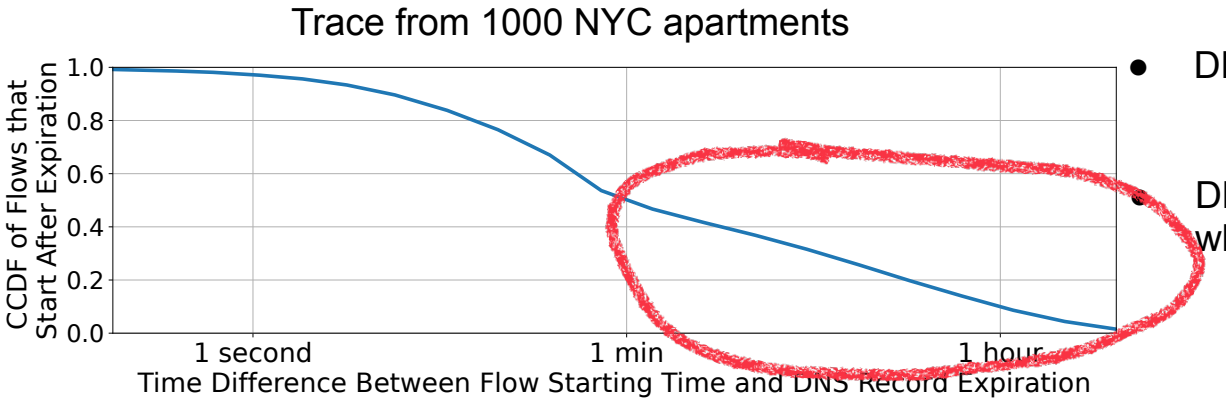

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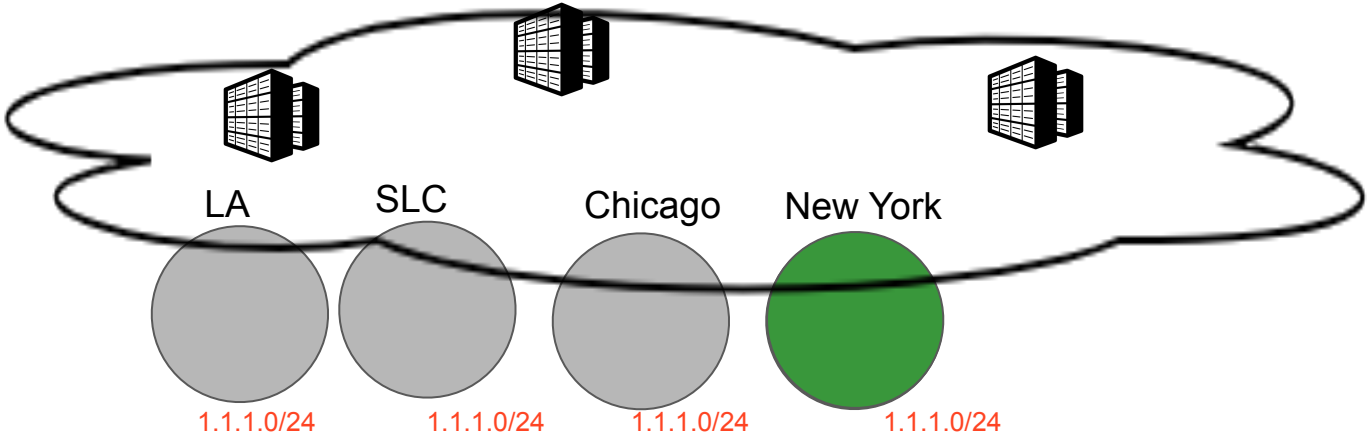

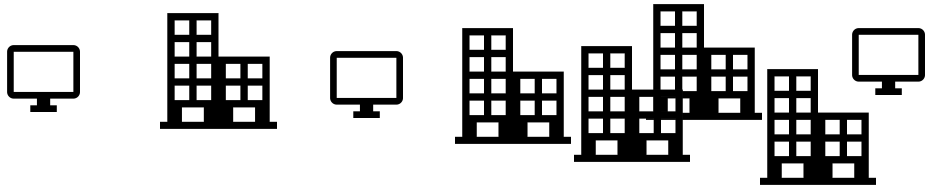

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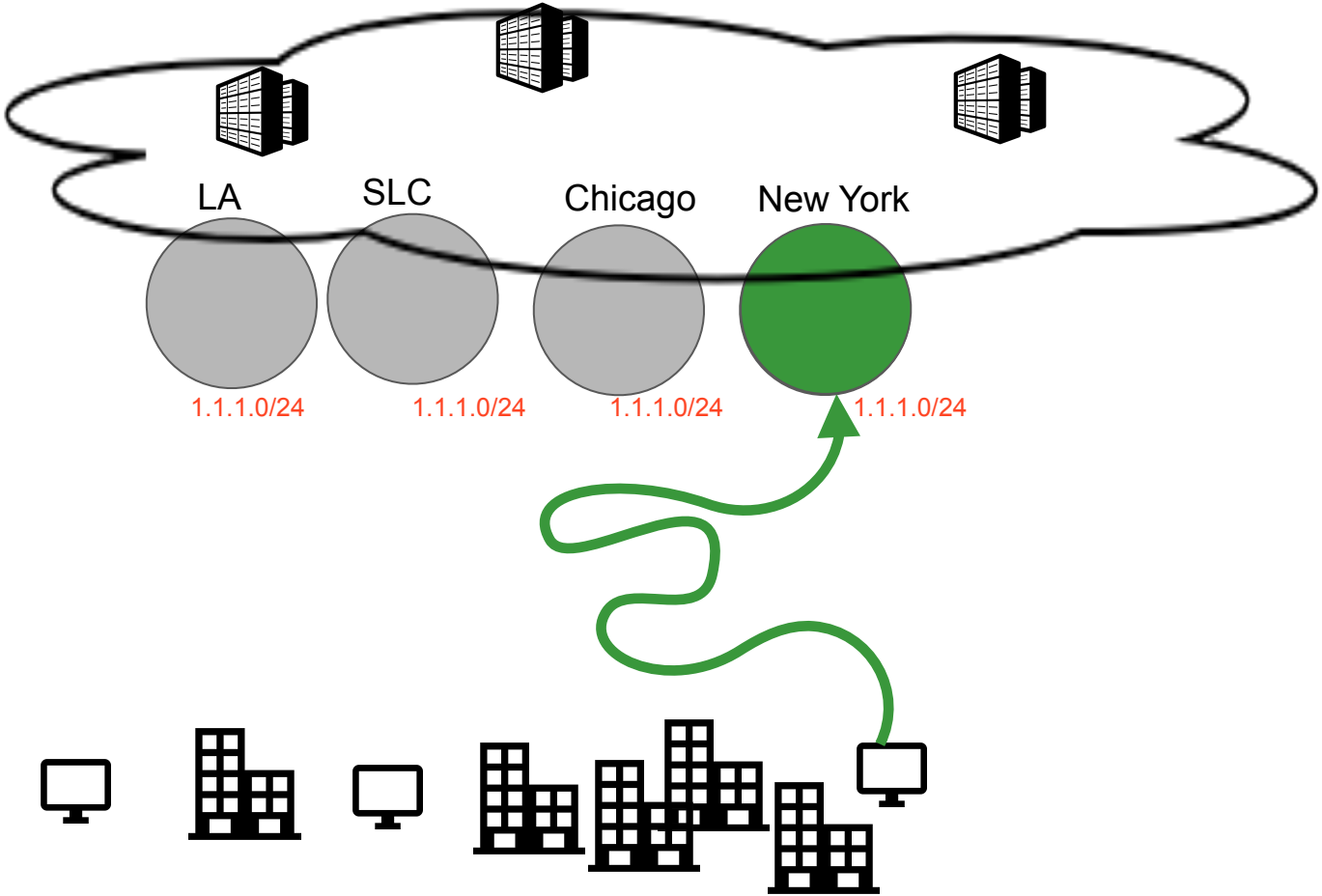

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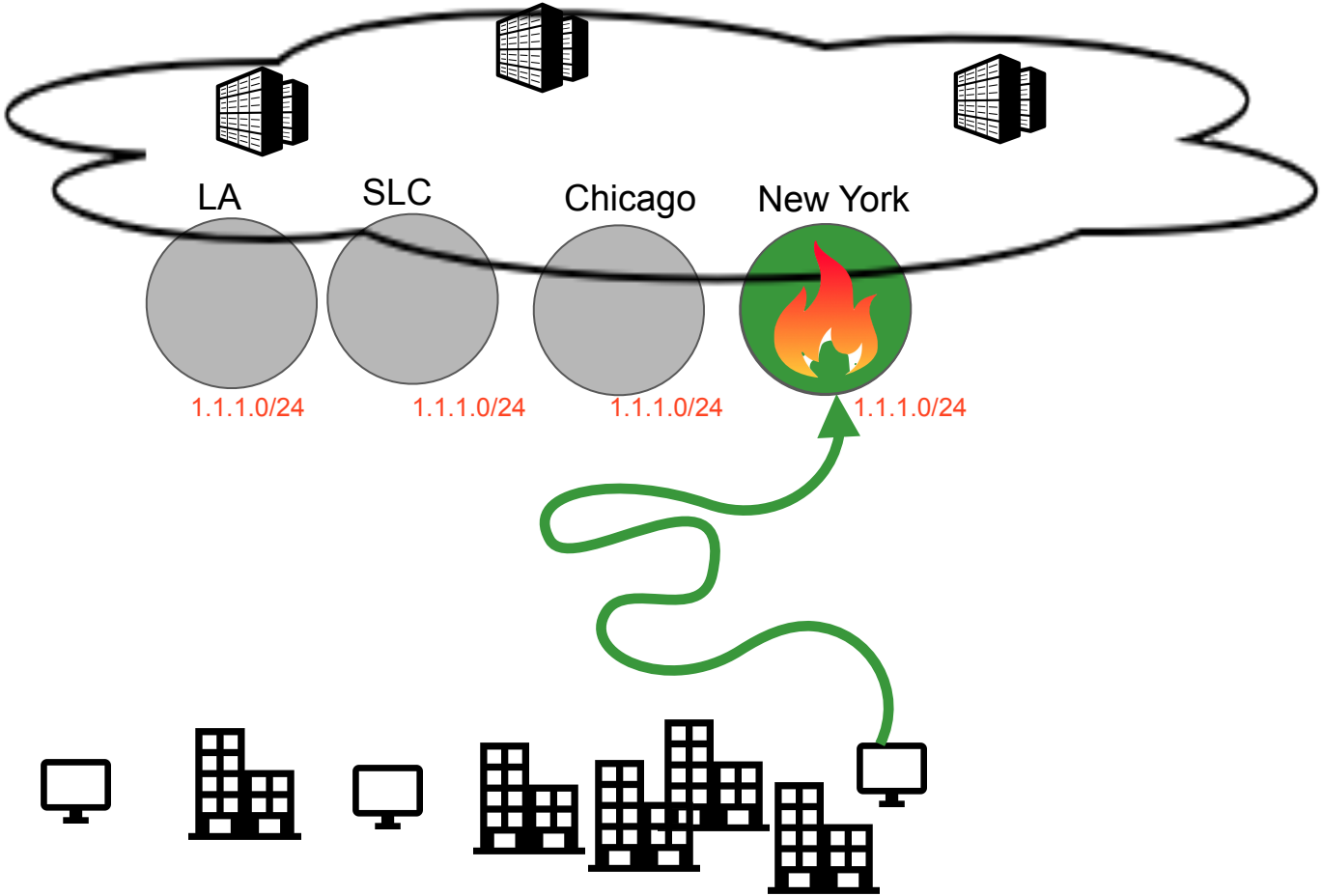

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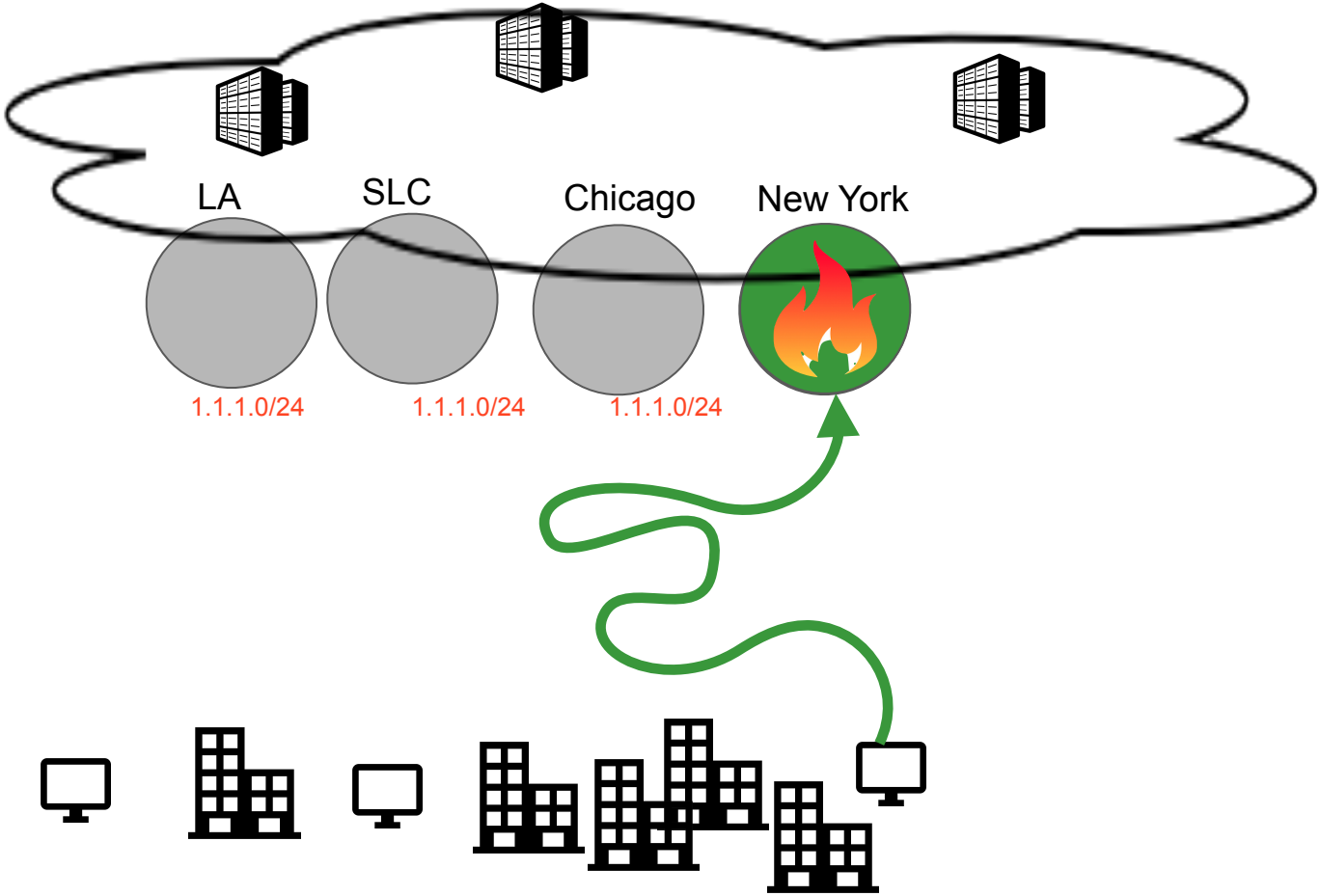

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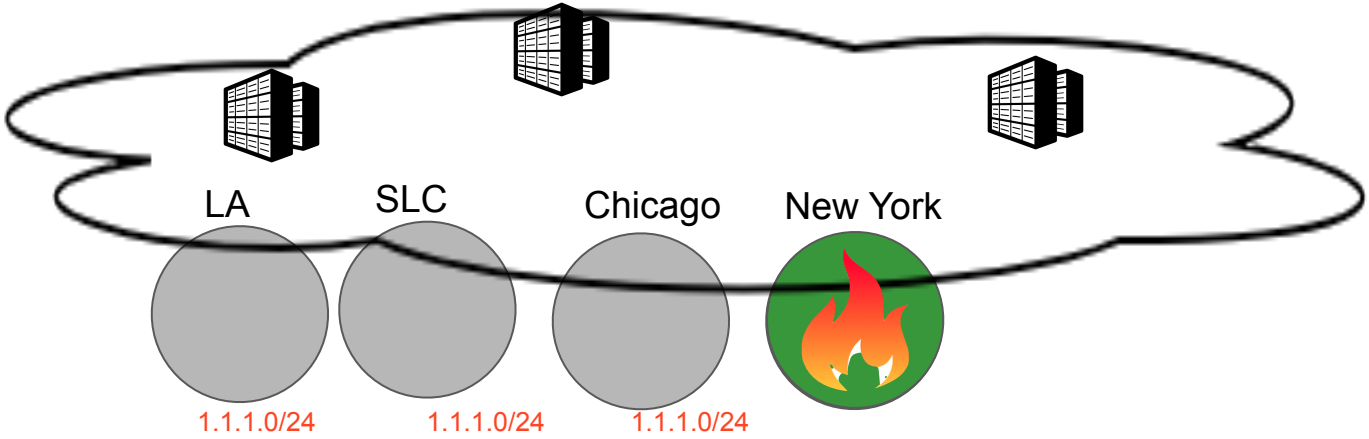

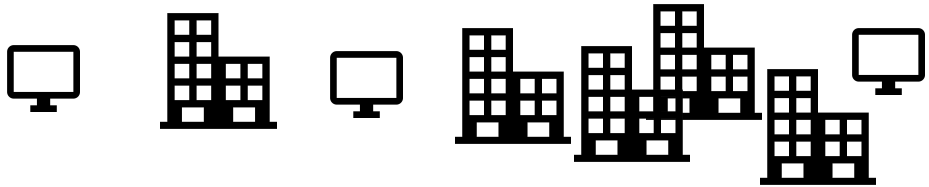

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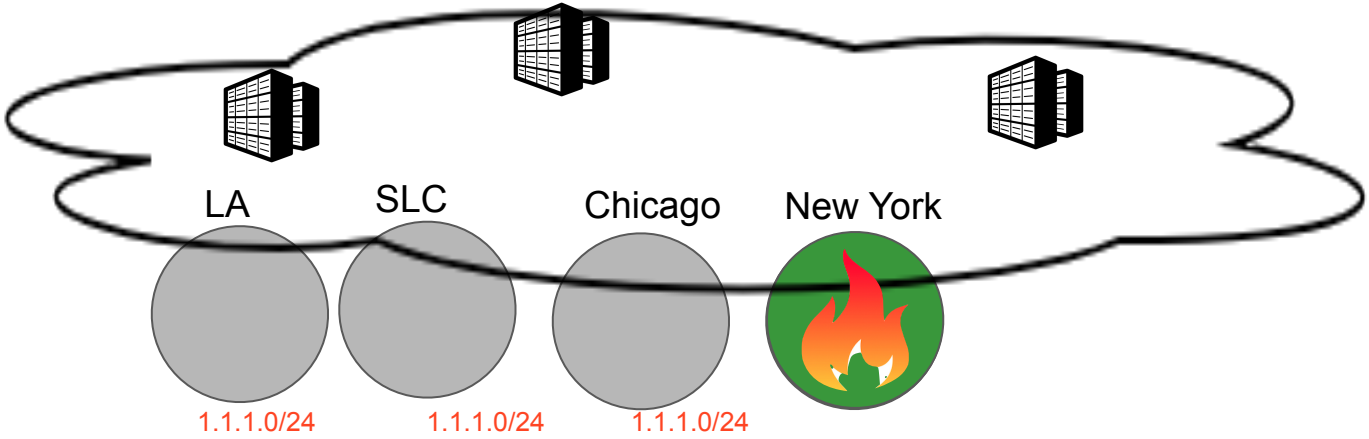
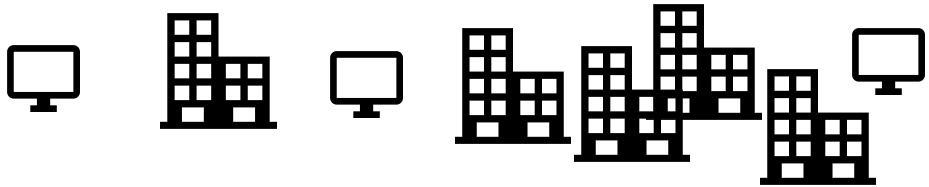


Routes to other sites are learned by networks and can attract traffic.



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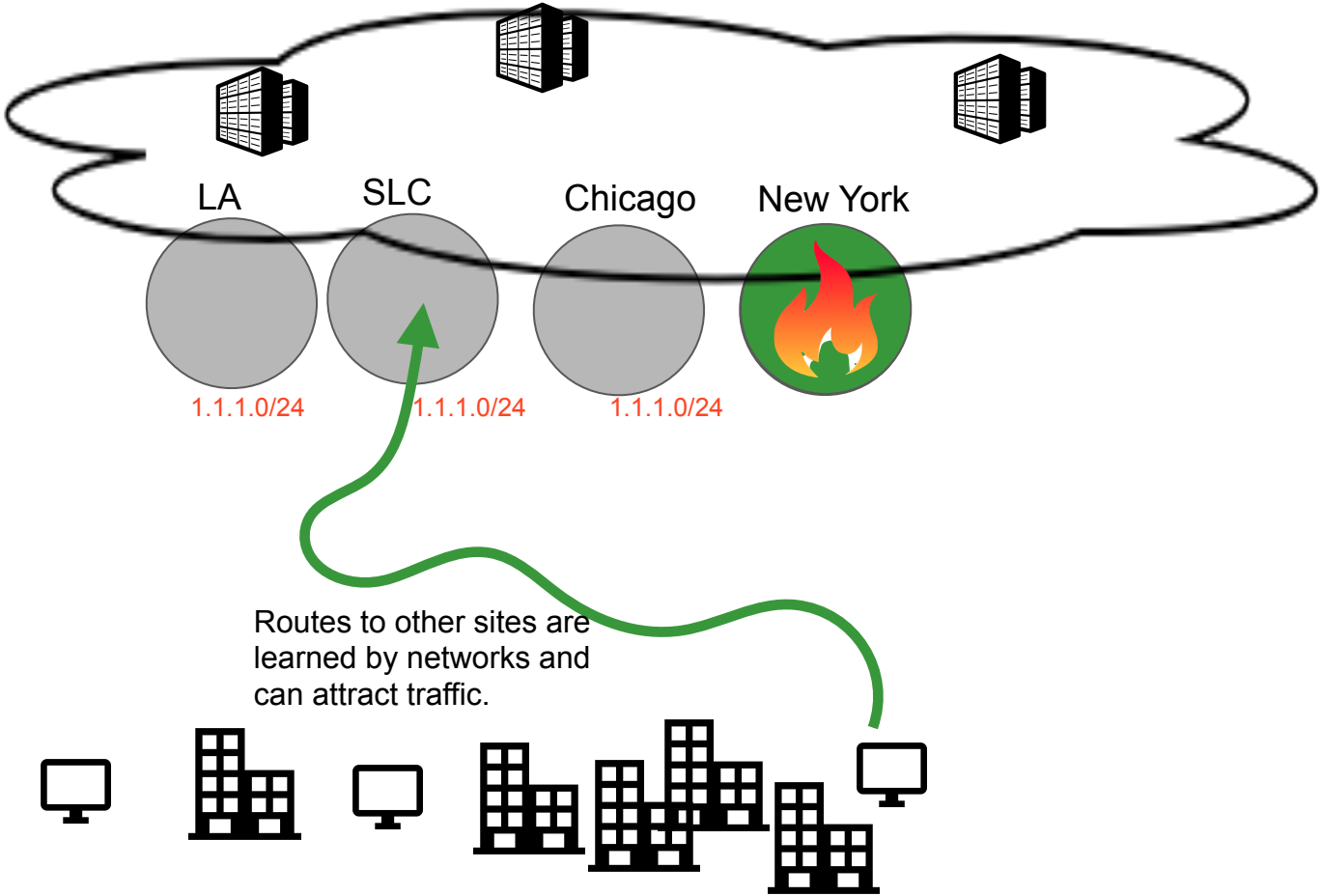
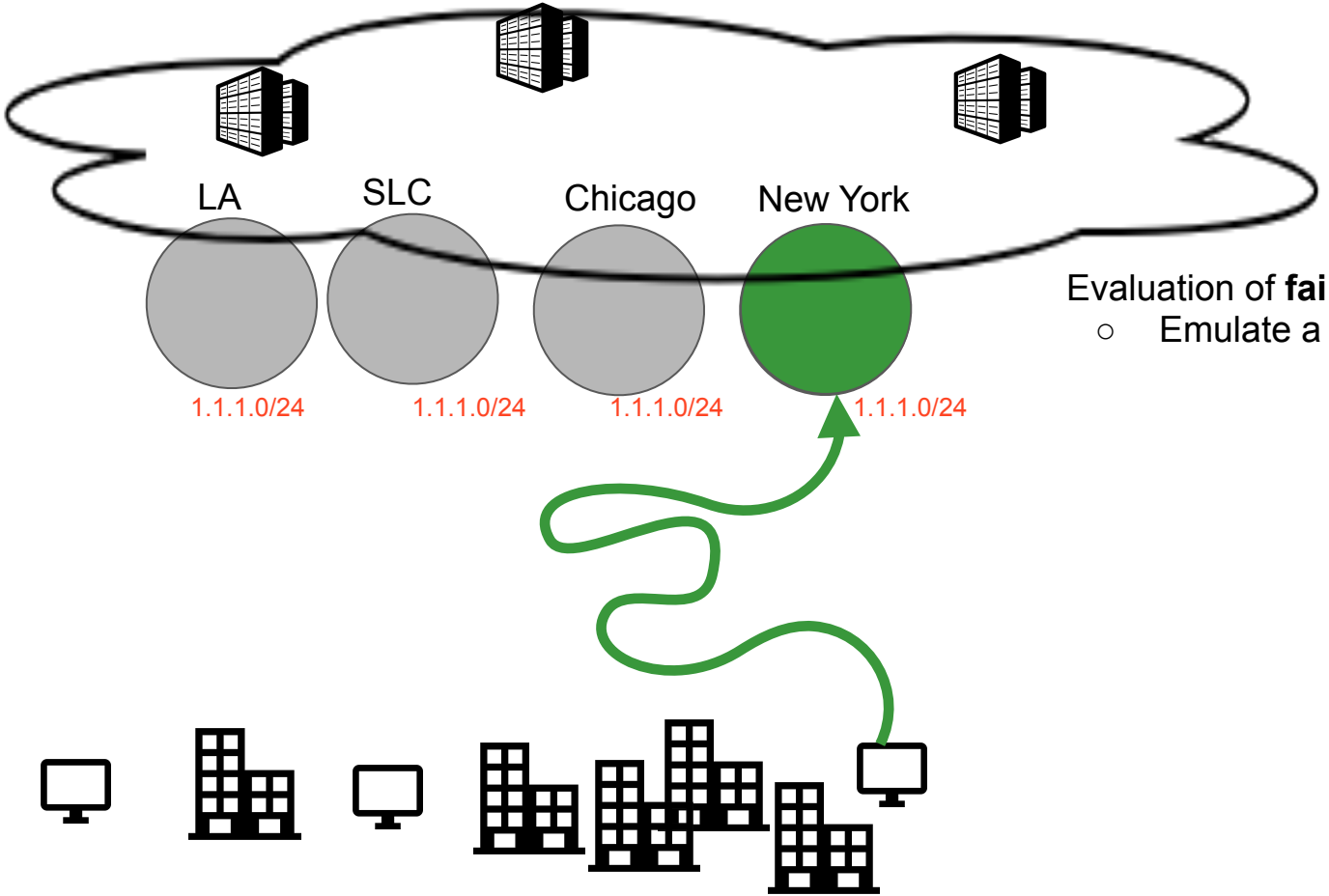


Measuring anycast failover



Evaluation of **failover time**

- Emulate a cloud provider / CDN

Updates on two community resources — please use them!

PEERING BGP testbed

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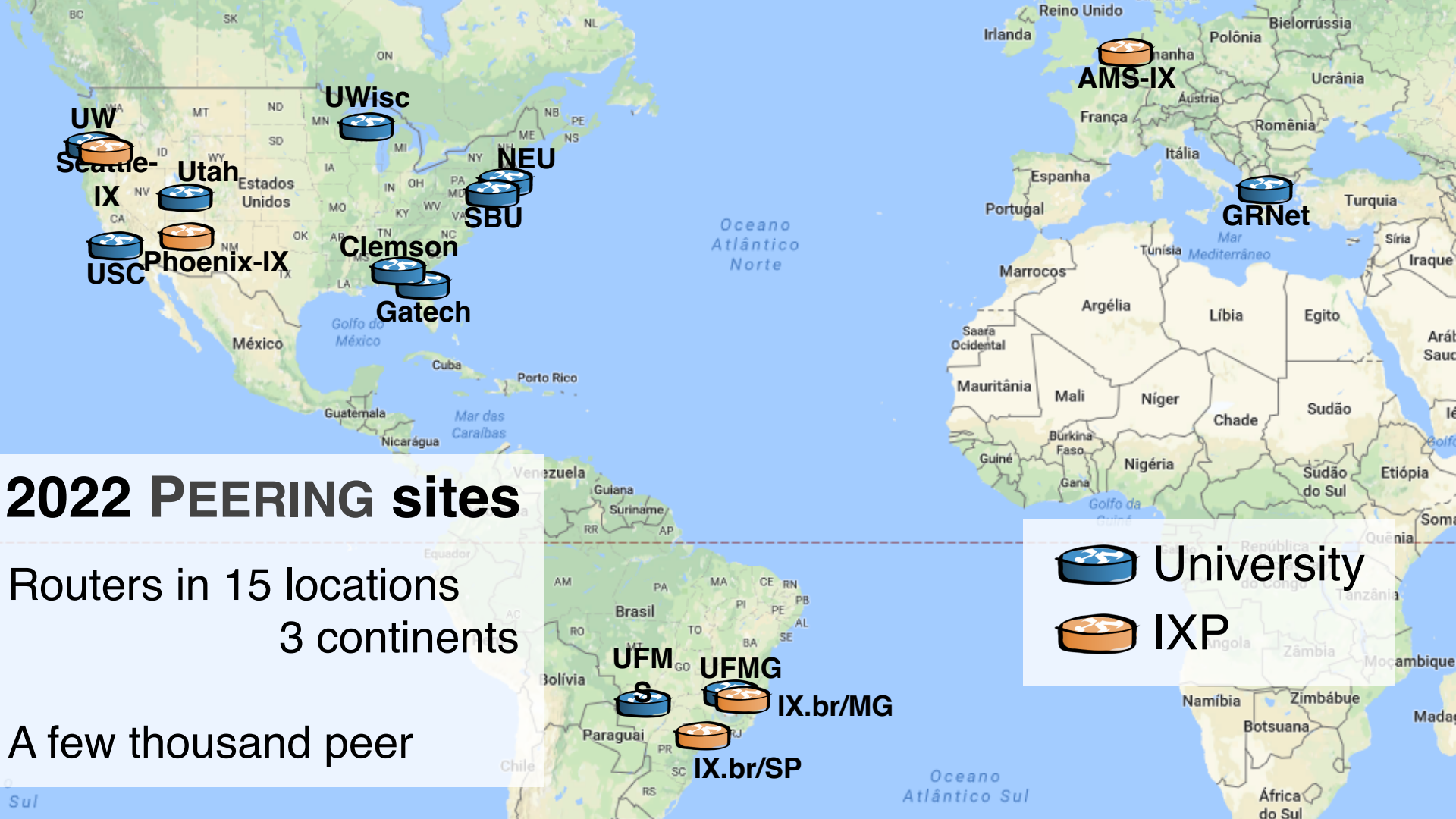


2022 PEERING sites

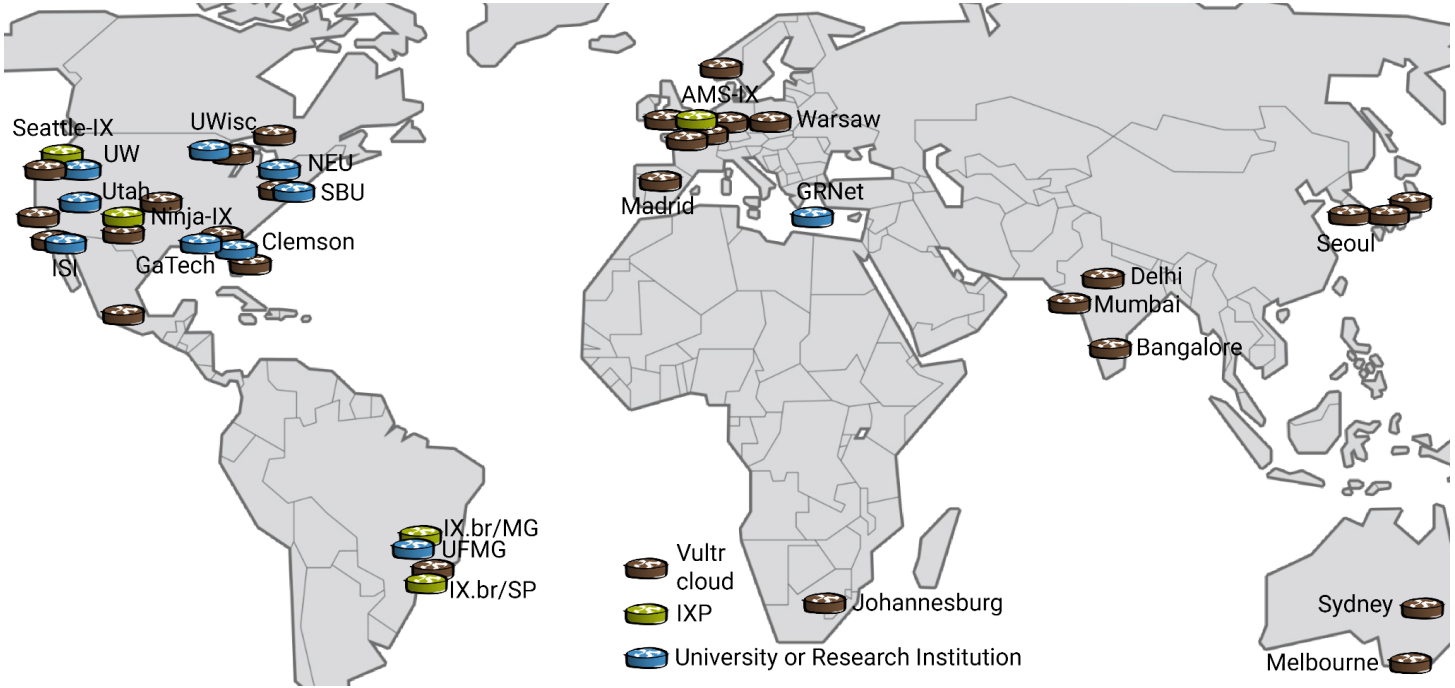
Routers in 15 locations
3 continents

A few thousand peer

University

IXP

PEERING sites - Deployed on Vultr data centers



PEERING sites - Announce from Cloudflare PoPs

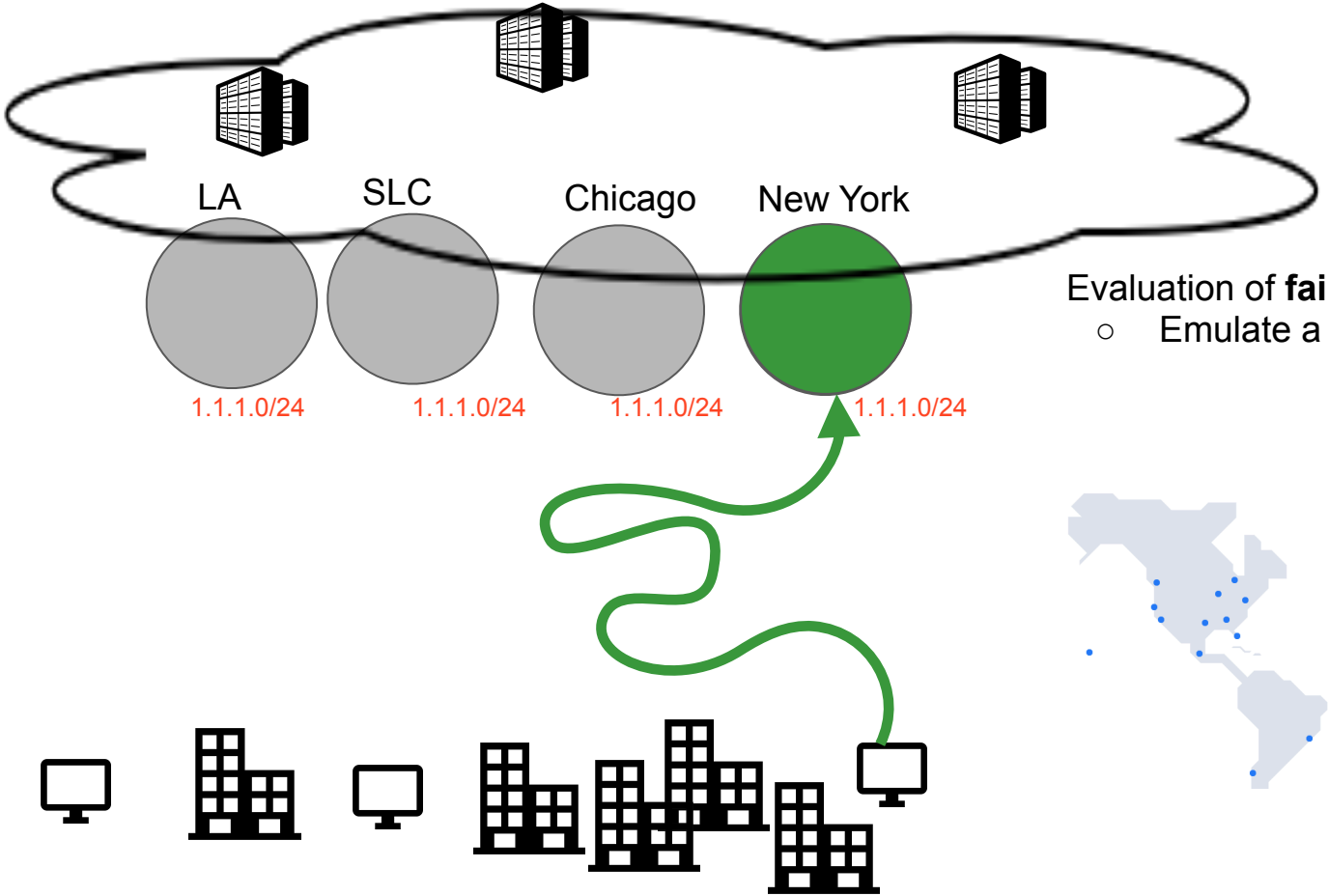
PEERING site capabilities

	# sites	# neighbor ASes	exchange traffic	control BGP announcements	select outgoing routes
universities	10	~10	Y	Y	Y
IXPs	5	~1500	Y	Y	Y
Vultr	32	~6000	Y	Y	N
Cloudflare	335	~13,000	Y	N	N

Data collection

- Looking Glass on PEERING routers so experimenters can view routes
  - Especially useful for debugging your own experiments to check your own experiments
- Traceroutes:
  - 48 teams of 400 RIPE Atlas probes run traceroute to PEERING prefixes every 20 minutes
  - Can configure exact source probes and destination PEERING prefixes/addresses
- Route monitoring
  - Monitor route visibility of PEERING announcements from RIPE RIS
  - https://github.com/PEERINGTestbed/peeringmon_exporter
- TODO: Feed routes to RouteViews/RIS/GIII
  - Announcements that experiments make
  - Routes we learn from the Internet

Measuring anycast failover



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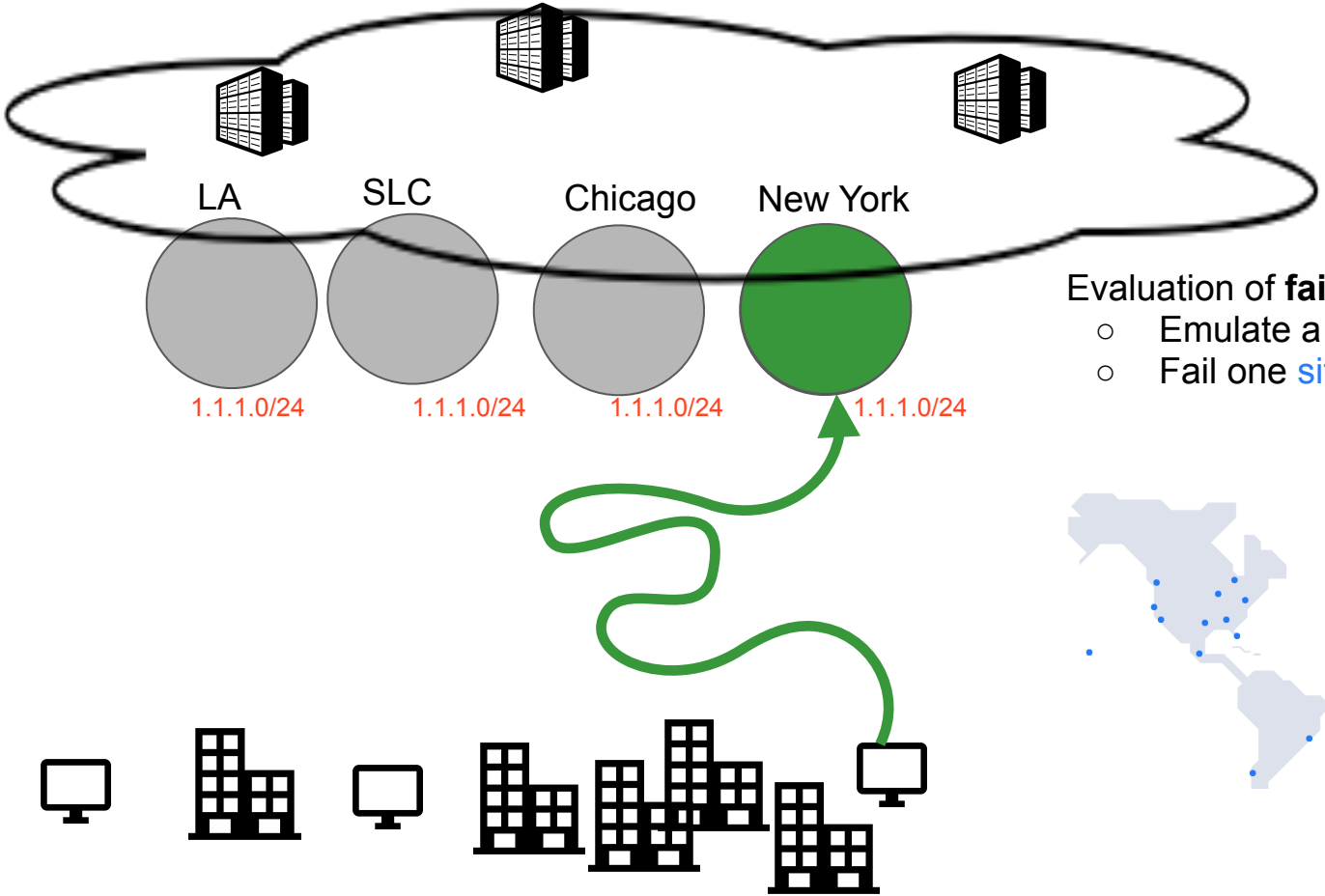

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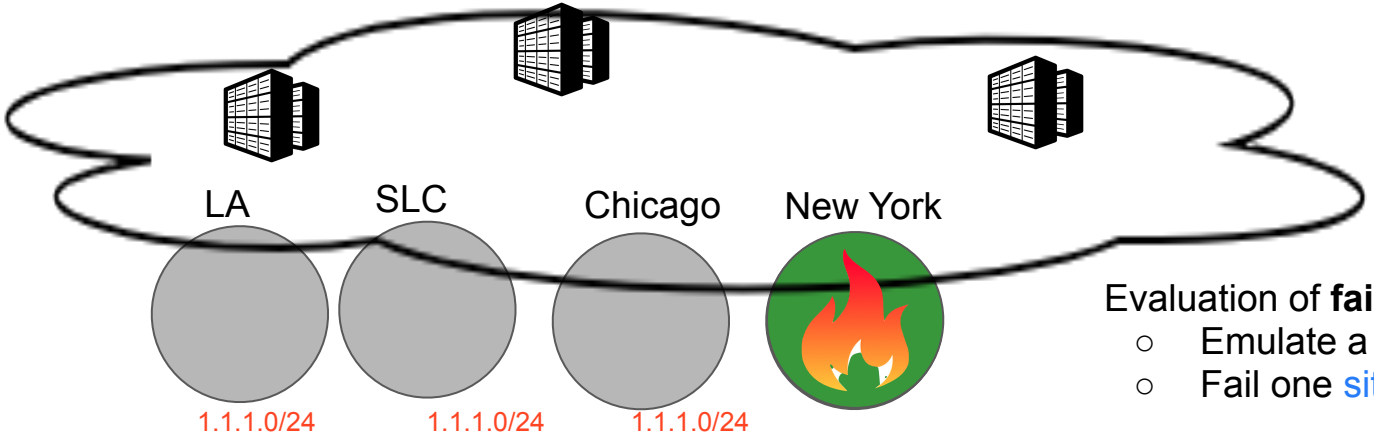

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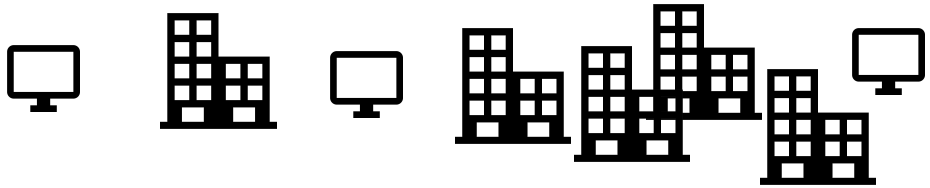

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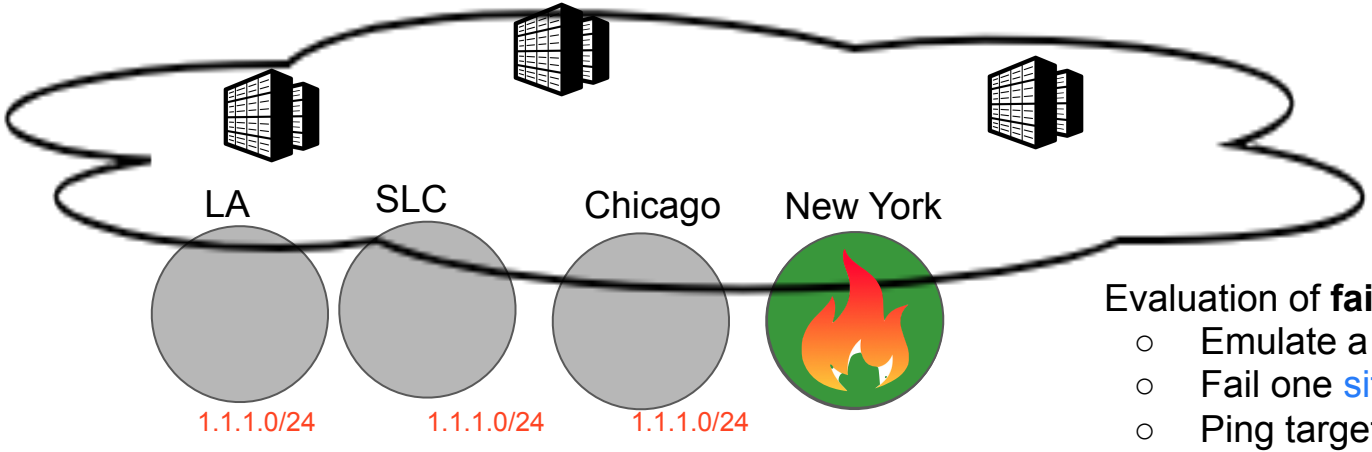

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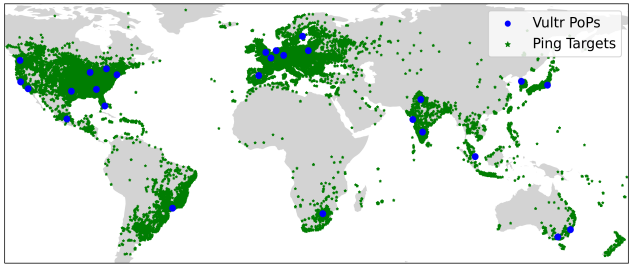

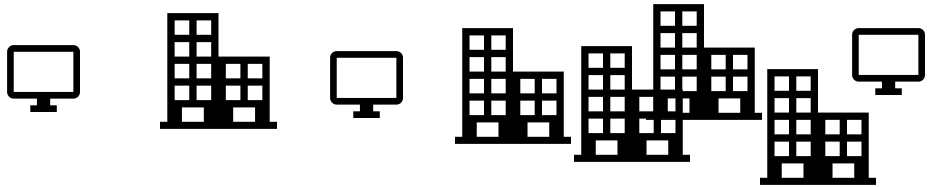

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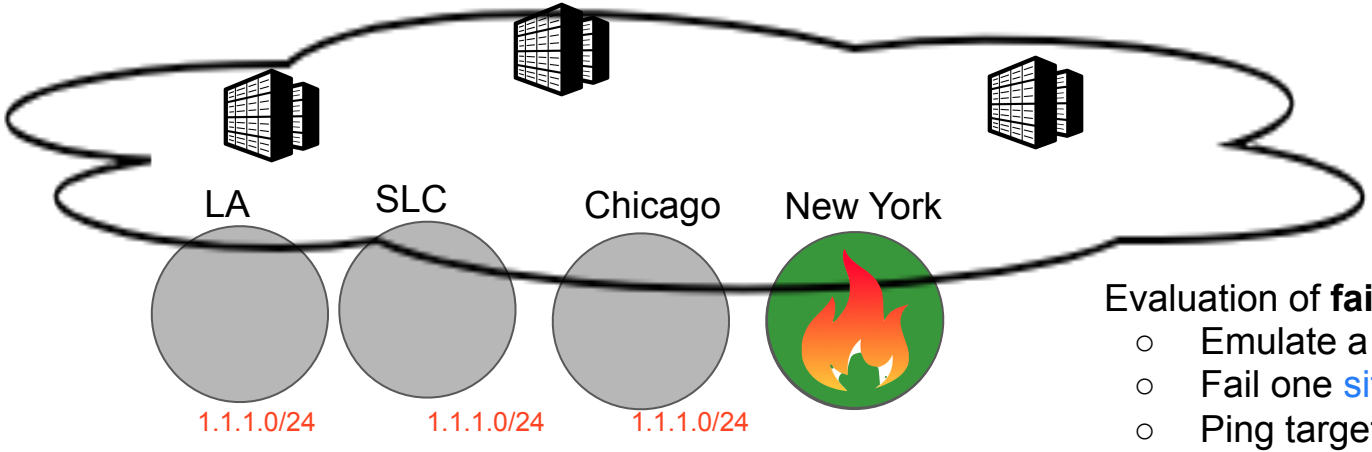

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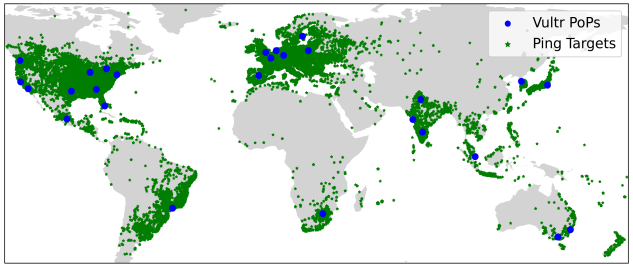

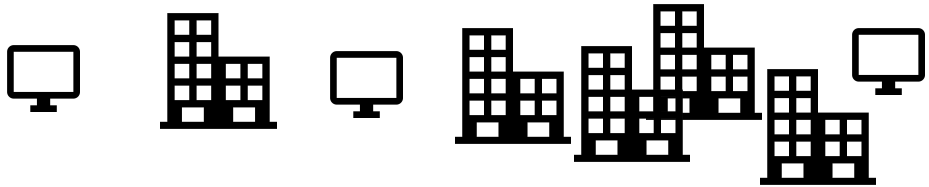

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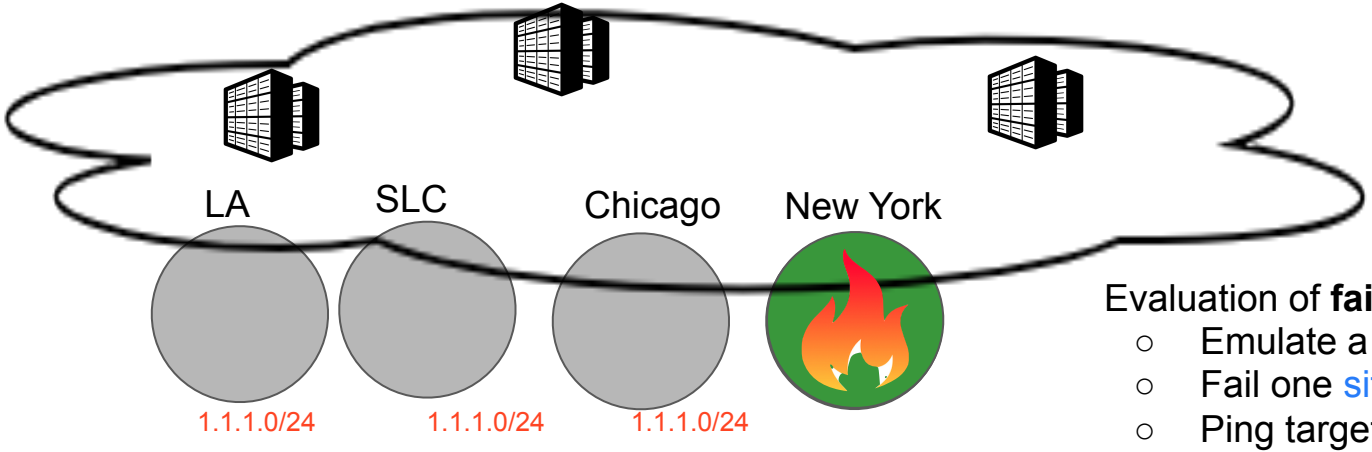

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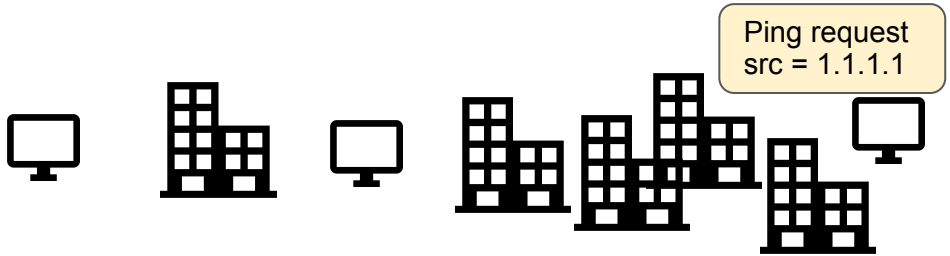
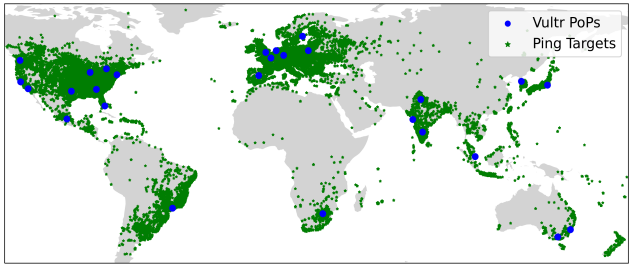
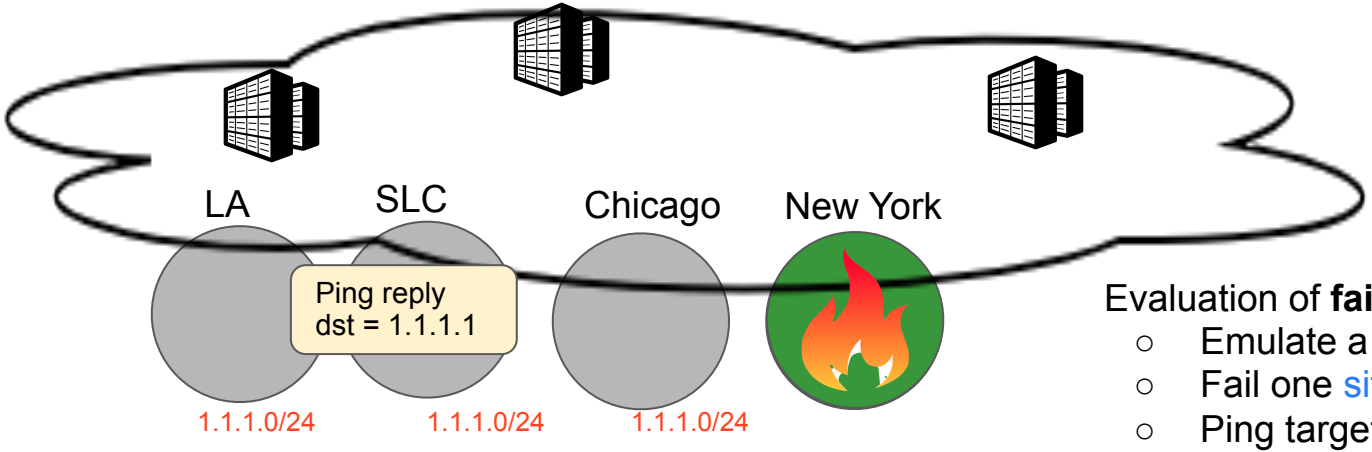




Measuring anycast failover



Evaluation of **failover time**

- Emulate a cloud provider / CDN
- Fail one site at a time
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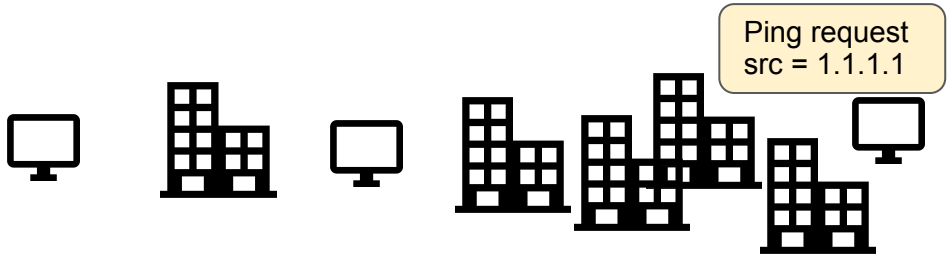

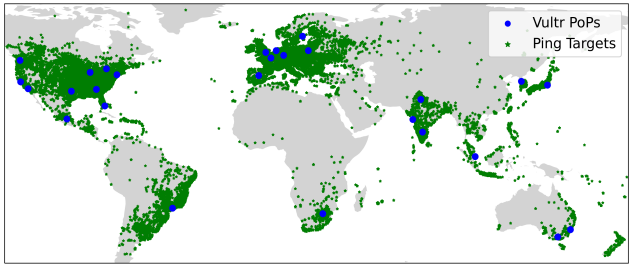

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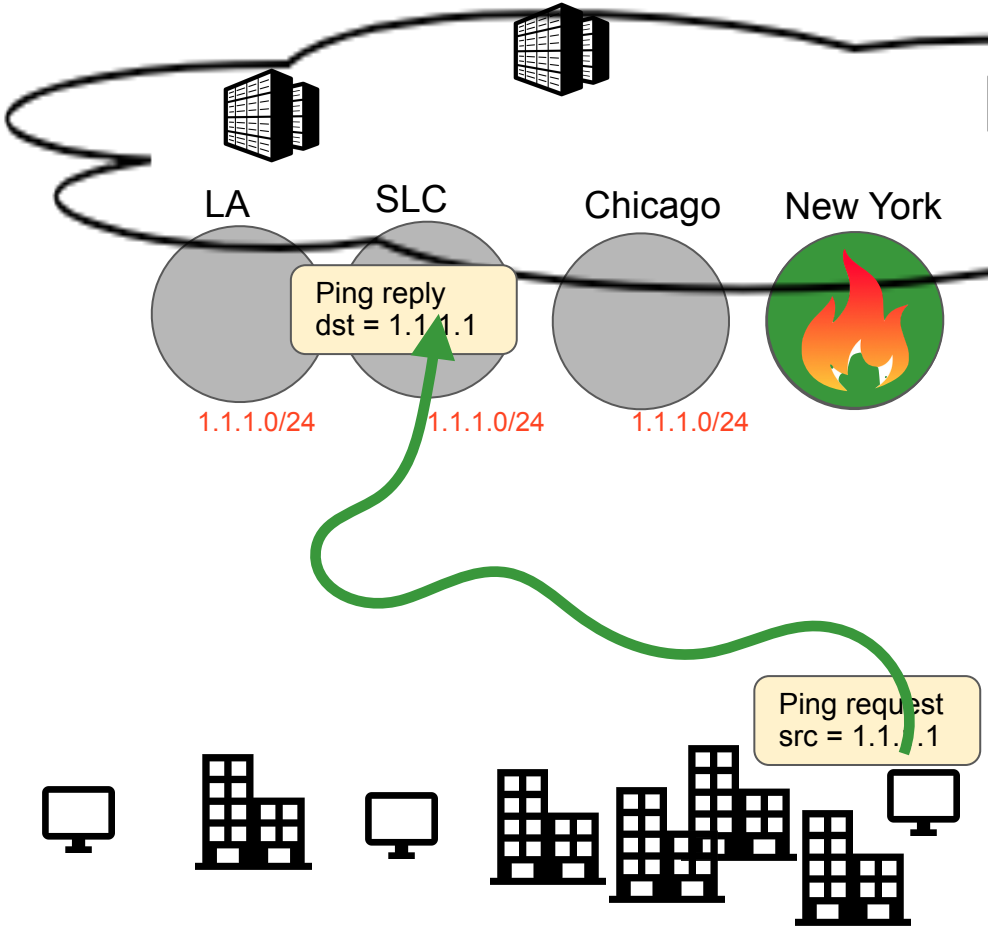

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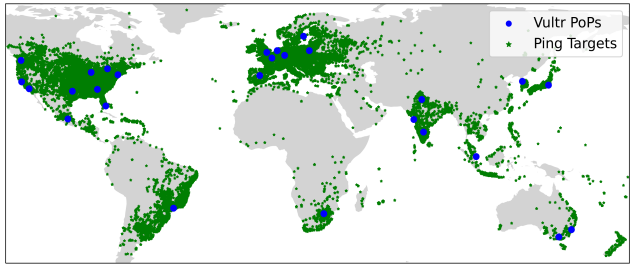

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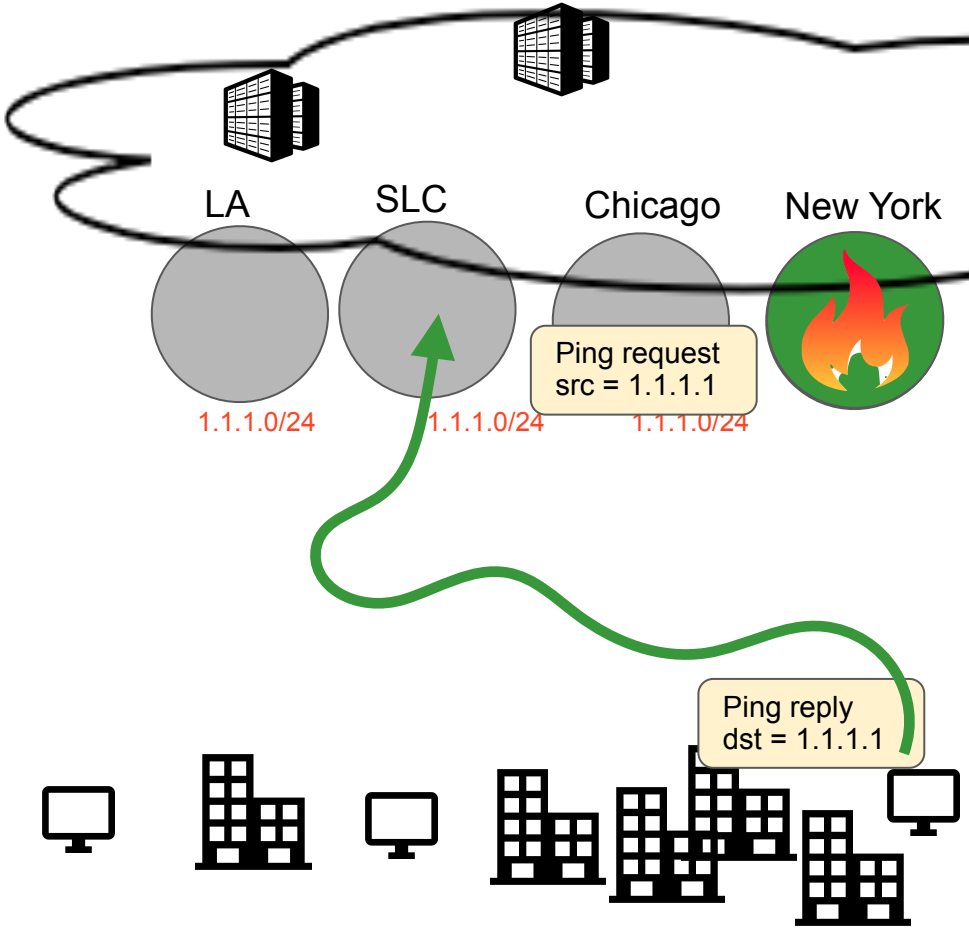
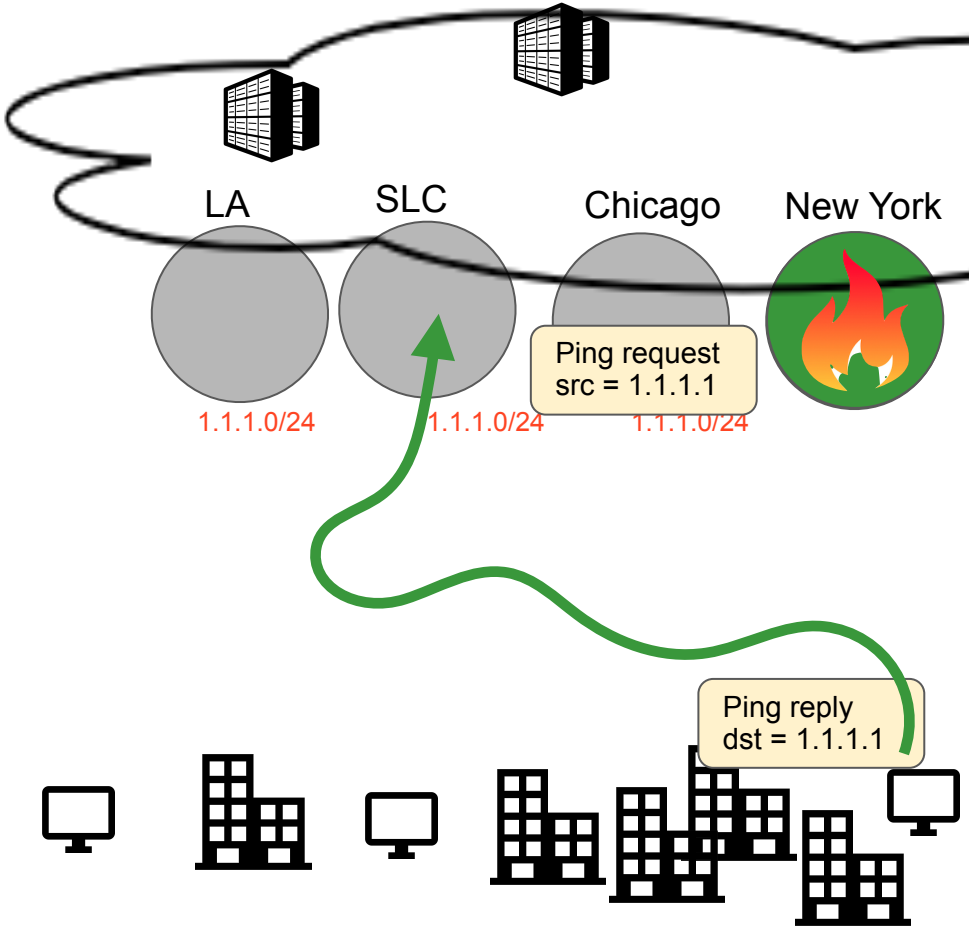


Evaluation of **failover time**

- Emulate a cloud provider / CDN
- Fail one site at a time
- Ping target “clients” to measure failover
- Median failover < 2 seconds

Technique	Control	Availability
Unicast	High	Low
Anycast	Low	

Measuring anycast failover



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PEERING BGP testbed

Residential traffic traces

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- Currently ~1000 units, 4 hrs / day
  - Plan to scale to 8000 units, 24x7

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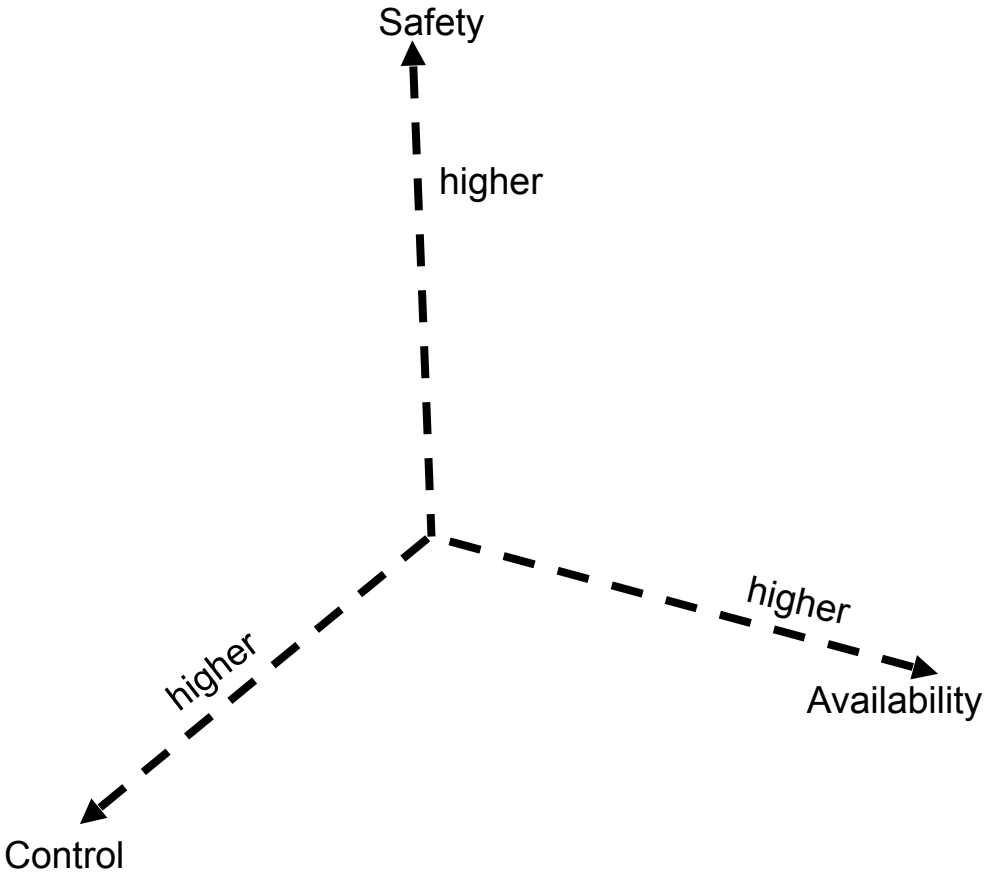
Residential traffic traces

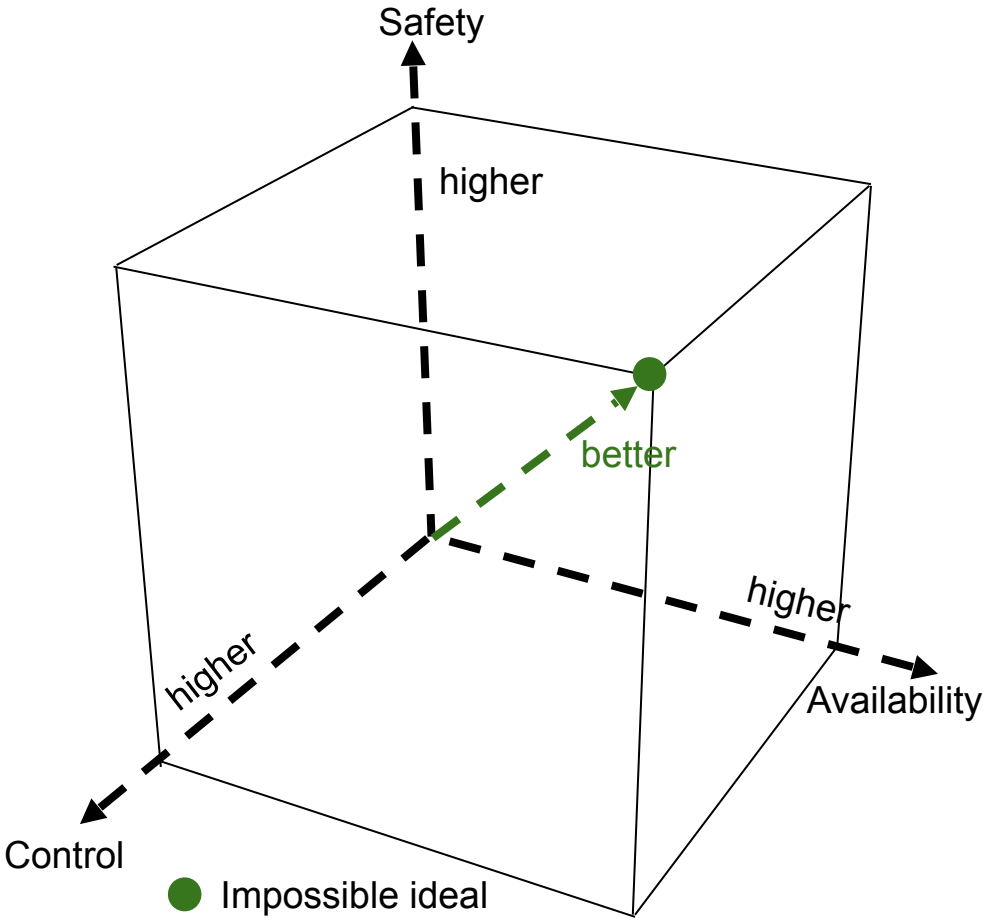
- Collecting since 2023 and plan to continue indefinitely
- Currently ~1000 units, 4 hrs / day
  - Plan to scale to 8000 units, 24x7
- We can share the data
- Submit IRB approval/exemption including description of data needed
- Data aggregated and anonymized as appropriate
  - Flows or packets
  - Individual (anonymized) units (rotating anonymization key), or truncated by prefix

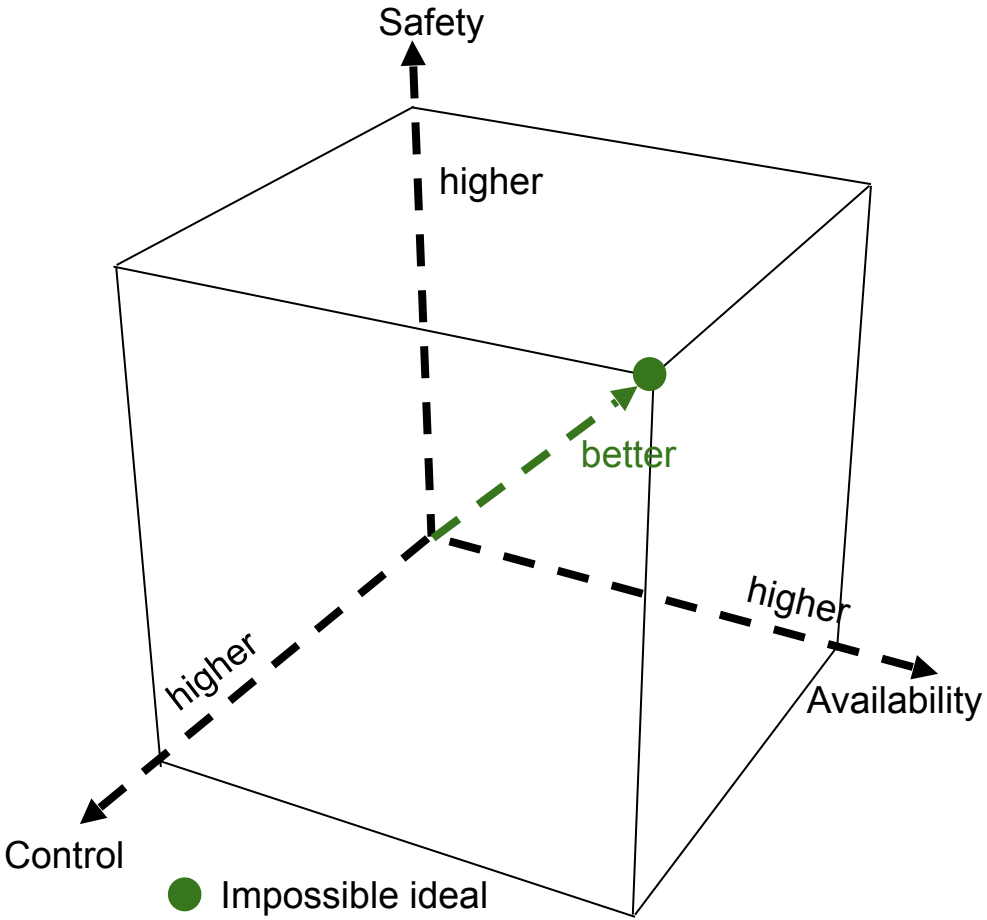
Fundamental tradeoffs in cloud/CDN ingress routing

Technique	Control	Availability
Unicast	High	Low
Anycast	Low	High

- Existing techniques compromise control or availability
- Announcing failed site's prefix from other sites upon failure (***reactive*** anycast) runs risk of turning a local failure into a widespread one, compromising ***safety***
- Tradeoffs are fundamental:
  any technique relying on DNS + BGP for content redirection
  must compromise at least one of *control, availability, or safety*

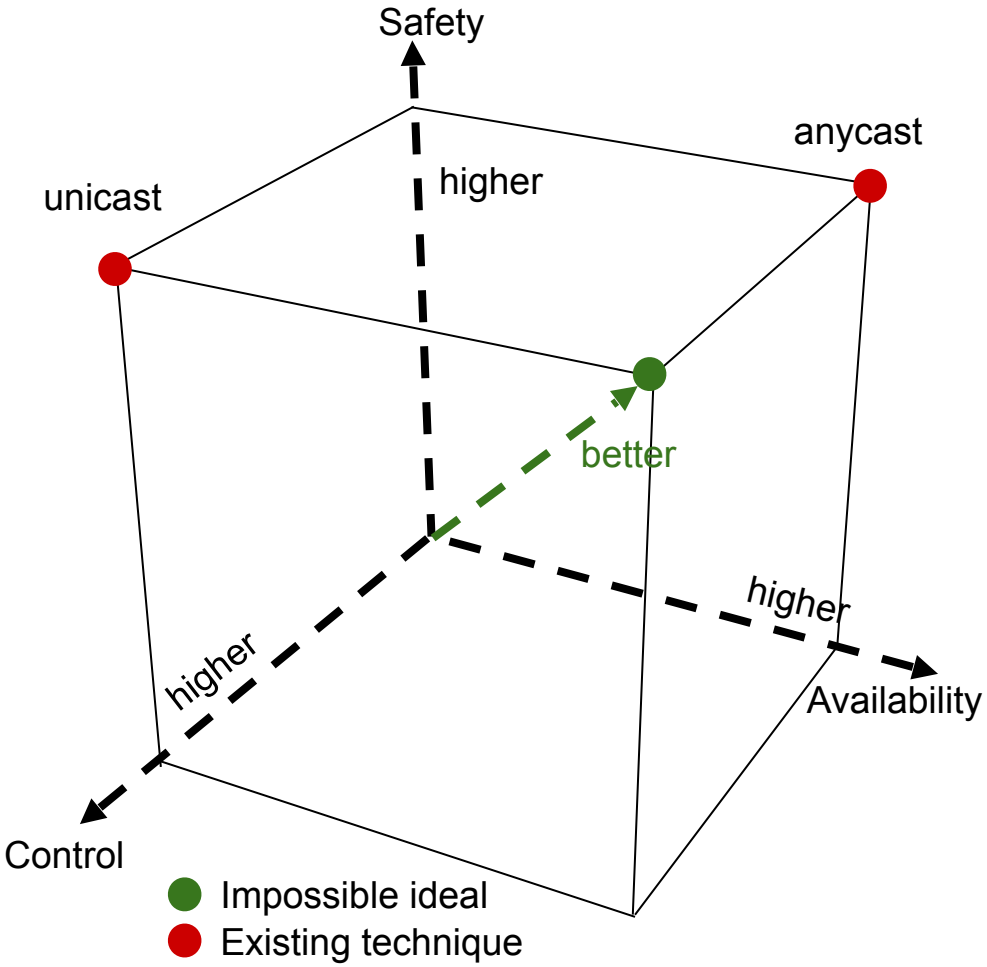

Safety
higher
higher
higher
Availability
Control


Safety
higher
better
higher
higher
Availability
Control
Impossible ideal



- Existing techniques compromise **control** or **availability**.

Technique	Control	Availability	Safety
Unicast	High	Low	High
Anycast	Low	High	High



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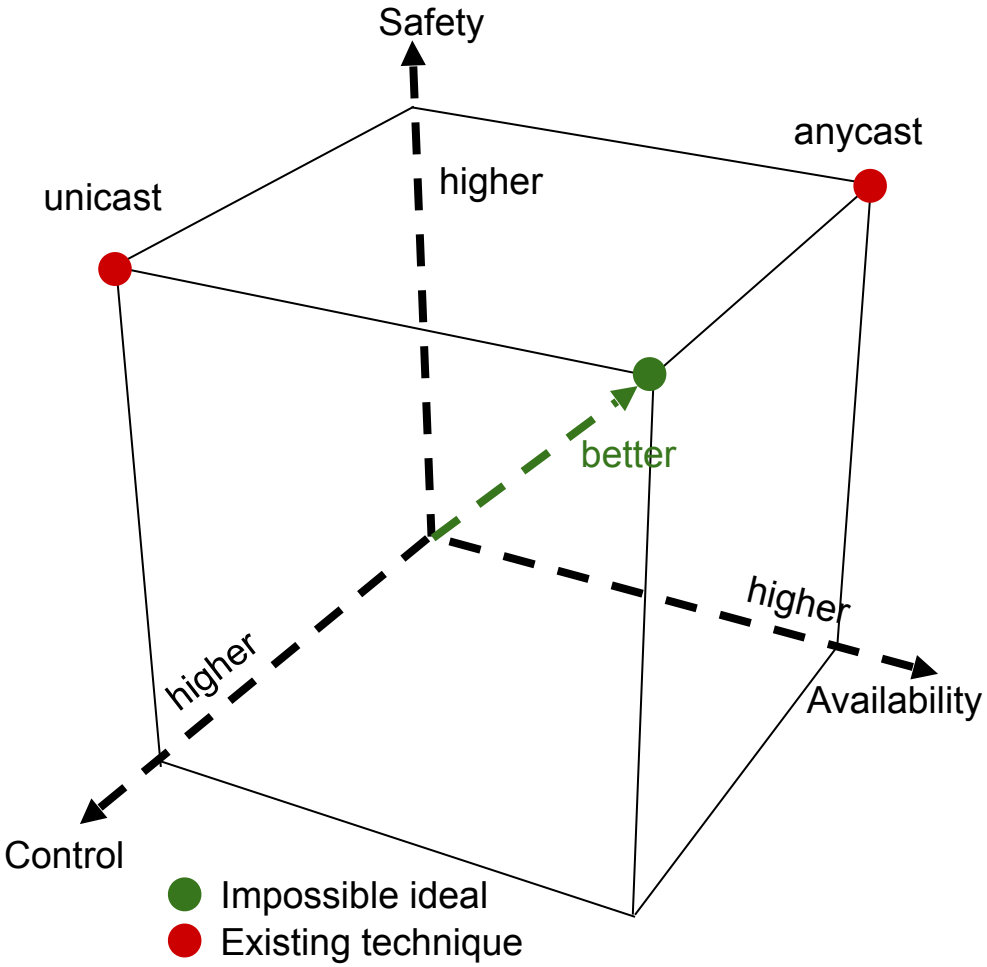

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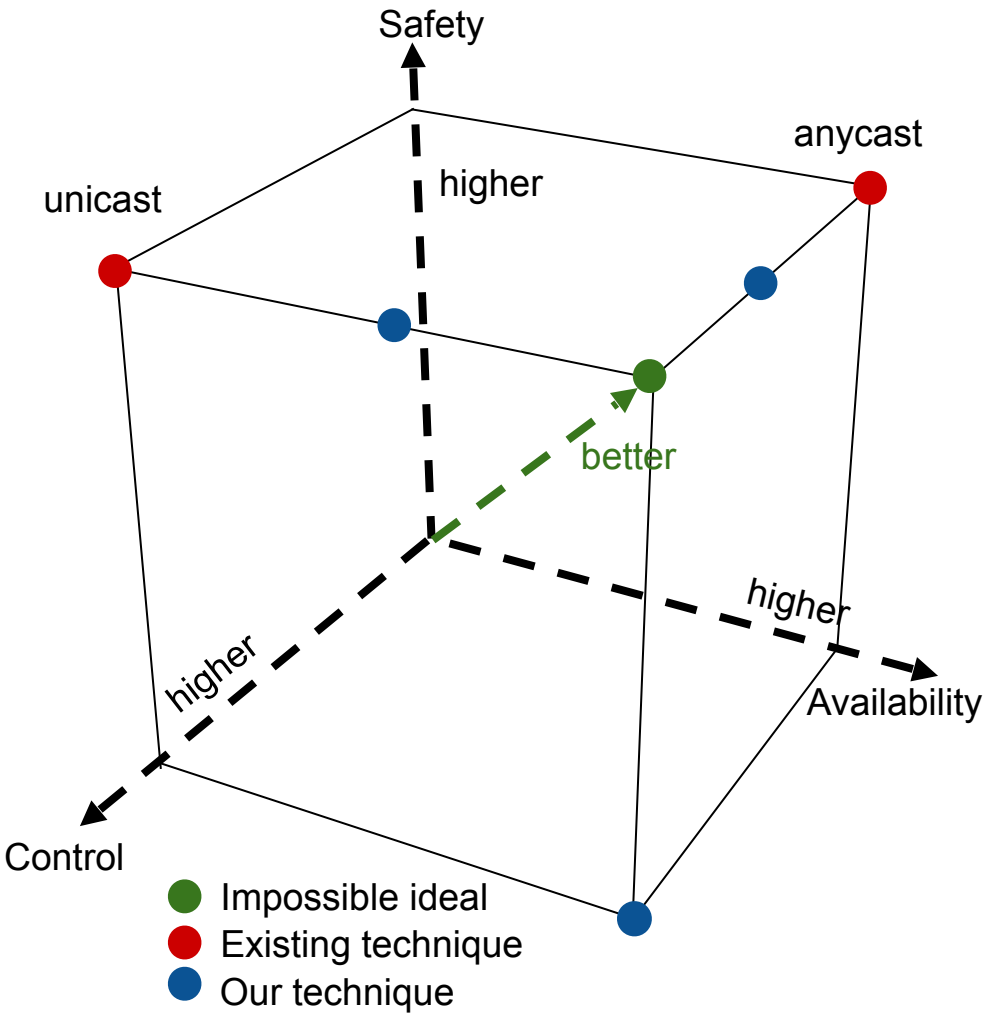

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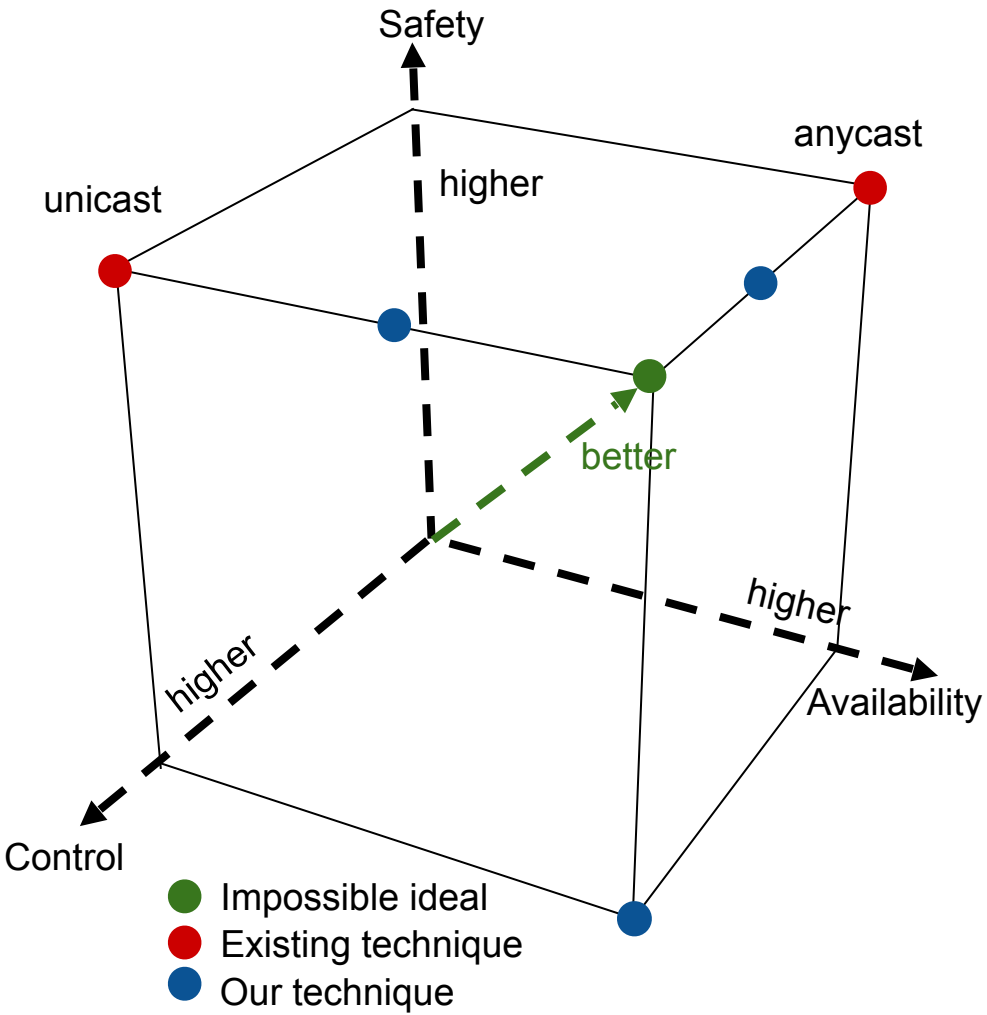

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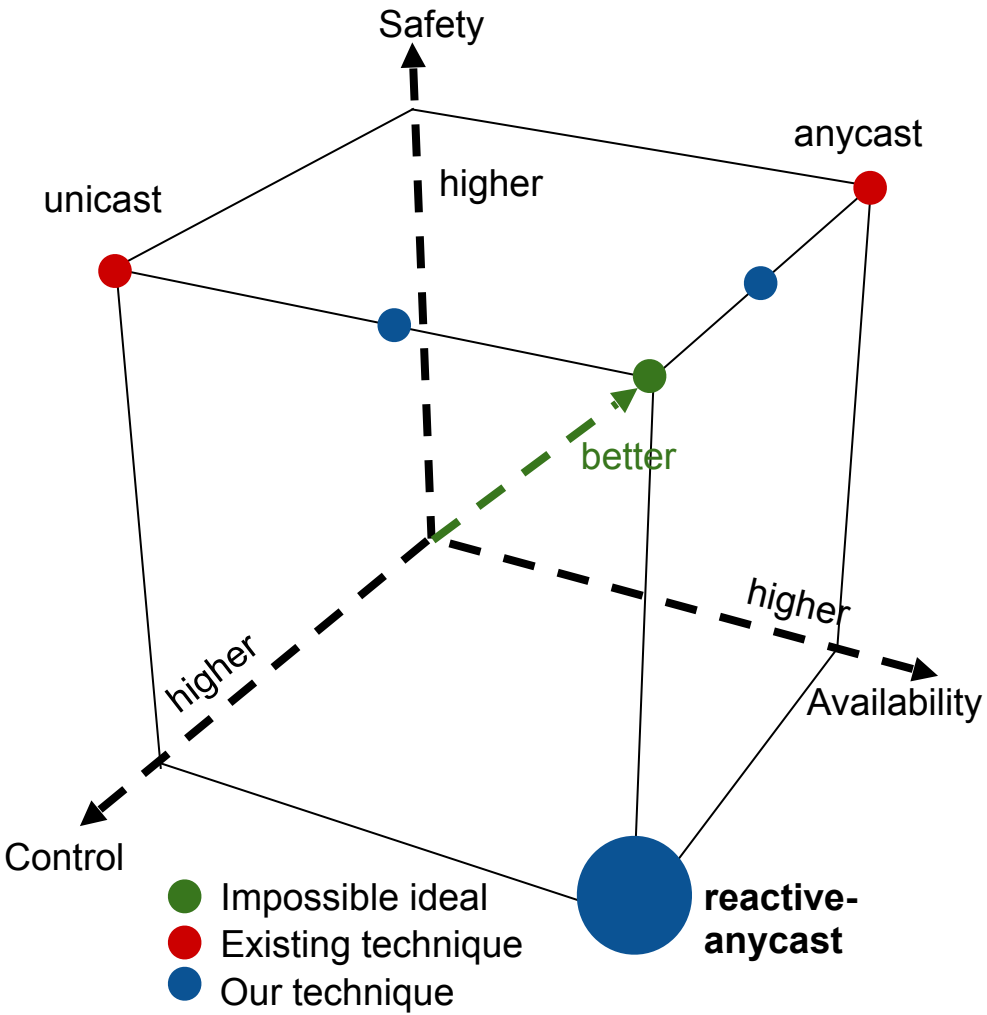

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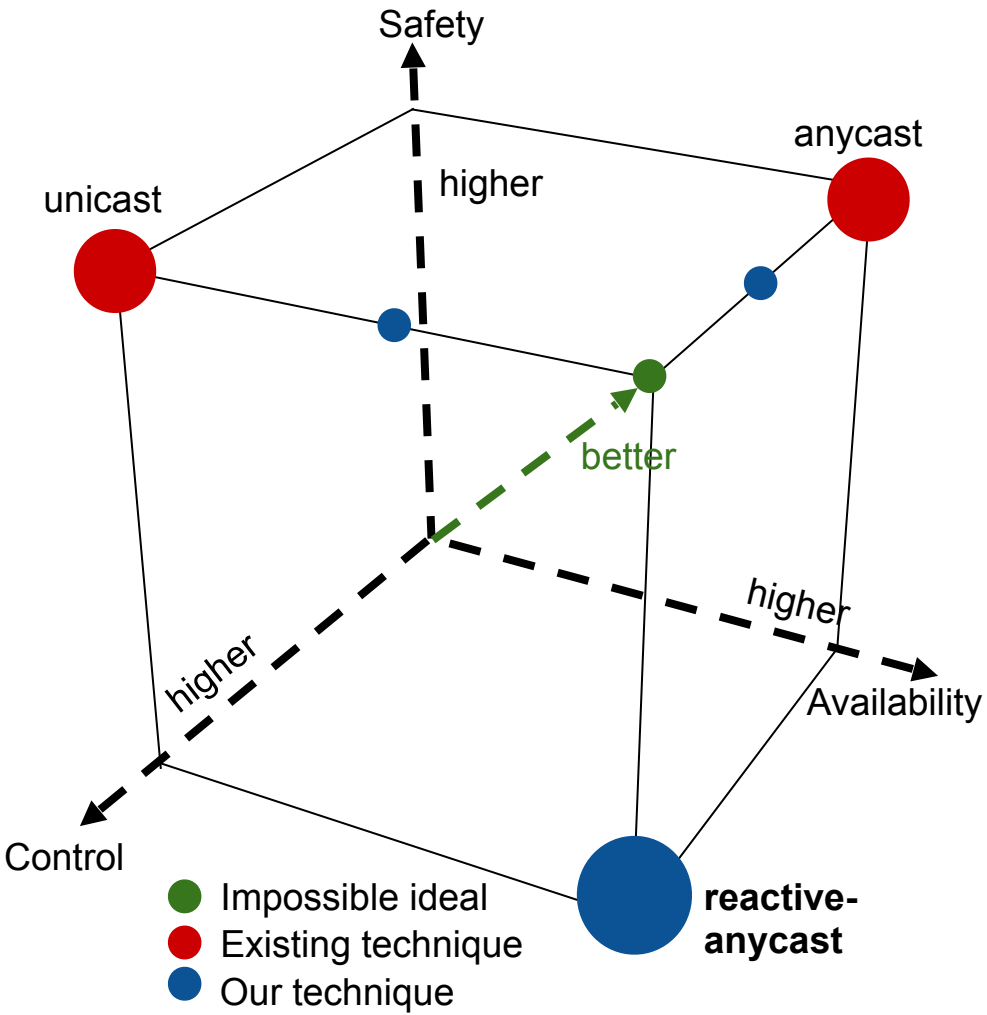
Reactive	High	High	Low



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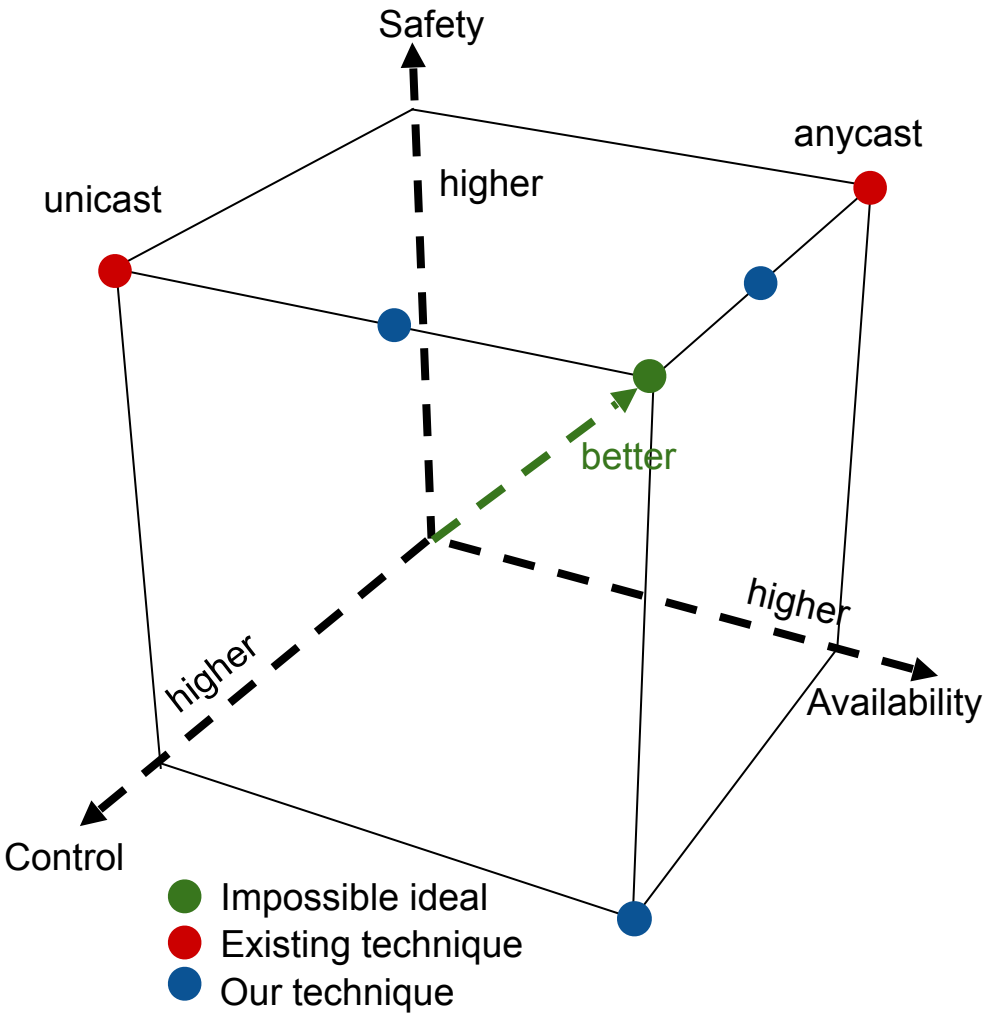

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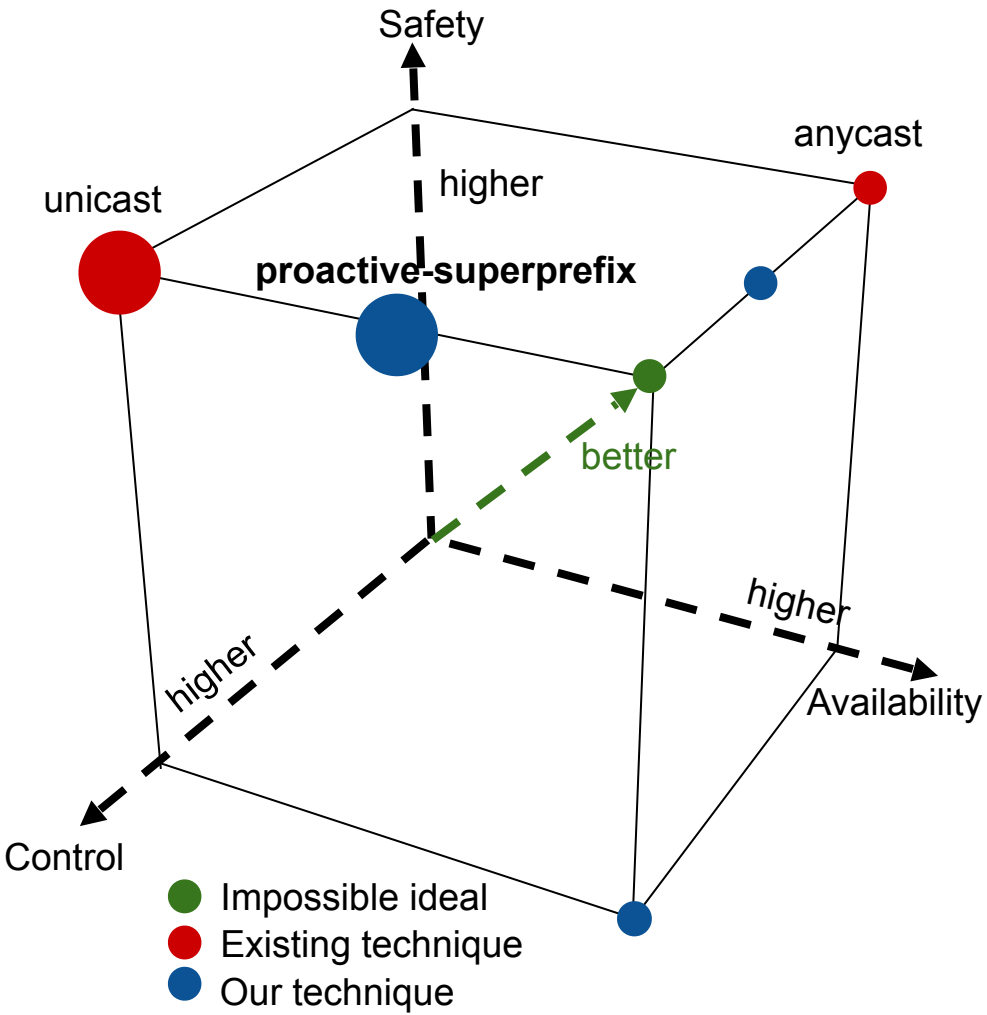

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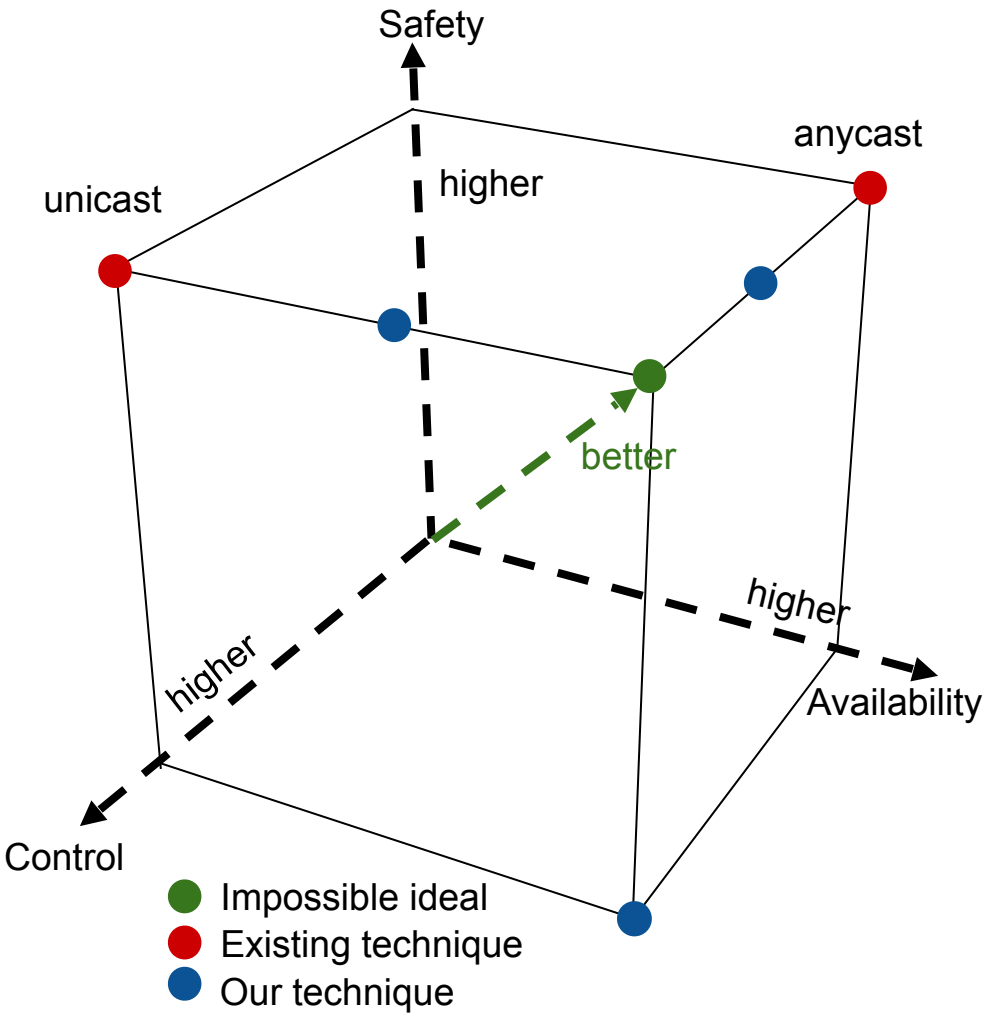
	Technique	Control	Availability	Safety
	Unicast	High	Low	High
Proactive	*Superprefix*	High	Medium	High
Proactive	Anycast	Low	High	High
	Reactive	High	High	Low



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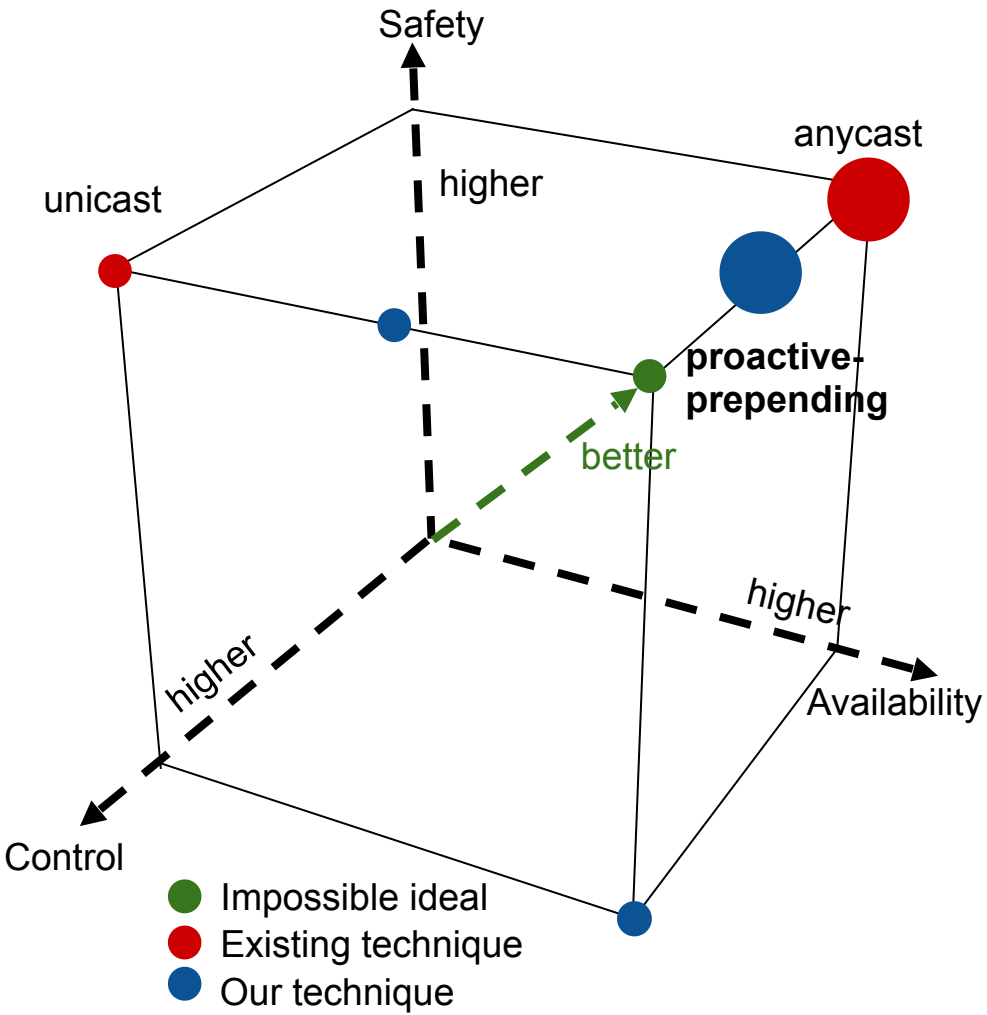

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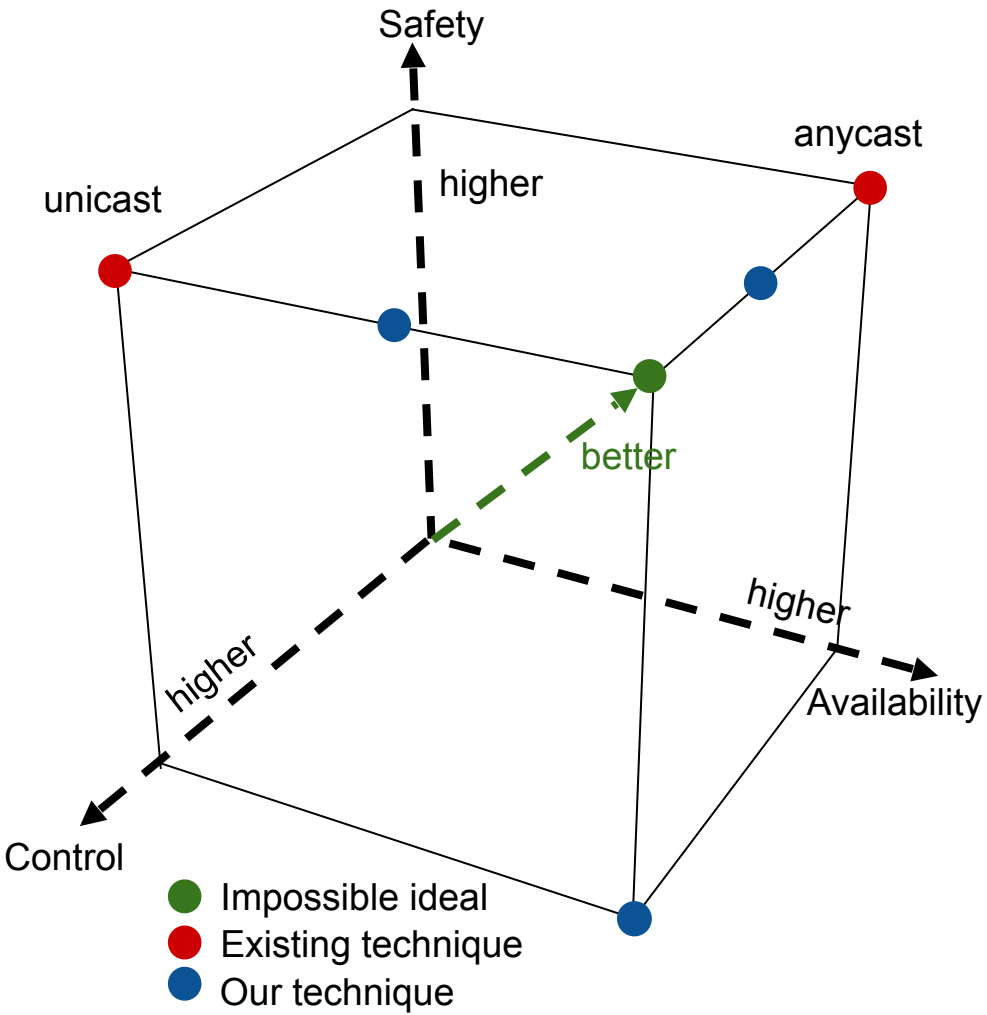

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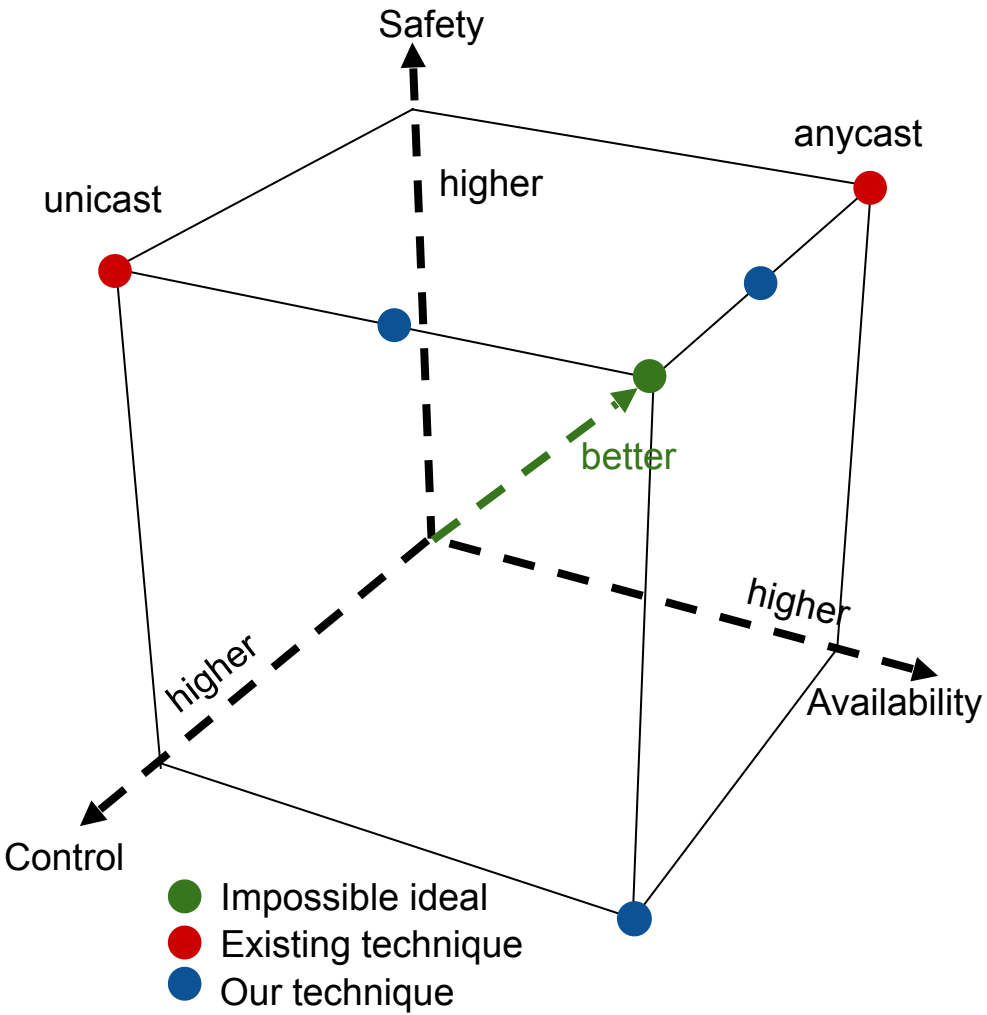

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- For each pair of goals, a new technique optimizes them while achieving better trade-offs than existing techniques.

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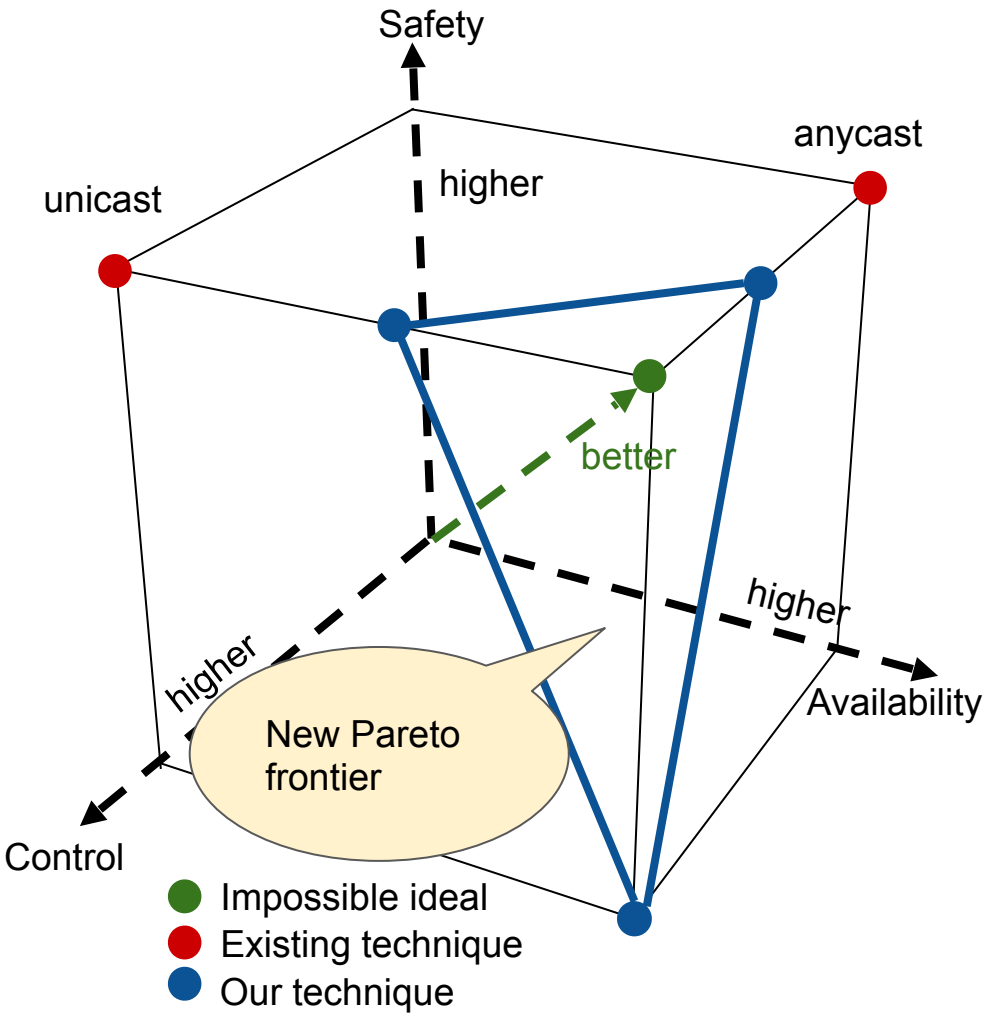

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New approaches for cloud/CDN ingress routing enable new tradeoffs

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- Tradeoffs are fundamental:
  any technique relying on DNS + BGP for content redirection
  must compromise at least one of *control, availability, or safety*
- For each pair of goals, one of our new technique optimizes them while achieving better trade-offs than existing techniques.
  Initial techniques at IMC 2022 (Best Short Paper). Improvements under submission
- Or: Use special deployments to sidestep DNS + BGP
  to optimize all 3 goals, without being universal
  PAINTER, SIGCOMM 2023. SCULPTOR, under submission.