Towards a global IP Anycast service

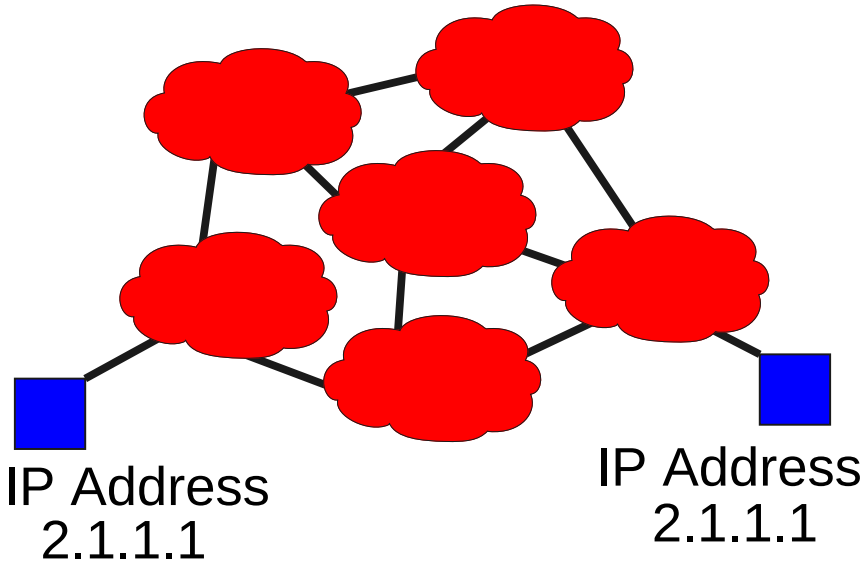
Hitesh Ballani, Paul Francis

Cornell University

ACM SIGCOMM 2005

What is IP Anycast?

One-to-Any communication with no changes to routing and clients



Robust and efficient service discovery

- Query-Reply Services : DNS Root-Servers etc.
- Routing Services : IPv6 transition (6to4) etc.

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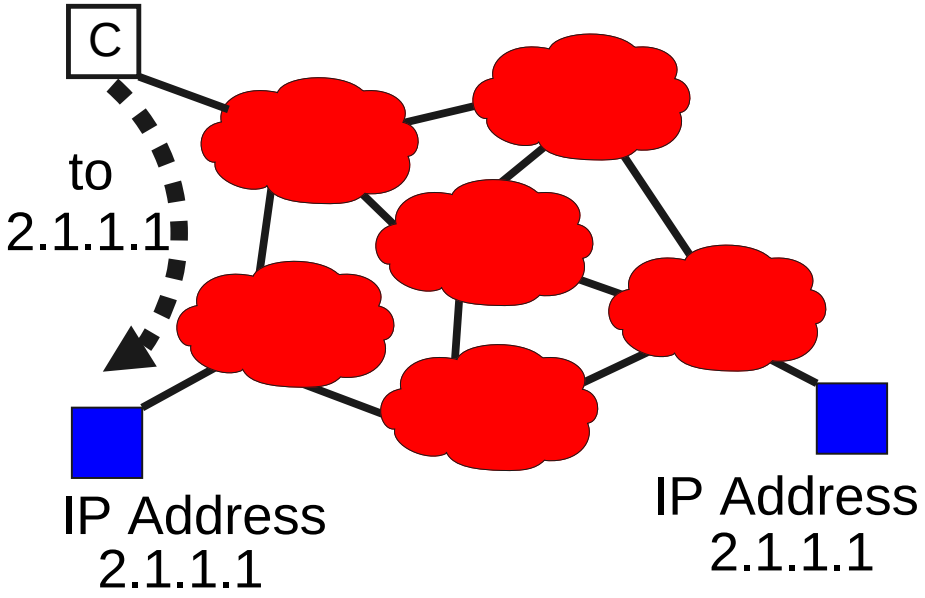

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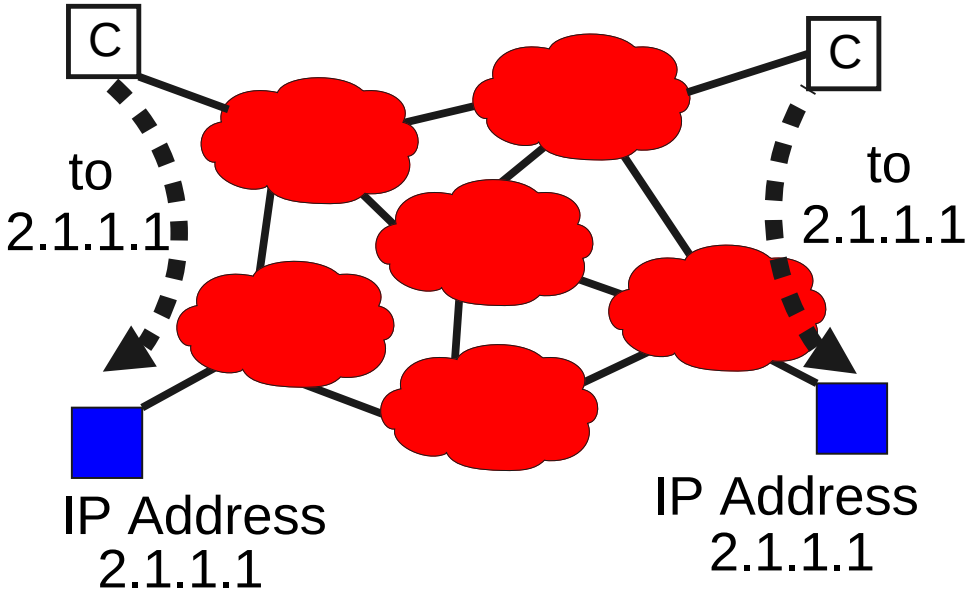

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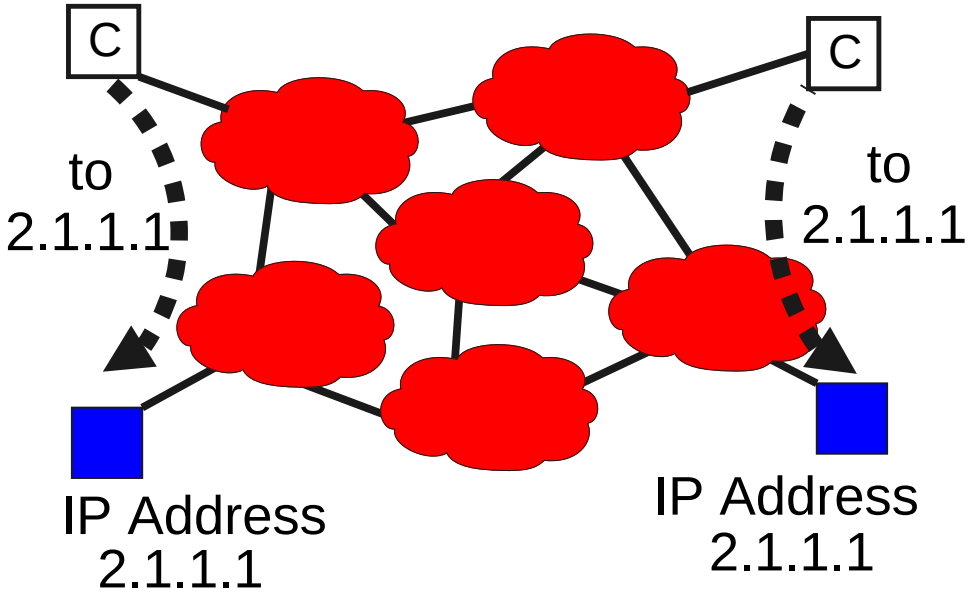


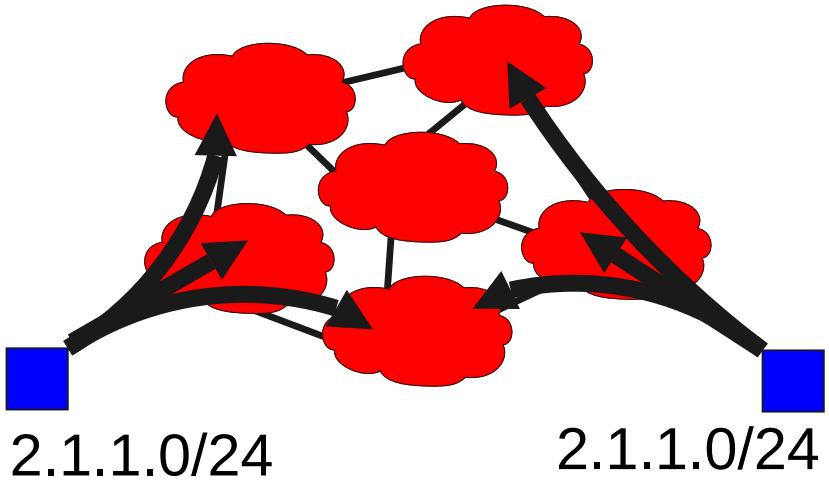
Robust and efficient service discovery

- Query-Reply Services : DNS Root-Servers etc.
- Routing Services : IPv6 transition (6to4) etc.

But its use has been limited?

Limitations of Inter-domain IP Anycast

- Wastes address space
- Does not scale by number of groups



- Difficult to deploy
  - obtain an address prefix
  - a certain level of expertise
- Is limited by IP routing
  - inability to offer load-based selection

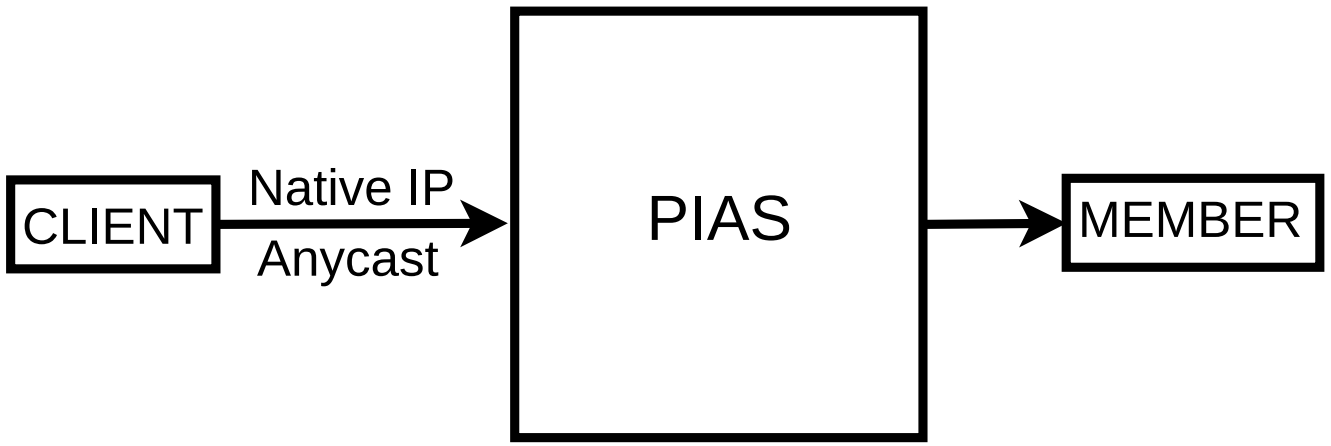
Proxy IP Anycast Service (PIAS)

What is PIAS?

A practical anycast deployment architecture

- addresses native IP Anycast limitations
- offers new features
  - opens new anycast usage avenues

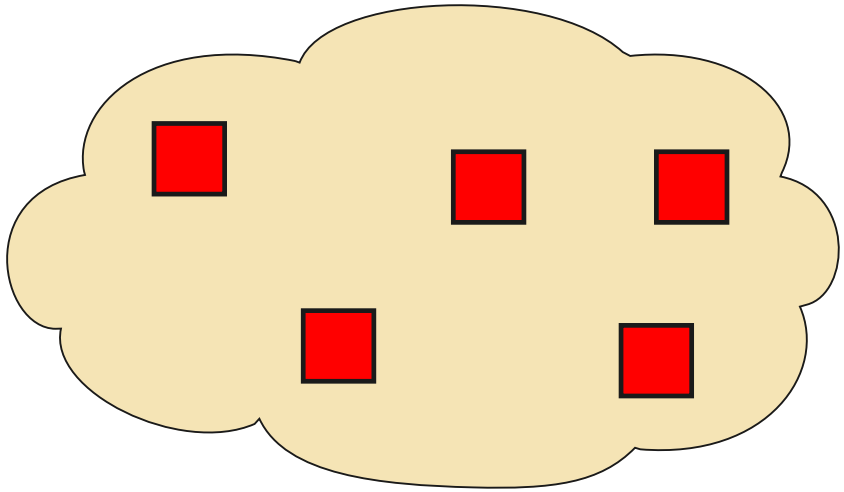
Key Insight



PIAS: Basic Idea

Deploy Anycast Proxies

All proxies advertise the same prefix

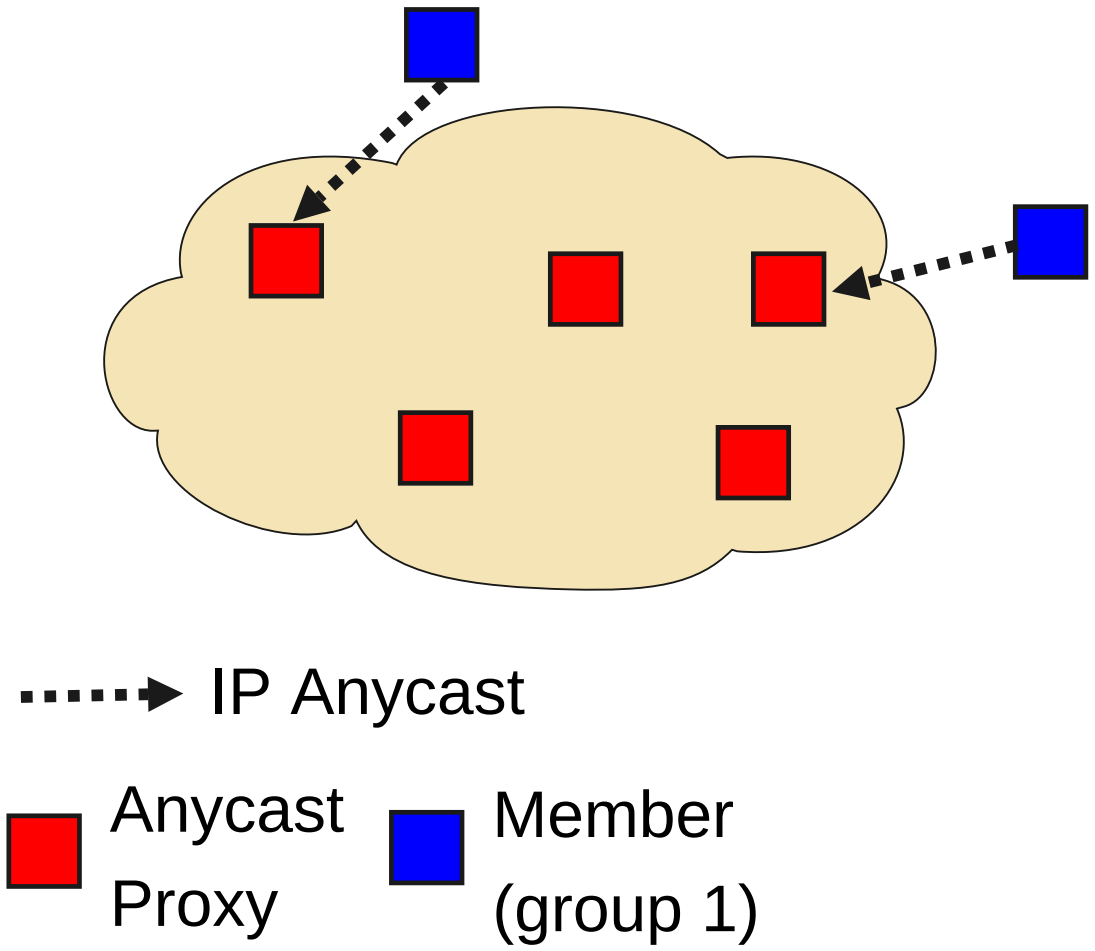


Anycast

Proxy

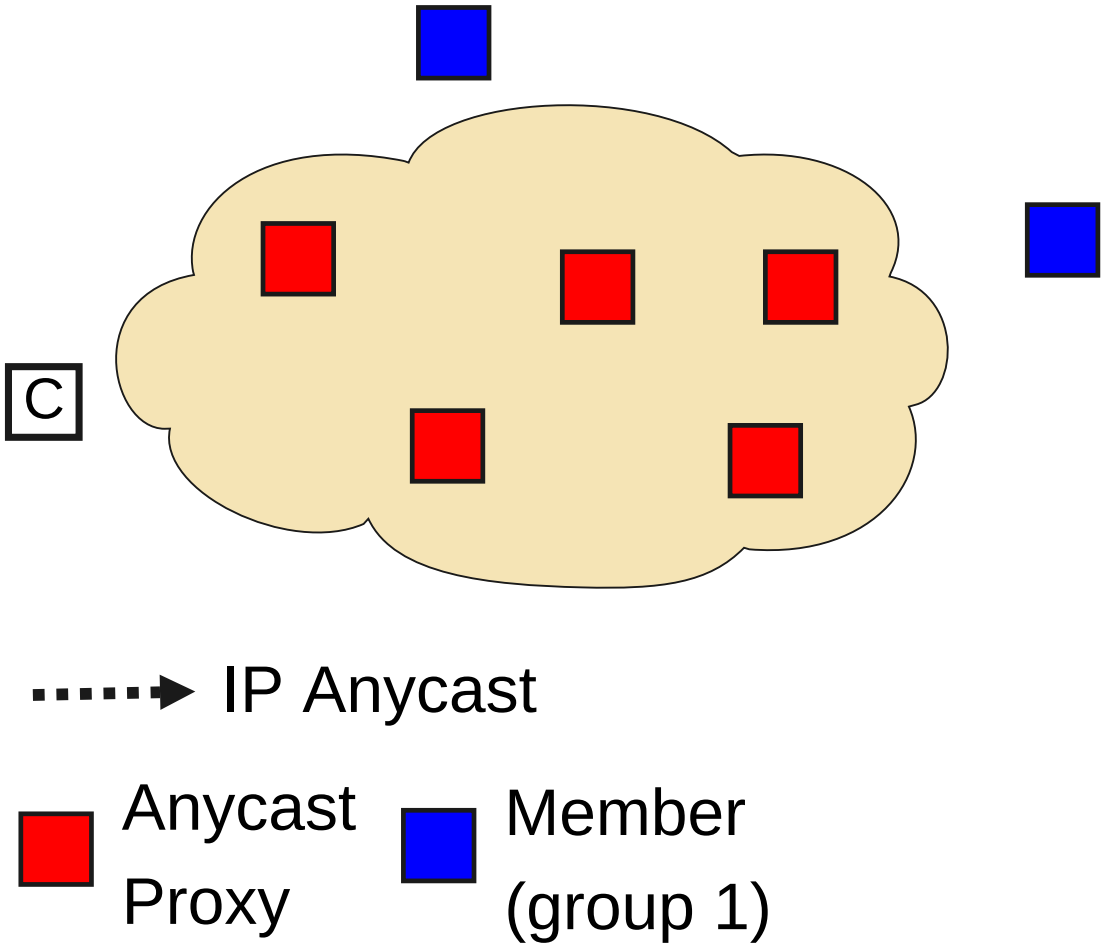
PIAS: Basic Idea

Group Members register with proxies



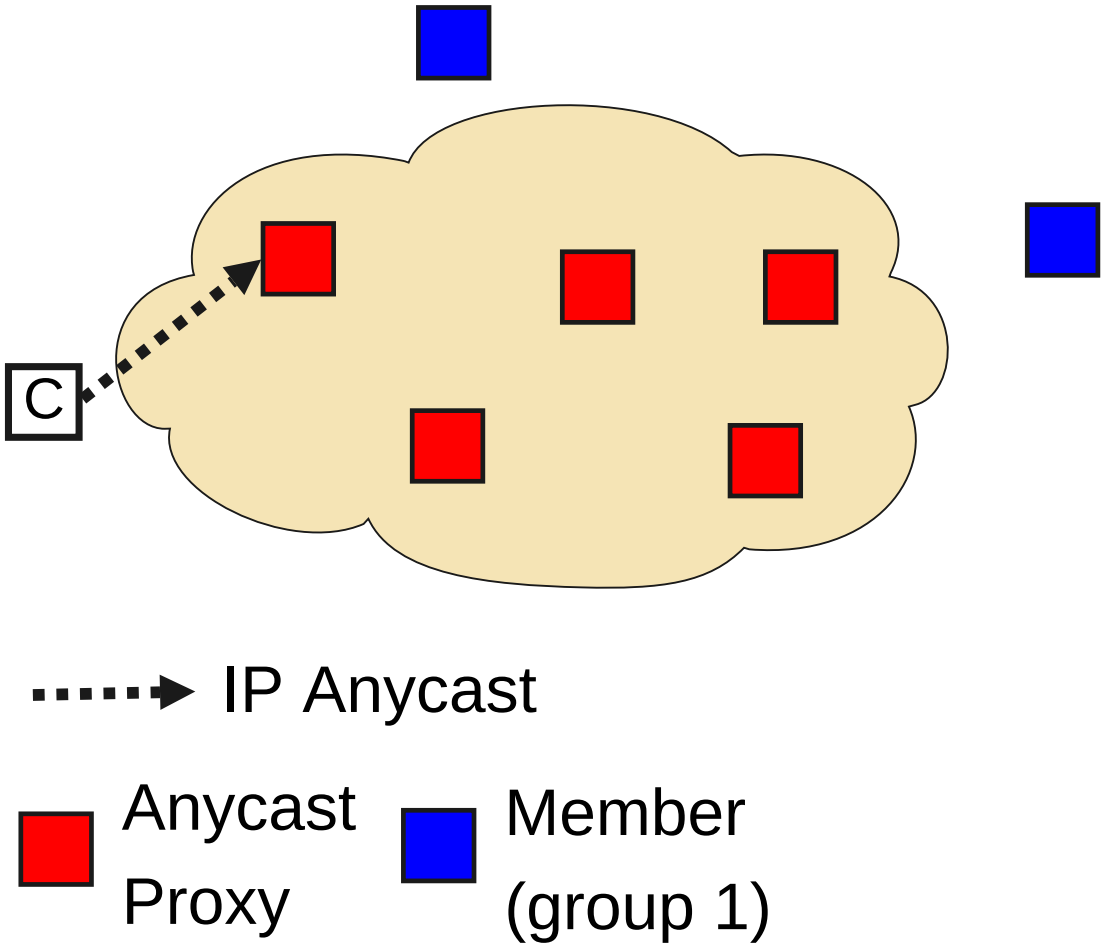
PIAS: Basic Idea

Client (C) $\Rightarrow$ Group 1 (blue group)



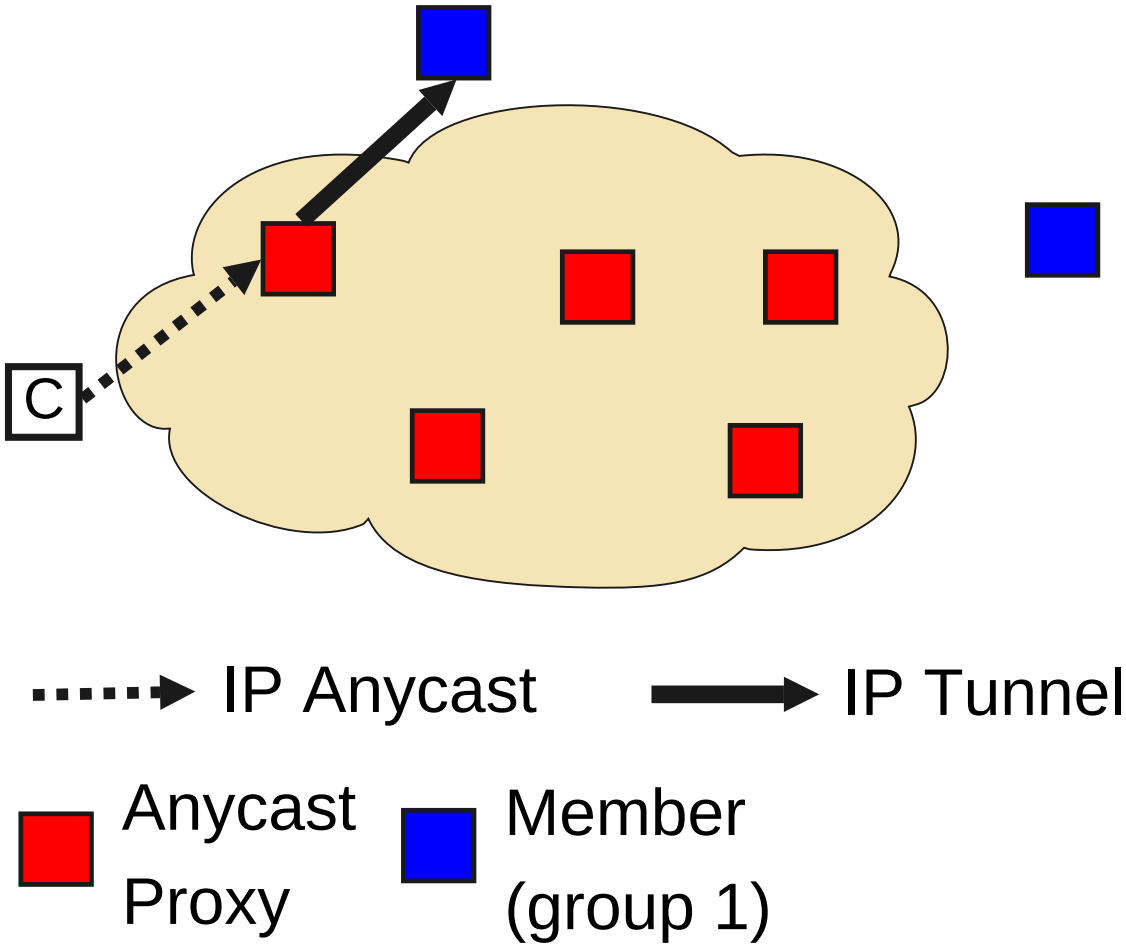
PIAS: Basic Idea

Native IP Anycast delivers packets to proxies



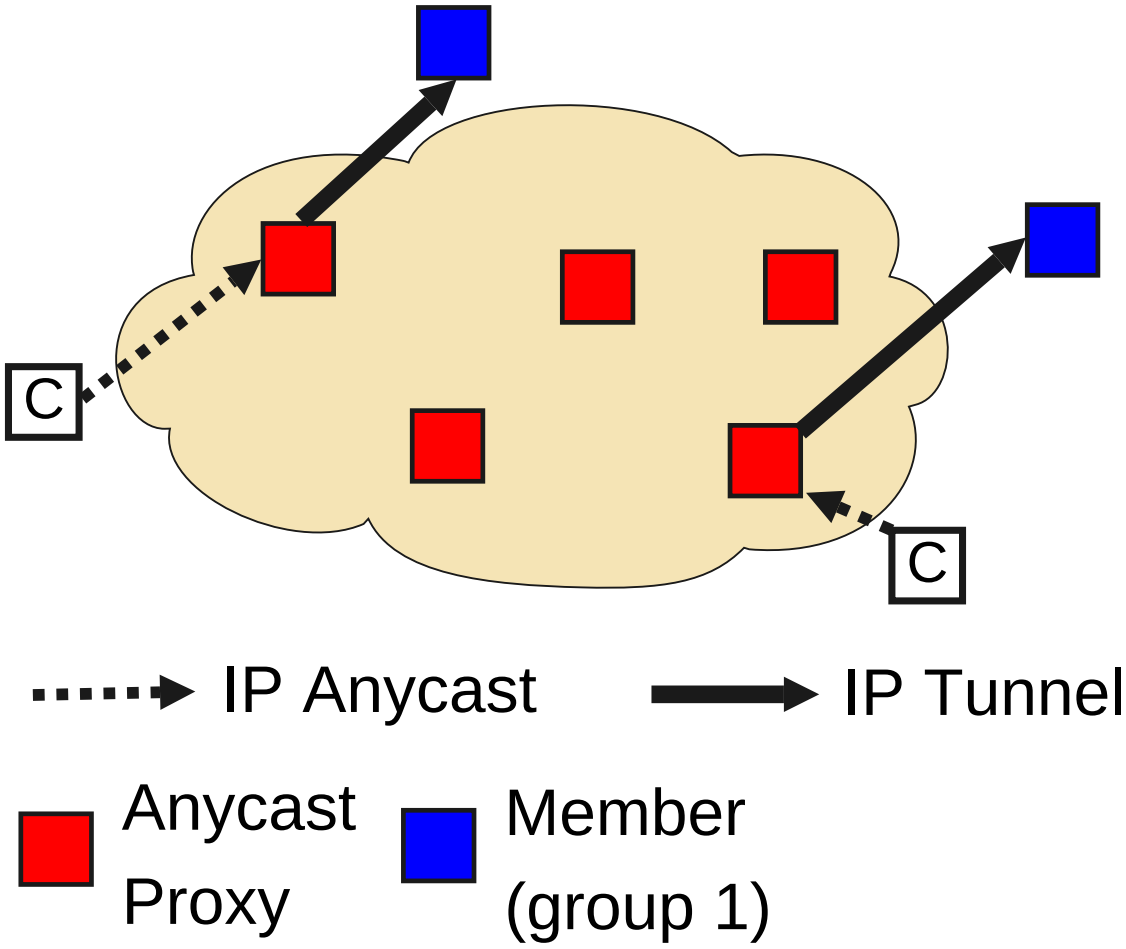
PIAS: Basic Idea

Proxies tunnel to appropriate member



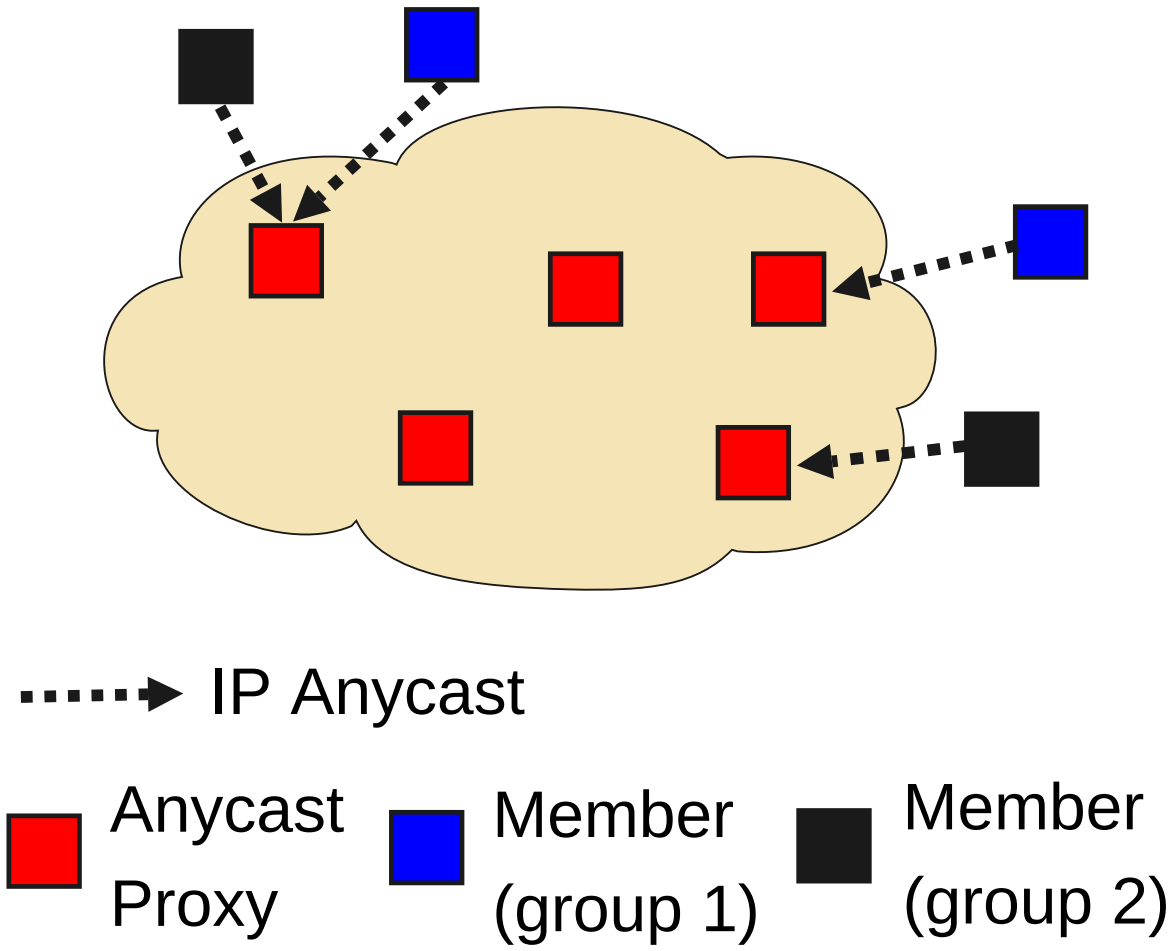
PIAS: Basic Idea

Different client might go to a different member

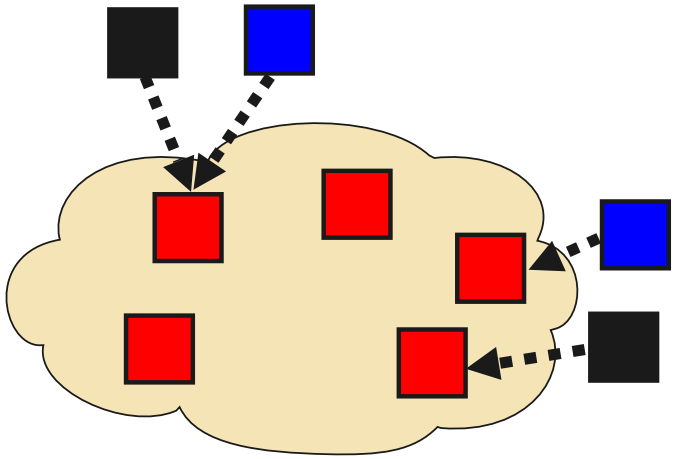


PIAS: Basic Idea

Multiple groups can register



What does PIAS solve?



- Address Usage
- Effort Amortization
- Ease-of-Use
- Backwards Compatible
- Selection Criteria

Efficient use of address space

Thousands of groups per IP address in prefix

Group address - [IP-Address]:[Port]

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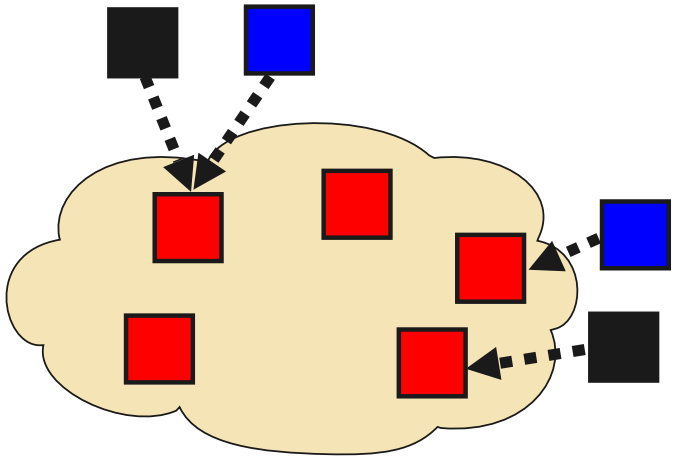

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Amortization of effort

Deployment effort spread across thousands of groups

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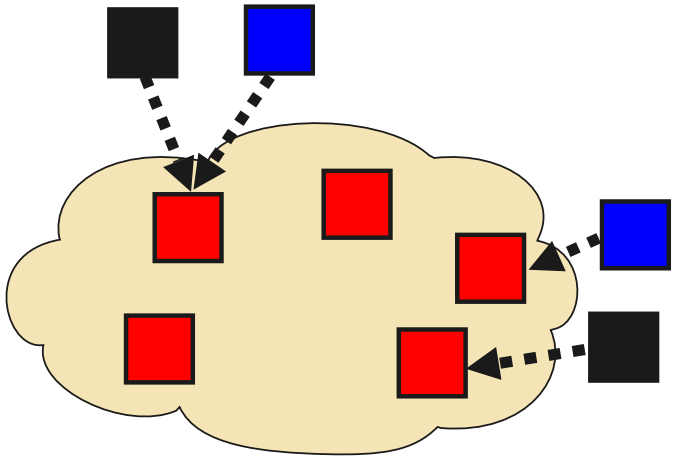

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Ease of join/leave

No interaction with routing

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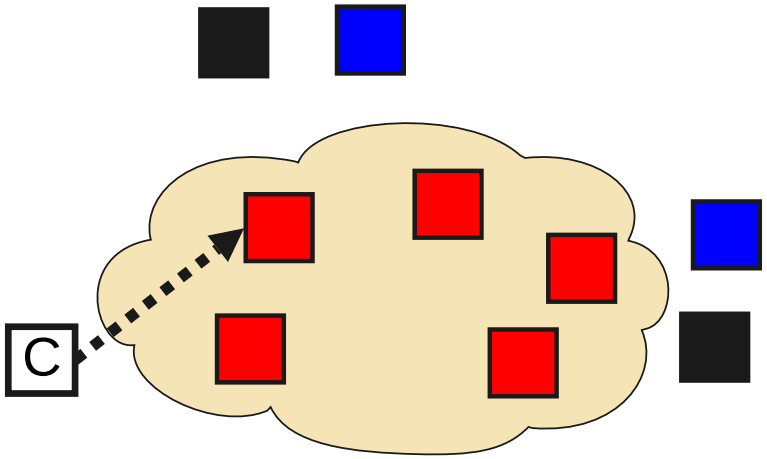

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No changes to clients

just as native IP Anycast

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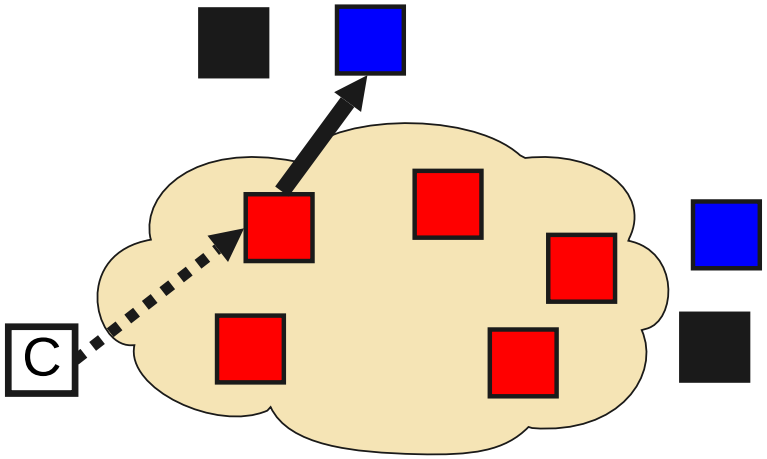

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Multiple selection criteria

for example, load balance, proximity

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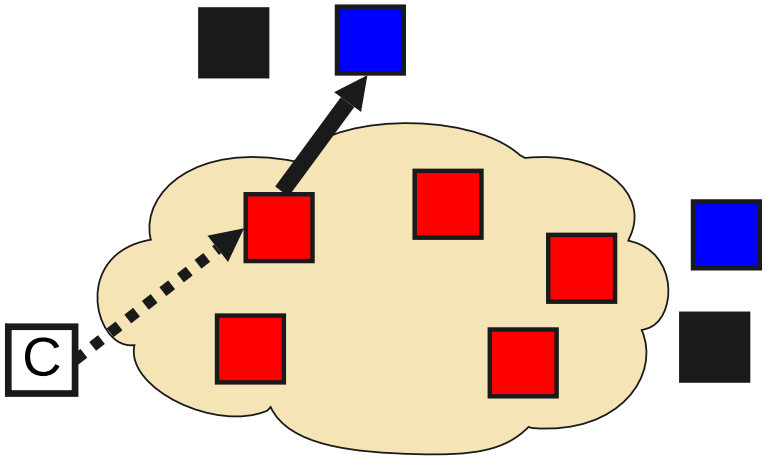

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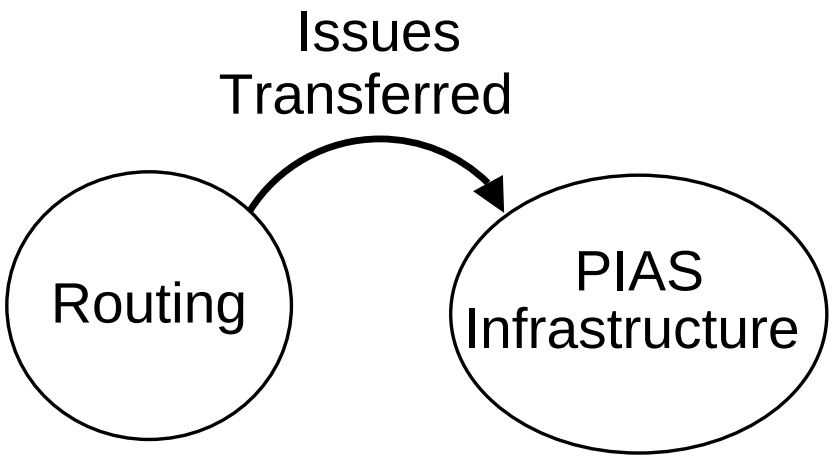
Group members can be clients for the group!

What does PIAS solve?



- Address Usage
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All this just by proxying?

- decoupled issues from routing
- can be easily addressed in proxy infrastructure

PIAS : design challenges

- Scalability by
  - no. of groups, group size/dynamics
  - no. of proxies
- Robustness and fast-failover

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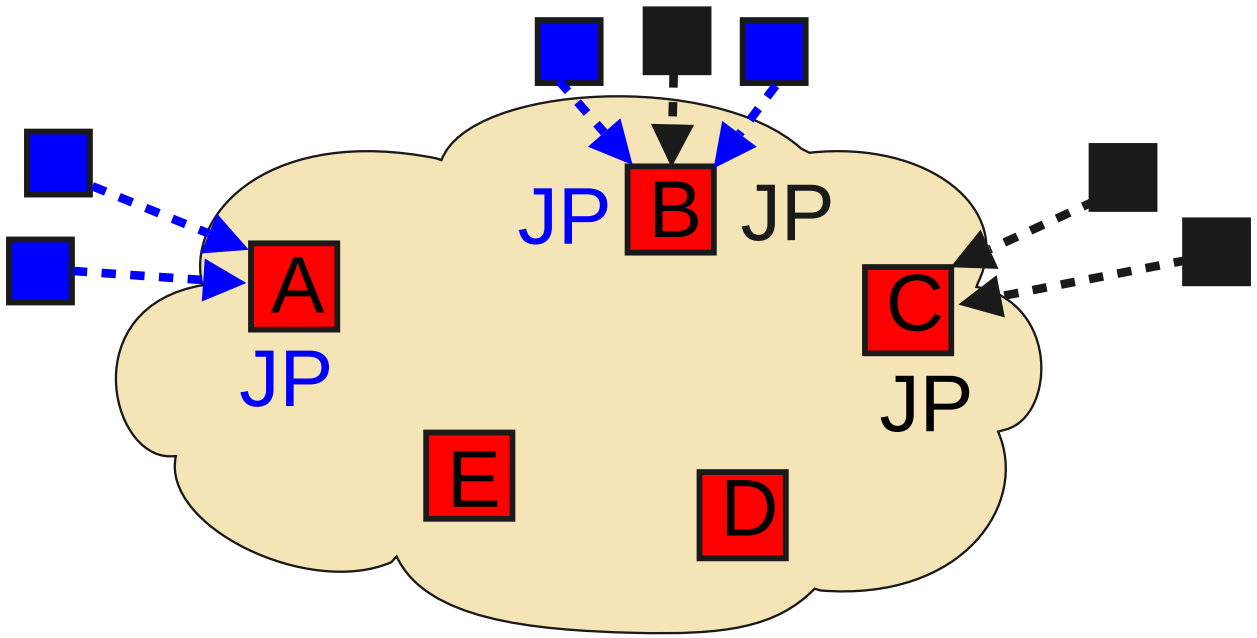

Members register with *Join Proxies (***JP***)*

Registration involves member authentication

PIAS : design challenges

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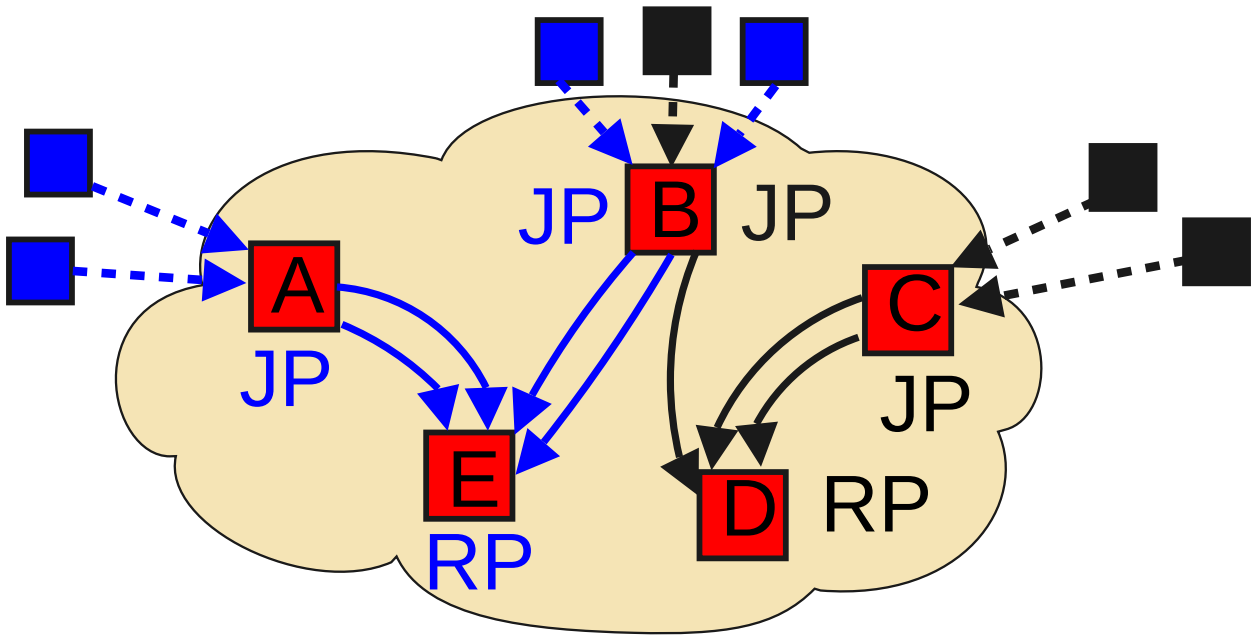

*Rendezvous Proxies (**RP**)*

group address mapped to RP using consistent hash

PIAS : design challenges

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  - no. of proxies
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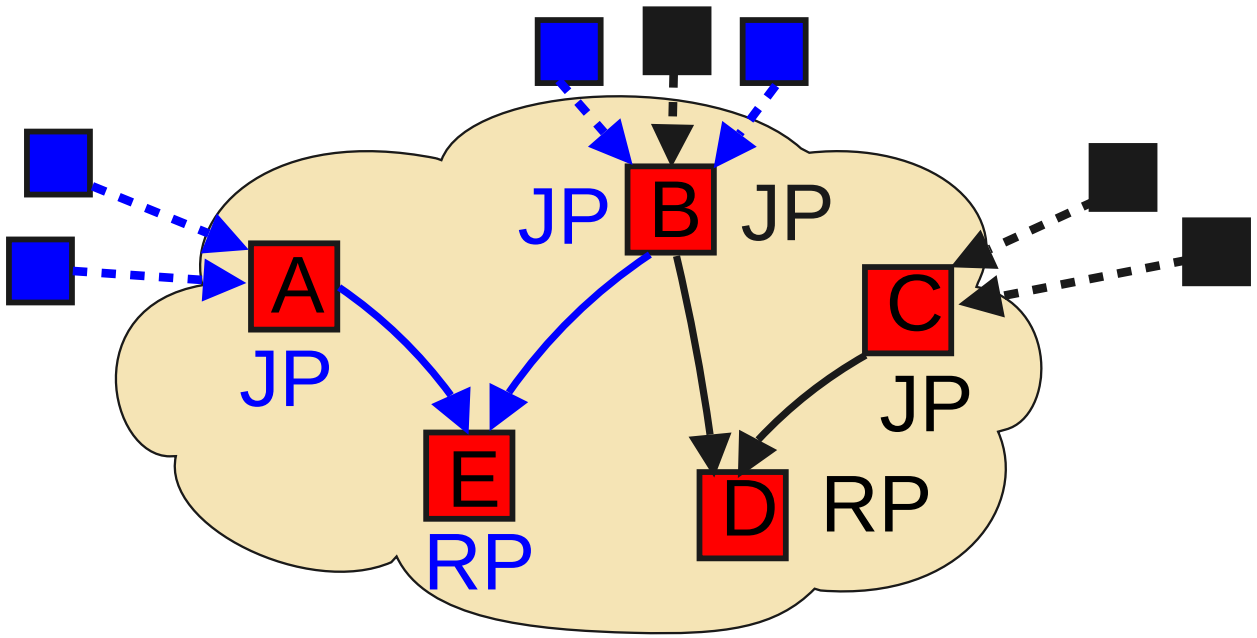

Hierarchy

RPs track JPs, JPs track members

PIAS : design challenges

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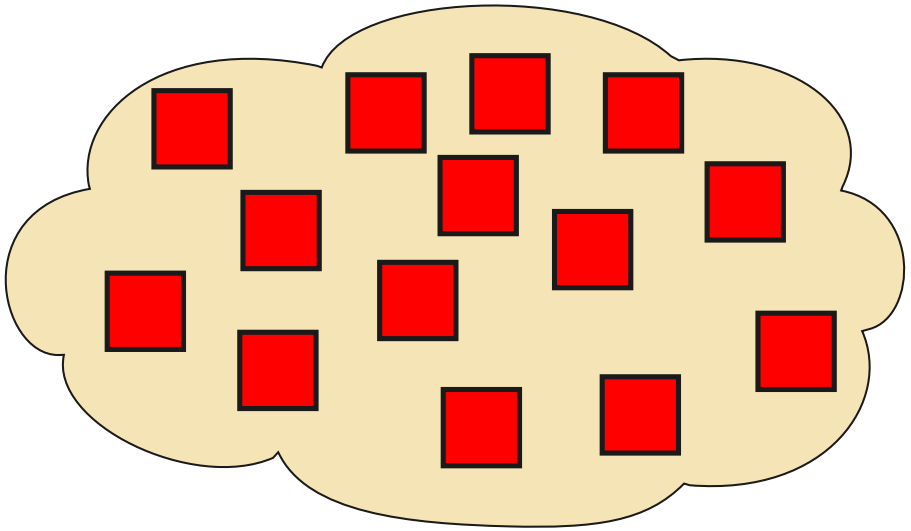

Overlay and Routing issues

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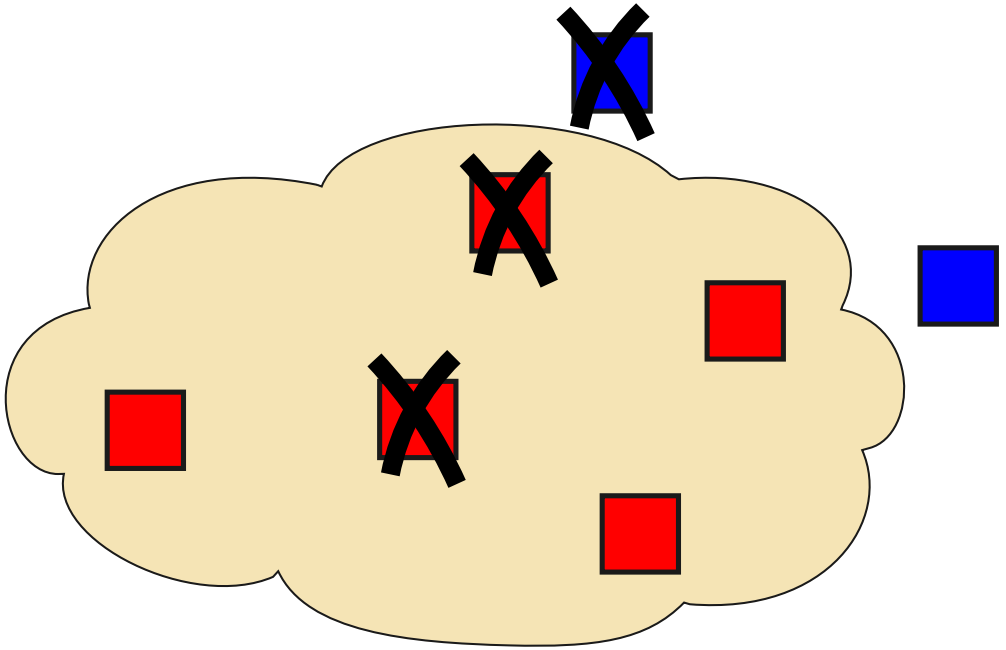
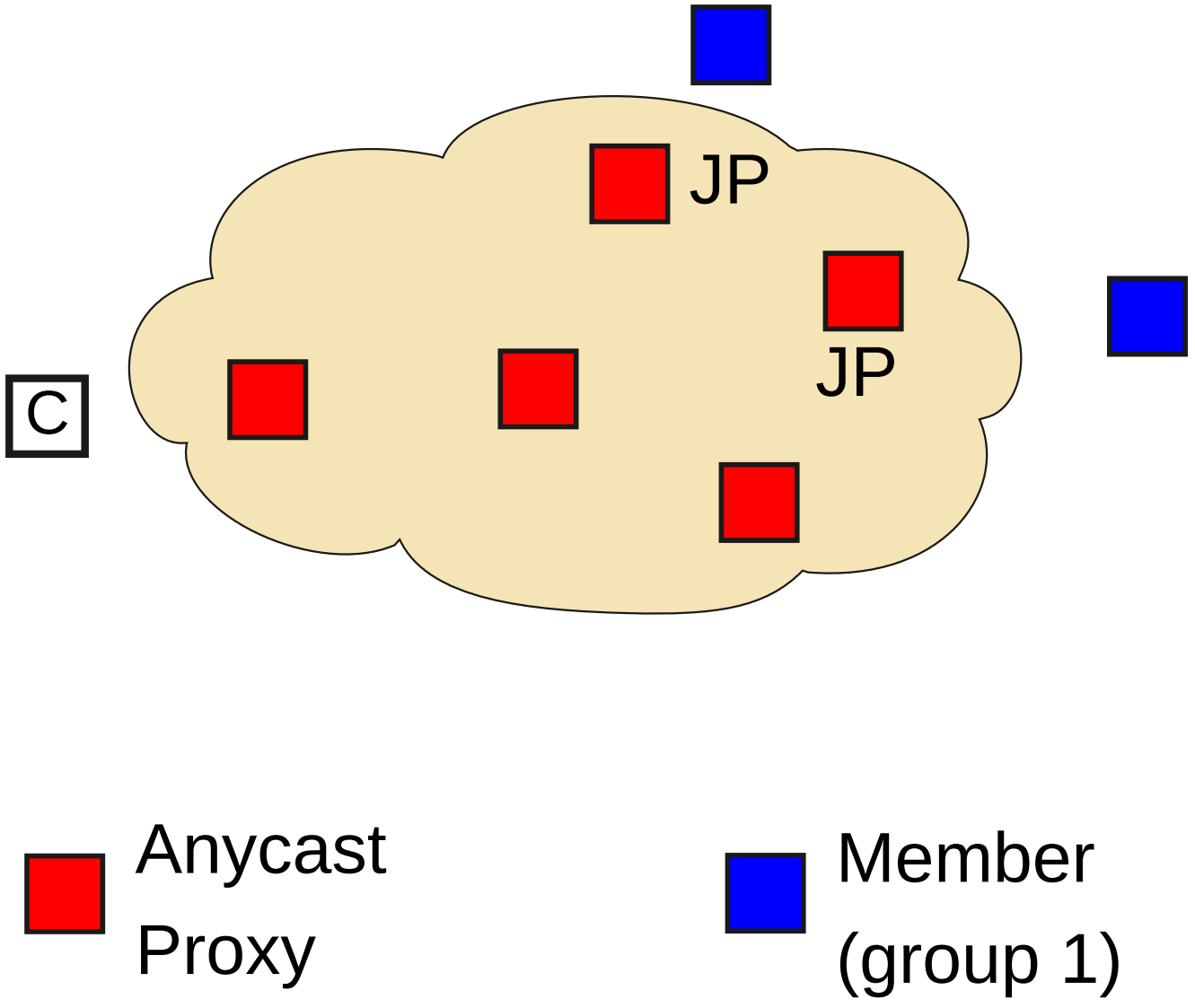


Proxy and Member failures

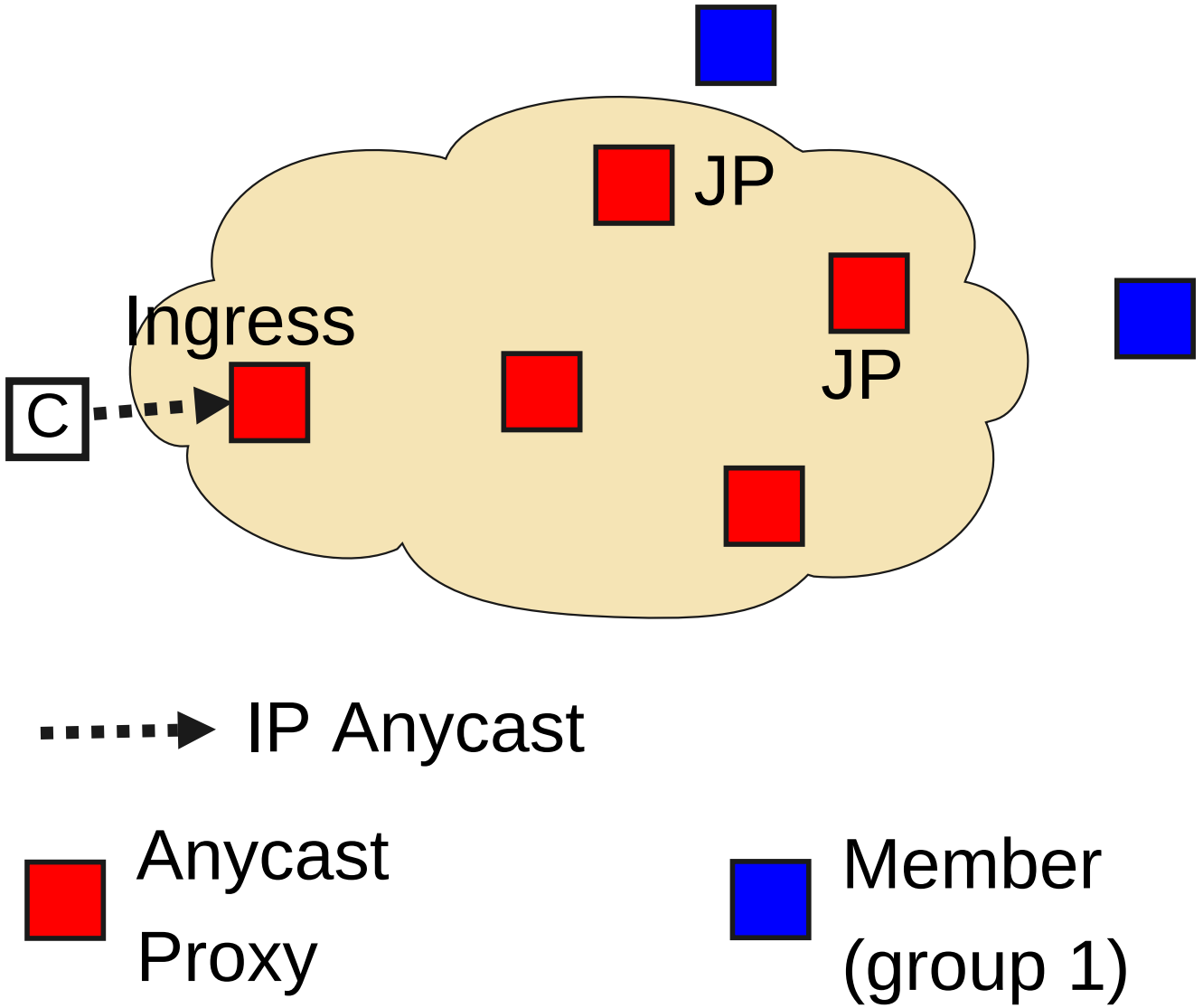
PIAS : putting it all together

Anycast : Client (C) to Group 1 (blue)



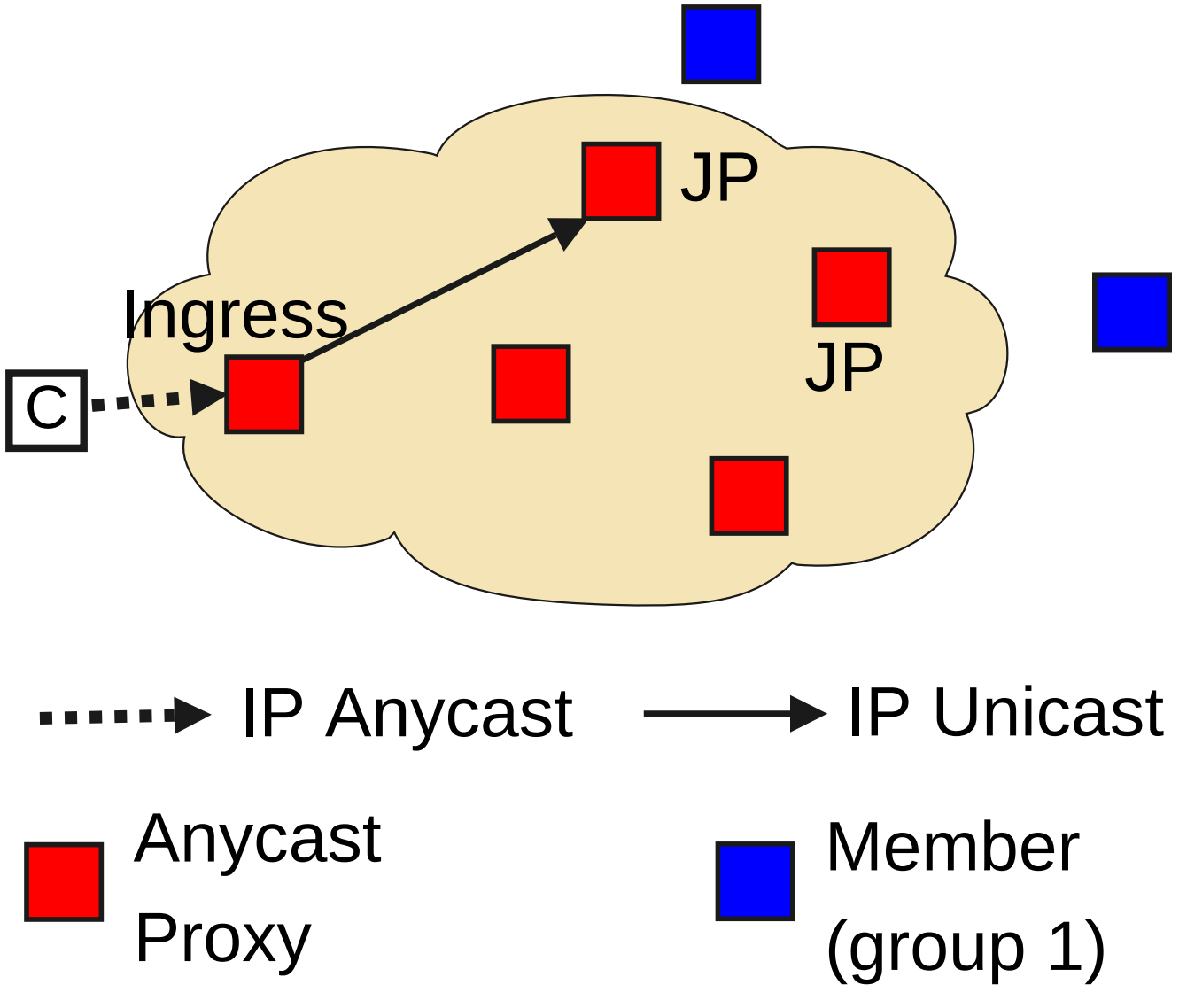
PIAS : putting it all together

C ⇒ *Ingress Proxy*



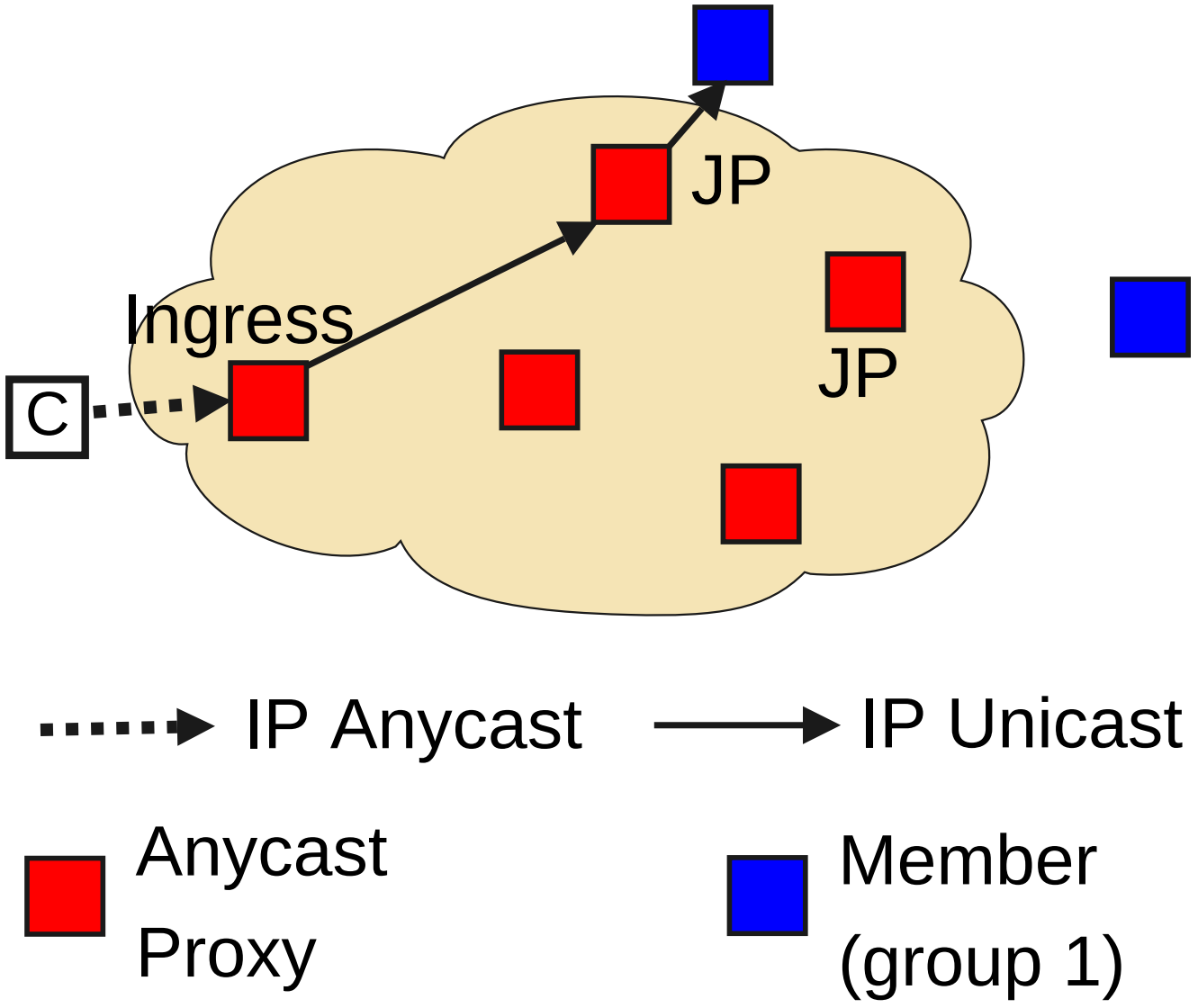
PIAS : putting it all together

Ingress Proxy ⇒ Join Proxy



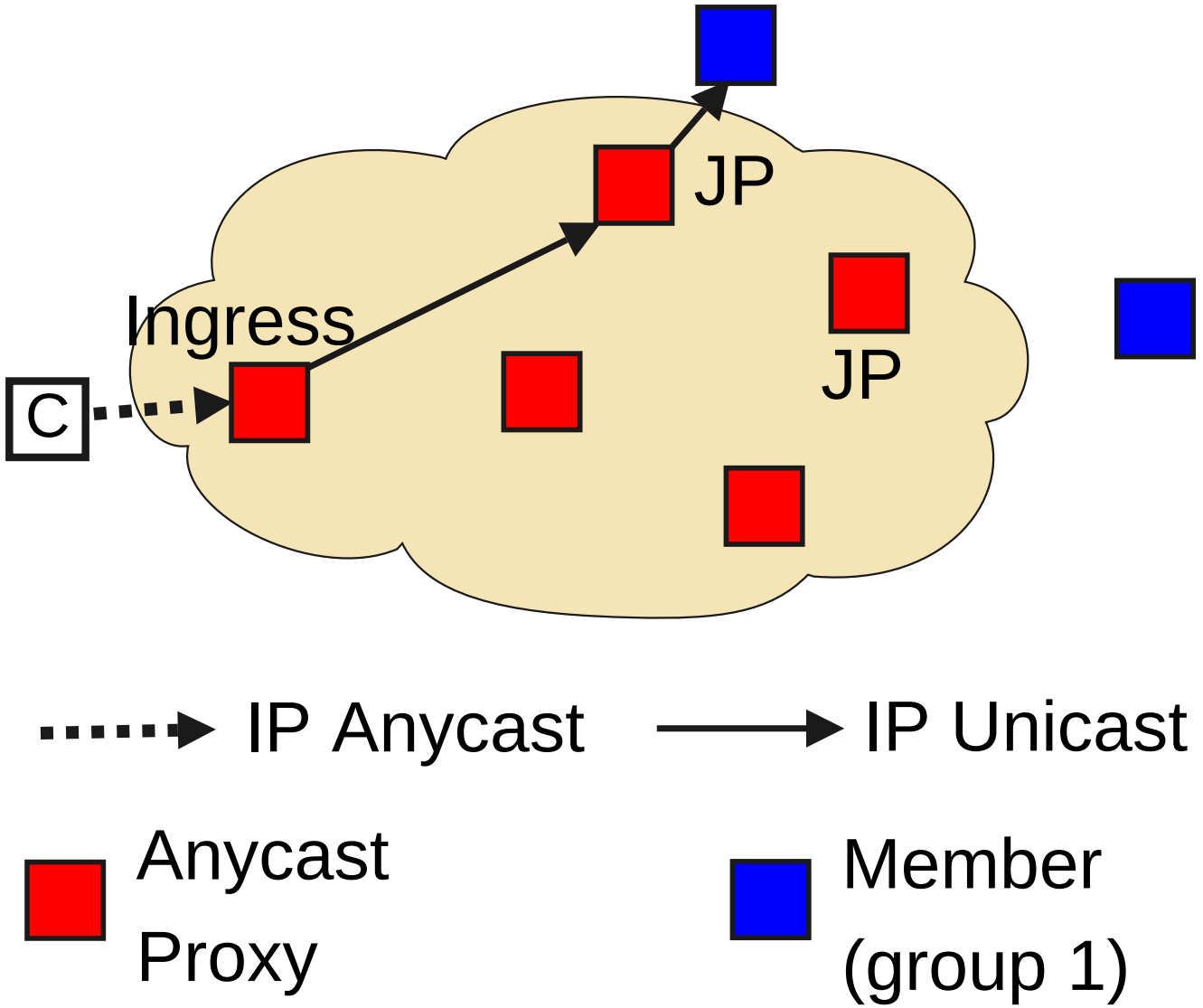
PIAS : putting it all together

Join Proxy ⇒ Member



PIAS : putting it all together

Client ⇒ Ingress P. ⇒ Join P.⇒ Member



New anycast applications

Anycast service offered by PIAS

- practical
- easy-to-use
- scales by group number/size/dynamics
- group members can be clients too

Applications

- Peer discovery : network games, p2p applications etc.
- Reaching an overlay network : querying OpenDHT, global RON, *i3* etc.

PIAS : possible problems

- Stretch
- Affinity
- Proximity

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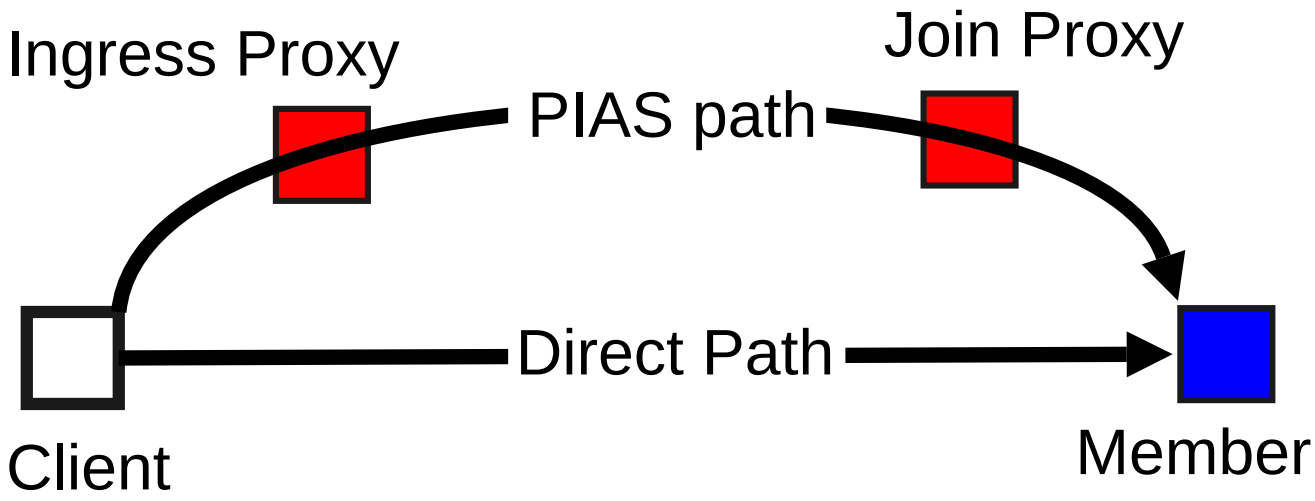

Stretch = PIAS path len. / Direct path len.

What is the stretch imposed by PIAS?

PIAS : possible problems

- Stretch : simulation
- Affinity
- Proximity

Topology

- POP-level topology for tier-1 ISPs (Rocketfuel)
- 22 ISPs, 687 POPs, 2825 inter-POP links
- Annotated links with actual distance (kms)

Simulation

- SSFNET for BGP route calculation

PIAS : possible problems

- Stretch : simulation
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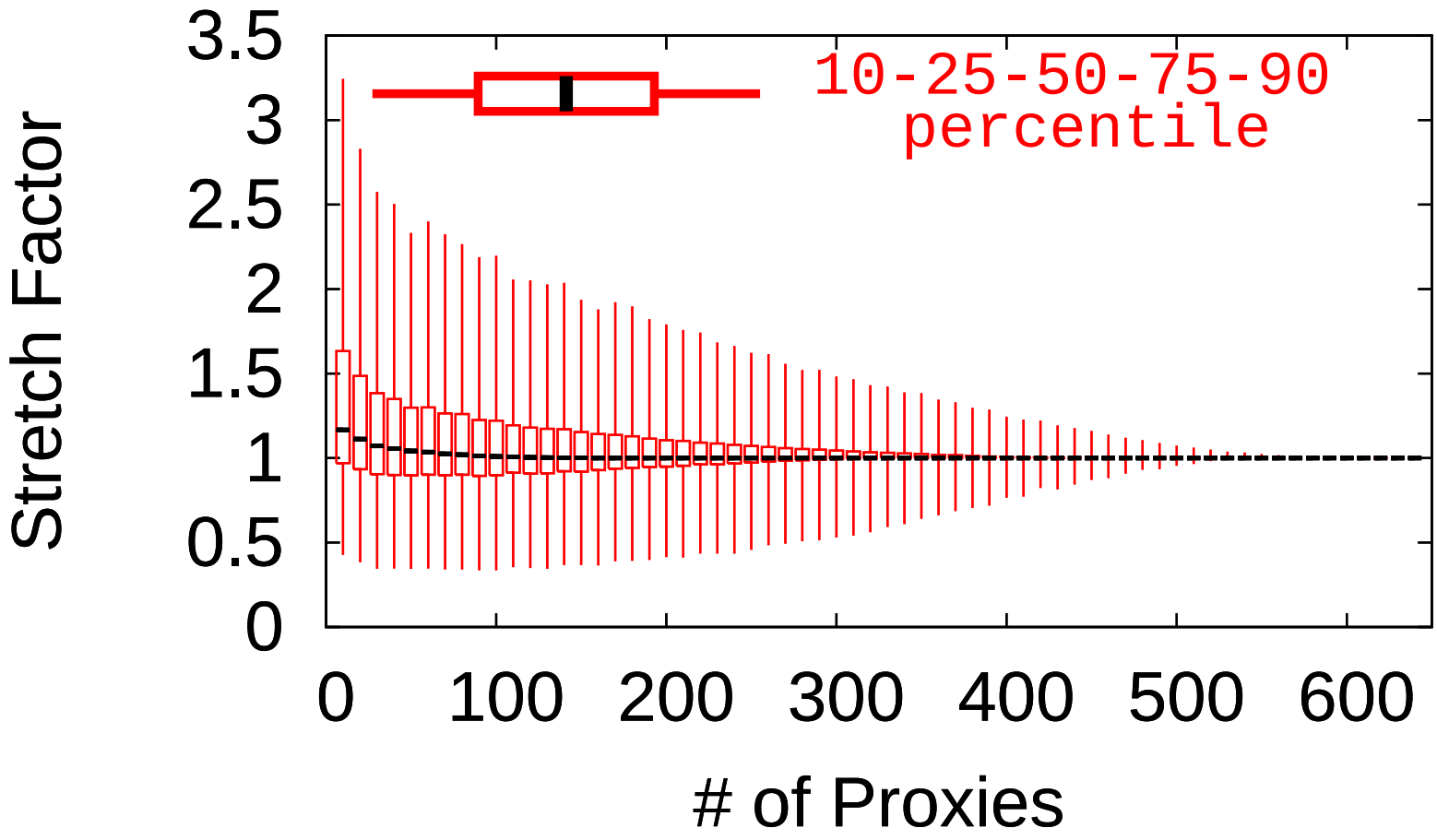

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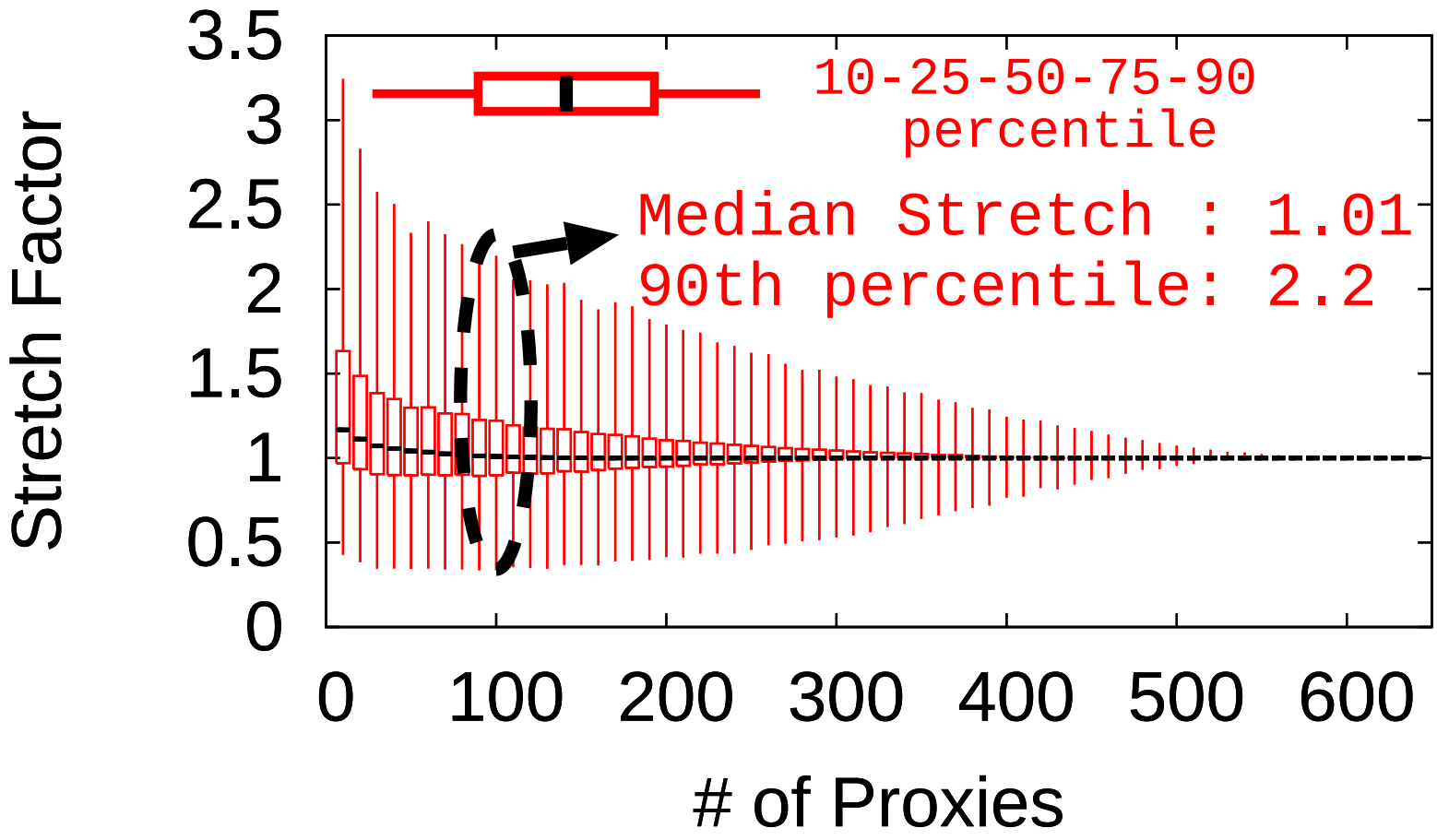

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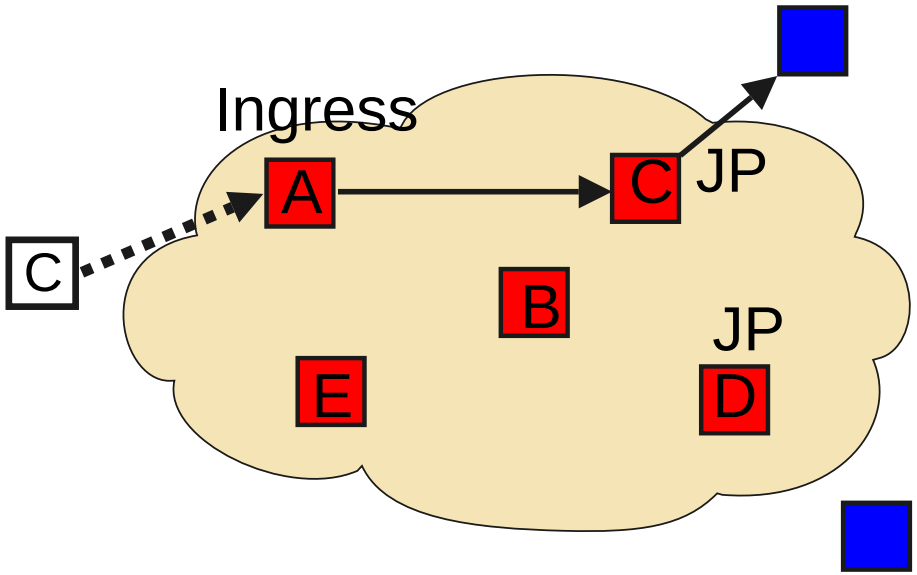

Affinity : same client to same ingress

PIAS : possible problems

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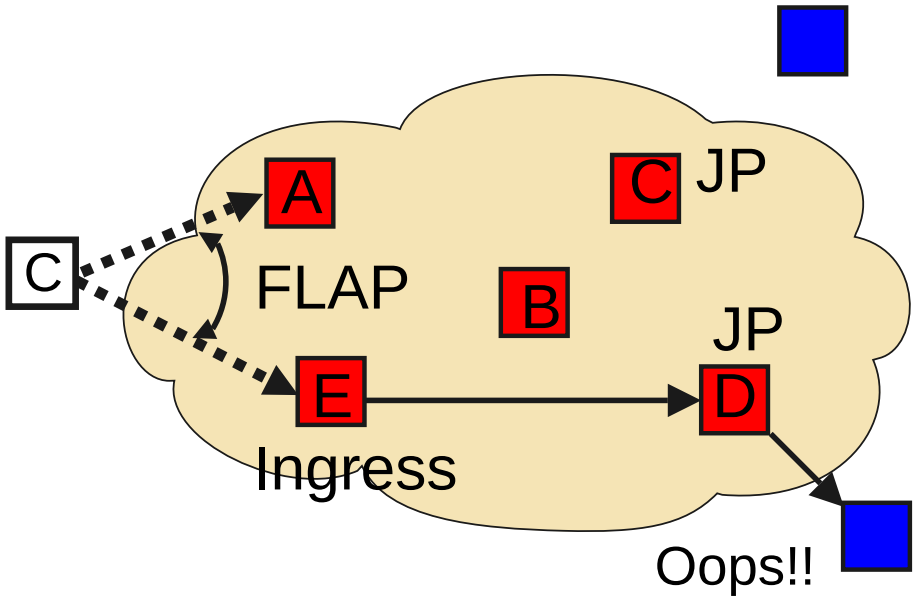

Affinity : same client to same ingress

What is the affinity offered by native IP Anycast?

PIAS : possible problems

- Stretch
- Affinity : measured anycasted DNS root-servers
- Proximity

Traceroute-Servers

- 244 vantage points
- Duration : 7 days
- Europe-centric distribution

Planetlab

- 163 Planetlab sites
- Duration : 3 months (Dec'04-Mar'05)
- US-centric distribution

PIAS : possible problems

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- Affinity : measured anycasted DNS root-servers
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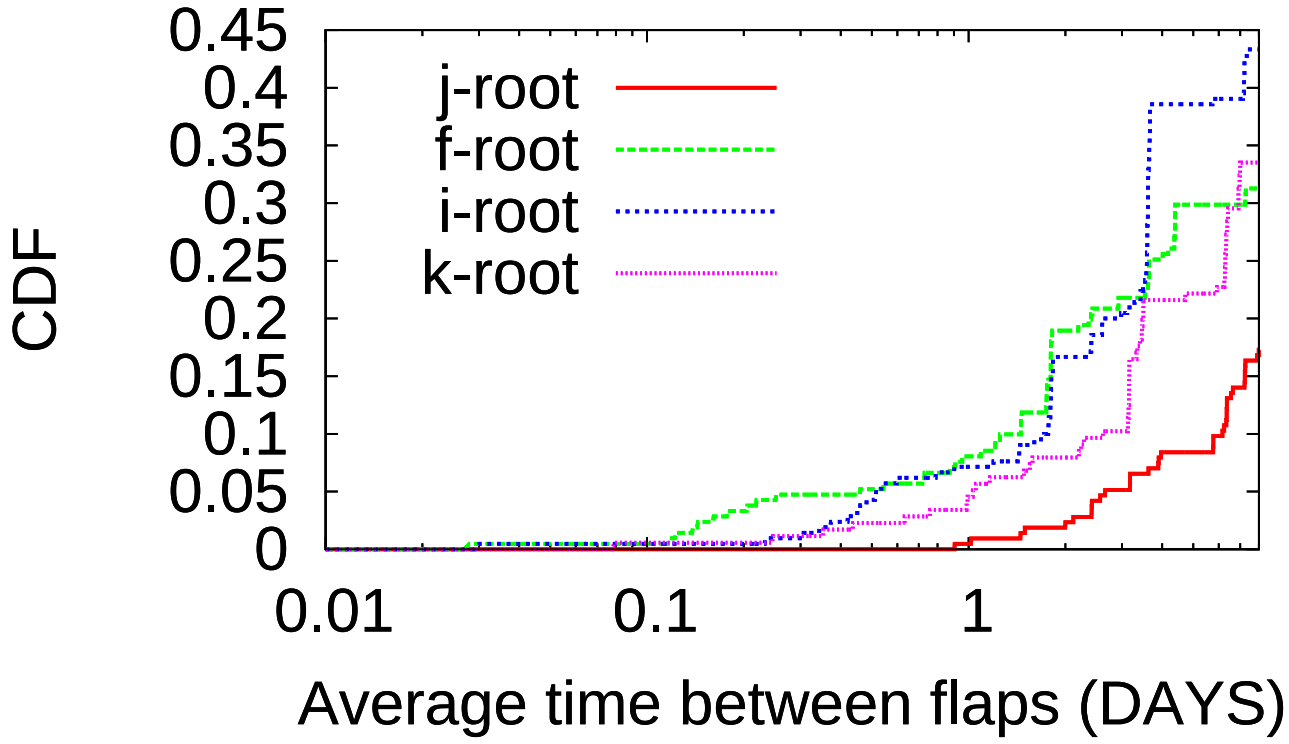

Tracert-Server Probing

PIAS : possible problems

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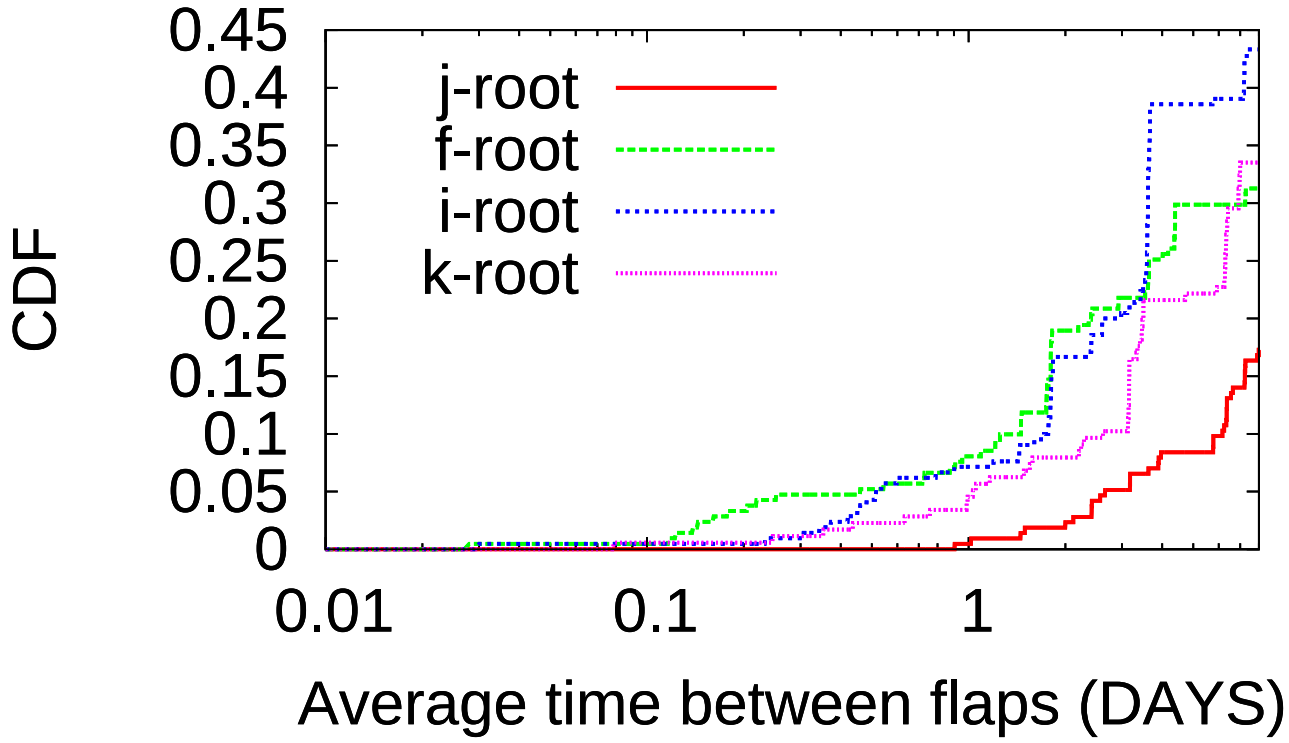

Tracert-Server Probing

Less than 1 flap per day for $\sim$95% of nodes

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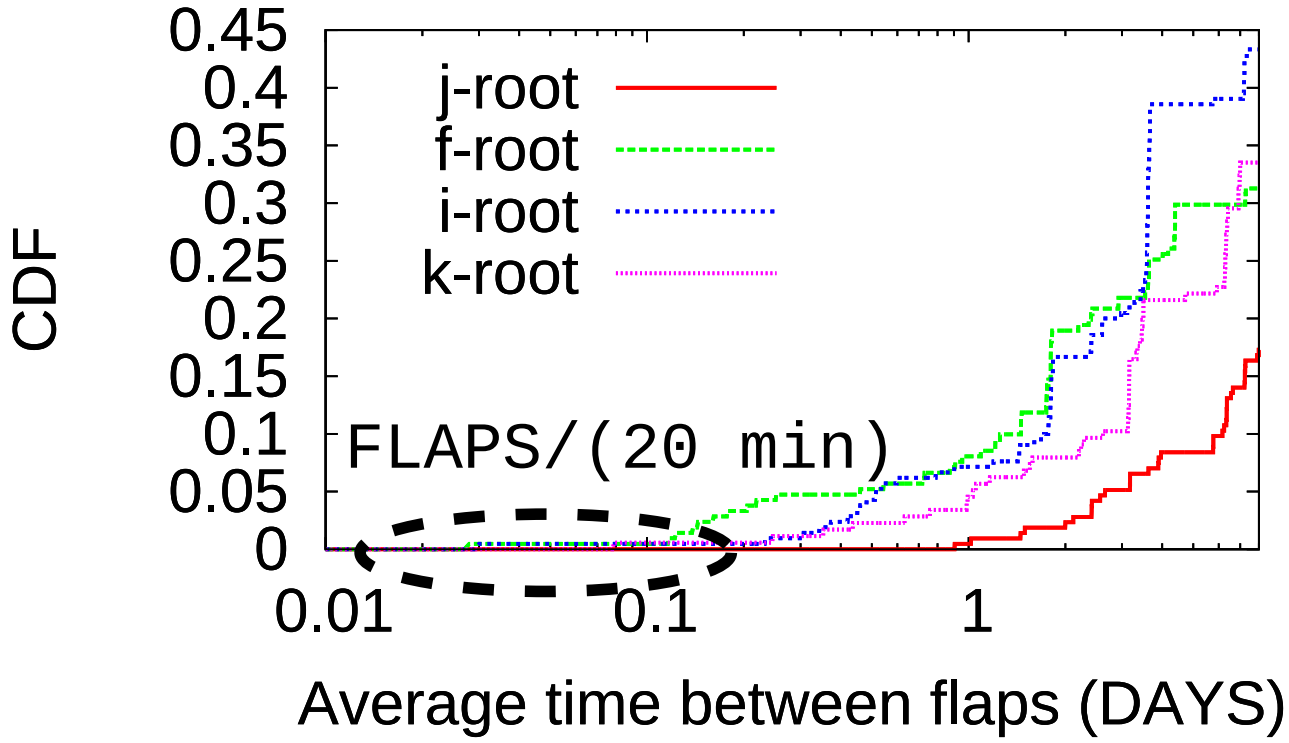

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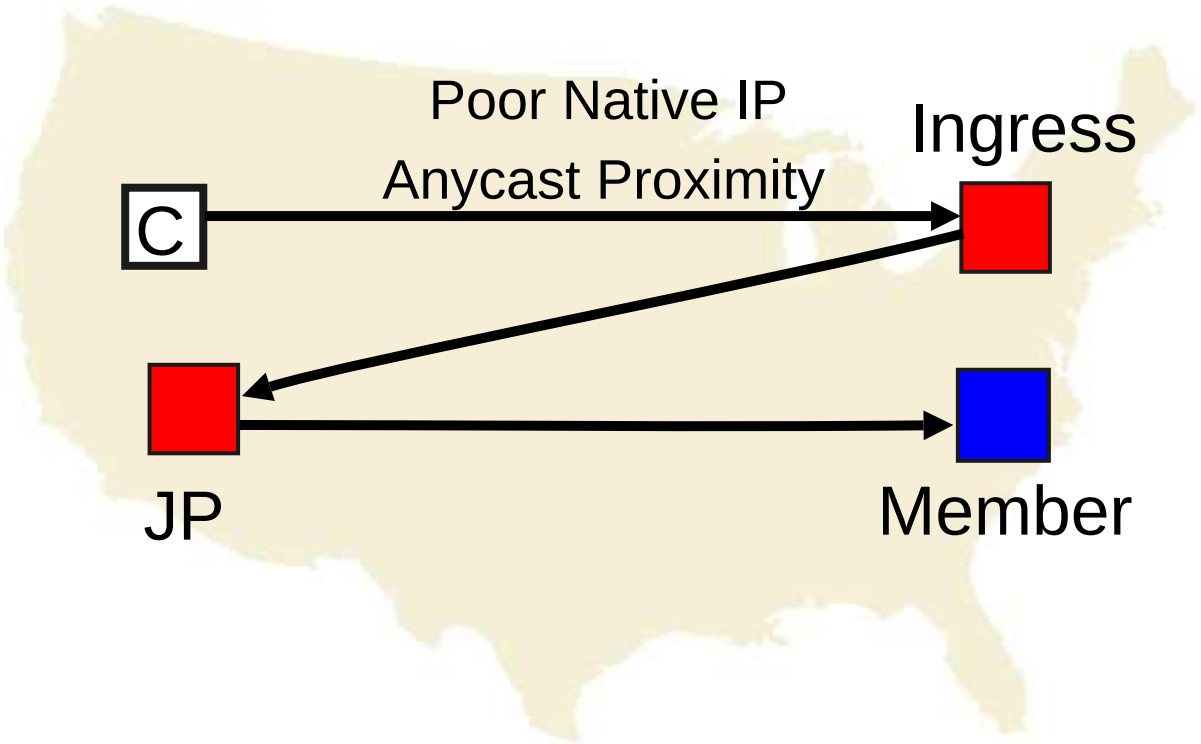


Is native IP anycast based proximity useful?

PIAS : possible problems

- Stretch
- Affinity
- Proximity : measuring proximity

Does IP Anycast offer latency-based proximity?

- measured the proximity offered by root-server anycast deployments
- from $\sim$40000 clients

PIAS : possible problems

- Stretch
- Affinity
- Proximity : measuring proximity

Does IP Anycast offer latency-based proximity?

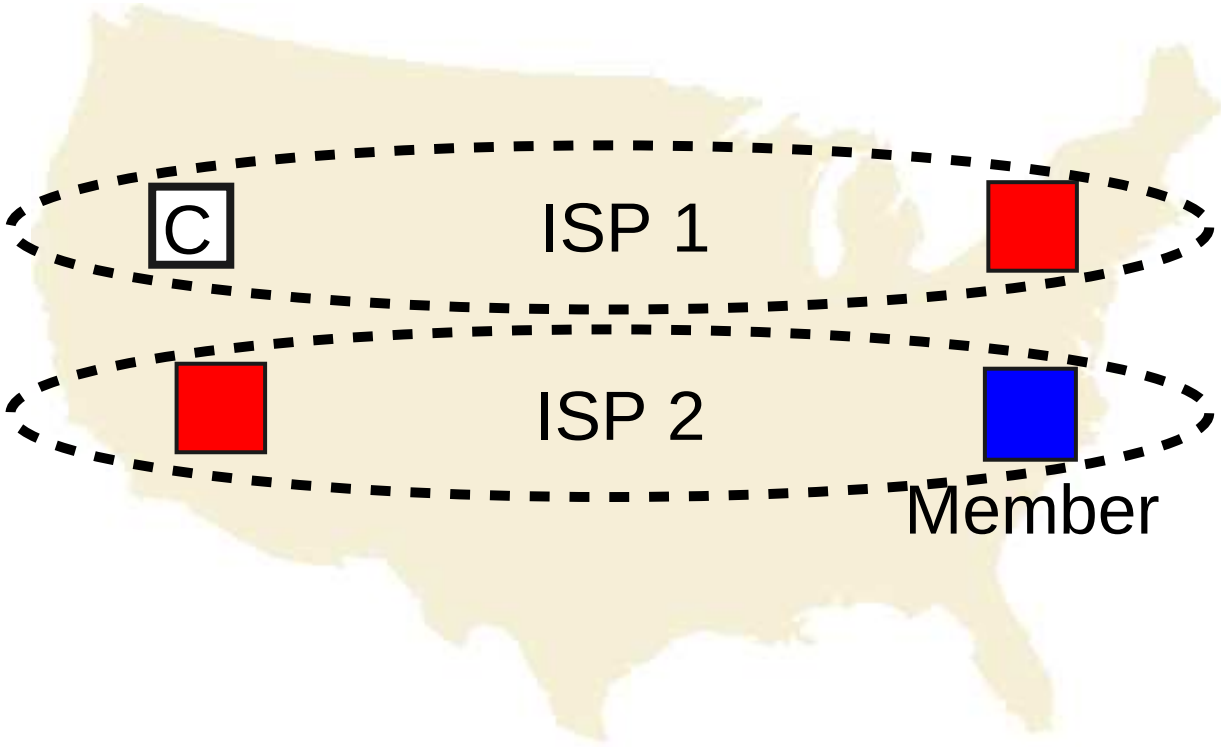
- measured the proximity offered by root-server anycast deployments
- from ∼40000 clients

Results (details in technical report)

- No (for a naive deployment)
  - 5-6 times the ideal proximity was common

PIAS : possible problems

- Stretch
- Affinity
- Proximity : example of poor proximity



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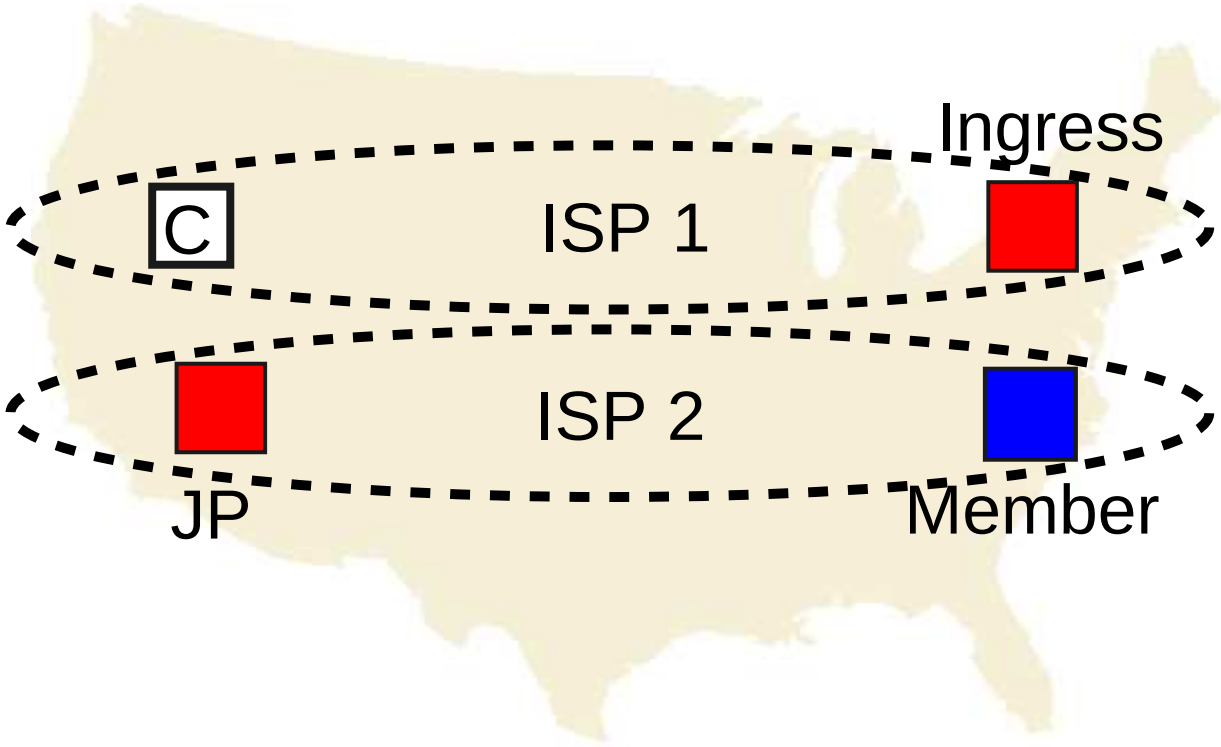

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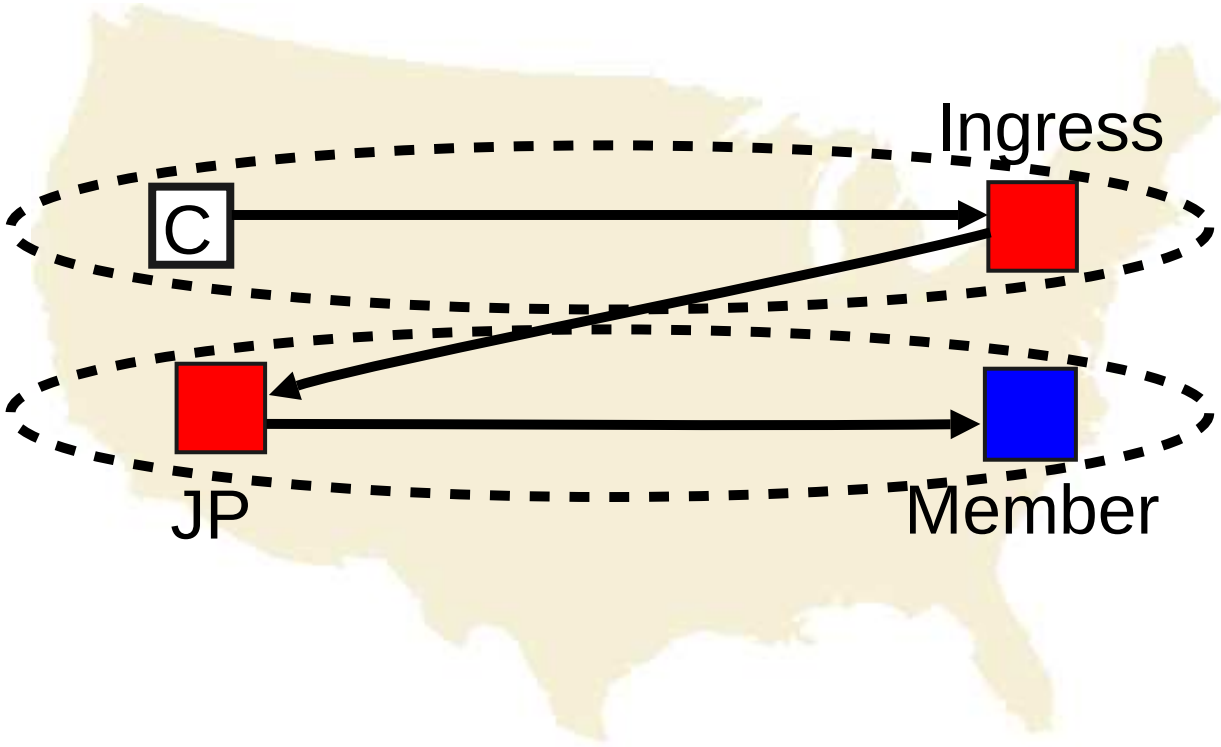

PIAS : possible problems

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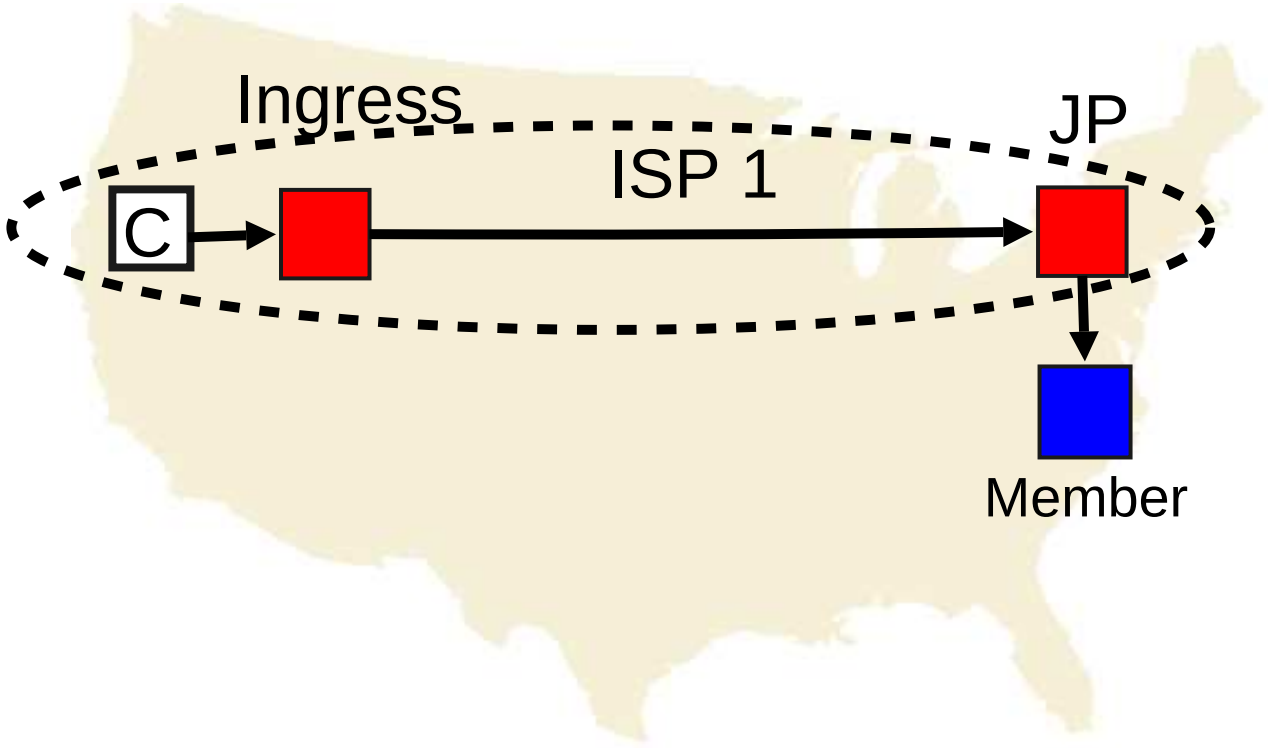
- Proximity : a simple alleviative



Planned deployment to attain proximity

Why bother?

Application-layer anycast is already out there

Why bother?

Application-layer anycast is already out there

Advantages of PIAS ...

- ✓ use for low-level protocols
- ✓ proximity is a lot easier
  - ✓ easier management
- ✓ faster failover
- ✓ no extra round-trip
  - ✗ the overhead of proxy traversal

Summary

Proxy IP Anycast Service

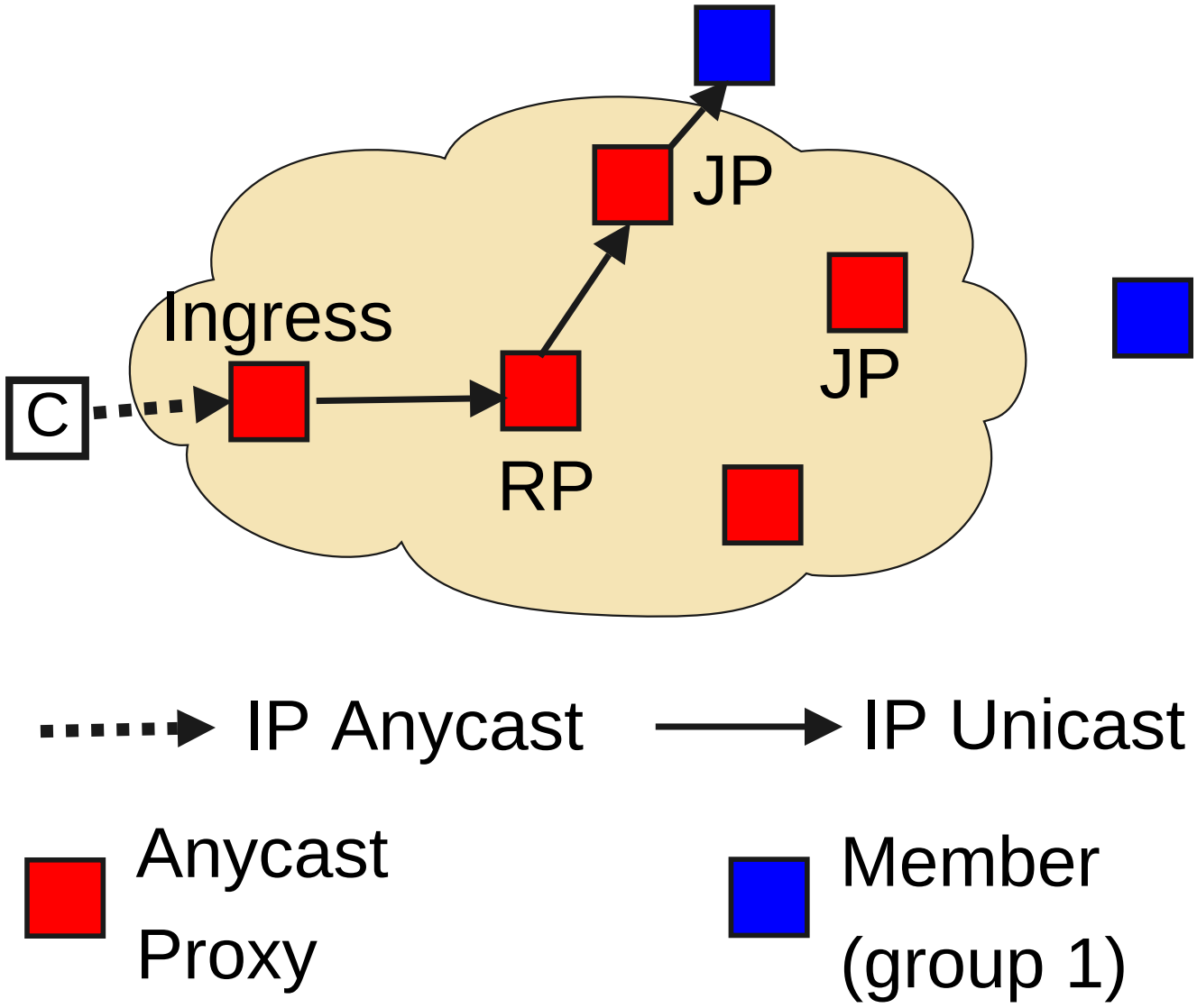
- practical anycast deployment architecture
- addresses native IP and application-layer anycast limitations
- opens new usage avenues

Anycast for the network community

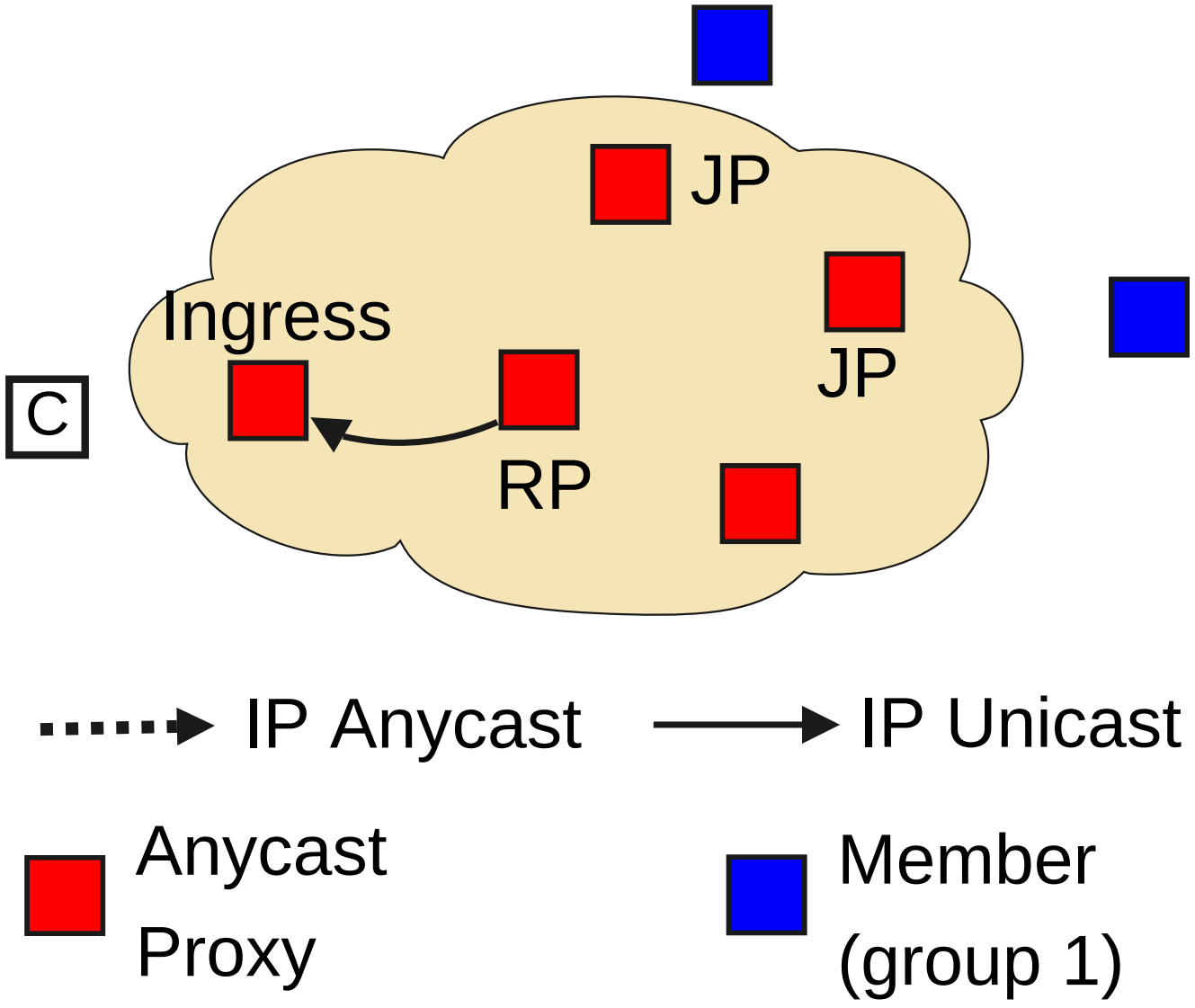
- currently deploying PIAS
- publicly usable in the near future

http://pias.gforge.cis.cornell.edu

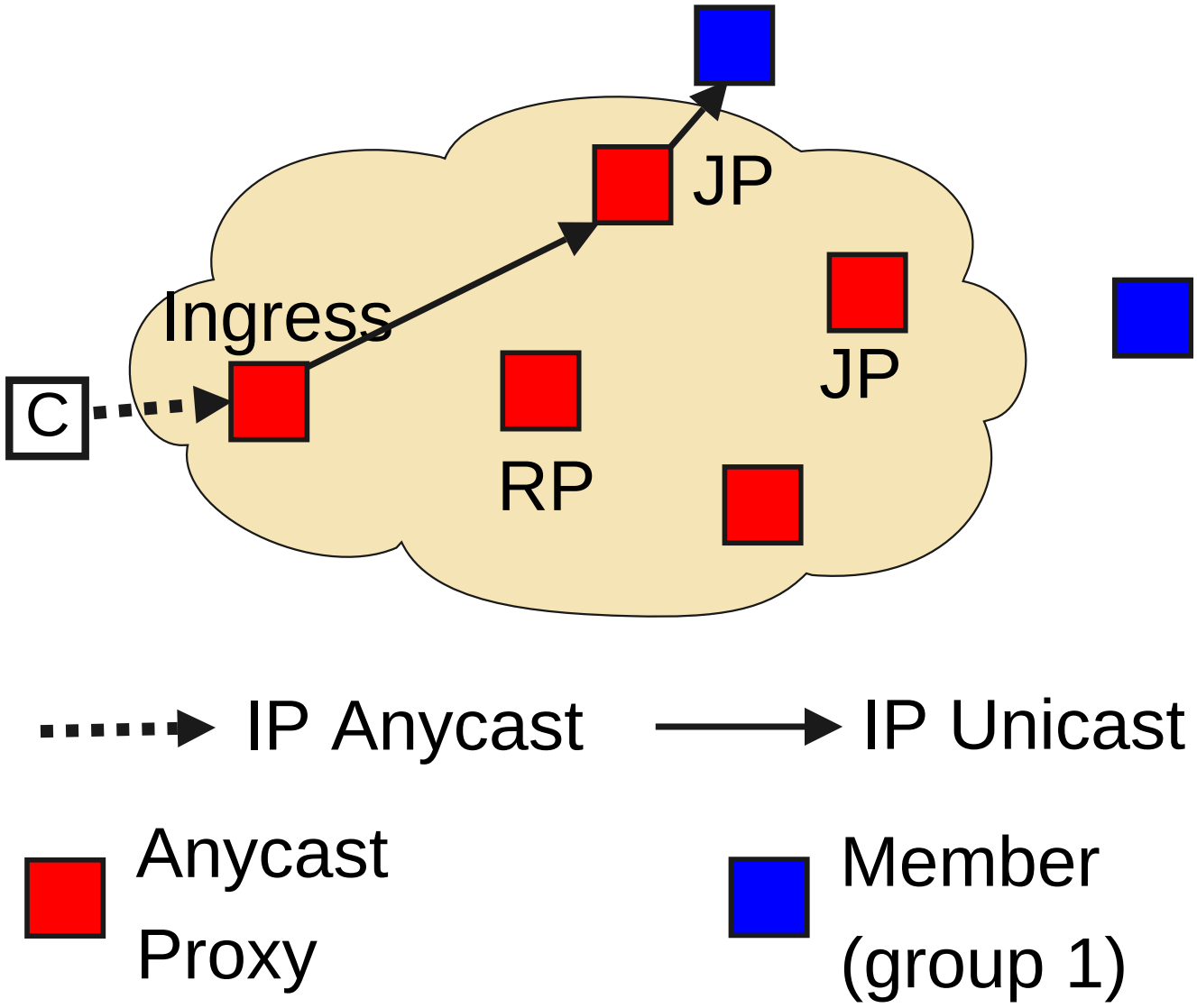
PIAS : the real picture



PIAS : the real picture



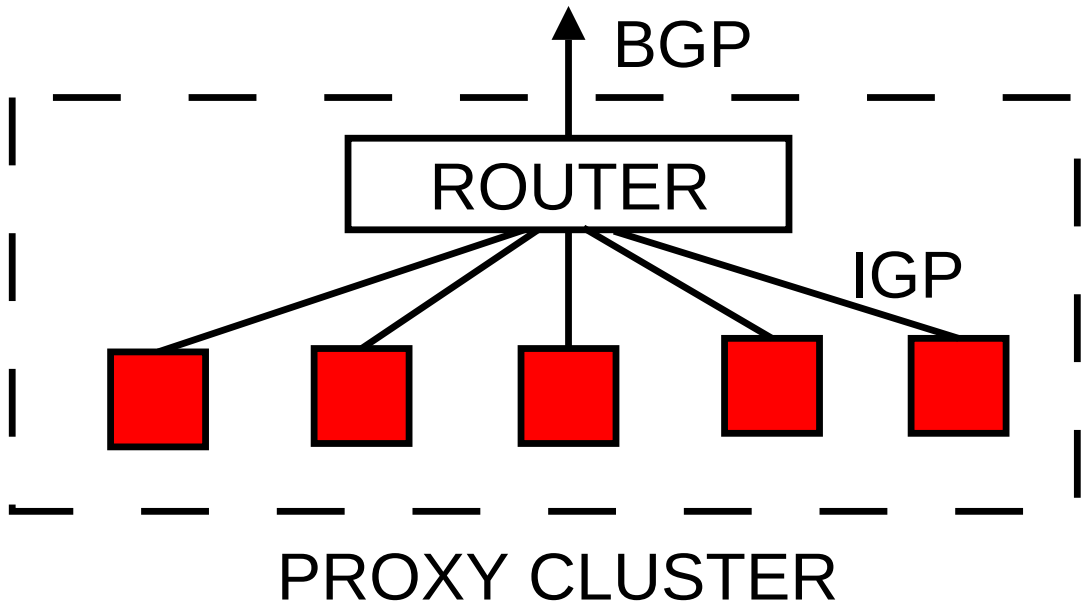
PIAS : the real picture



PIAS : engineering issues

Scalability by no. of proxies

- a clustered deployment model
- decouples proxy dynamics from inter-domain routing



PIAS : engineering issues

Failures

- no impact on inter-domain routing