Gozar: NAT-friendly Peer Sampling with One-Hop Distributed NAT Traversal

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Introduction
Gossip-based Peer Sampling Service

- Gossip-based peer sampling services (PSS) have been widely used in large scale distributed applications.
  - Information dissemination
  - Aggregation
  - Overlay topology management

- A PSS provides a node with a uniform random sample of live nodes from all nodes in the system (partial view).
Gossip-based Peer Sampling Protocol (1/7)
Gossip-based Peer Sampling Protocol (2/7)
Gossip-based Peer Sampling Protocol (4/7)
Gossip-based Peer Sampling Protocol (5/7)
Gossip-based Peer Sampling Protocol (6/7)
Gossip-based Peer Sampling Protocol (7/7)
Gossip-based Peer Sampling Design Space

- Peer Selection
- View Exchange
- View Merge
Gossip-based Peer Sampling Design Space

- **Peer Selection**
  - Random
  - Tail

- **View Exchange**
  - Push
  - Push-Pull

- **View Merge**
  - Blind
  - Healer
  - Swapper
Problem Description
NAT Environments (1/4)
NAT Environments (1/4)
NAT Environments (1/4)
NAT Environments (1/4)

Private node

Public node
Impact of NATs on PSS' (1/2)

- Size of the biggest cluster for an increasing percentage of NATs.

[A.M. Kermarrec – ICDCS'09]
Impact of NATs on PSS' (2/2)

- Ratio of non-stale references to private nodes.

[A.M.Kermarrec – ICDCS'09]
Solutions for Communicating with Private Nodes (1/3)

- Relay communications to the private node using a public relay node.
Solutions for Communicating with Private Nodes (2/3)

- Use a NAT hole-punching algorithm to establish a direct connection to the private node using a public rendezvous node.
Solutions for Communicating with Private Nodes (3/3)

- Route the request to private nodes using chains of existing open connections (of unbounded length).
Research Challenges for a NAT-friendly PSS

- Assuming distributed relay and rendezvous services, how do nodes discover which public nodes act as partners for the private nodes?

- Is hole-punching or relaying preferable for communicating with private nodes?
  - How much data will be sent over the connection and what are the latency requirements?

- How fairly should the gossiping load be balanced over public versus private nodes?
Gozar – NAT friendly Peer Sampling Service
Design Space

• Peer Selection
  - Rand
  - Tail

• View Propagation
  - Push
  - Push-Pull

• View Selection
  - Blind
  - Healer
  - Swapper
Design Space

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Gozar
NAT Friendliness in Gozar

- In Gozar, each private node connects to one or more public nodes, called partners that act as a relay or rendezvous server on behalf of the private node.

- A node's descriptor consists of both its own address, its NAT type, and its partners' addresses at the time of descriptor creation.

- When a node wants to gossip with a private node, it uses the partner addresses in its descriptor to communicate with the private node.
Partnering (3/10)

Bootstrap server

n1, public, null
n4, public, null
...

n1
...

n3
...

n5
...

n2
Partnering (5/10)

Bootstrap server

n1, public, null
n4, public, null

ACK

n2

n1

n3

n5

NACK

...
Partnering (7/10)

Bootstrap server

n1, public, null
n4, public, null
...

n2, private, n1
...

Shuffle exchange

n2

n1

n3

n5
Partnering (8/10)

Bootstrap server

- n1, public, null
- n4, public, null

Shuffle exchange

- n2, private, n1
- n5

- n2, private, n1
Partnering (9/10)

Bootstrap server

n1, public, null
n4, public, null
...

n2, private, n1
...

n2, private, n1
...

Shuffle request

n5

n3

n1
Partnering (10/10)
Relaying or Hole Punching?

- Relaying?
  - Lower latency message exchange.
    - Enables lower gossip cycle periods.
    - Necessary in dynamic networks

- Hole punching?
  - Decreases load on public nodes.
    - But not if shuffle messages are small.

- Applications that use the PSS can use partners to hole-punch or relay messages to private nodes.
Experiments
Experiment Setup

- Using the Kompics as a simulator platform.

- King dataset is used to model the latencies between nodes.

- 1000 nodes, 80% of nodes are private and 20% are public.

- Compare with Nylon and ARRG.

- Cyclon is used as a baseline.
Metrics

- **Randomness** properties:
  - Local randomness
  - In-degree distribution
  - Clustering coefficient
  - Avg. path length

- Protocol **overhead**.

- **Fairness** and **connectivity** in catastrophic failure.
Randomness

(a) Local randomness.
(b) Indegree distribution.
(c) Average path length.
(d) Clustering coefficient.
Protocol Overhead

(a) Protocol overhead of Gozar vs. Nylon.

(b) Overhead traffic of Gozar vs. Nylon for varying percentages of private nodes.
Fairness and Connectivity in Failure

(a) Fairness after catastrophic failure: overhead for public and private nodes for varying numbers of partners.

(b) Biggest cluster size after catastrophic failures.
Conclusions
Conclusions

- **Gozar** is a NAT-friendly gossip-based peer sampling service that also provides a distributed NAT traversal service to clients of the PSS.

- **Public** nodes are leveraged to provide both the *relaying* and *hole punching* services.

- Relaying is only used for gossiping to private nodes
  - lower connection latency
    - Enabling a faster gossiping cycle
  - The messages relayed are small
Thank you