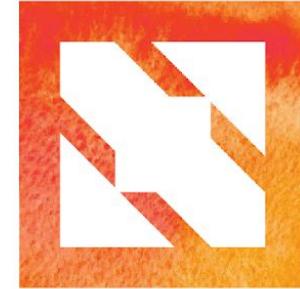


KubeCon

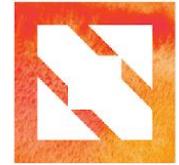


CloudNativeCon

Europe 2019



KubeCon



CloudNativeCon

Europe 2019



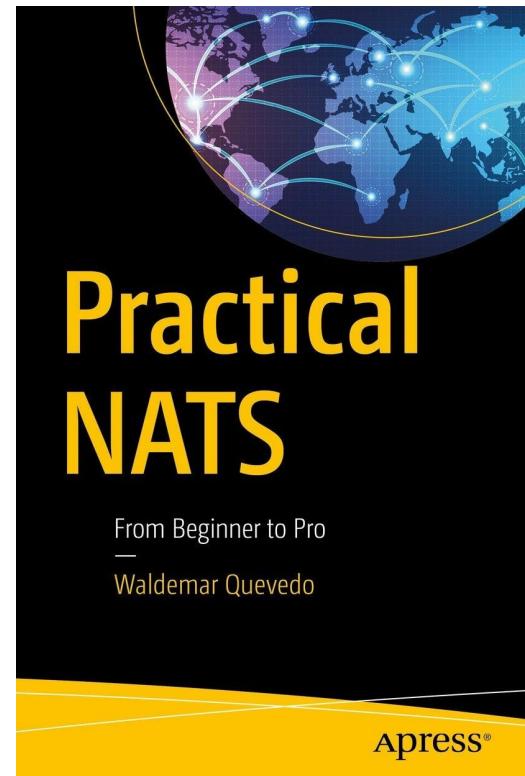
Introduction to NATS

Waldemar Quevedo
Synadia Communications, Inc

About me



- Waldemar Quevedo / [@wallyqs](https://twitter.com/wallyqs)
- Software Engineer at Synadia Communications, Inc
- NATS core maintainer
- Using NATS based systems since 2012
- Author of *Practical NATS* (Apress, 2018)



Agenda



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CloudNativeCon

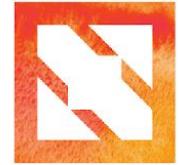
Europe 2019

- Overview of the NATS project
- New features part of the NATS v2
- Demo



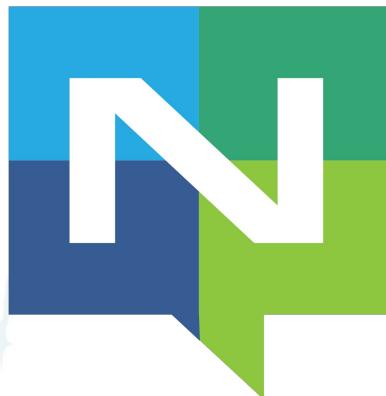


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CloudNativeCon

Europe 2019



NATS Overview

About NATS



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Europe 2019



CloudNativeCon

NATS is an eight year old, production proven, cloud-native messaging system made for developers and operators who want to spend more time doing their work and less time worrying about how to do messaging.

- ✓ DNA: Performance, simplicity, security, and availability
- ✓ Built from the ground up to be cloud native
- ✓ Multiple qualities of service
- ✓ Support for multiple communication patterns
- ✓ Over 30 client languages

CNCF Landscape

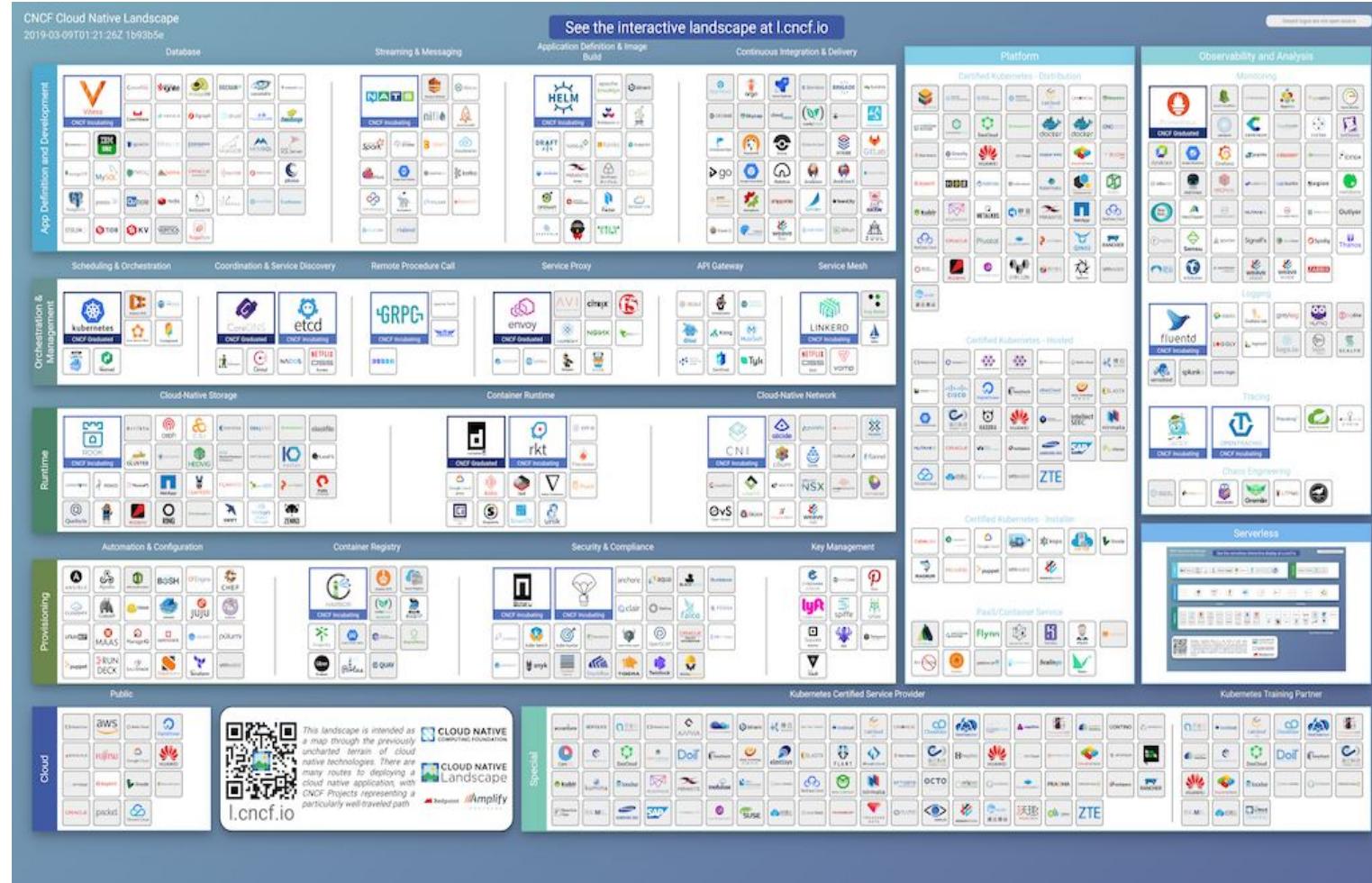


KubeCon



CloudNativeCon

Europe 2019 -



Joined CNCF as an
incubation project in
2018

<https://landscape.cncf.io>

CNCF Landscape

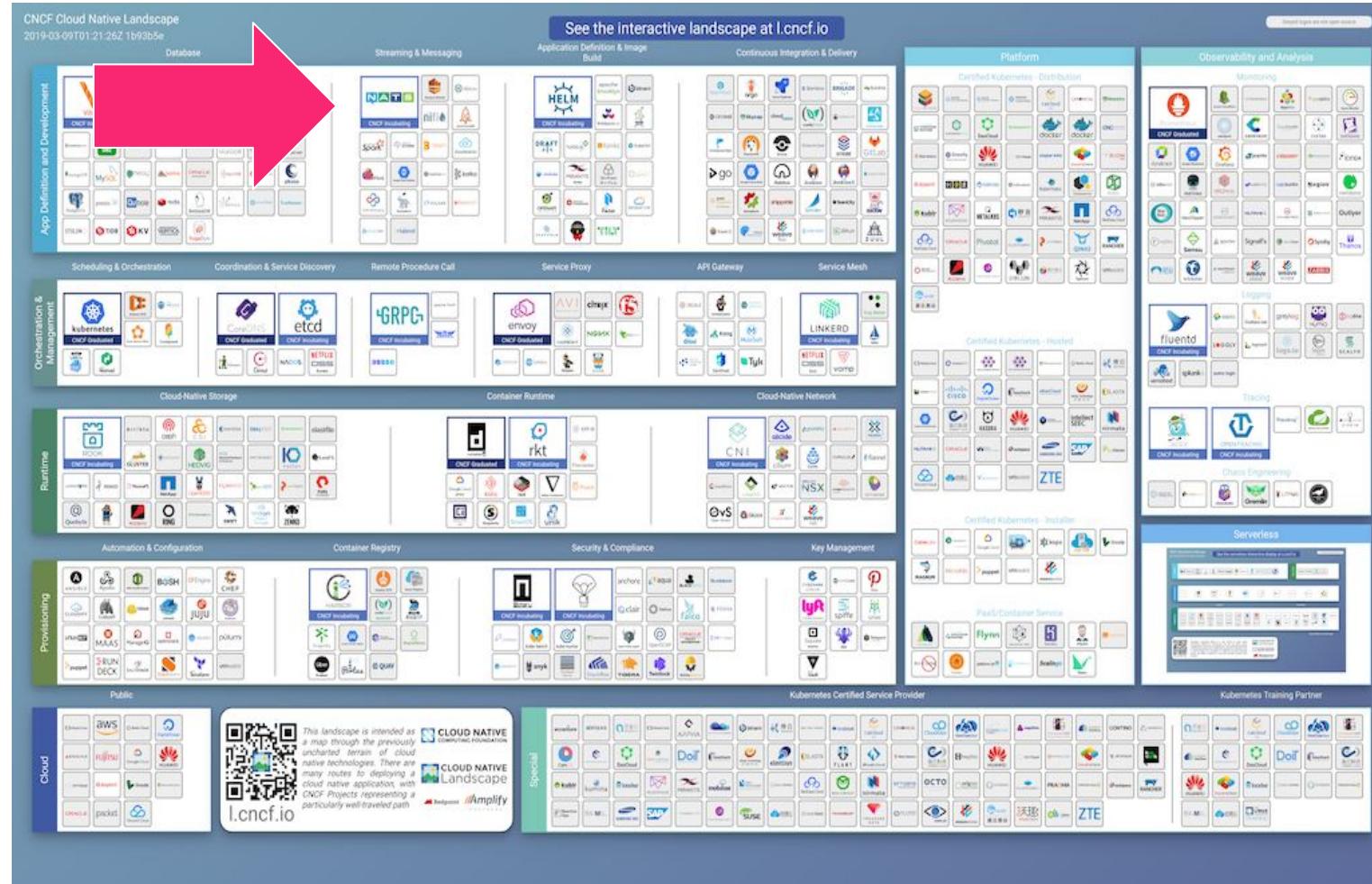


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Europe 2019



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incubation project in
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<https://landscape.cncf.io>

CNCF Landscape



KubeCon

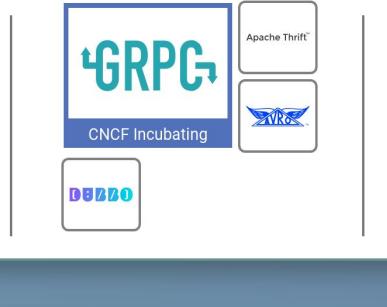
CloudNativeCon

Europe 2019

Streaming & Messaging

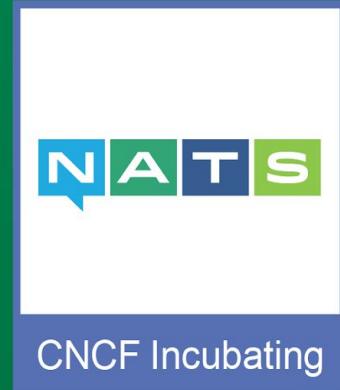


Remote Procedure Call



8. STREAMING & MESSAGING

When you need higher performance than JSON-REST, consider using gRPC or NATS. gRPC is a universal RPC framework. NATS is a multi-modal messaging system that includes request/reply, pub/sub and load balanced queues.



<https://landscape.cncf.io>

Contribution stats



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- Over 1000 contributors, over 100 with more than 10 commits*
- 30+ public repos
 - 50+ releases
 - 8000+ GitHub stars across repos
- ~35M NATS server Docker Hub pulls
- ~25M NATS streaming server pulls
- 1200+ Slack members
- 20+ releases of the NATS server since June 2014, \approx 5/year

<https://nats.devstats.cncf.io/d/9/developers-summary>

History



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Derek Collison

Founder and CEO at Synadia

Founder and former CEO at Apcera
CTO, Chief Architect at VMware
Architected CloudFoundry
Technical Director at Google
SVP and Chief Architect at TIBCO

Created by Derek Collison

Derek has been building messaging systems
and solutions > 25 yrs

Maintained by a highly experienced
messaging team

Engaged User Community

Growing Community: NATS End Users



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Use Cases



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- Cloud Messaging
 - ✓ Services (microservices, service mesh)
 - ✓ Event/Data Streaming (observability, analytics, ML/AI)
 - ✓ Command and Control
- IoT and Edge
 - ✓ Telemetry / Sensor Data / Command and Control
- Augmenting or Replacing Legacy Messaging



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A world map background where the continents are semi-transparent blue shapes, overlaid with a dense network of glowing blue lines and dots representing a global communication or data exchange network.

NATS as an always available dial tone to
connect everything



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Core of NATS: 3 Simple Patterns

Messaging Patterns



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- ✓ Publish/Subscribe
- ✓ Load Balanced Queue Subscribers
- ✓ Request/Reply

Subjects



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A subject is simply a string representing an interest in data.

- Simple subject: **foo**
- Hierarchically Tokenized: **foo.bar**
- Wildcard subscriptions
 - ✓ **foo.*** matches **foo.bar** and **foo.baz**.
 - ✓ **foo.*.bar** matches **foo.a.bar** and **foo.b.bar**.
 - ✓ **foo.>** matches any of the above
 - ✓ **>** matches everything in NATS

Request/Response (1:1)



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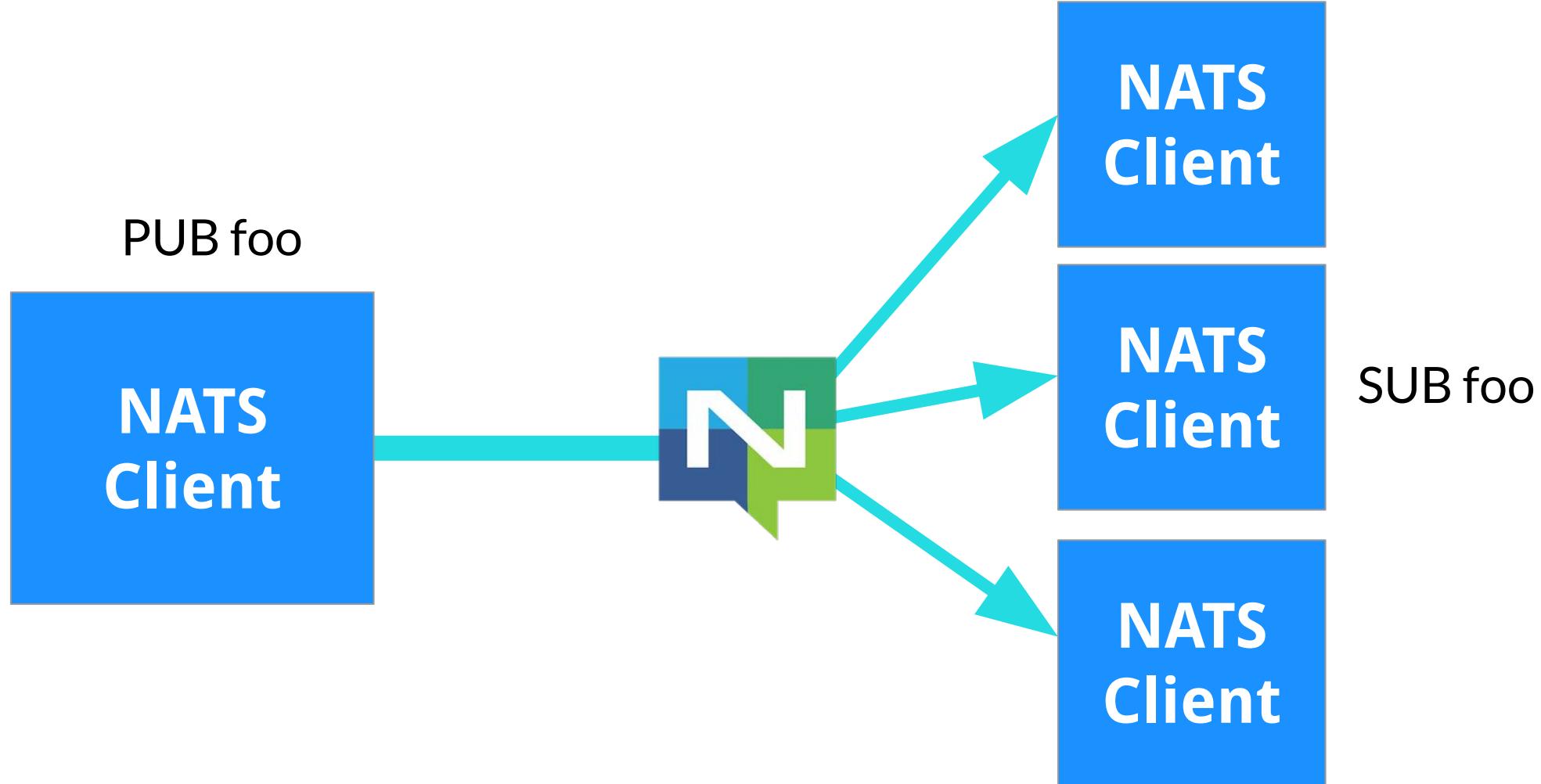
Publish/Subscribe (1:N)



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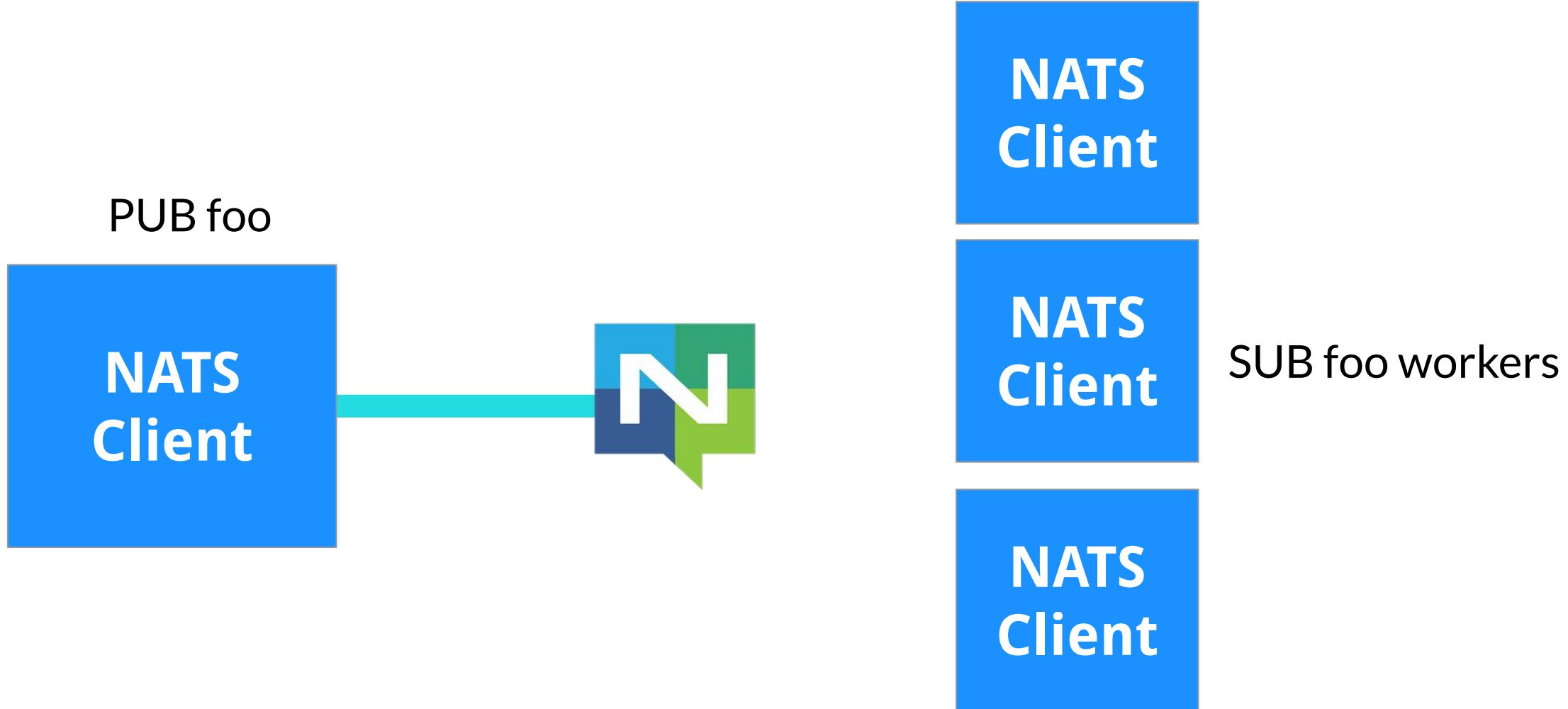
Load Balanced Queues



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Europe 2019



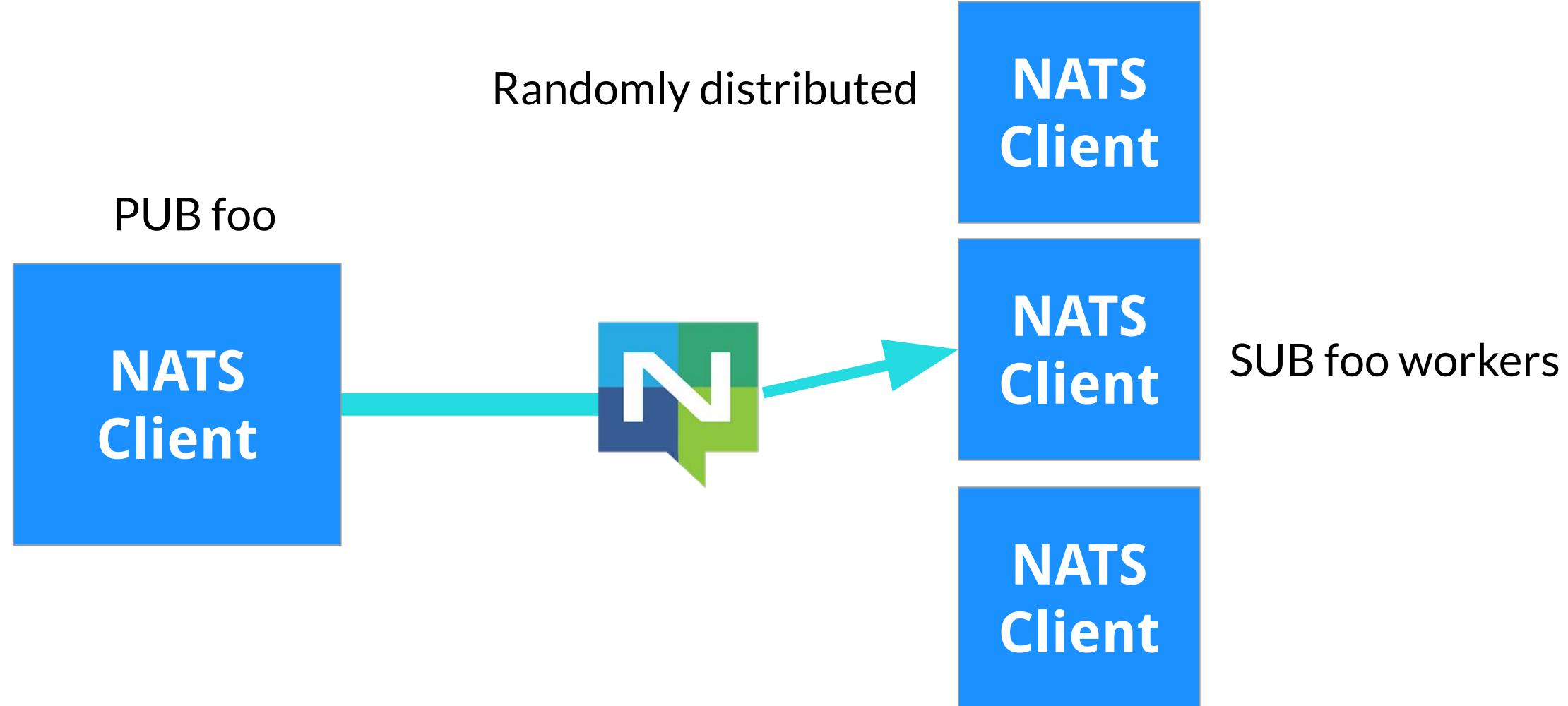
Load Balanced Queues



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CloudNativeCon

Europe 2019



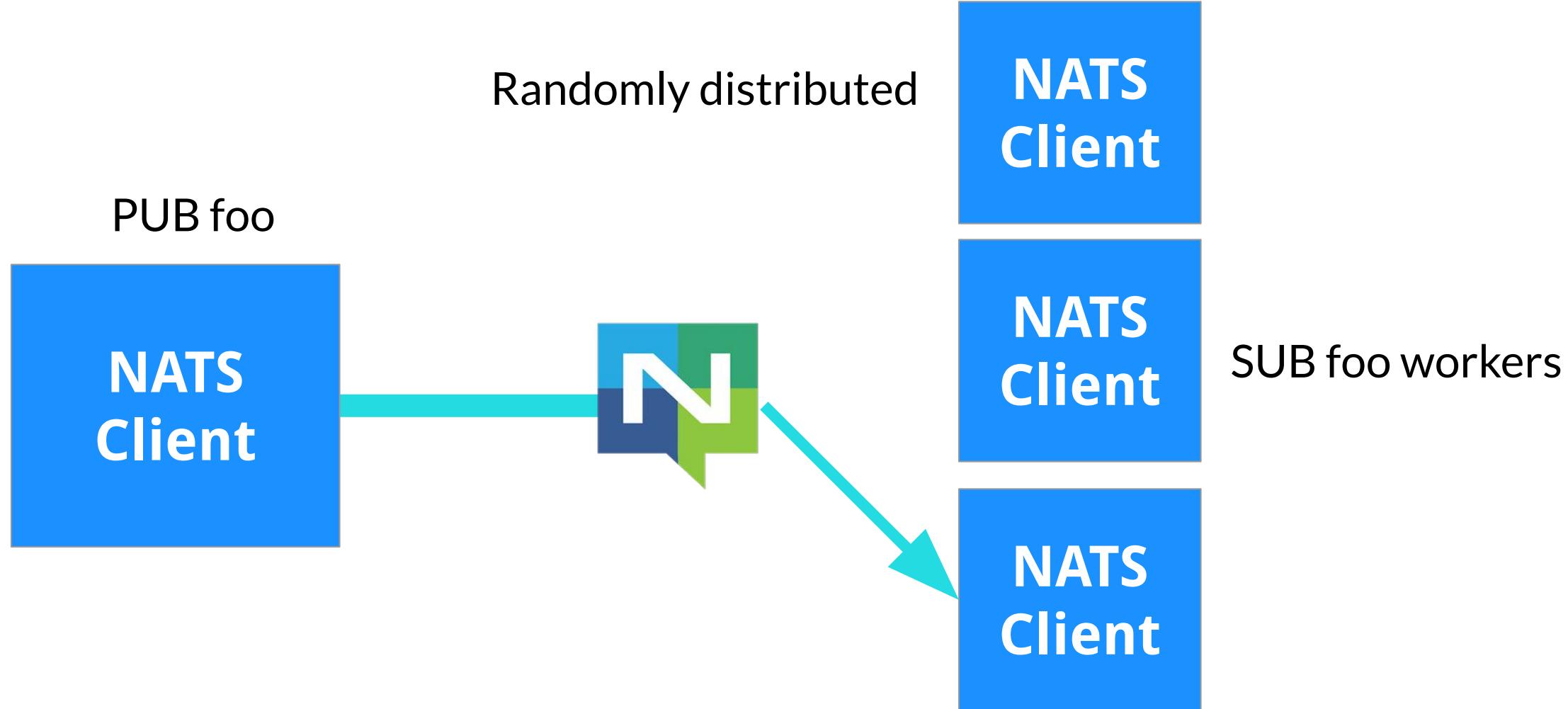
Load Balanced Queues



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CloudNativeCon

Europe 2019



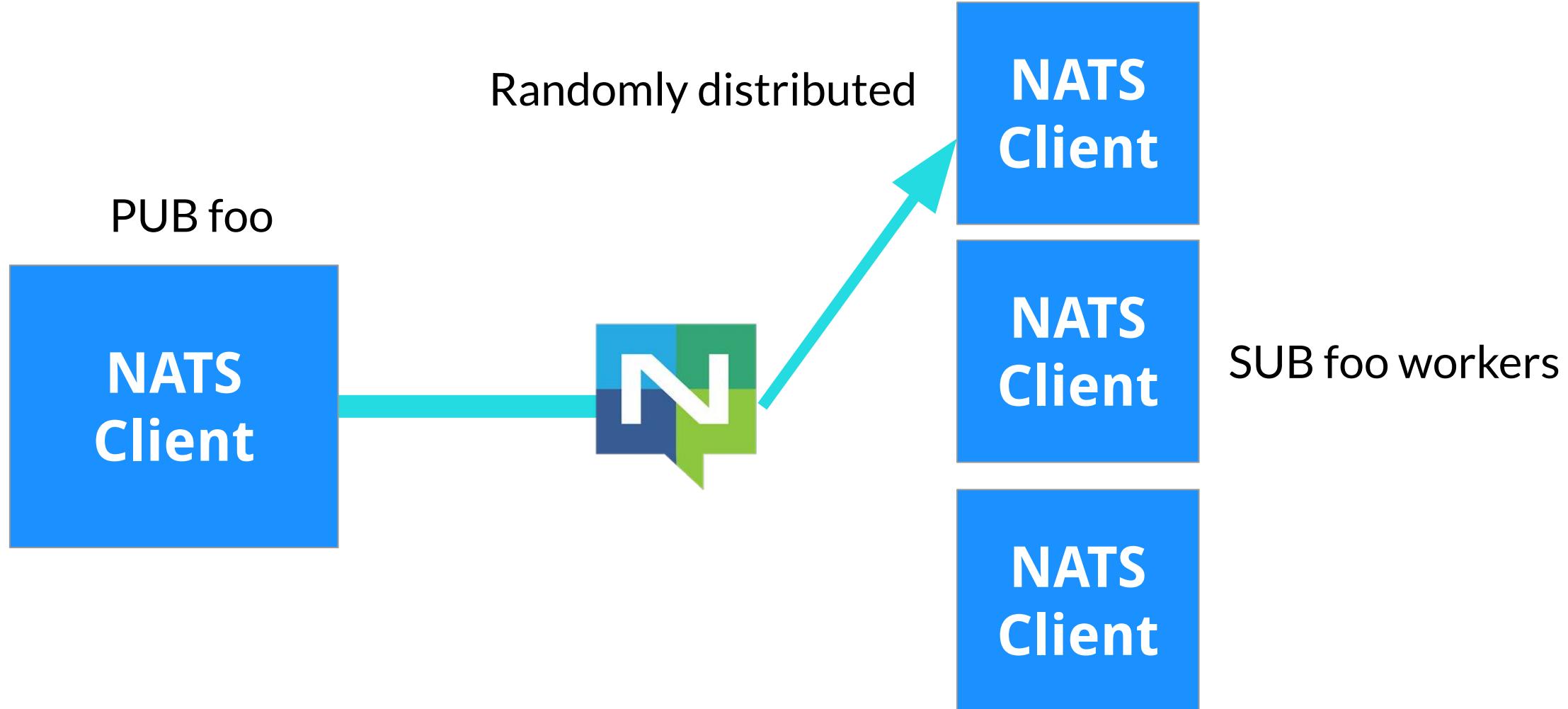
Load Balanced Queues



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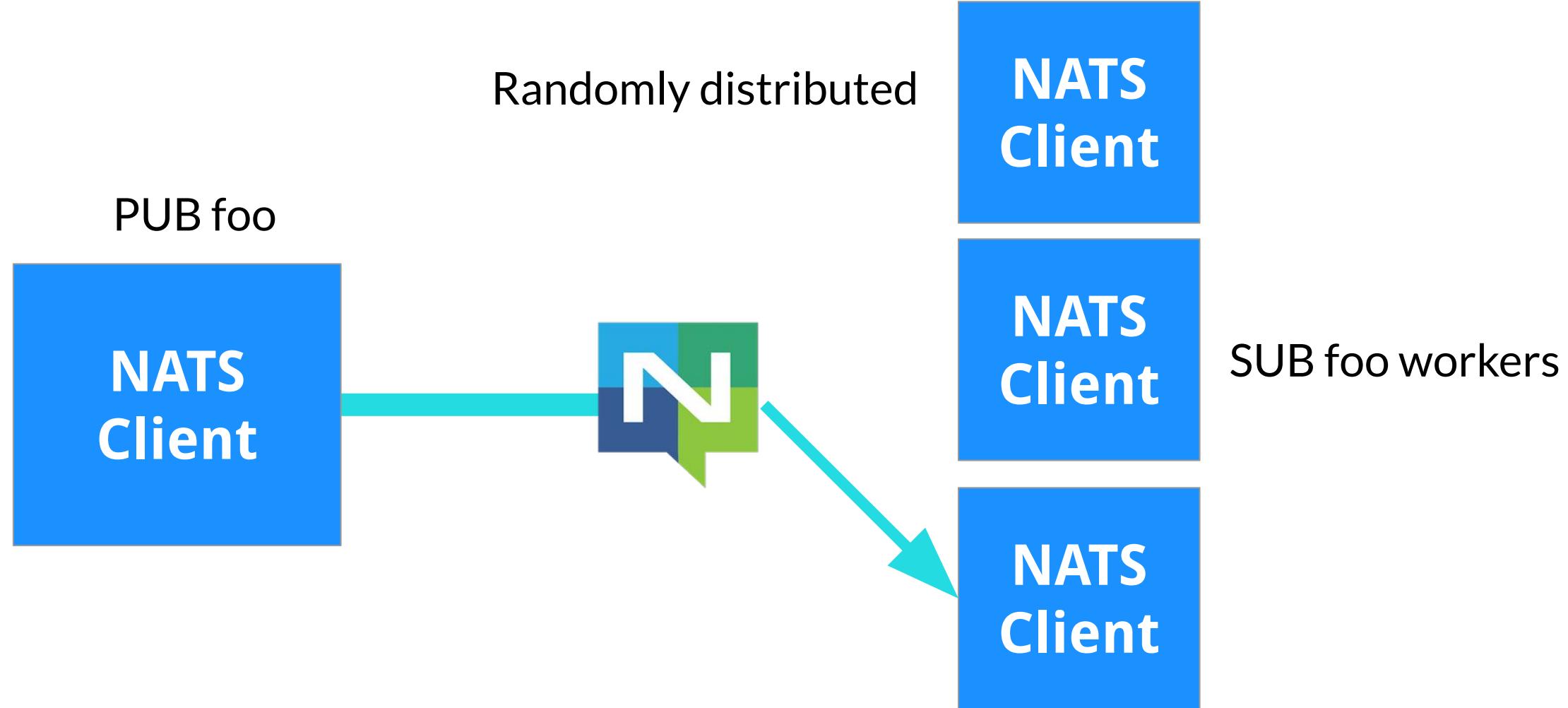
Load Balanced Queues



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Wildcards

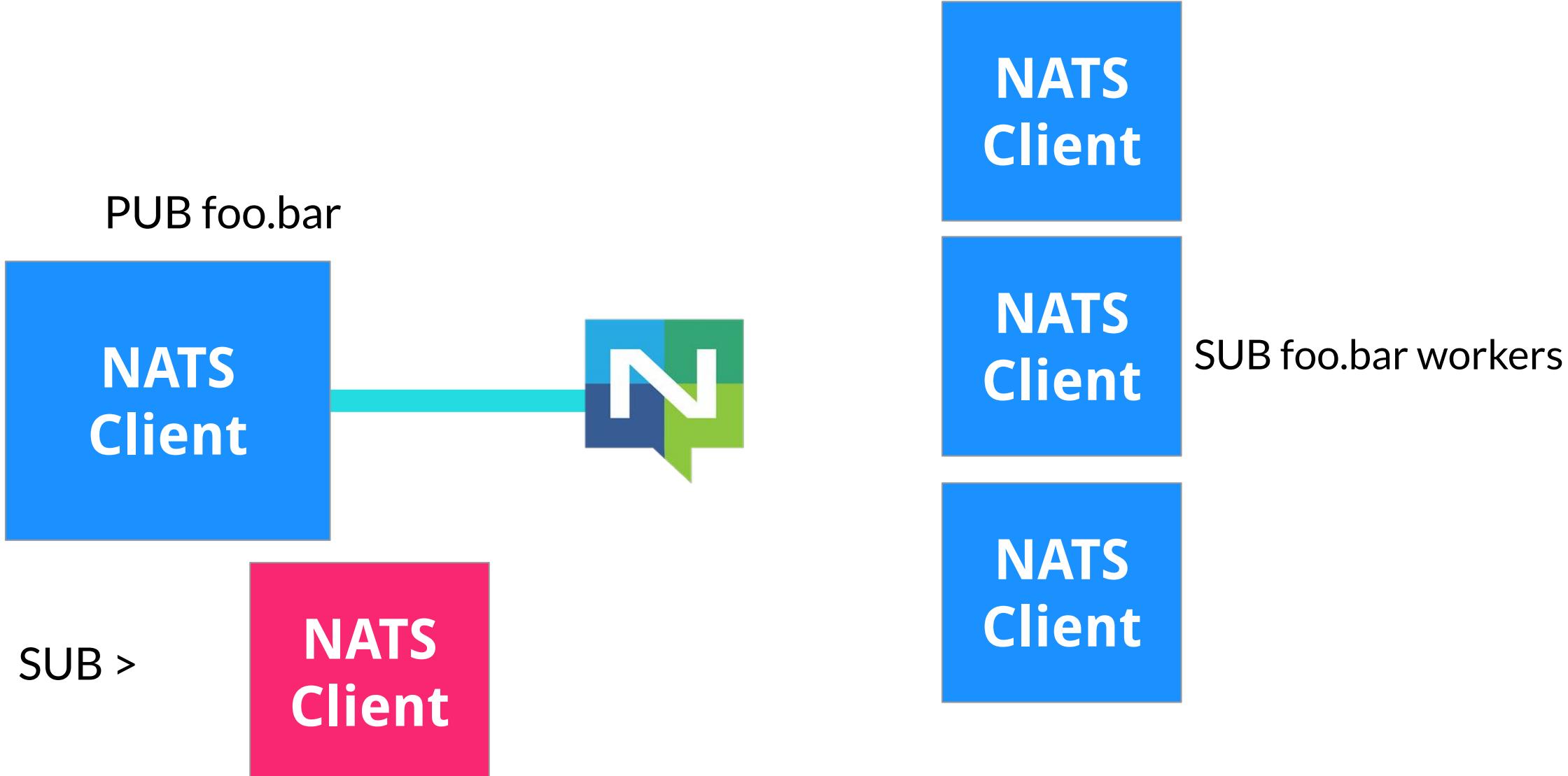


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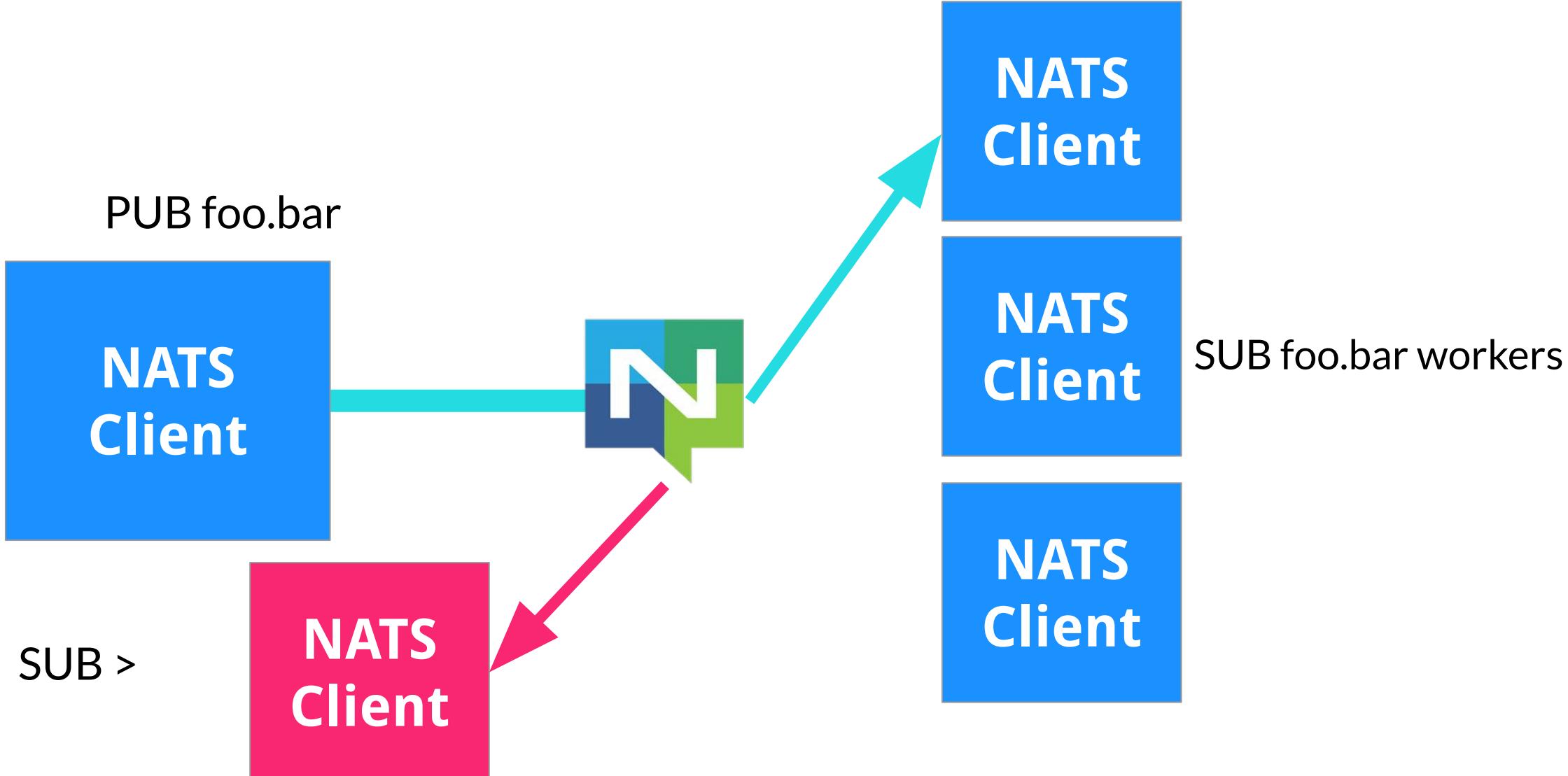
Wildcards



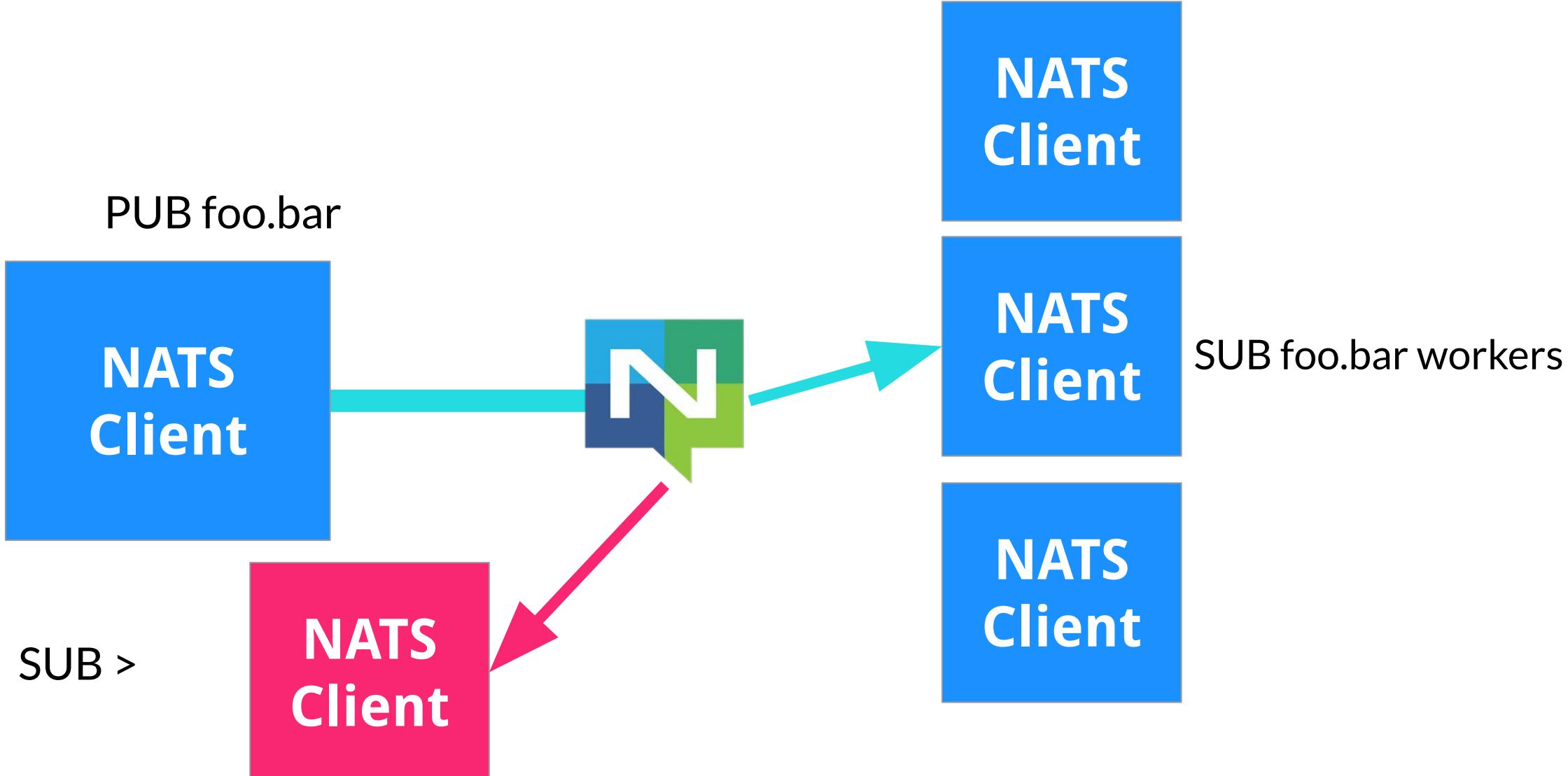
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Wildcards



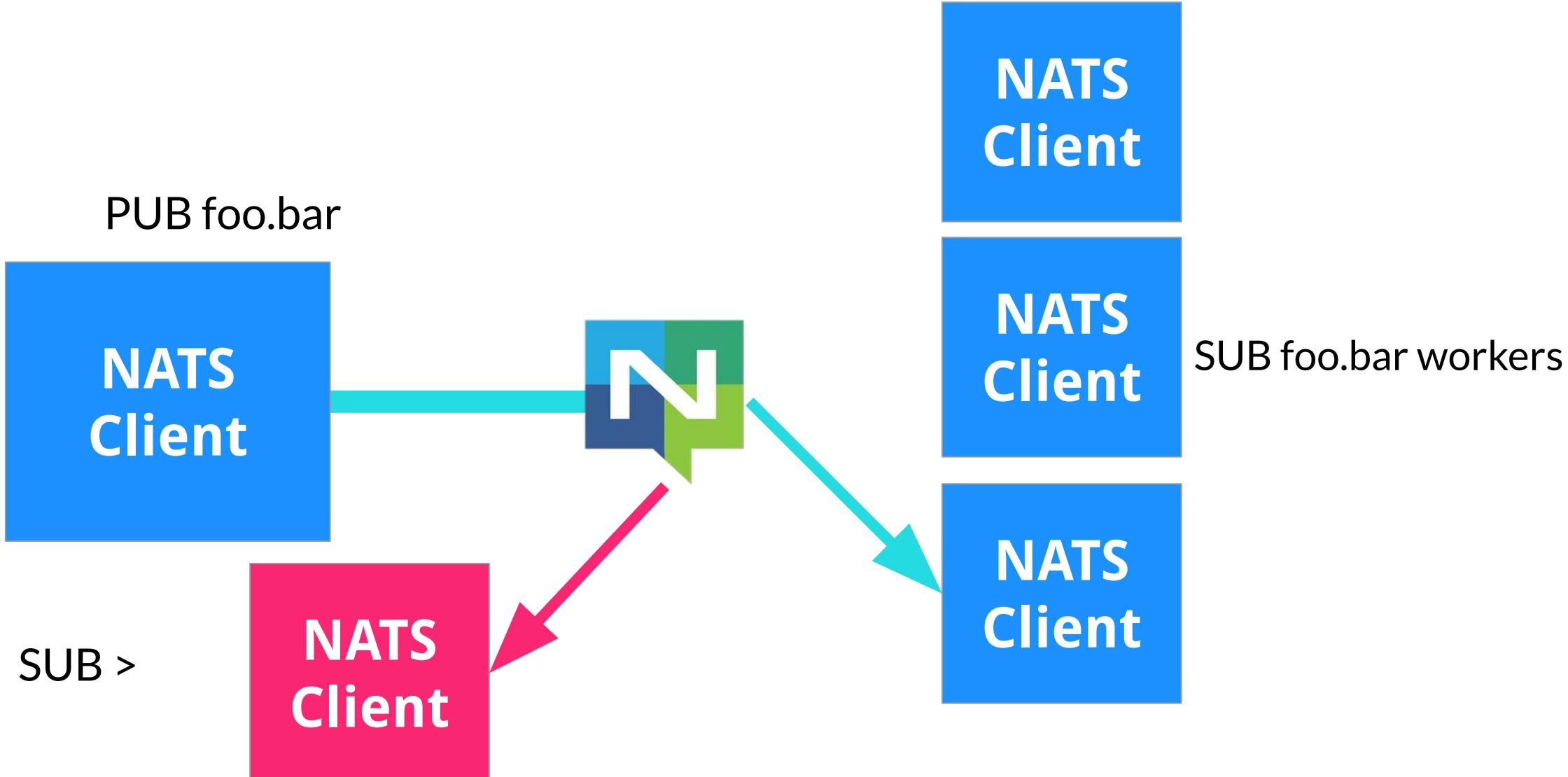
Wildcards



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Wildcards

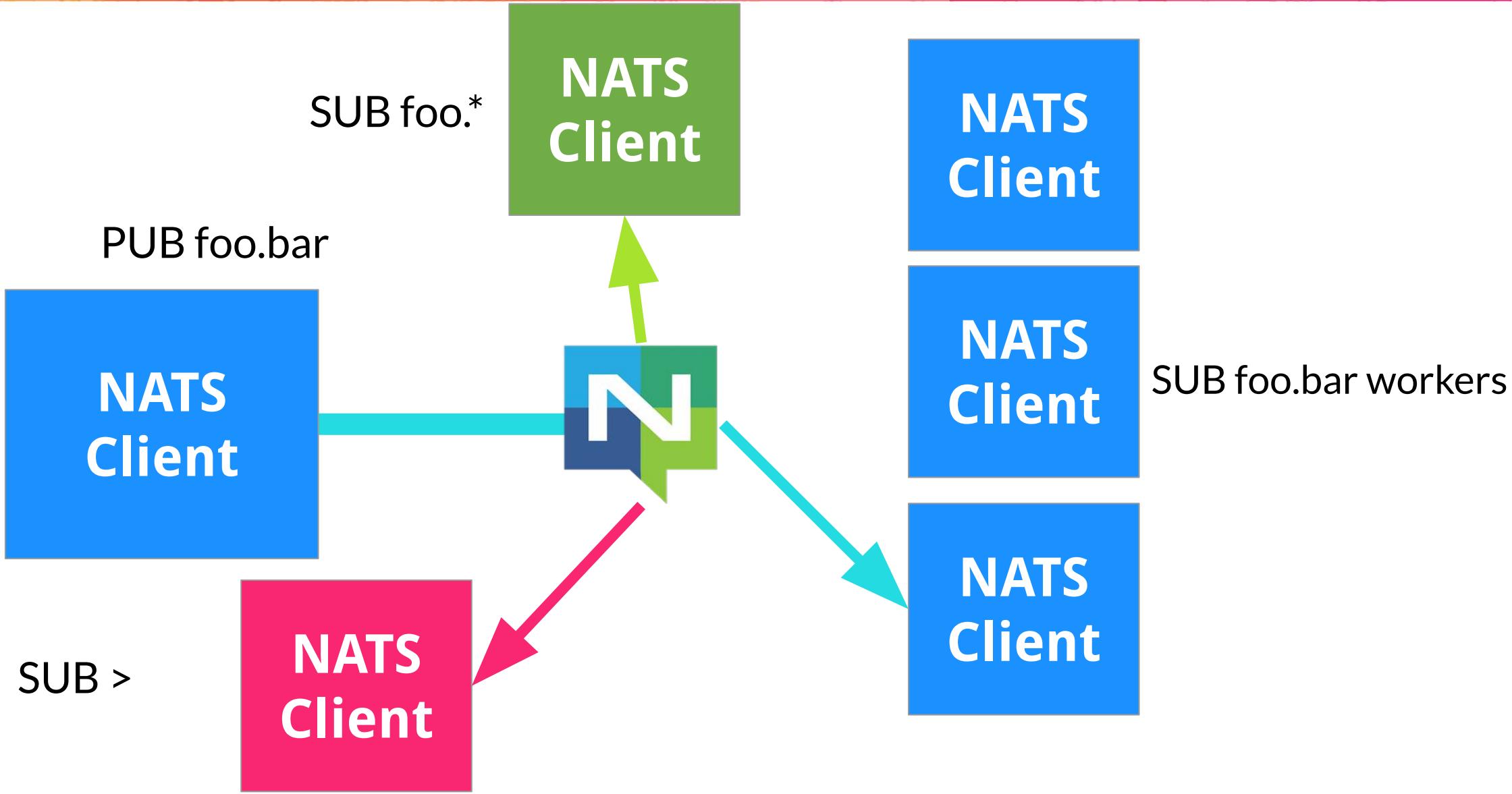


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Wildcards

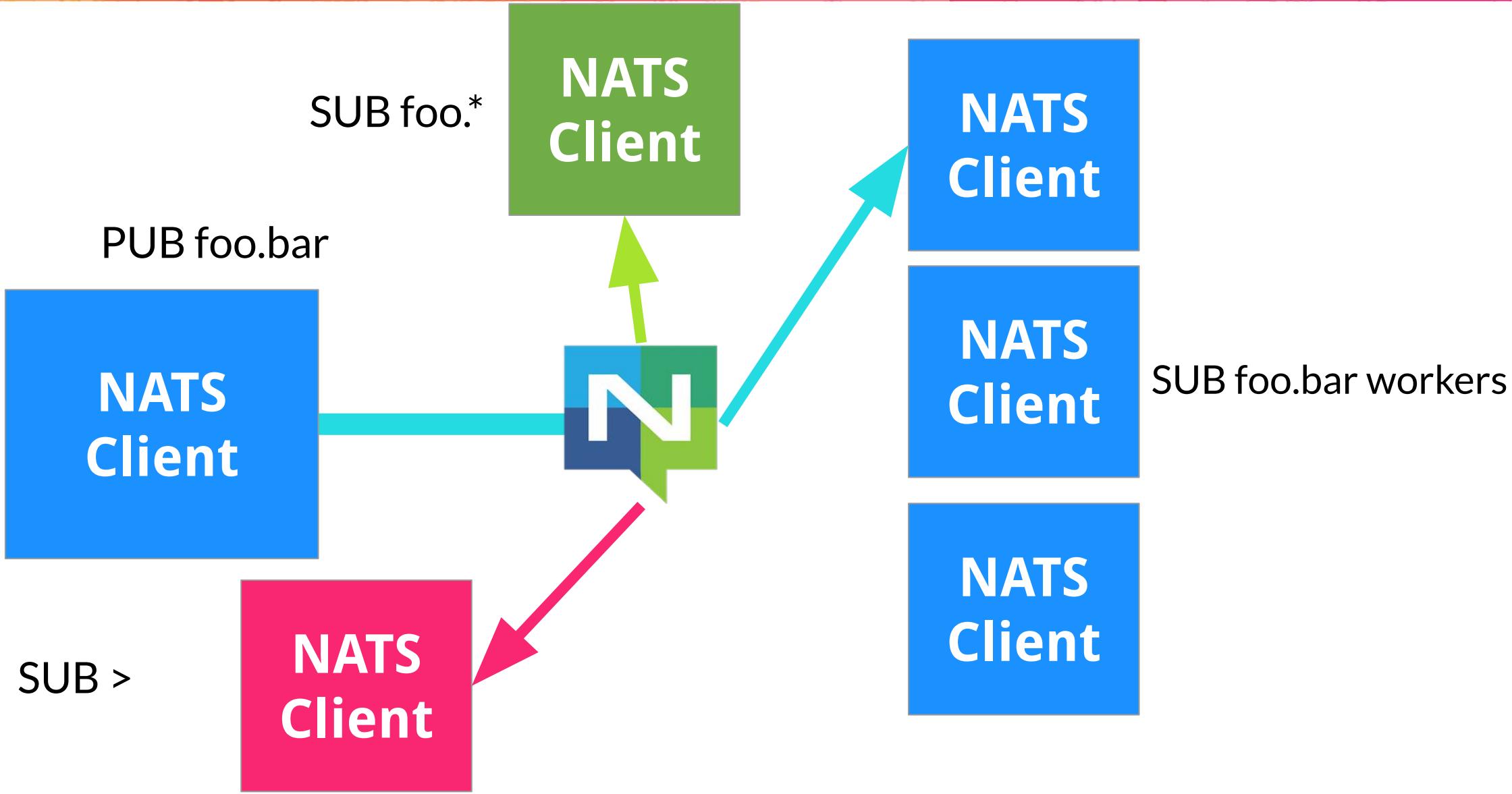


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Wildcards

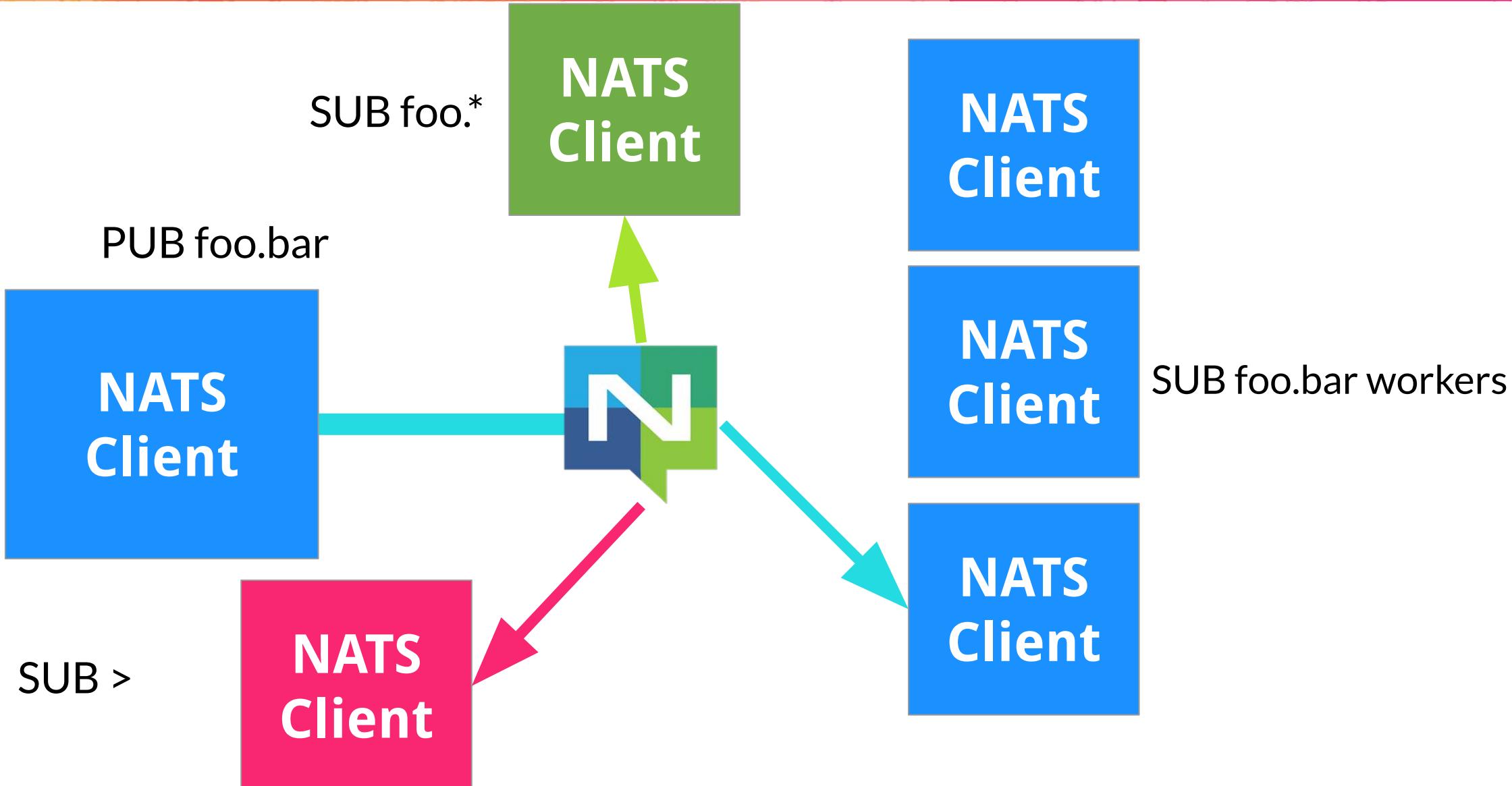


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Wildcards

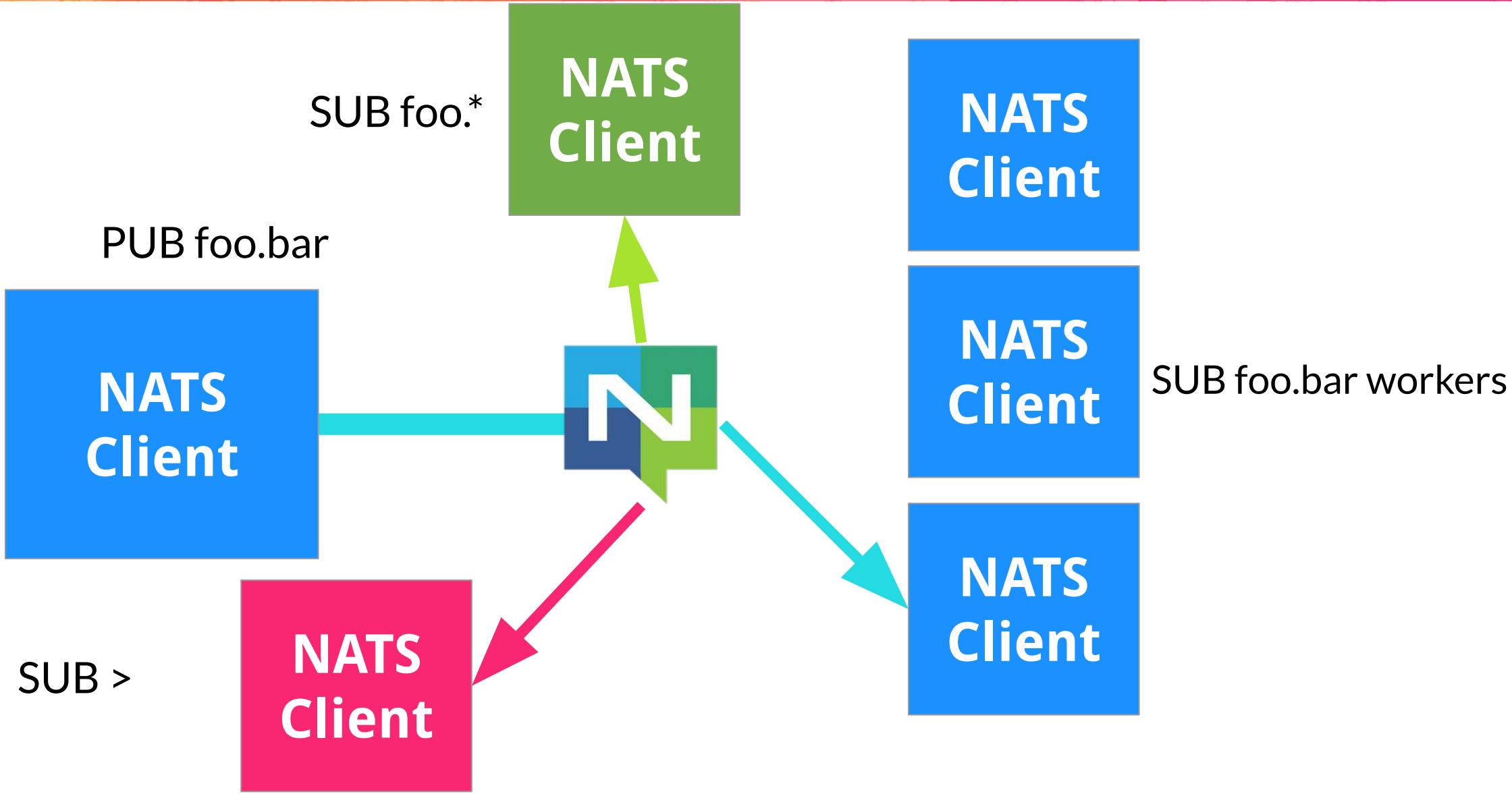


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Wildcards

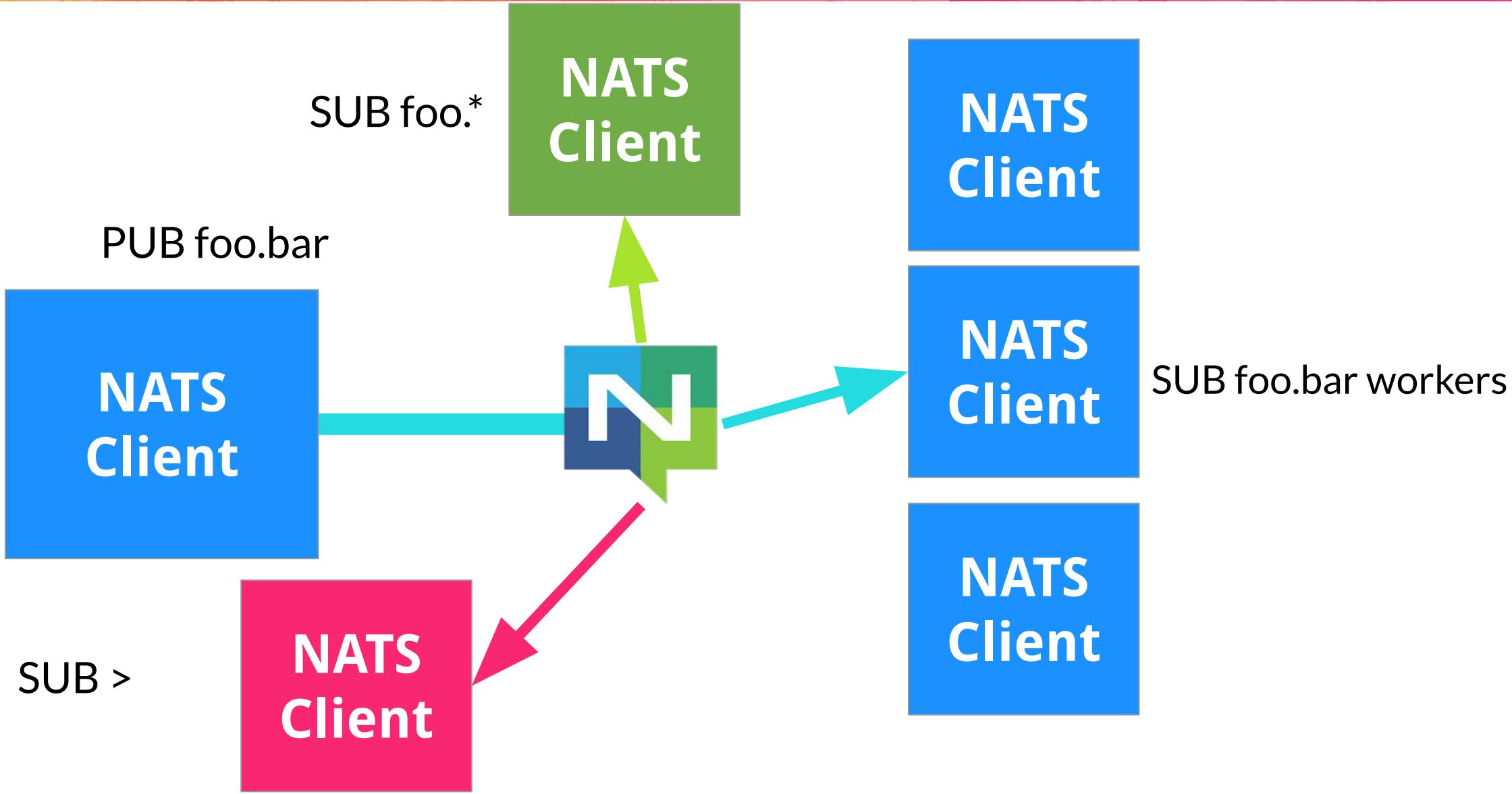


KubeCon



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Europe 2019



Wildcards

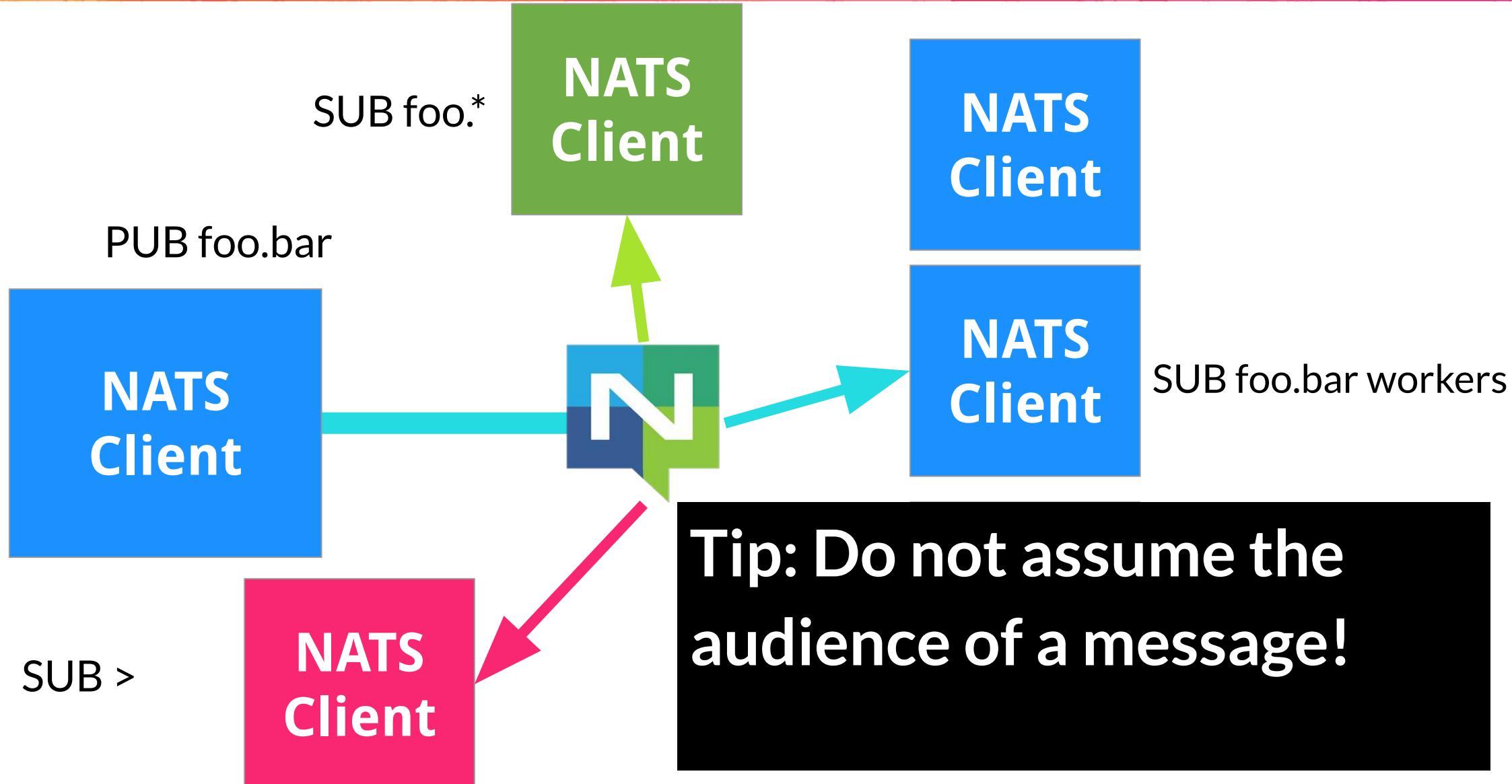


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**Performance,
Scalability, and
Resilience**

Performance



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18 million messages per second with one server, one data stream.
Up to **80 million** messages per second per server with multiple data streams.

Benchmark_____Pub0b_Payload-20	30000000	55.1 ns/op	199.78 MB/s
Benchmark_____Pub8b_Payload-20	30000000	55.8 ns/op	340.21 MB/s
Benchmark_____Pub32b_Payload-20	20000000	63.4 ns/op	694.34 MB/s
Benchmark____Pub128B_Payload-20	20000000	79.8 ns/op	1766.47 MB/s
Benchmark____Pub256B_Payload-20	20000000	98.1 ns/op	2741.51 MB/s
Benchmark____Pub1K_Payload-20	5000000	283 ns/op	3660.72 MB/s
Benchmark____Pub4K_Payload-20	1000000	1395 ns/op	2945.30 MB/s
Benchmark____Pub8K_Payload-20	500000	2846 ns/op	2882.35 MB/s
Benchmark_AuthPub0b_Payload-20	10000000	126 ns/op	86.82 MB/s
Benchmark_____PubSub-20	10000000	135 ns/op	
Benchmark____PubSubTwoConns-20	10000000	136 ns/op	
Benchmark____PubTwoQueueSub-20	10000000	152 ns/op	
Benchmark____PubFourQueueSub-20	10000000	152 ns/op	
Benchmark____PubEightQueueSub-20	10000000	152 ns/op	

Performance Decisions



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Performance is a part of every decision we make...

- ✓ Design for scale
- ✓ Careful analysis of the fastpath

Just as important is what **NOT** to implement...

- ✗ Message guarantees in core NATS
- ✗ Transactions
- ✗ Message Schemas
- ✗ Last Will and Testament
- ✗ Message Groups

Availability



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The health and availability of the system as a whole is prioritized over servicing any individual client or server.

- ✓ NATS server “selfish optimization”
 - ✓ Full Mesh clustering of NATS servers
 - ✓ Server and client connections self heal
- ...creates a NATS dial-tone, always on, always available.

Simplicity



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- Single binary
- 7.8 MB docker image with no external dependencies
- “Text-based” protocol with just a handful of verbs
- Low Configuration
 - ✓ Clients only need a url and credentials
 - ✓ Servers auto-discover
 - ✓ You can share configuration files amongst servers
- Simple and Straightforward API

Auto-Discovery



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Europe 2019

- Auto-Discovery
 - ✓ Automatically Exchange Server Topology
 - ✓ Server ↔ Server
 - ✓ Server → Client
- No configuration updates
 - ✓ Failover to auto-discovered servers
- Great for rolling upgrades



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Delivery Modes

Delivery Modes



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Europe 2019

NATS supports two delivery modes:

- At most once (*Core*)
 - ✓ No guarantee of delivery - messages can be lost - applications must detect and handle lost messages
- At least once (*Streaming*)
 - ✓ A message will always be delivered, but in certain cases may be delivered more than once
- ✗ Exactly once is arguably unnecessary, always complex, and inevitably slow.

Delivery Modes



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Europe 2019

NATS Streaming is a data streaming system atop core NATS

- **At-least-once** delivery
- Replay by time or sequence number
- Last/initial value caching
- Durable subscribers
- Rate matching per subscriber
- Memory, File, or Database storage
- High Availability through fault tolerant or clustered configurations
- Scale through partitioning

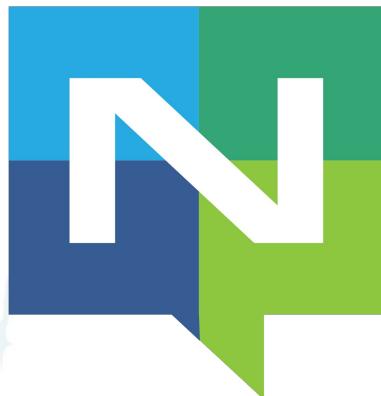


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NATS Server

aka. core NATS

NATS Server



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- Written in Go
- At-most-once delivery guarantees
 - No persistence of messages
- Extremely high performance
- TLS support
- Authorization and Authentication
- Full-mesh one hop clustering for HA
- Auto discovery via gossip



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Europe 2019

Main project repo name has changed recently:

Before:

<https://github.com/nats-io/gnatsd>

Now:

<https://github.com/nats-io/nats-server>



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CloudNativeCon

The clients repositories have also changed:

Before:

<https://github.com/nats-io/go-nats>

Now:

<https://github.com/nats-io/nats.go>

NATS Official Clients



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nats.go

Golang client for NATS, the cloud native messaging system.

go golang microservices nats cloud-native



Go ★ 2,265 ⚡ 303 Apache-2.0 3 issues need help Updated a day ago

nats.rb

Ruby client for NATS, the cloud native messaging system.

ruby client messaging cncf pubsub nats eventmachine



Ruby ★ 823 ⚡ 131 Apache-2.0 Updated a day ago

nats.java

Java client for NATS

java client middleware messaging nats messaging-library



Java ★ 194 ⚡ 68 Apache-2.0 Updated a day ago

nats.ex

Elixir client for NATS, the cloud native messaging system. <https://nats.io>



client elixir nats nats-io

Elixir ★ 33 ⚡ 11 MIT 1 issue needs help Updated 6 days ago

nats.js

Node.js client for NATS, the cloud native messaging system.

JavaScript ★ 672 ⚡ 96 Apache-2.0 Updated 8 days ago



nats.net

The official C# Client for NATS

client visual-studio csharp messaging message-bus pubsub

C# ★ 232 ⚡ 63 Apache-2.0 3 issues need help Updated 2 days ago



nats.c

A C client for NATS

c messaging message-bus message-queue messaging-library

C ★ 139 ⚡ 45 Apache-2.0 Updated 7 days ago



nats.py

An asyncio based Python 3 client for NATS

aio nats python3 asyncio cloud-native aio-nats



Python ★ 187 ⚡ 34 Apache-2.0 Updated 4 days ago

NATS Client API: Go



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```
package main

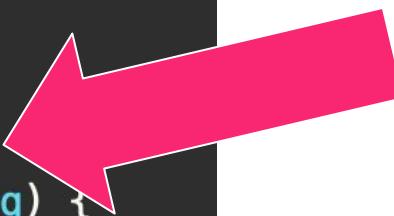
import (
    "log"
    "time"

    "github.com/nats-io/nats.go"
)

func main() {
    nc, err := nats.Connect("demo.nats.io")
    if err != nil {
        log.Fatal(err)
    }
    defer nc.Close()

    nc.Subscribe("greetings", func(m *nats.Msg) {
        log.Println("[Received]", string(m.Data))
    })

    for range time.NewTicker(1 * time.Second).C {
        nc.Publish("greetings", []byte("Hello!"))
    }
}
```



Receives all the messages published on the *greetings* topic that have been published since it registered interest.

Full mesh NATS Cluster

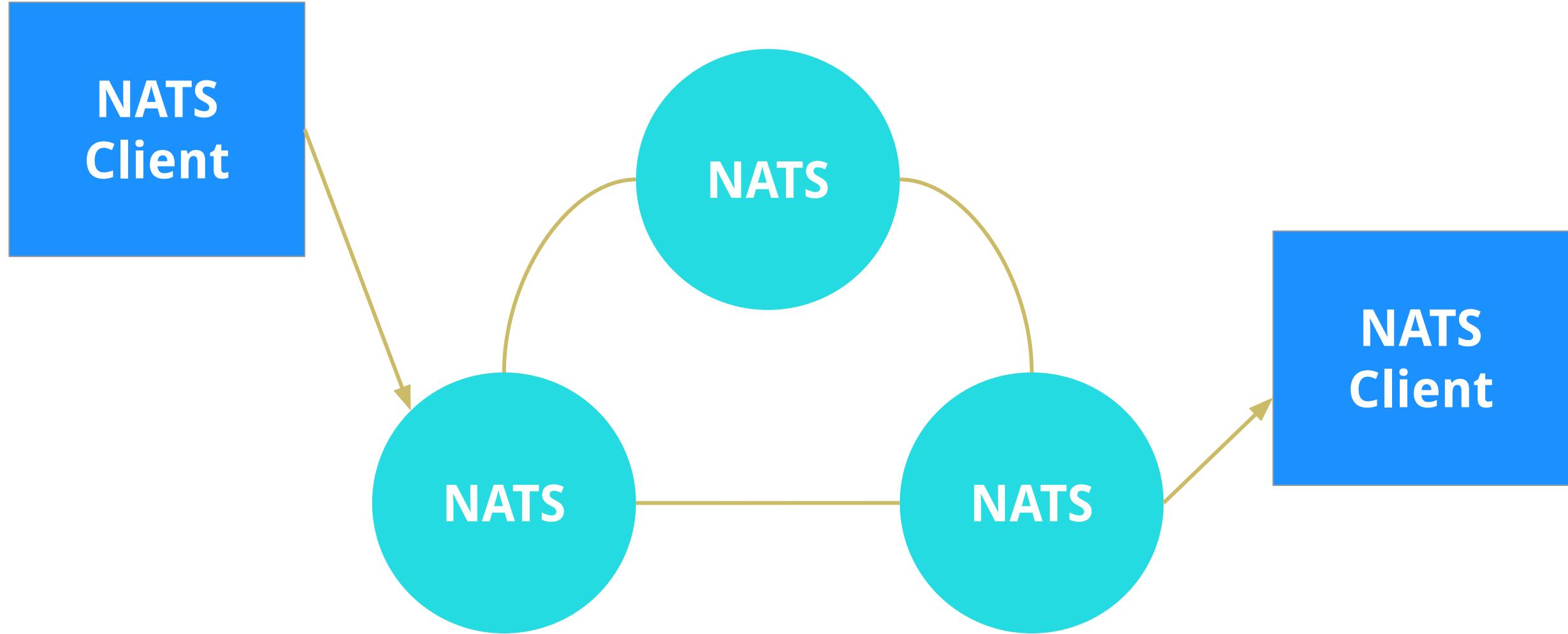


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Europe 2019



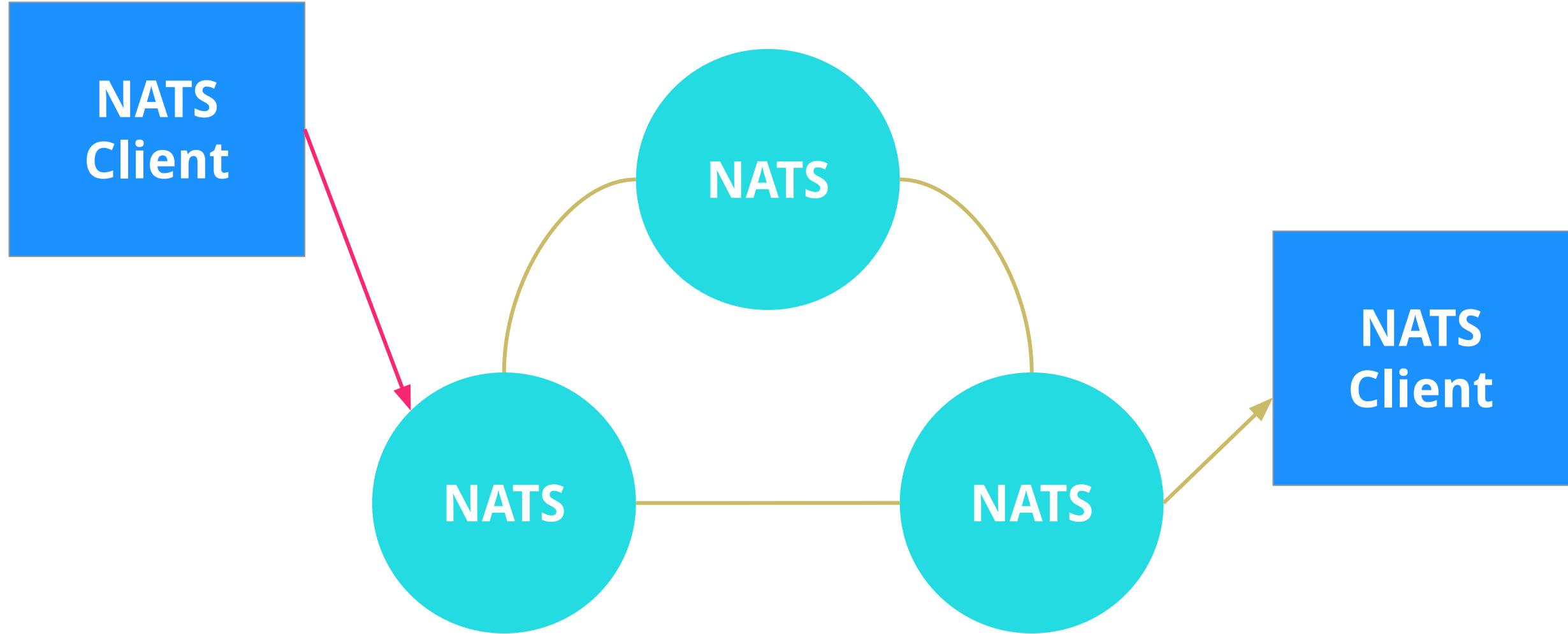
Full mesh NATS Cluster



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Europe 2019



Full mesh NATS Cluster

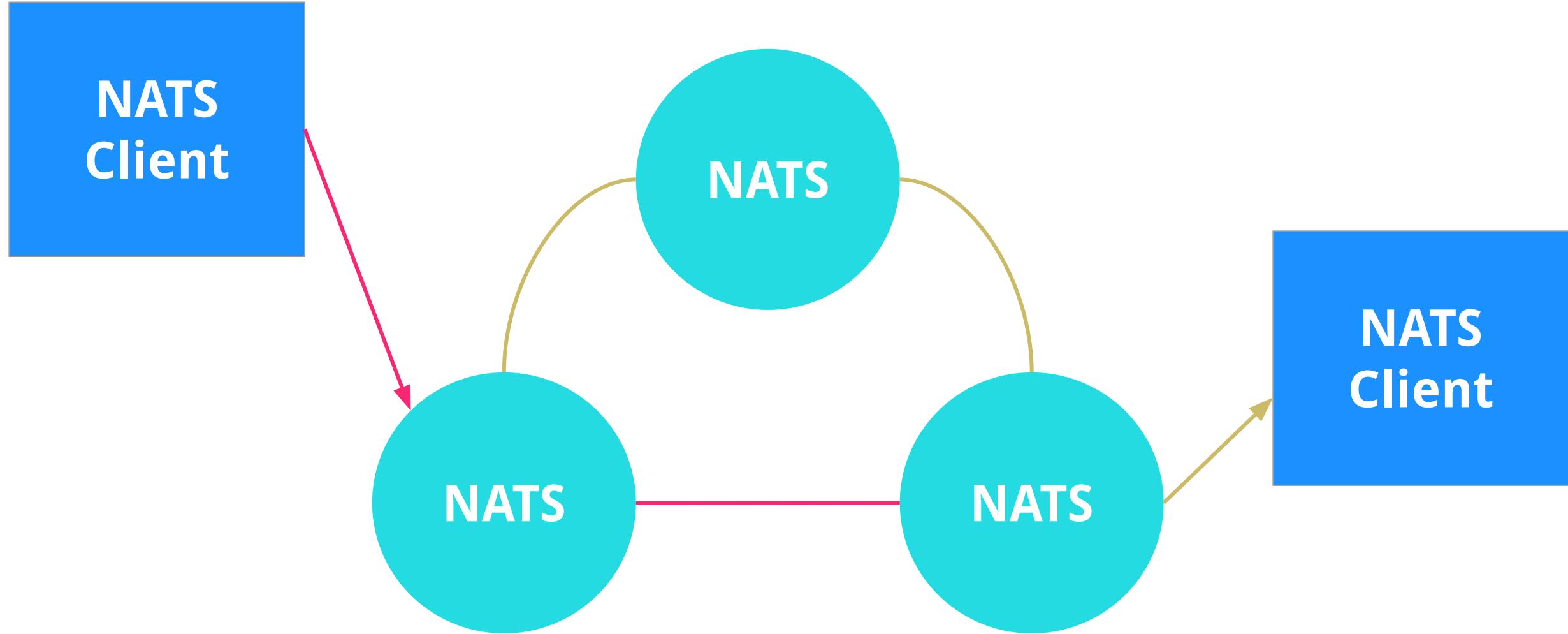


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Europe 2019



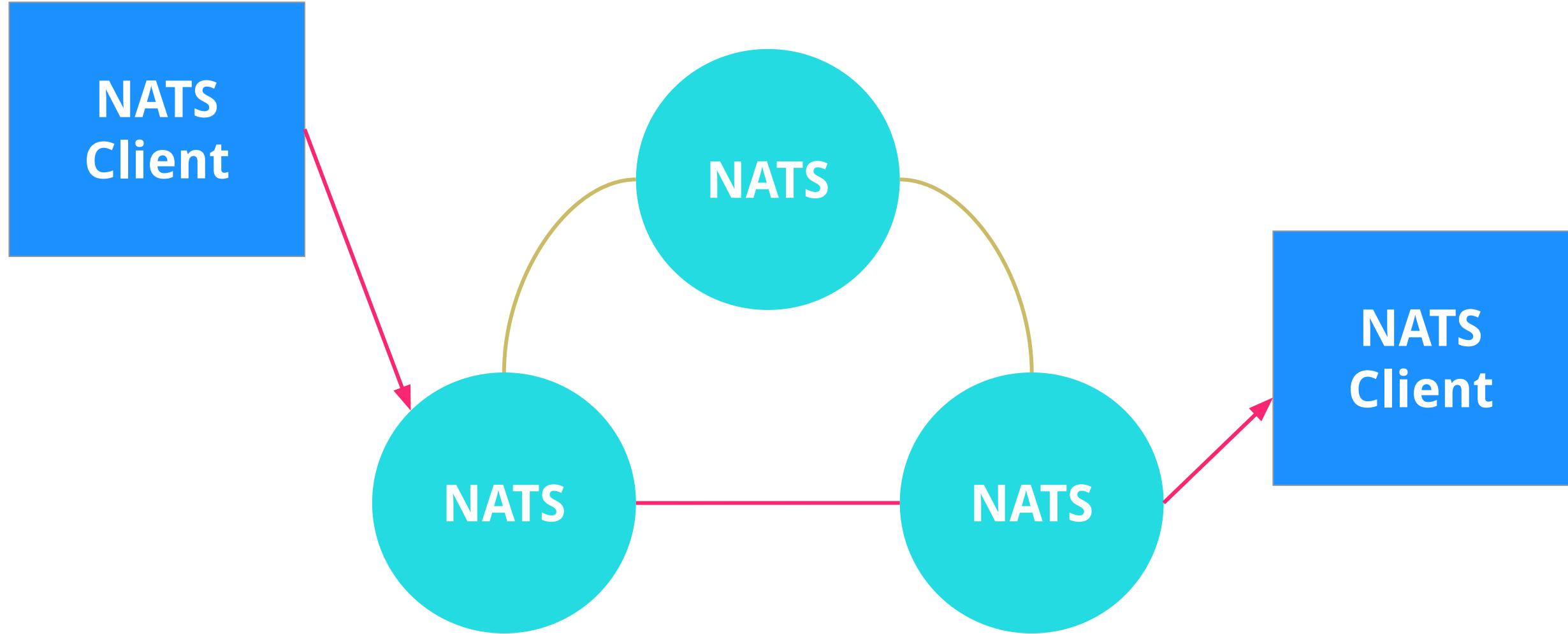
Full mesh NATS Cluster



KubeCon

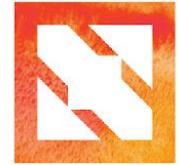
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NATS Streaming

aka. STAN

NATS Streaming (STAN)



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Europe 2019

- Supports *at-least-once* delivery guarantees
<https://github.com/nats-io/nats-streaming-server>
- Persistence of messages / ‘Message replay’
- Raft based replicated log for clustering
- Protocol based on NATS Request/Reply



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CloudNativeCon

Europe 2019

The nats-streaming clients repositories have also changed:

Before:

<https://github.com/nats-io/go-nats-streaming>

Now:

<https://github.com/nats-io/stan.go>

STAN Official Clients



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stan.go

NATS Streaming System

● Go ★ 371 ⚡ 70 📊 Apache-2.0 Updated 2 days ago



stan.js

Node.js client for NATS Streaming

● JavaScript ★ 143 ⚡ 34 📊 Apache-2.0 Updated 2 days ago



stan.net

The official NATS .NET C# Streaming Client

nats nats-streaming nats-messaging streaming-client natsio

● C# ★ 74 ⚡ 30 📊 Apache-2.0 Updated 8 days ago



stan.java

NATS Streaming Java Client

● Java ★ 62 ⚡ 21 📊 Apache-2.0 Updated 8 days ago



stan.py

Python Asyncio NATS Streaming Client

python nats asyncio nats-streaming

● Python ★ 52 ⚡ 6 📊 Apache-2.0 Updated 2 days ago



stan.rb

Ruby NATS Streaming Client

ruby nats nats-streaming

● Ruby ★ 16 ⚡ 2 📊 Apache-2.0 Updated 8 days ago



STAN Client API: Go



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```
package main

import (
    "log"
    "time"

    "github.com/nats-io/stan.go"
)

func main() {
    sc, err := stan.Connect("test-cluster", "client-123")
    if err != nil {
        log.Fatal(err)
    }
    defer sc.Close()

    go func() {
        for range time.NewTicker(1 * time.Second).C {
            sc.Publish("greetings", []byte("Hello!"))
        }
    }()

    sc.Subscribe("greetings", func(m *stan.Msg) {
        log.Println("[Received]", string(m.Data))
    }, stan.DeliverAllAvailable())

    select {}
}
```

Receives all the messages
ever published on the
greetings topic.

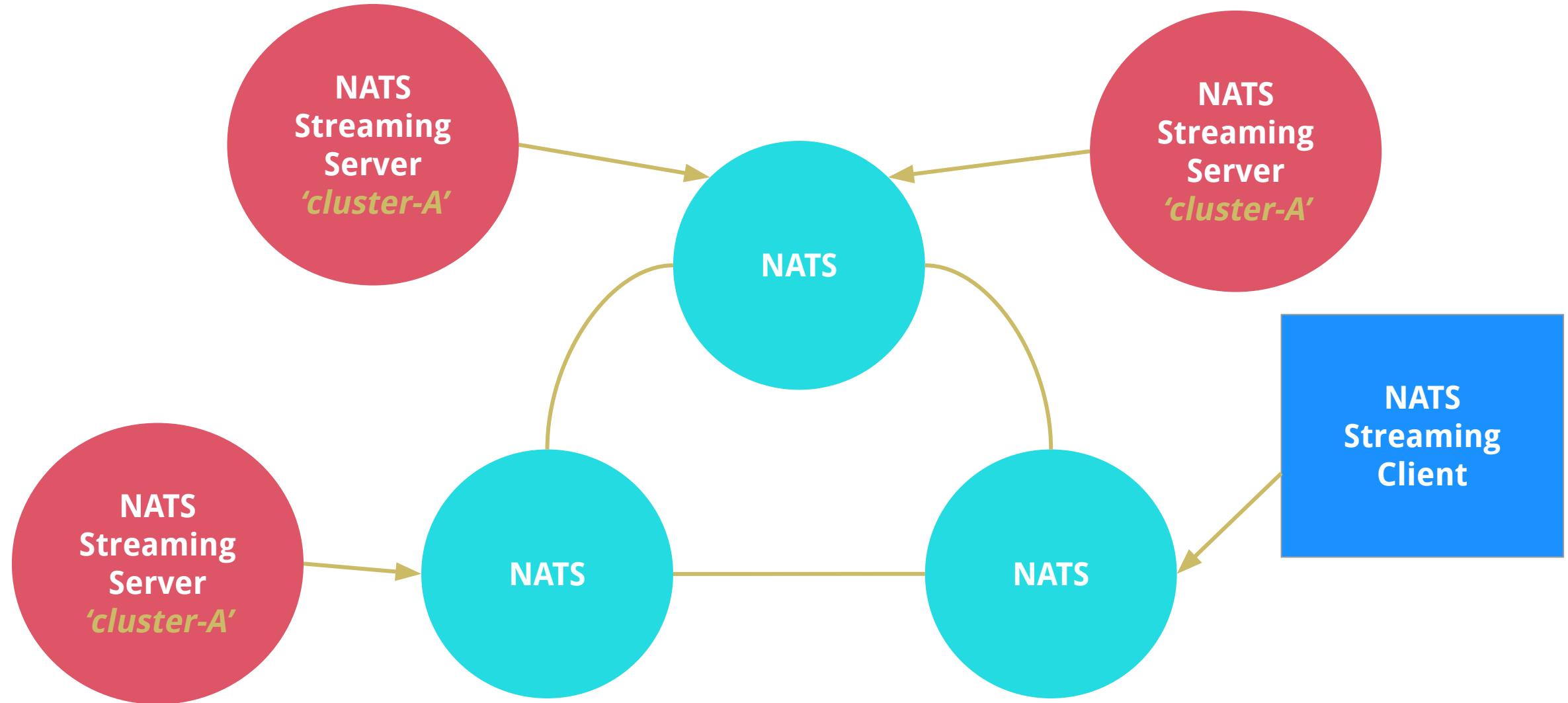
STAN on top of NATS



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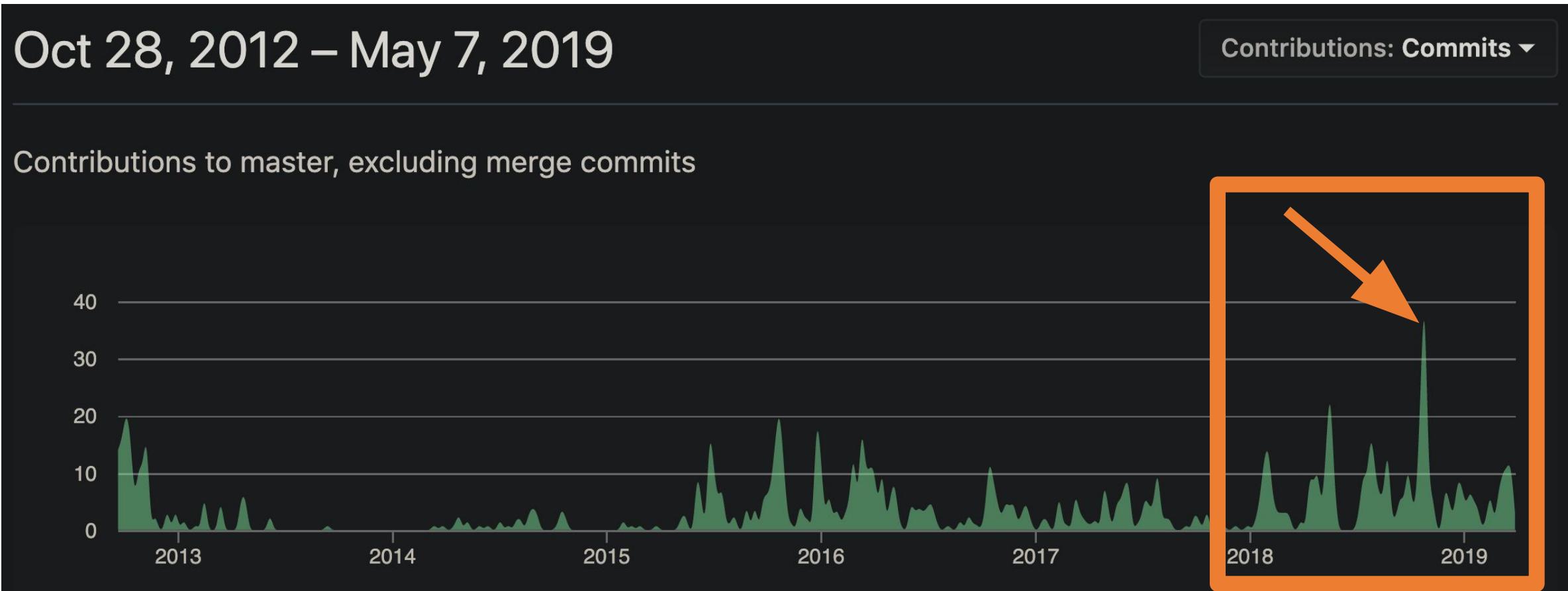
The NATS v2 Release

Biggest release of the project since it started.

Oct 28, 2012 – May 7, 2019

Contributions: Commits ▾

Contributions to master, excluding merge commits



NATS v2

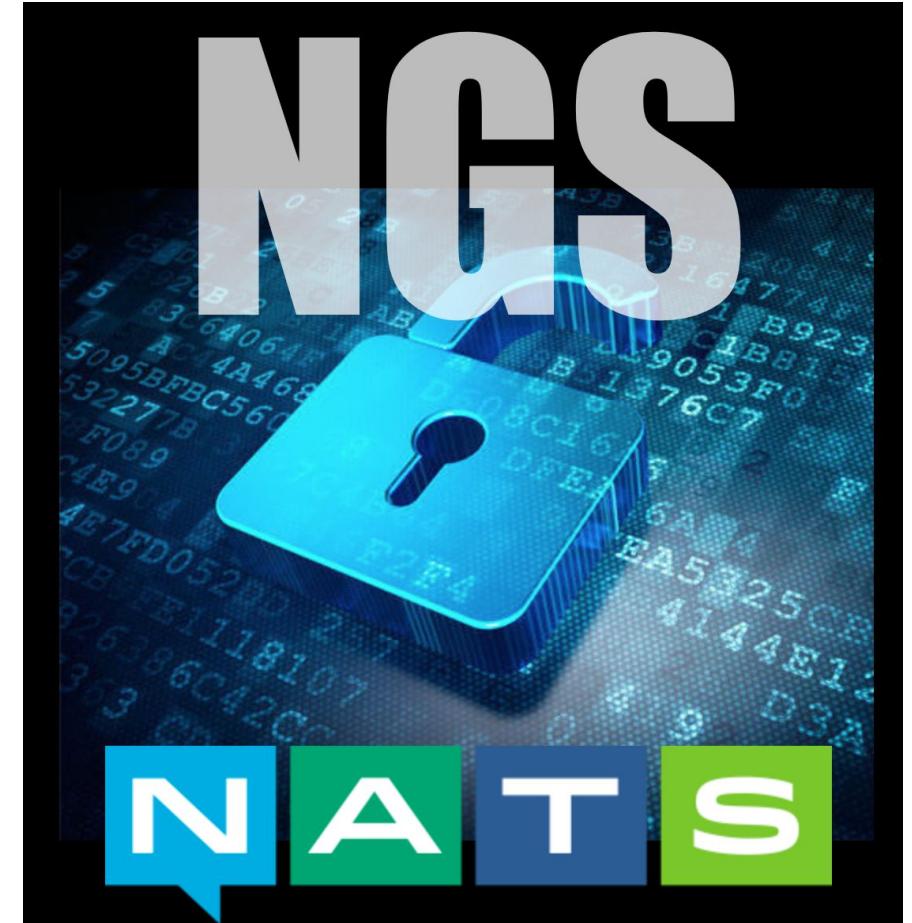


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Expands the security and project capabilities of the server to become a core component used to build a global communication network.



<https://synadia.com/ngs>



KubeCon



CloudNativeCon

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- Gateways, Super clusters & Leafnodes
- New clustering protocol
 - Client protocol is 100% backward compatible
- Accounts isolation
- Like containers for messaging
- NKEYS (ed25519 based keys)
- Decentralized authorization with JWTs
- System Accounts
- Graceful shutdown
- TLS certs DN/SAN based auth

Accounts



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- Accounts are isolated communication contexts allowing secure multi-tenancy
- Bifurcate technology from business driven use cases
 - ✓ Data silos are created by design, not software limitations
- Easy, Secure and Cost Effective
 - ✓ One NATS deployment for operators to manage
 - ✓ Decentralized - organizations can self-manage
- Share data between accounts
 - ✓ Secure Streams and Services
 - ✓ Only mutual agreement will permit data flow

Streams & Services



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Europe 2019

Service: A secure RPC endpoint

- Export a service to allow other accounts to import
- Import a service to allow requests to be sent and **securely, seamlessly, and anonymously** to another account

Stream: Data flow between accounts

- Export a stream to allow egress
- Import a stream to allow ingress

Zero client configuration or client API changes!

Streams & Services



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```
accounts {  
    synadia {  
        users = [  
            {user: nats, password:  
$2a$10$BYItxVAGPCbHakeKXegN7uGNJQB45p5sQT4D5Jrlb/gOI13Orx.RK}  
            {nkey:  
UC53TQCCXLUYSYTJ7PHSHDAORV6OSON7SNZQAWVMJUGM5JC3GR2AA  
D2M}  
        ]  
  
        # For sharing streams and services with others.  
        exports = [  
            # Network status updates available for anyone.  
            {stream: "cloud.network.status"}  
  
            # Service to request developer statistics  
            {service: "private.devstats", accounts: [CNCF]}  
        ]  
    }  
}
```

Streams & Services



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Europe 2019

```
accounts {  
    synadia {  
        users = [  
            {user: nats, password:  
$2a$10$BYItxVAGPCbHakeKXegN7uGNJQB45p5sQT4D5Jrlb/gOI13Orx.RK}  
            {nkey:  
UC53TQCCXLUYSYTJ7PHSHDAORV6OSON7SNZQAWVMJUGM5JC3GR2AA  
D2M}  
        ]  
  
        # For sharing streams and services with others.  
        exports = [  
            # Network status updates available for anyone.  
            {stream: "cloud.network.status"}  
  
            # Service to request developer statistics  
            {service: "private.devstats", accounts: [CNCF]}  
        ]  
    }  
}
```



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A new NATS Identity authentication and authorization system.

- ED25519 based encoded keys made simple
 - Fast and resistant to side-channel attacks
 - Sign and Verify
- NATS servers **never see private keys**
 - Server sends nonce during connect, verifies client signatures
- JWT associate users with accounts and permission sets



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JWTs are used to represent identities in NATS

- User, Account, Cluster, or Server

User JWTs Contain

- Account NKey (Issuer)
- Public NKey (Subject)
- Friendly Name
- Permissions
- Limits
- Not Before and Expiration



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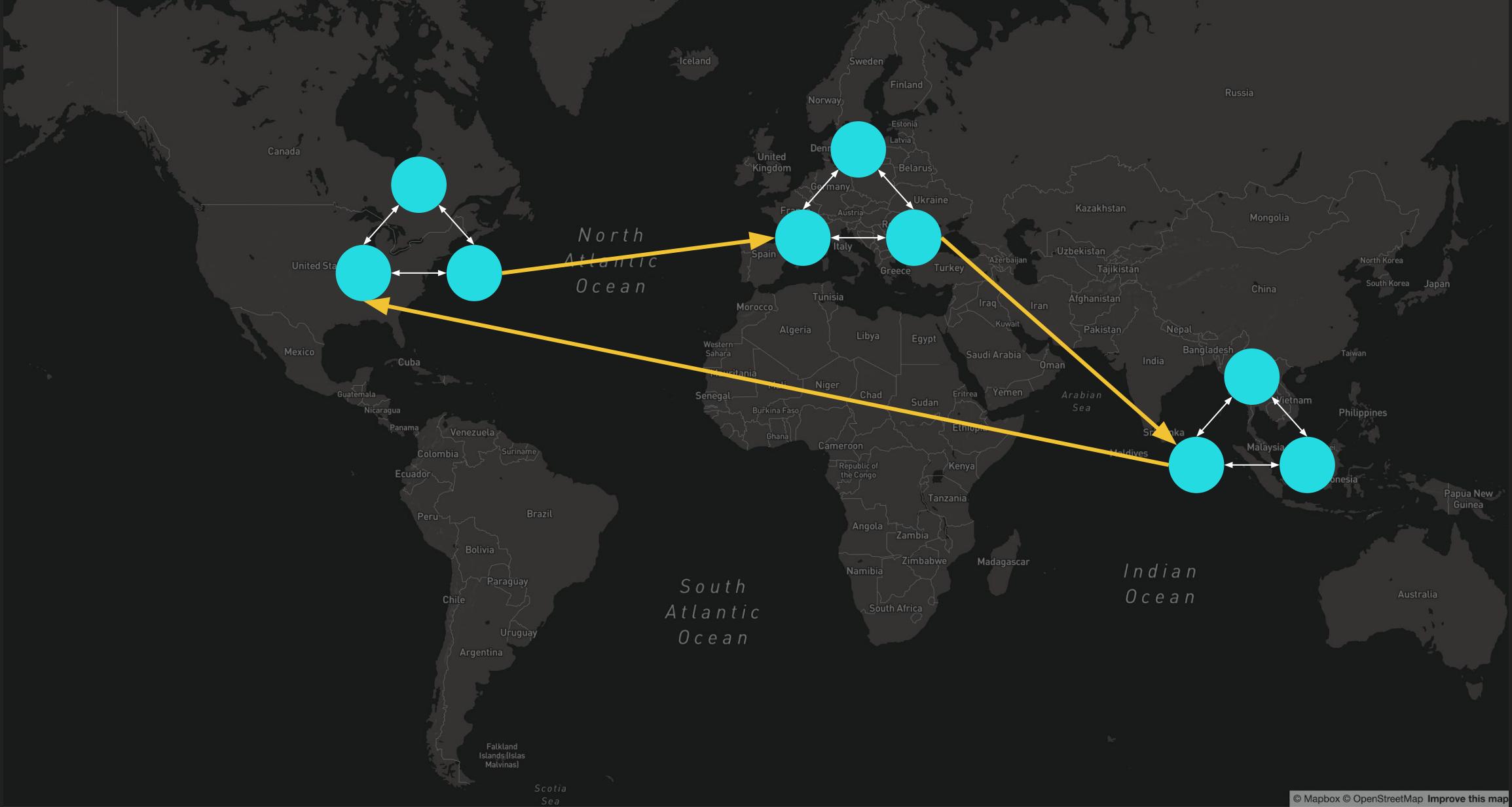


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```
{  
  "jti": "3Y2OIRCSQLHOZI2WXPS7JCRIR5BT5GZ5G74VHFCMUJAZUPCYCA",  
  "iat": 1544140248,  
  "iss": "ADQO262SKHLYIQTIBU3VG2K4GWRVO4TXYYJDHKI7QBMWYW6HACLQZIVB",  
  "name": "Waldemar",  
  "sub": "UCZRG6WDXWMIKDPLUMMRS2UAO2NSA5GOU2WCTXQLK7TRUWLLQ2CAXY7M",  
  "type": "user",  
  "nats": {  
    "pub": {  
      "allow": [  
        "public.>"  
      ]  
    },  
    "sub": {  
      "deny": [  
        "private.>"  
      ]  
    }  
  }  
}
```

NATS Super Cluster



NATS Super Cluster



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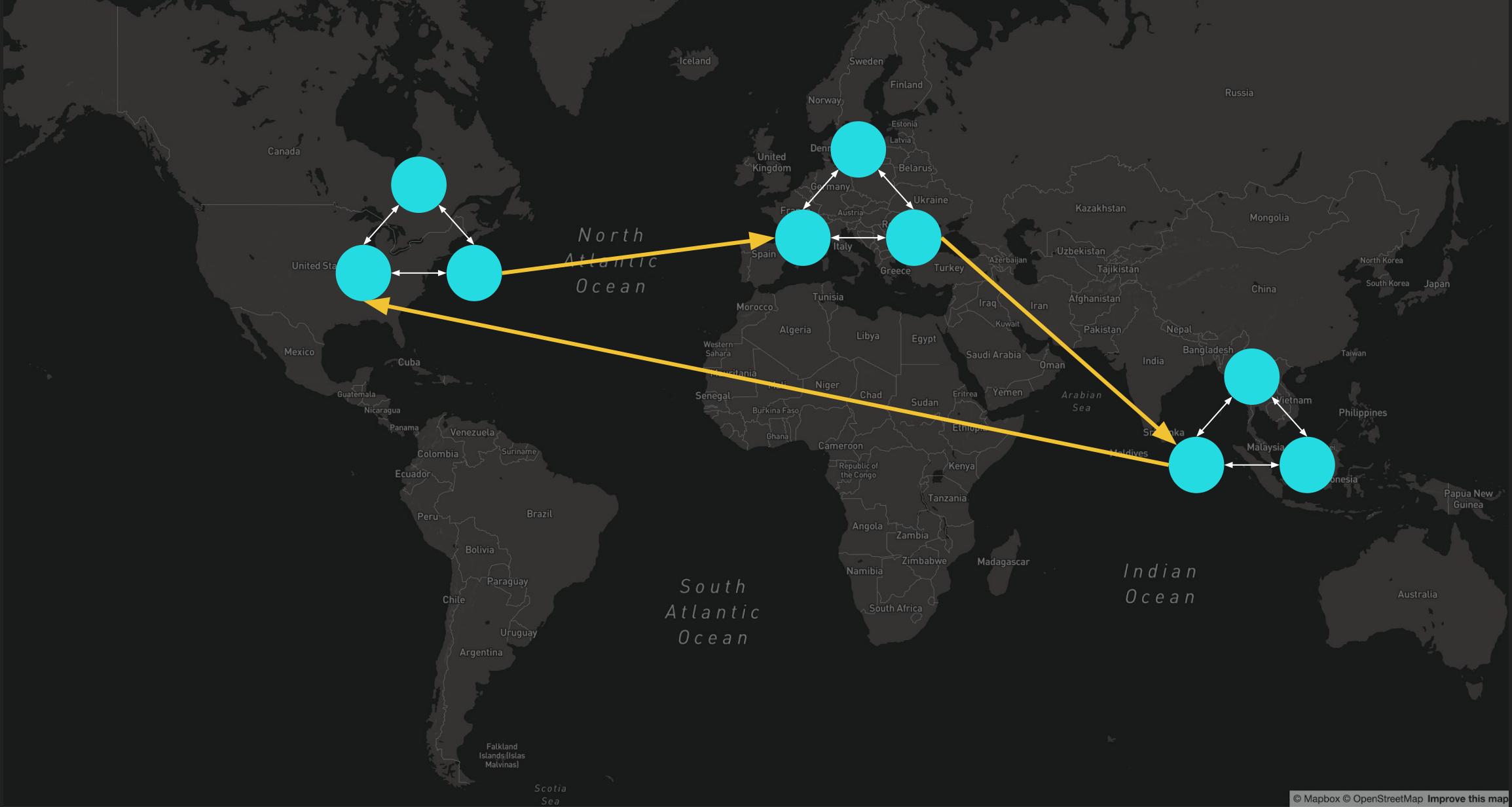
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```
NATS $ telnet ams.nats-super-cluster.global 4222
Trying 206.189.109.60...
Connected to ams.nats-super-cluster.global.
Escape character is '^]'.
```

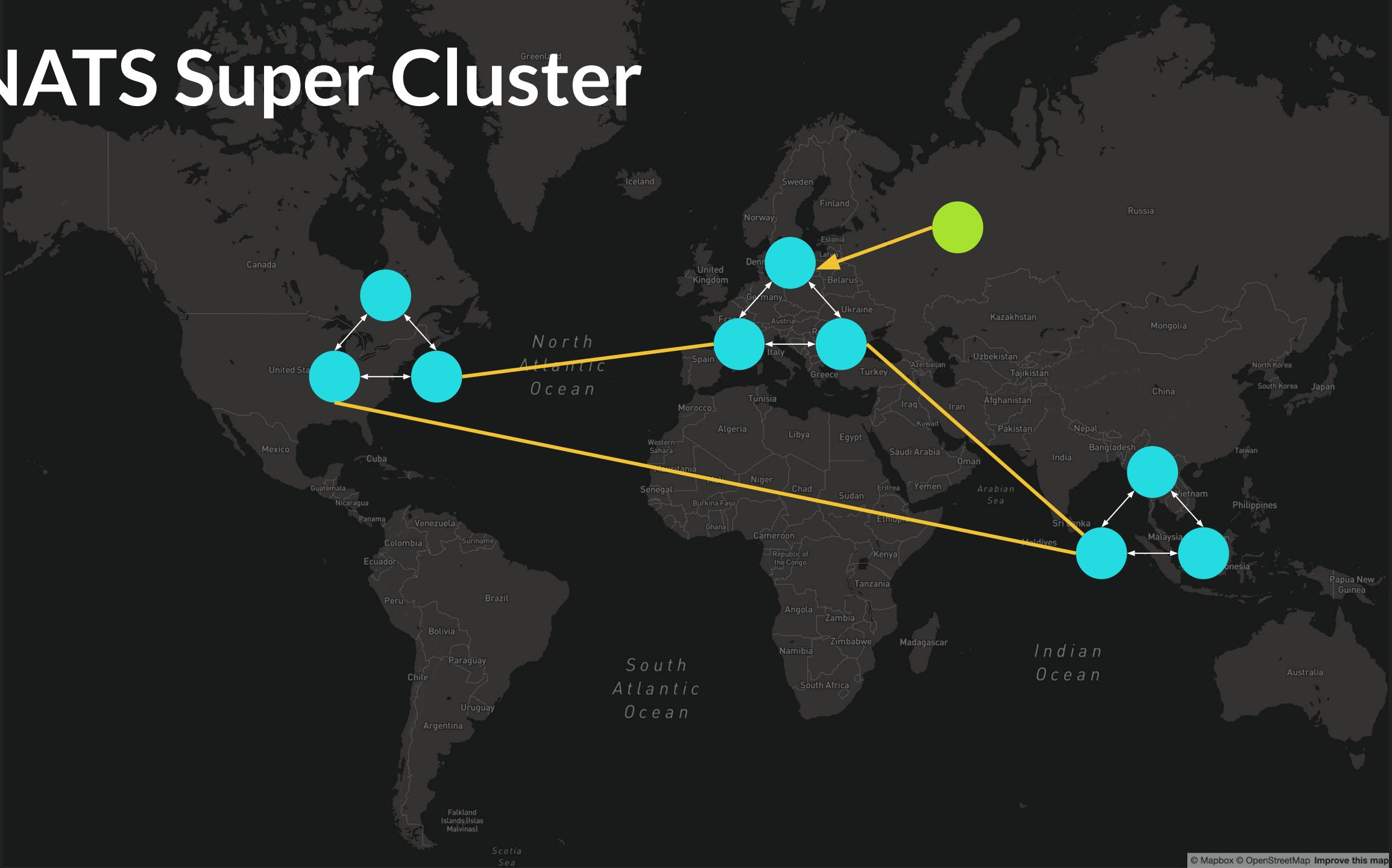
```
0 bash
NATS $ telnet nyc.nats-super-cluster.global 4222
```

```
1 bash
NATS $ telnet blr.nats-super-cluster.global 4222
```

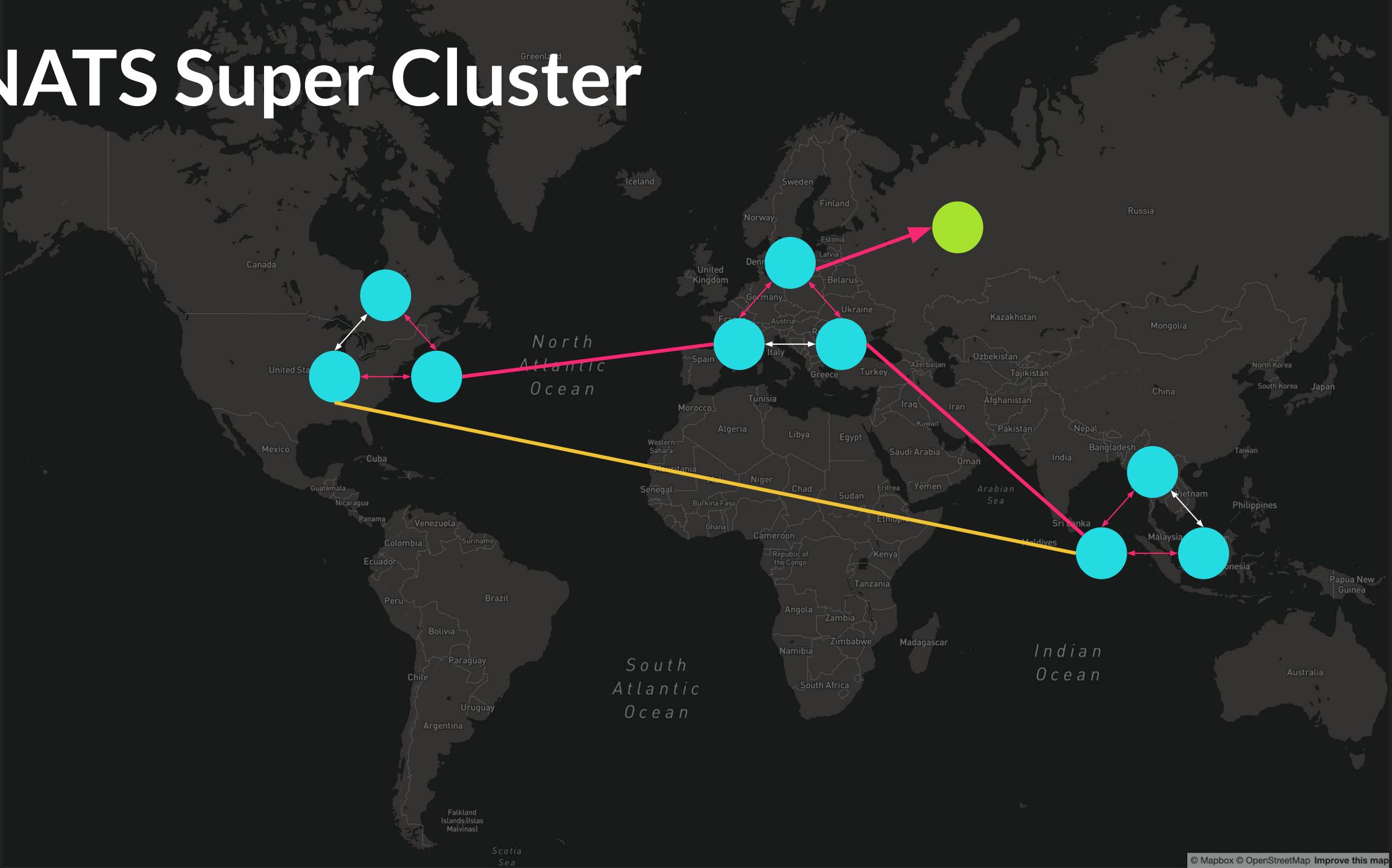
NATS Super Cluster



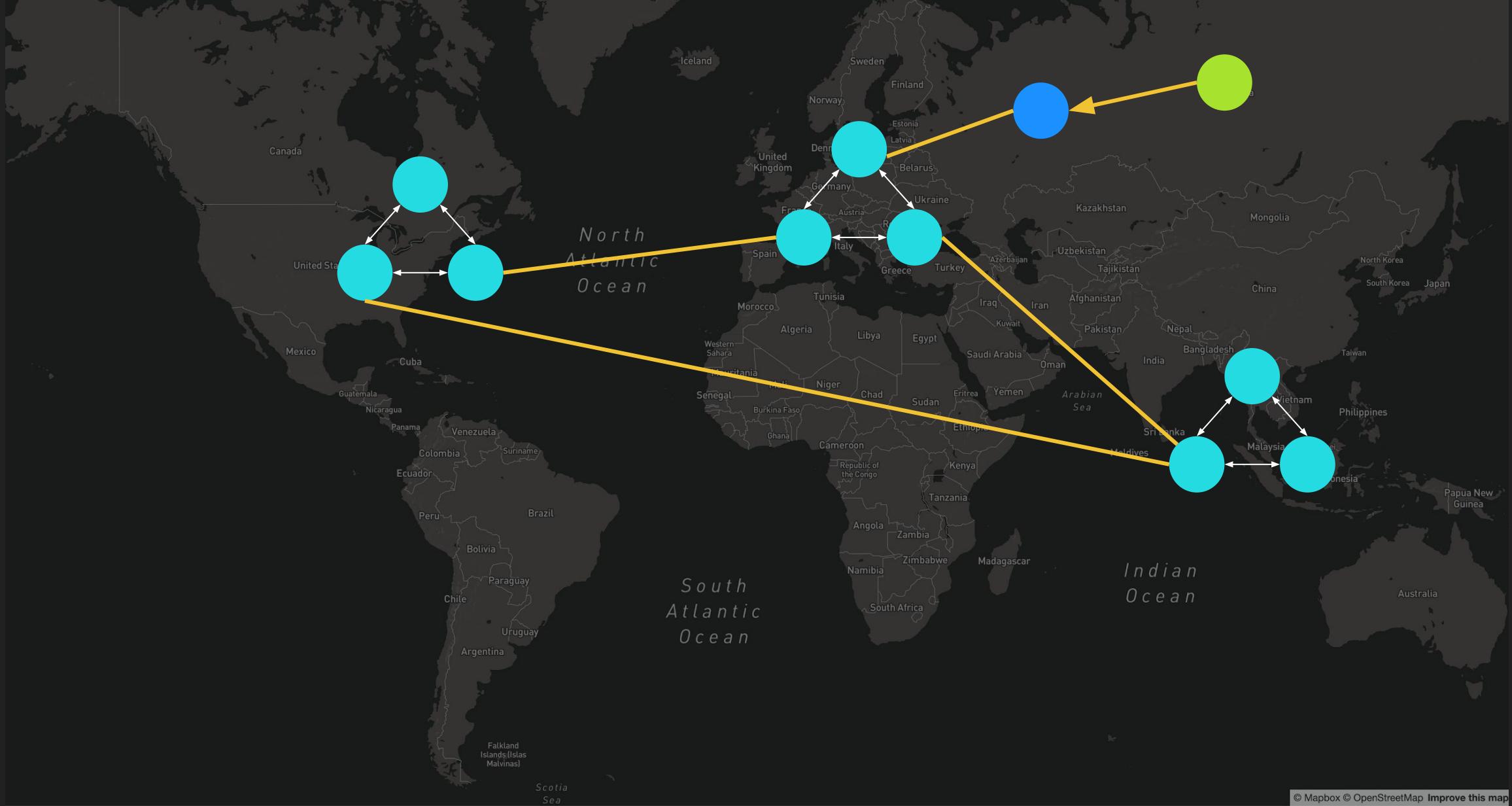
NATS Super Cluster



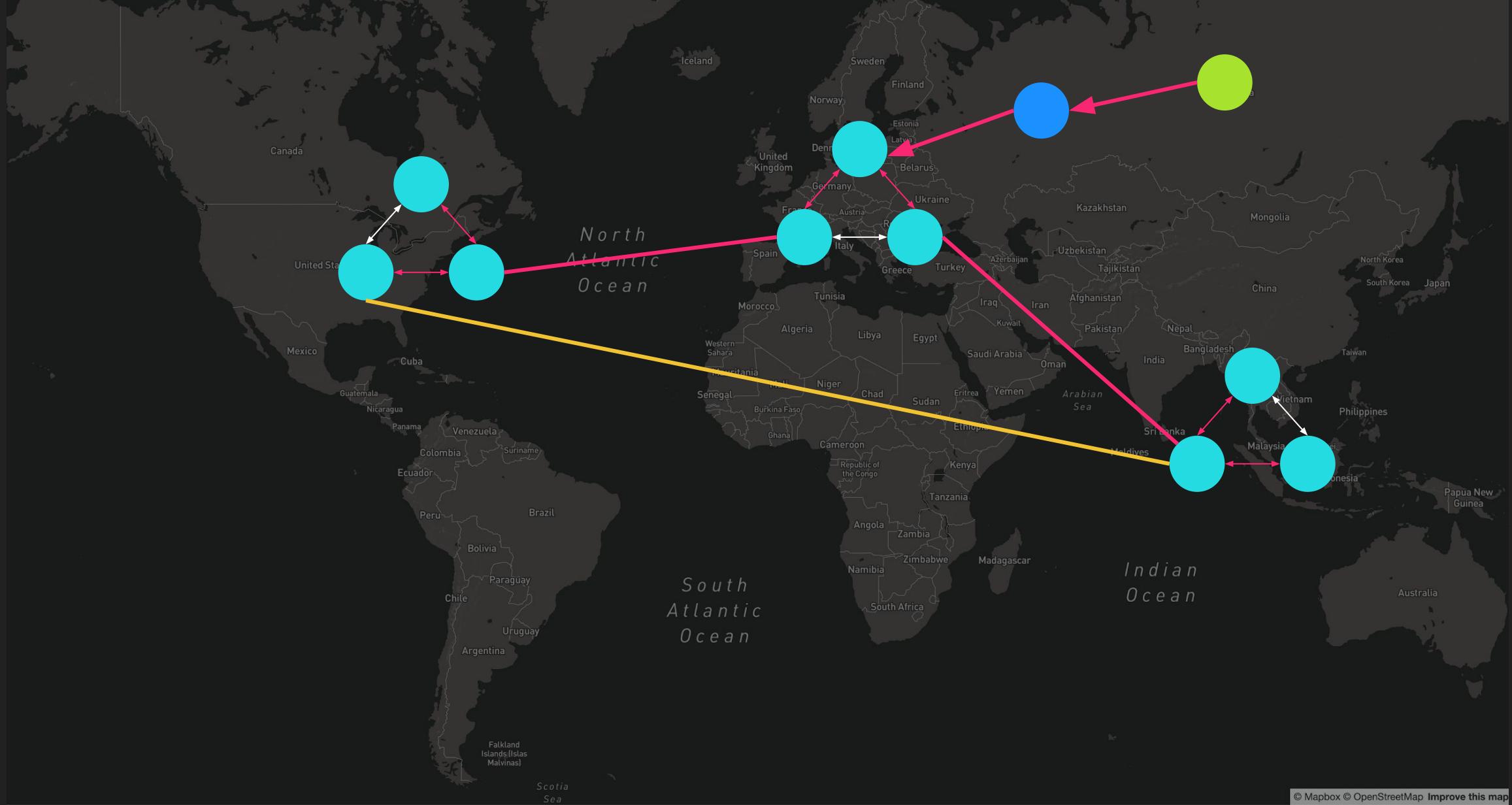
NATS Super Cluster



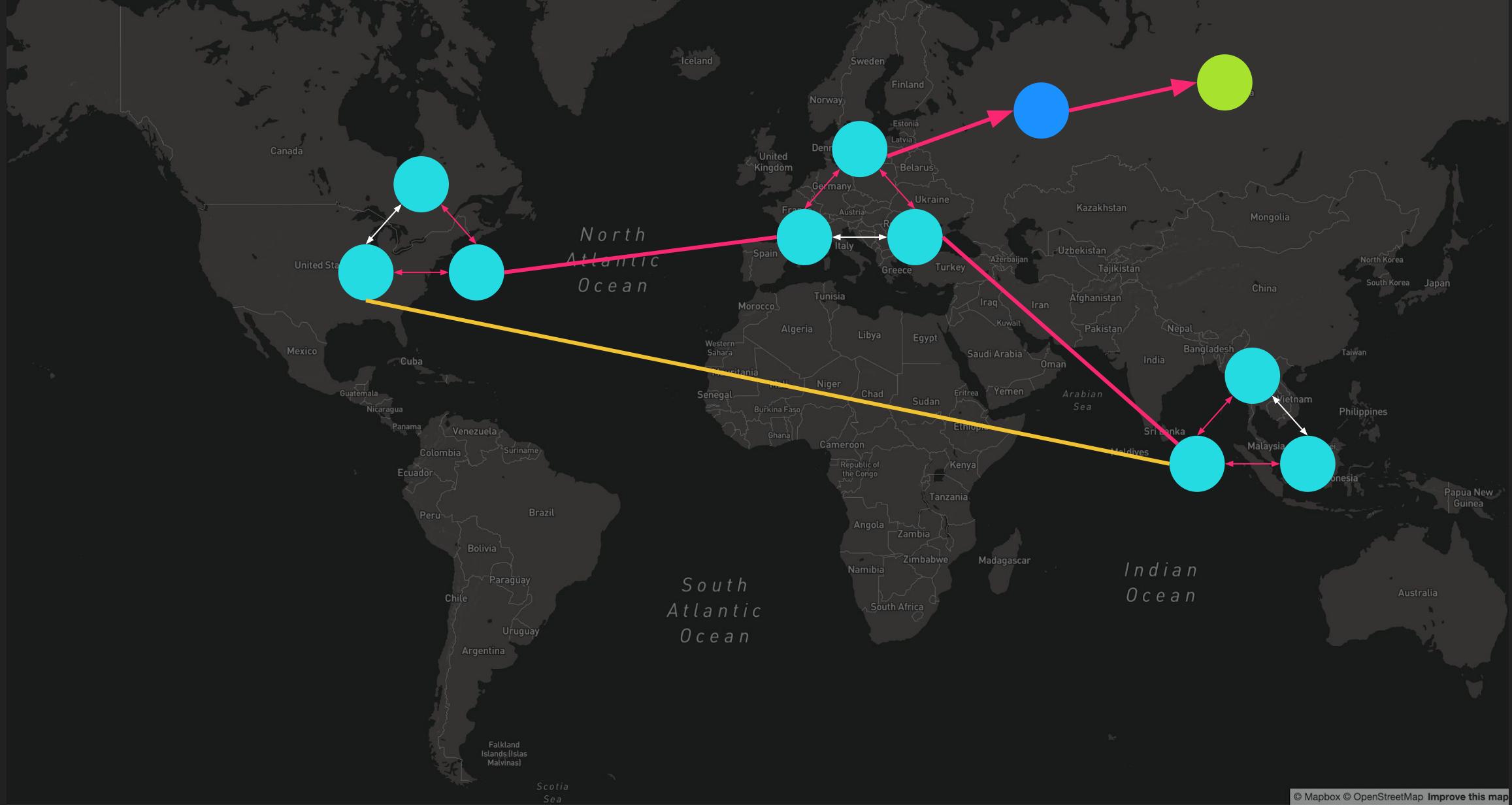
NATS Super Cluster + Leafnodes



NATS Super Cluster + Leafnodes



NATS Super Cluster + Leafnodes





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NATS Ecosystem



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The recommended way of running NATS on Kubernetes

<https://github.com/nats-io/nats-operator>

```
apiVersion: nats.io/v1alpha2
kind: NatsCluster
metadata:
  name: example-nats-cluster
spec:
  size: 3
  version: "1.4.0"
```



NATS Prometheus Exporter

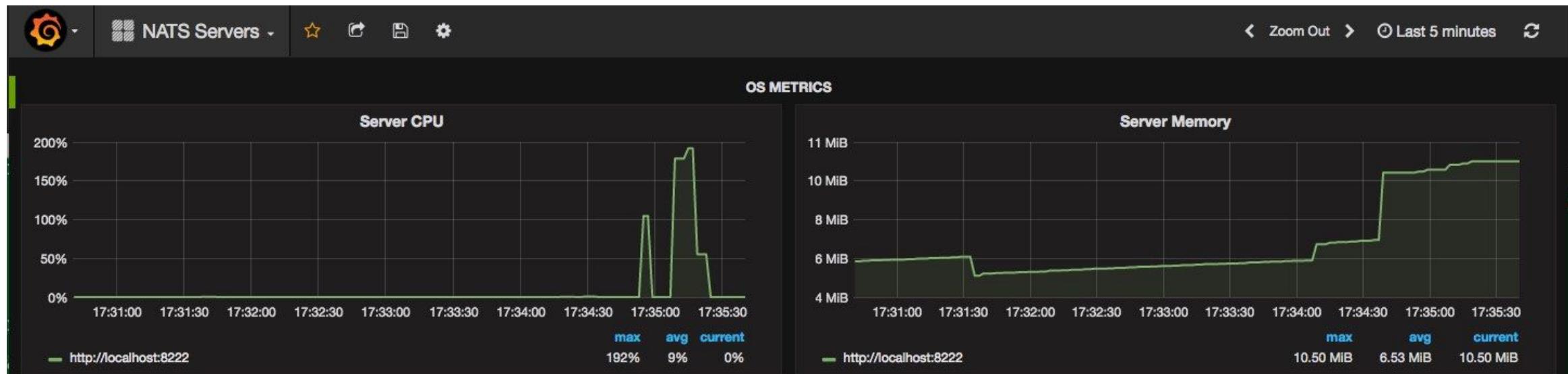


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- Maintained by the NATS team
<https://github.com/nats-io/prometheus-nats-exporter>
- Core NATS + NATS Streaming support



NATS Account Server



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<https://github.com/nats-io/nats-account-server>

A screenshot of the GitHub repository page for "nats-account-server". The page features the NATS logo at the top left. Below it, the repository name "nats-account-server" is displayed in large, bold, white font. A horizontal line separates this from the repository details. Underneath the line, there are several status indicators: "License Apache2", "go report A+", "build passing", and "coverage 81%". A brief description follows: "A simple HTTP server to host account JWTs for nats-server 2.0 account authentication." A detailed explanation of NATS 2.0 accounts and their authentication mechanism is provided below this. At the bottom of the page, there is a "Code navigation" section with links to "Code", "Issues", "Pull requests", and "Commits".

nats-account-server

License Apache2 go report A+ build passing coverage 81%

A simple HTTP server to host account JWTs for nats-server 2.0 account authentication.

NATS 2.0 introduced the concept of accounts to provide secure multi-tenancy through separate subject spaces. These accounts are configured with JWTs that encapsulate the account settings. User JWTs are used to authenticate. The nats-server can be configured to use local account information or to rely on an external, HTTP-based source for account JWTs. The server in this repository is intended as a simple to use solution for hosting account JWTs.



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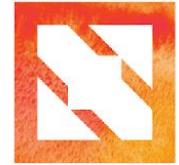


Demo

Deploying a NATS v2 Super Cluster on Kubernetes with the NATS Operator



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Questions?



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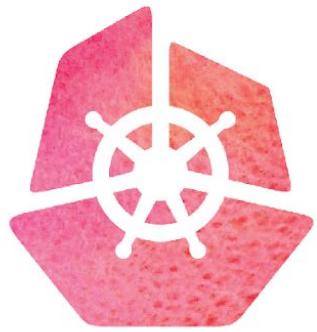


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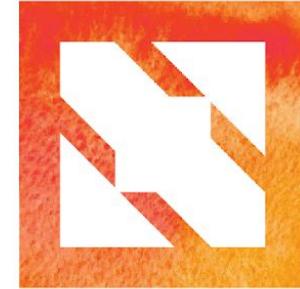
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Thanks!



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