ShorTor

Improving Tor Network Latency via Multi-Hop Overlay Routing

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Overview

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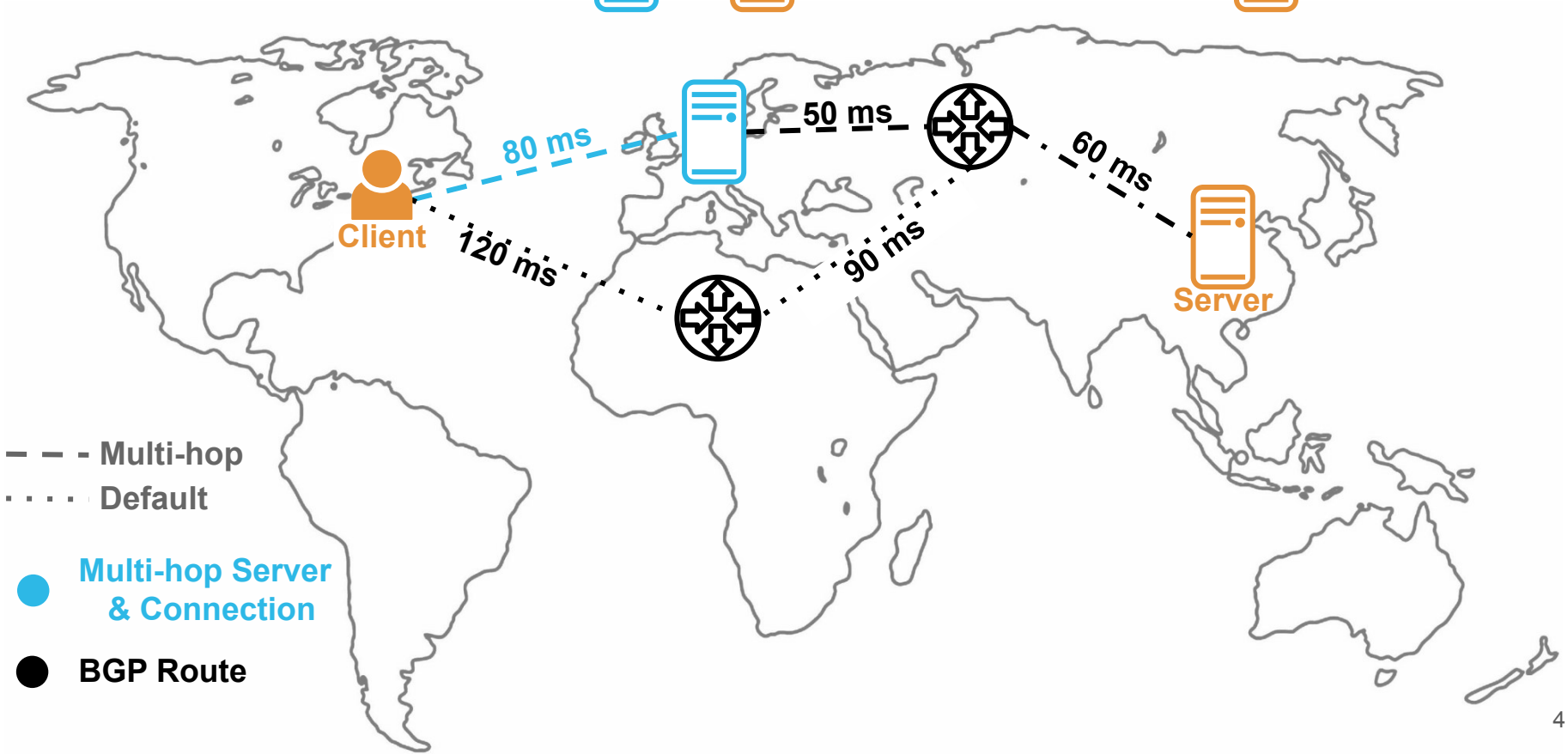
Design: multihop overlay routing for Tor

Evaluation: measurement dataset of latencies between pairs of Tor relays

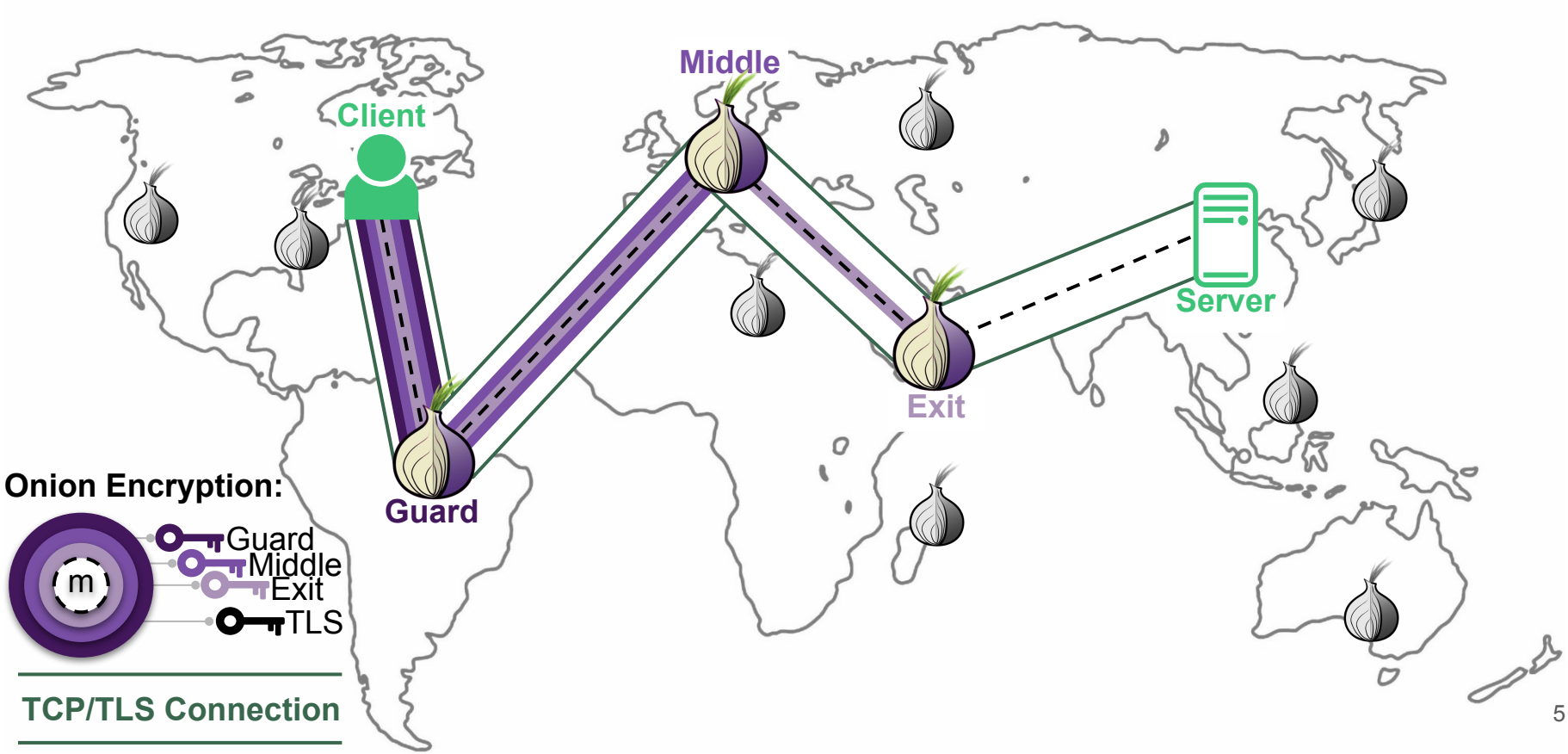
Integration with Tor: incremental deployment to relays, not clients

Security: no modification to client behavior

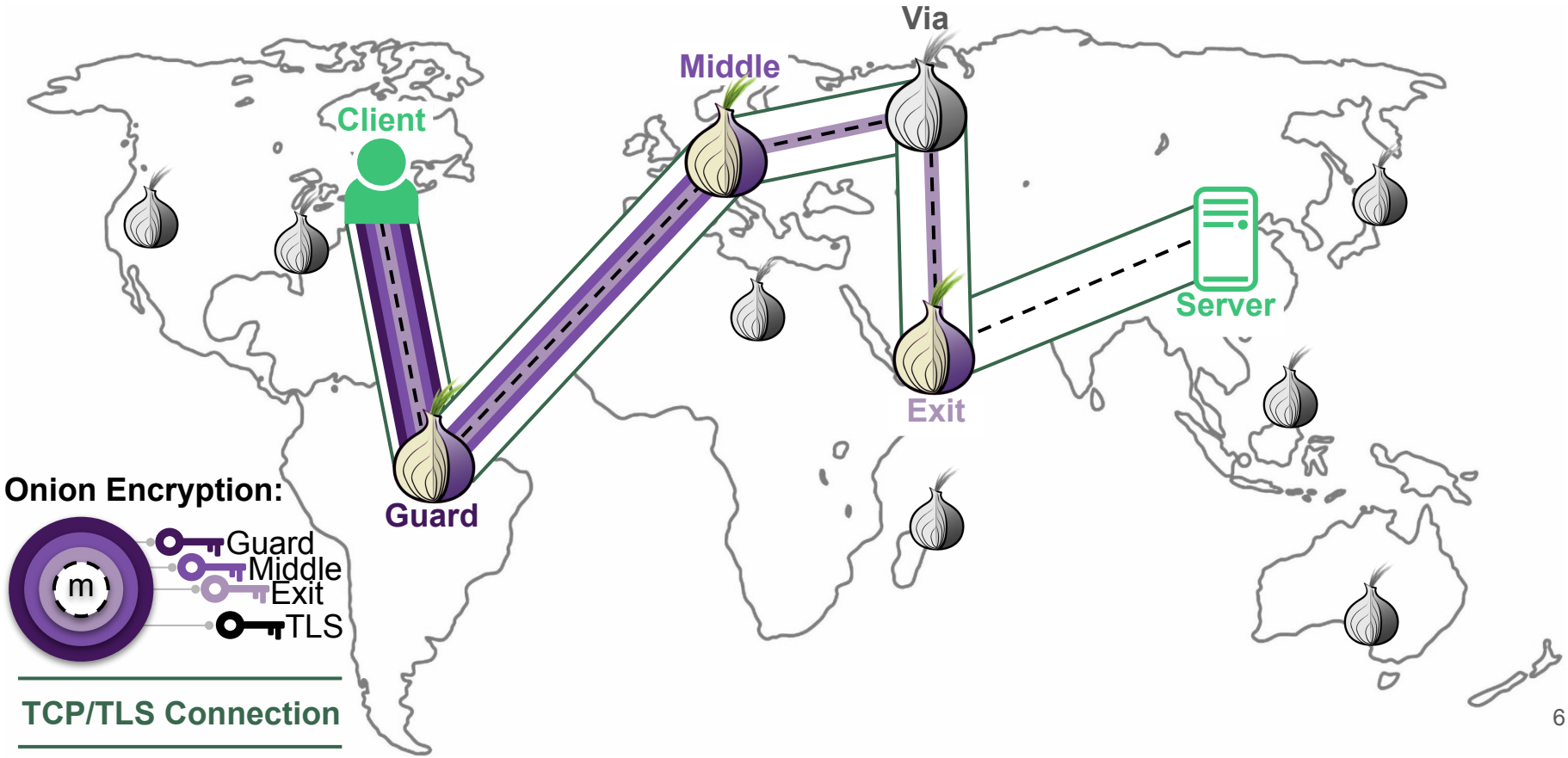
Overlay Routing: faster than



Tor Connections: already contain multiple hops

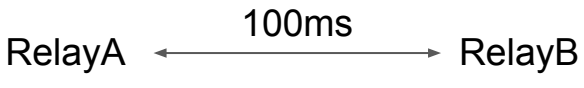


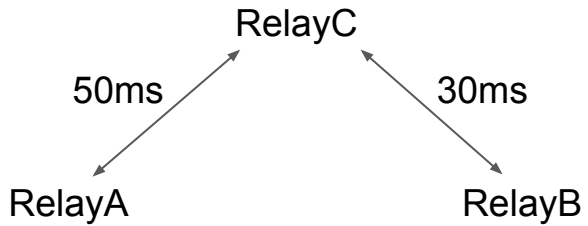
ShorTor Connections: via an additional relay if faster



ShorTor

Used when: A↔B > A↔C + C↔B





To evaluate, we need to know the latencies between relays in Tor

Interlude: Ethics

1. We ran our proposed measurement scheme by the Tor Research Safety Board and incorporated their feedback prior to starting measurements

2. We announced our intent to measure latencies to the relay operators mailing list and allowed operators to opt-out of being measured

3. While we are running active Tor relays as part of our measurements process, they have very restrictive policies and bandwidth advertisements that effectively prevent them from being chosen for circuits

4. We do not observe or record any information about any other traffic on Tor

Evaluation: measuring latency between Tor relays

Current dataset:

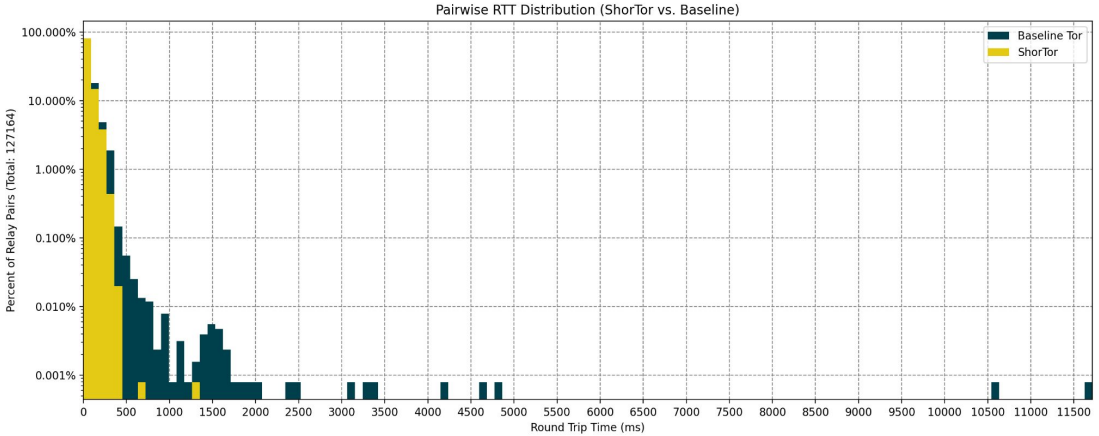
- ~125k pairs
- Focusing on relays with largest consensus weight
  - These are most likely to be chosen for circuits
  - Are also most likely to be up and responsive when measured

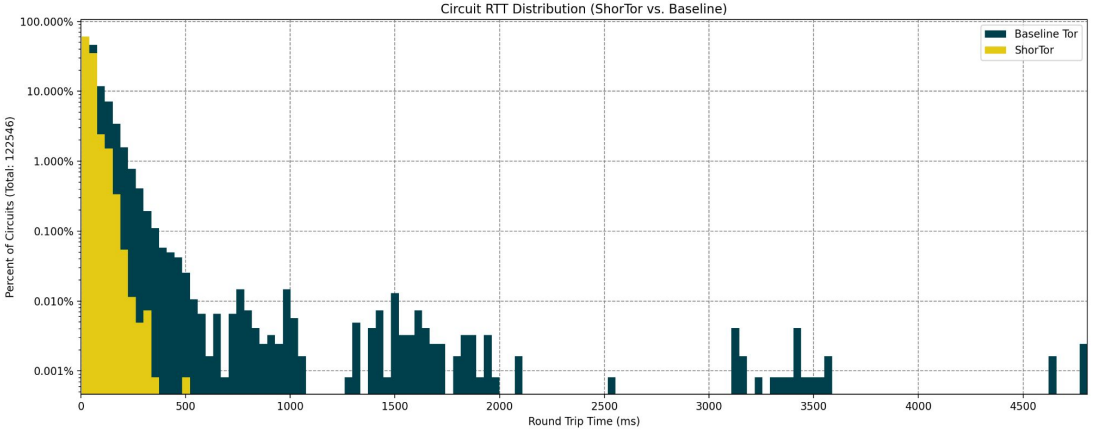
Future:

- All* pairs of relays active in Tor

* Tor has high churn and some relays will go offline prior to completion of measurements

Reduction in Latency using ShorTor





Pairs of Relays - not all pairs have equal probability of being selected!

Need to also look at circuits to see expected latency reduction in practice

~125k circuits chosen by TorPS from the relays in our dataset

Integration with Tor

ShorTor is an overlay on Tor's onion routing and is agnostic to relay selection/encryption

It **does**, however, require support from Tor relays

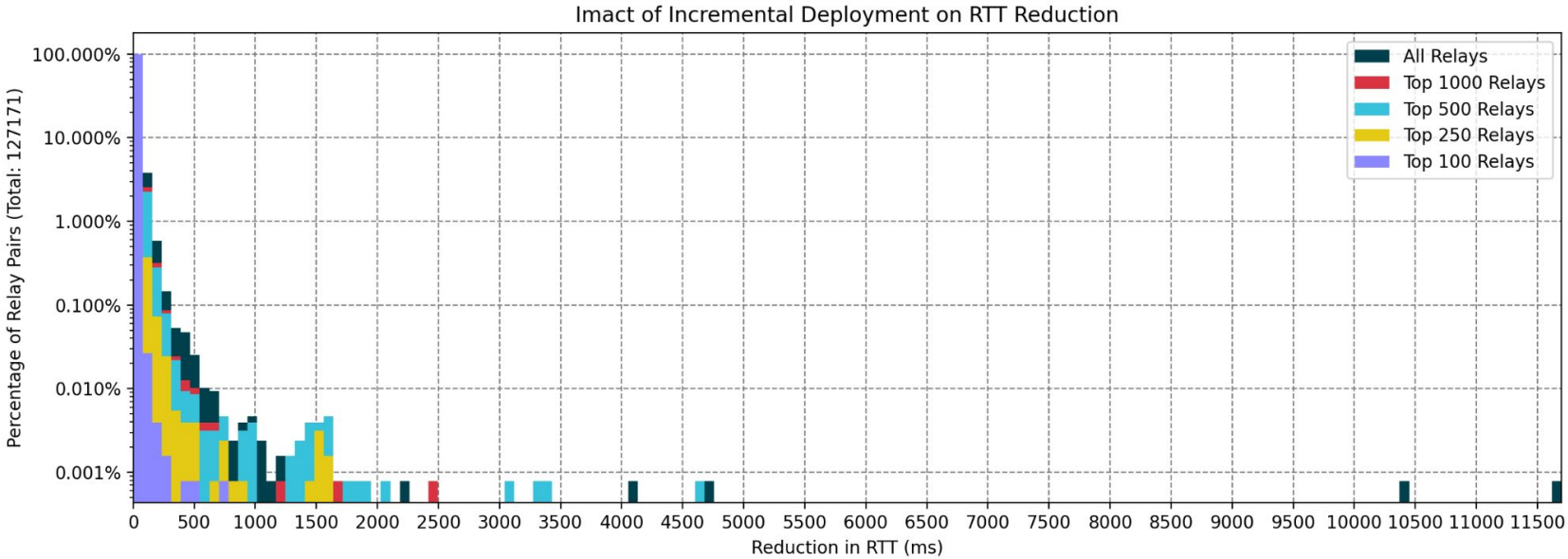
In order to benefit from ShorTor a circuit must, at a minimum, have:

1. Two adjacent relays that both support ShorTor
2. Some other relay that also supports ShorTor and provides a faster path

This is most likely to occur when most relays in the Tor network support ShorTor

However, users can still benefit even if a relatively small fraction of relays update

Incremental Deployment



“top” here means “largest consensus weight” or “most likely to be selected by users”

Security

ShorTor reduces latency ***without*** changing how Tor clients select their circuits

As a result, both relays and vias are chosen completely independent from client identity or location

We analyse ShorTor's security using the MATors framework along with the relative network share of relays.

Network share refers to the possibility that an adversarial relay may see a larger fraction of Tor traffic when acting as a via in ShorTor than it did as a circuit relay in vanilla Tor

Additionally, ShorTor trivially supports alternate security-focused circuit selection procedures that, e.g., avoid passing through the same autonomous system twice

Next Steps

Finish measurement collection!

Our dataset is currently incomplete and not necessarily representative of the full Tor network

All pairs for top 1k relays: 1M measurements

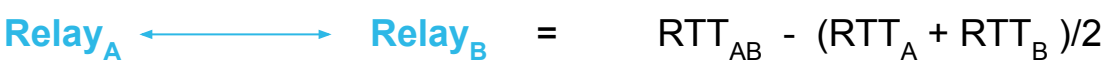
These relays are present on ~75% of Tor circuits

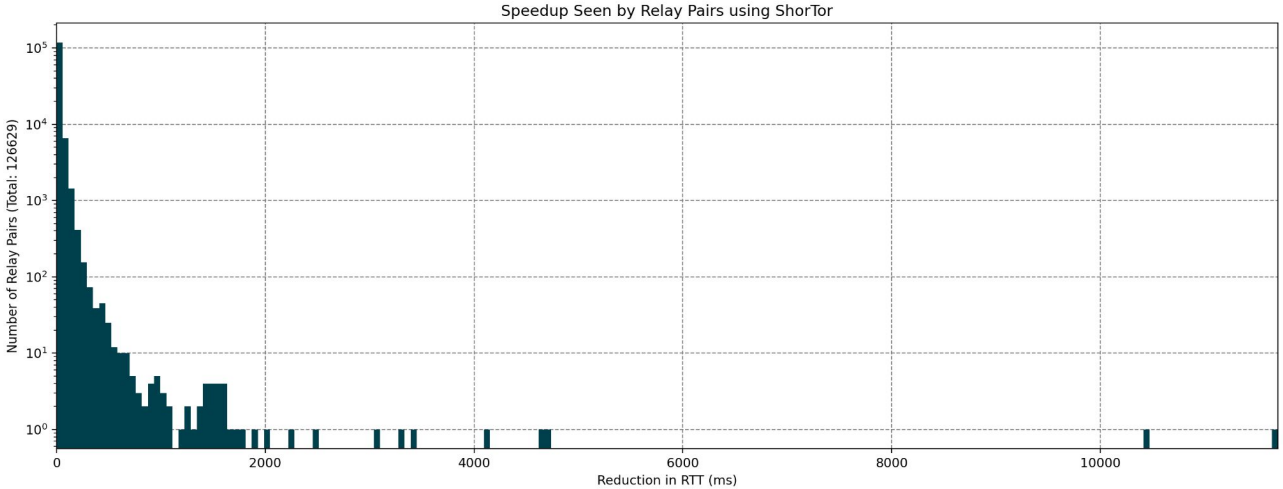
All pairs for all Tor relays: ~50M measurements

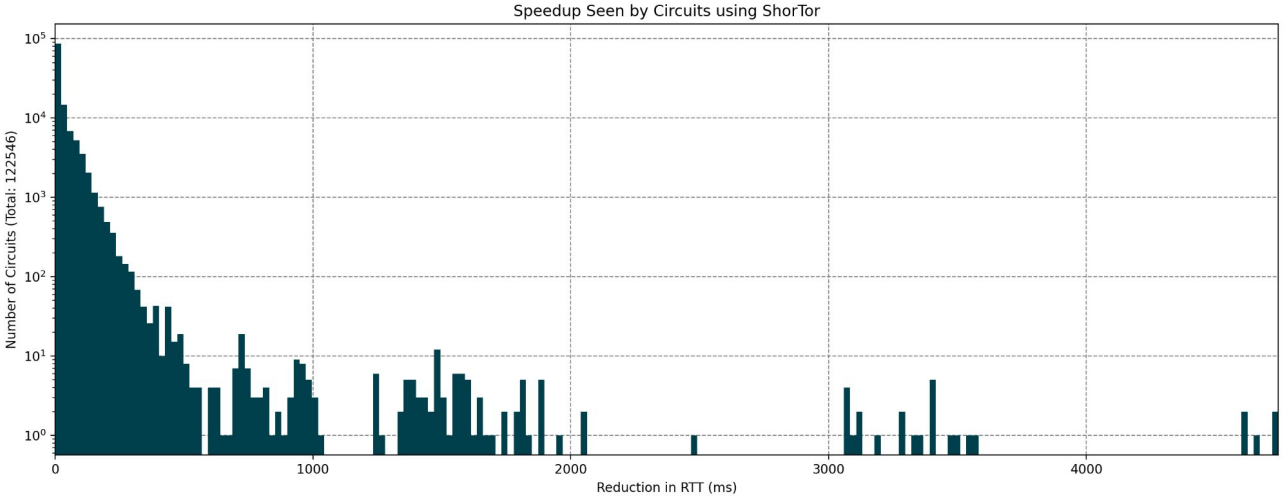
Evaluate ShorTor’s effectiveness and security at different levels of deployment

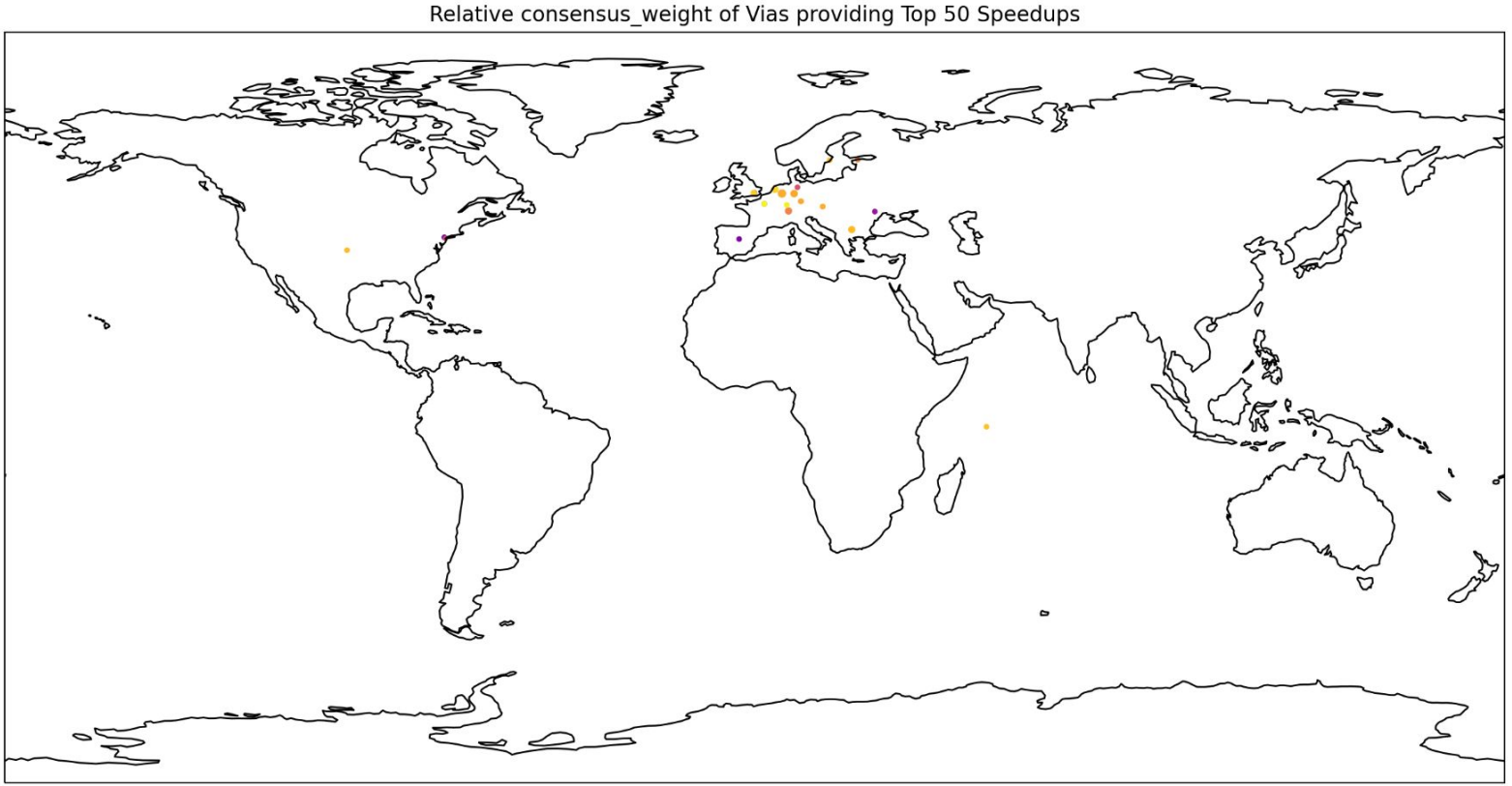
Questions?

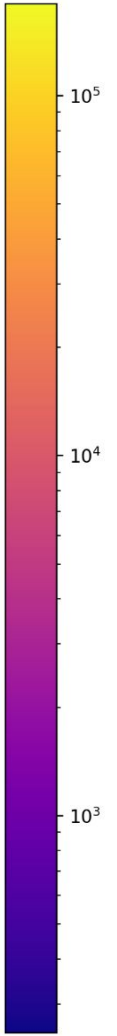
Measurement Circuits




Speedup Seen by Relay Pairs using ShorTor
Number of Relay Pairs (Total: 126629)
10^5
10^4
10^3
10^2
10^1
10^0
0
2000
4000
6000
8000
10000
Reduction in RTT (ms)

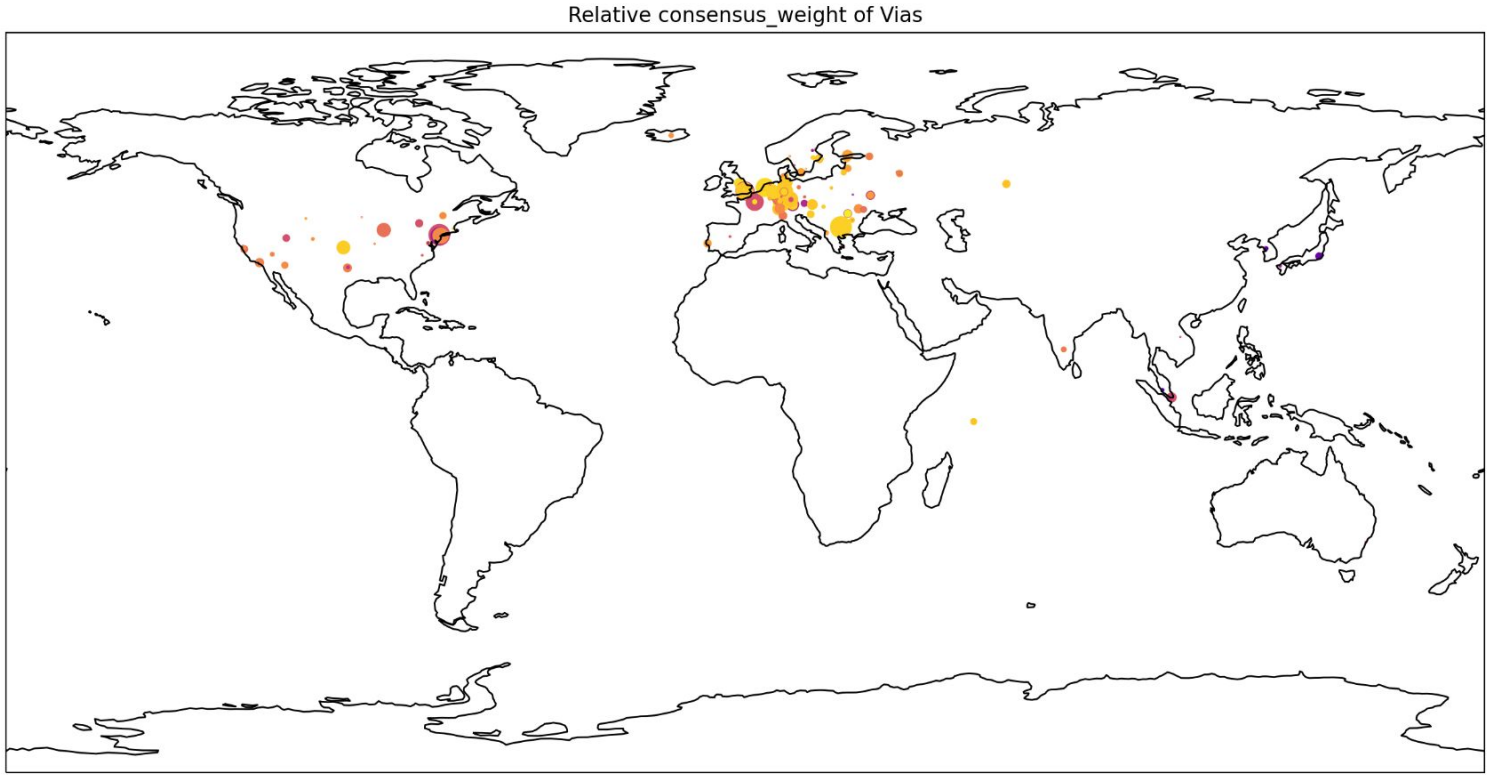

Speedup Seen by Circuits using ShorTor
Number of Circuits (Total: 122546)
10^5
10^4
10^3
10^2
10^1
10^0
0
1000
2000
3000
4000
Reduction in RTT (ms)

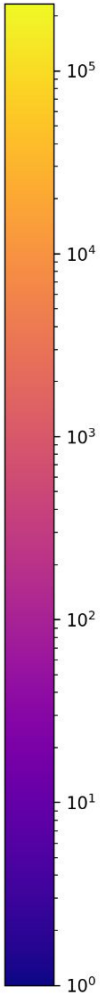




Color = consensus weight

size = # of times chosen





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