

Dissecting the African Internet

An Intra-Continental Study

GAIA IETF-100

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LACNIC

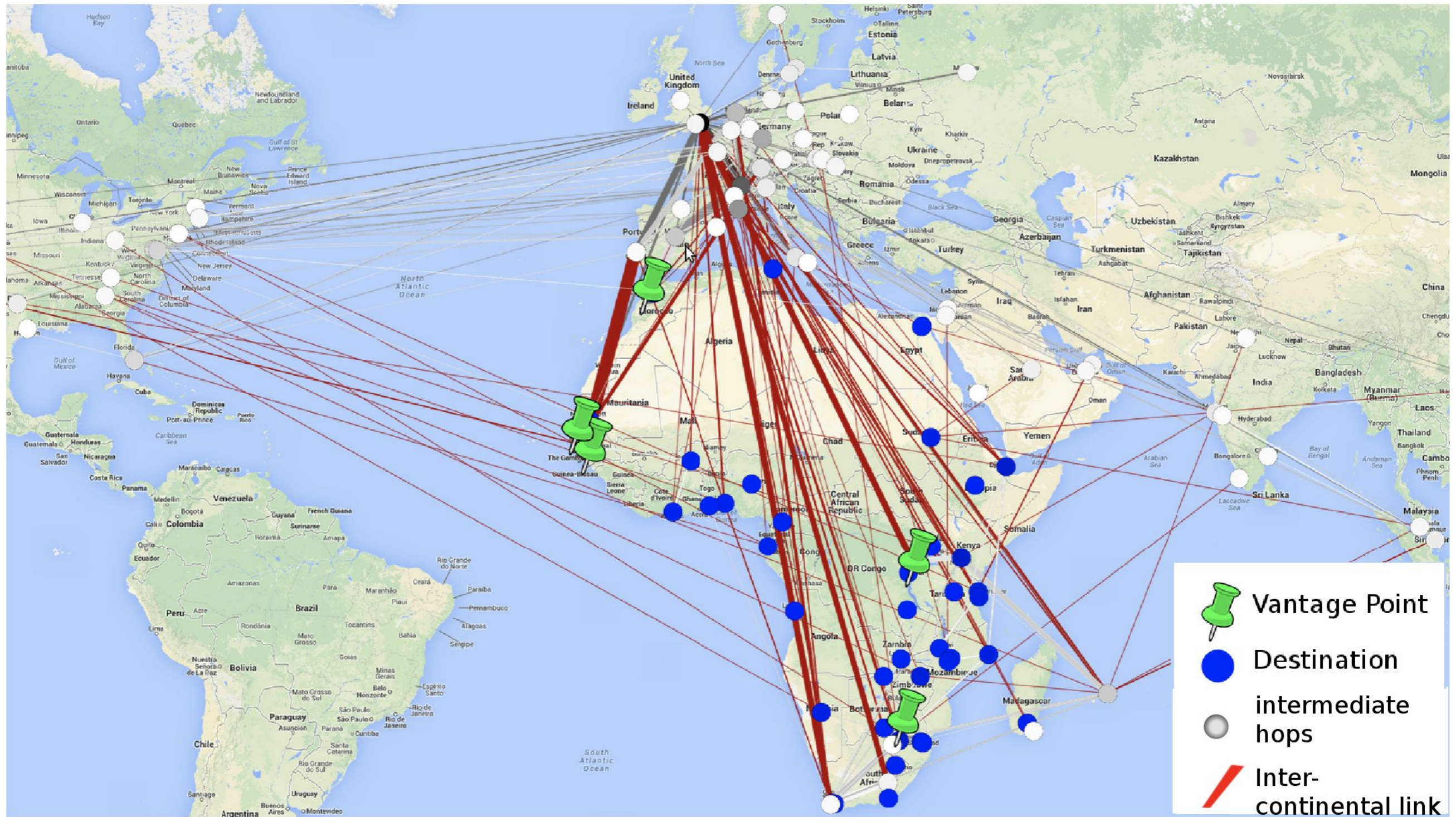
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Cambridge University

Gareth Tyson
Princeton University

What We Know



Circuitous routes and high end-to-end latencies across the continent

Research Questions



Source:
AXIS Project

Which countries are better inter-connected, which ones are not?

- Key clusters of connectivity in the region
- How are inter-country latencies impacted by topology and interconnection strategies?

Measurement Platform

Two platforms for launching measurements



- 229 RIPE Atlas probes in Africa
 - 36 African countries
 - Hardware-based
- However:
 - mostly in university networks and ISPs?
 - about 50% of Atlas probes in Africa are in ZA



- 850 probes in Africa
 - 52 African countries
 - Software-based (Windows PCs)
 - Include edge networks / home users
- However:
 - No IPv6
 - Unreliability (based on hosts' availability)

Vantage Points

- Speedchecker Probes (www.speedchecker.xyz)
 - 850 software probes
 - 319 ASes
 - 52 countries
- 50% of the countries had at least 20% of their ASes probed.



Speedtest.net Targets



213
SpeedTest
servers

42
African
countries

Data Collection

Ping from each probe:

- select random African Speedtest server as target
- launch 10 consecutive pings (one second apart) to their randomly chosen Speedtest server
- return the minimum delay (RTT) observed at that time period

Traceroute from each probe:

- launch a Traceroute to randomly selected Speedtest server
- for each router hop
 - determine the ASN using the RIPE Routing Information Service
 - attach the geolocation using MaxMind GeoLite2-City

Data Collection

**3
months**

**4 times a
day**

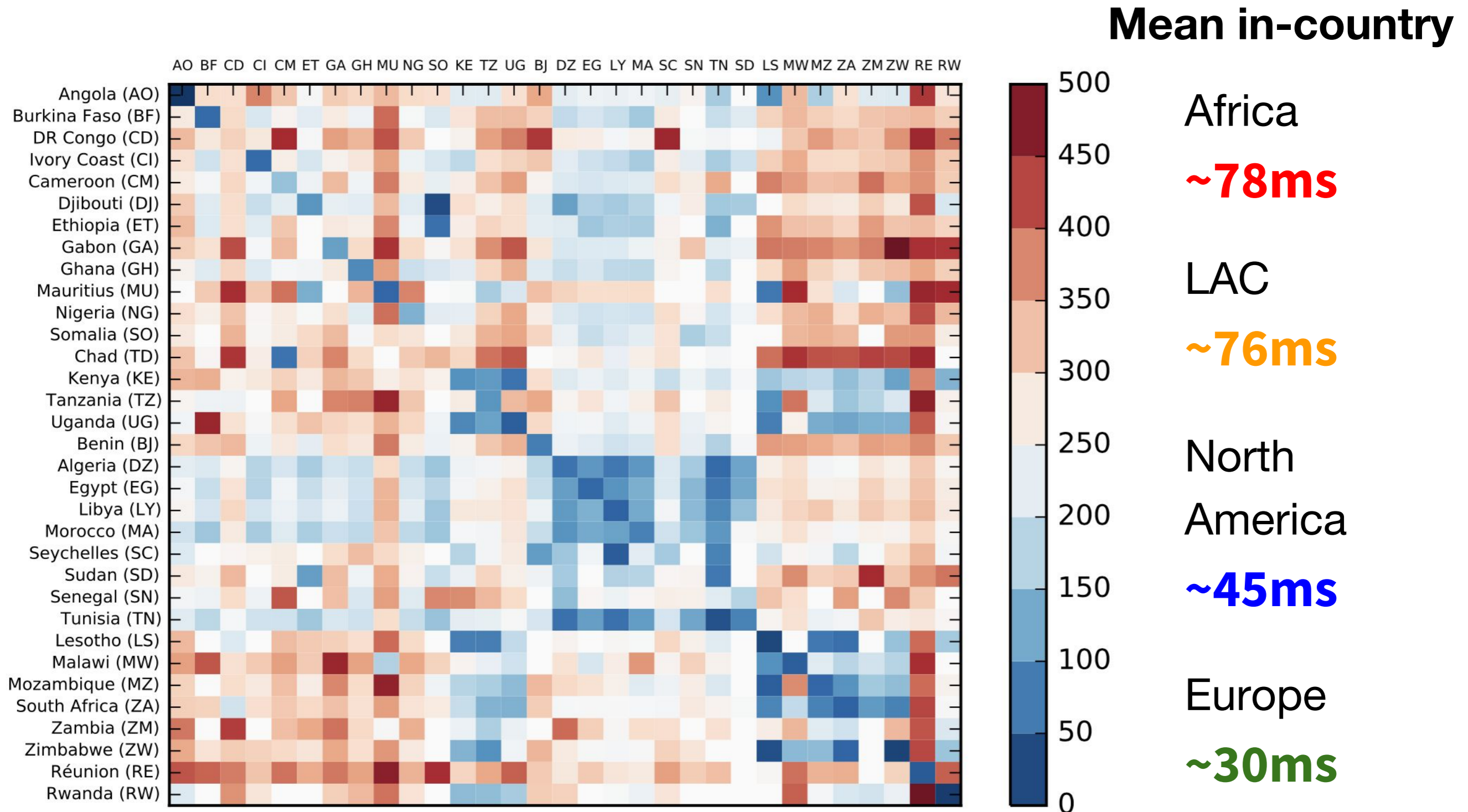
**Pings and
traceroute**

**42 200
RTT
samples**

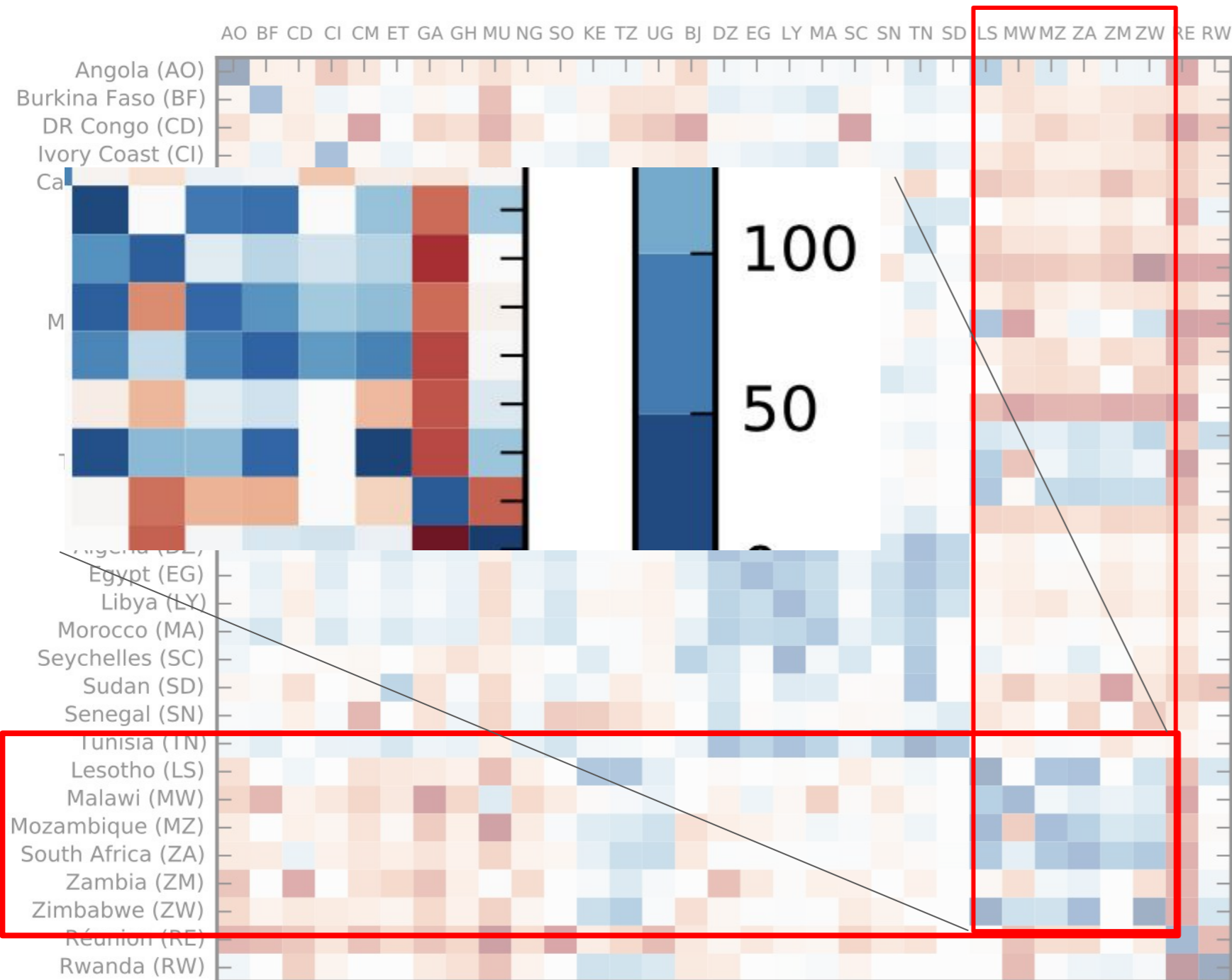
**31 500
traces
captured**

**319
ASNs**

Country-level Latencies



Country-level



Mean in-country

Under **30ms**

- Mauritius
- Reunion
- Cote D'Ivoire

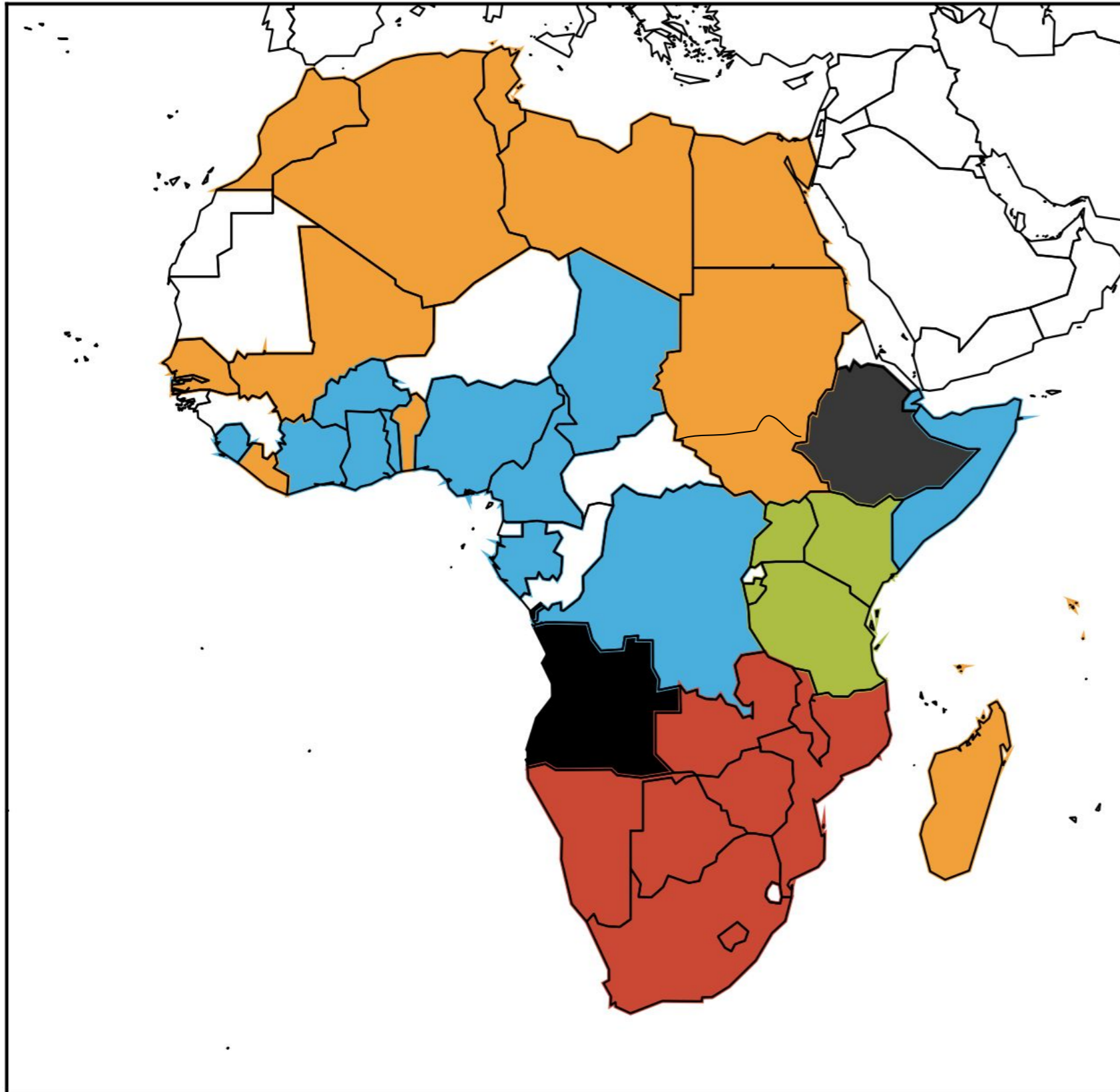
Under **40ms**

- South Africa
- Egypt
- Benin

ZM <-> MW | ZM <-> ZW | MU <-> MZ | MU <-> RE

LOOKING FOR CLUSTERS

Africa Latency Clusters



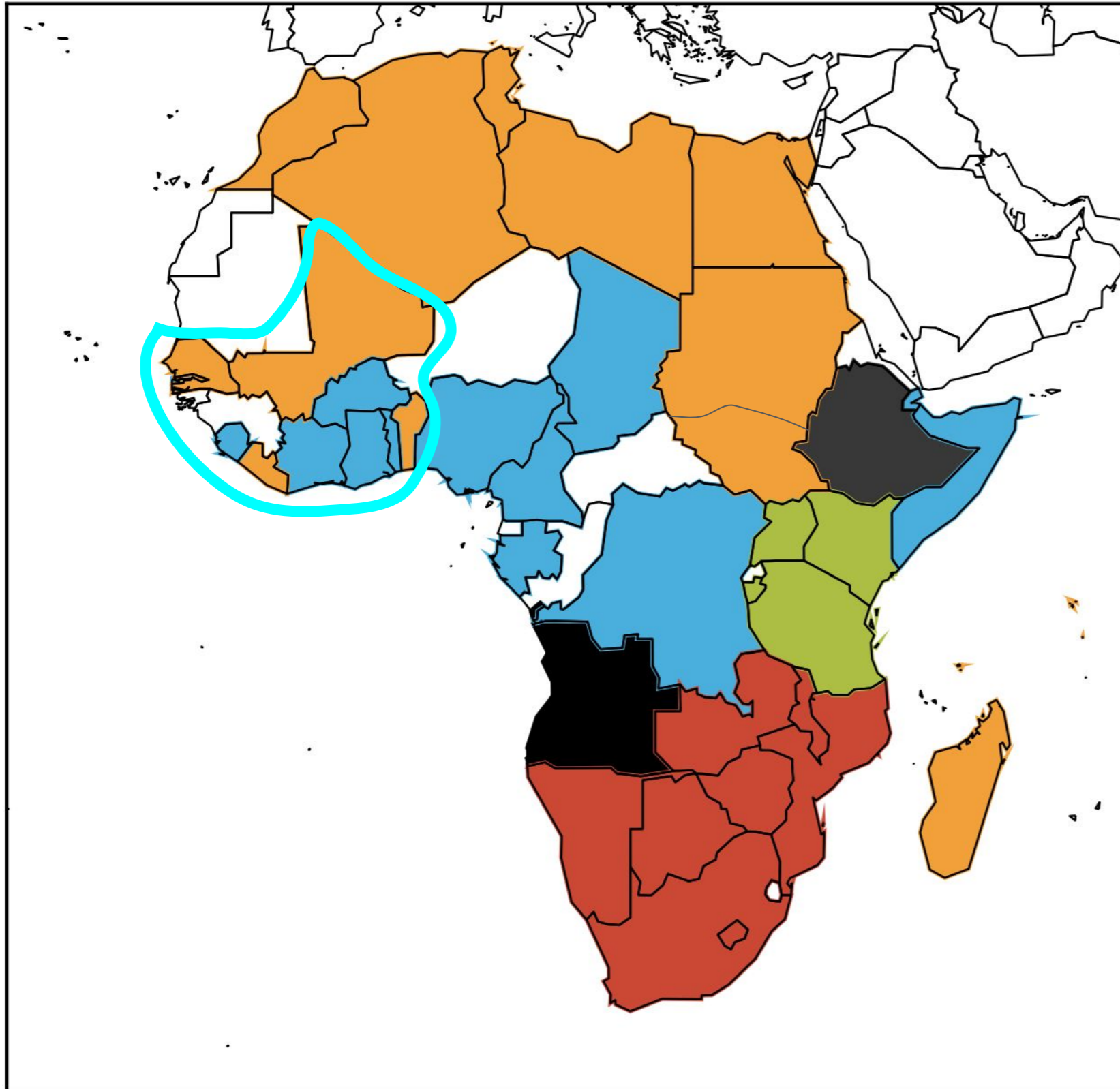
- Northern
- Southern
- Eastern
- Western

Africa Latency Clusters



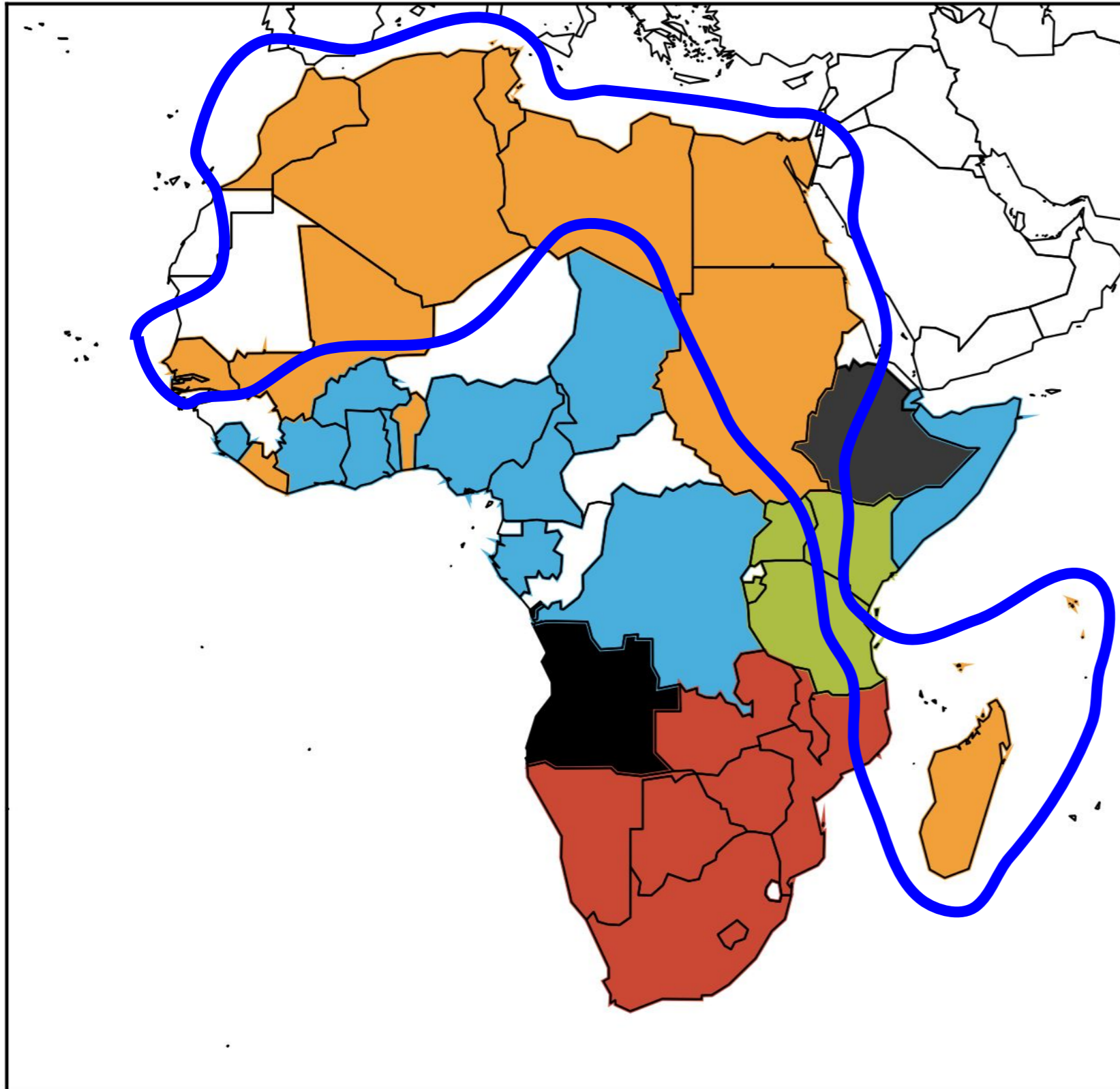
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Unusual Cases in Latency Clusters



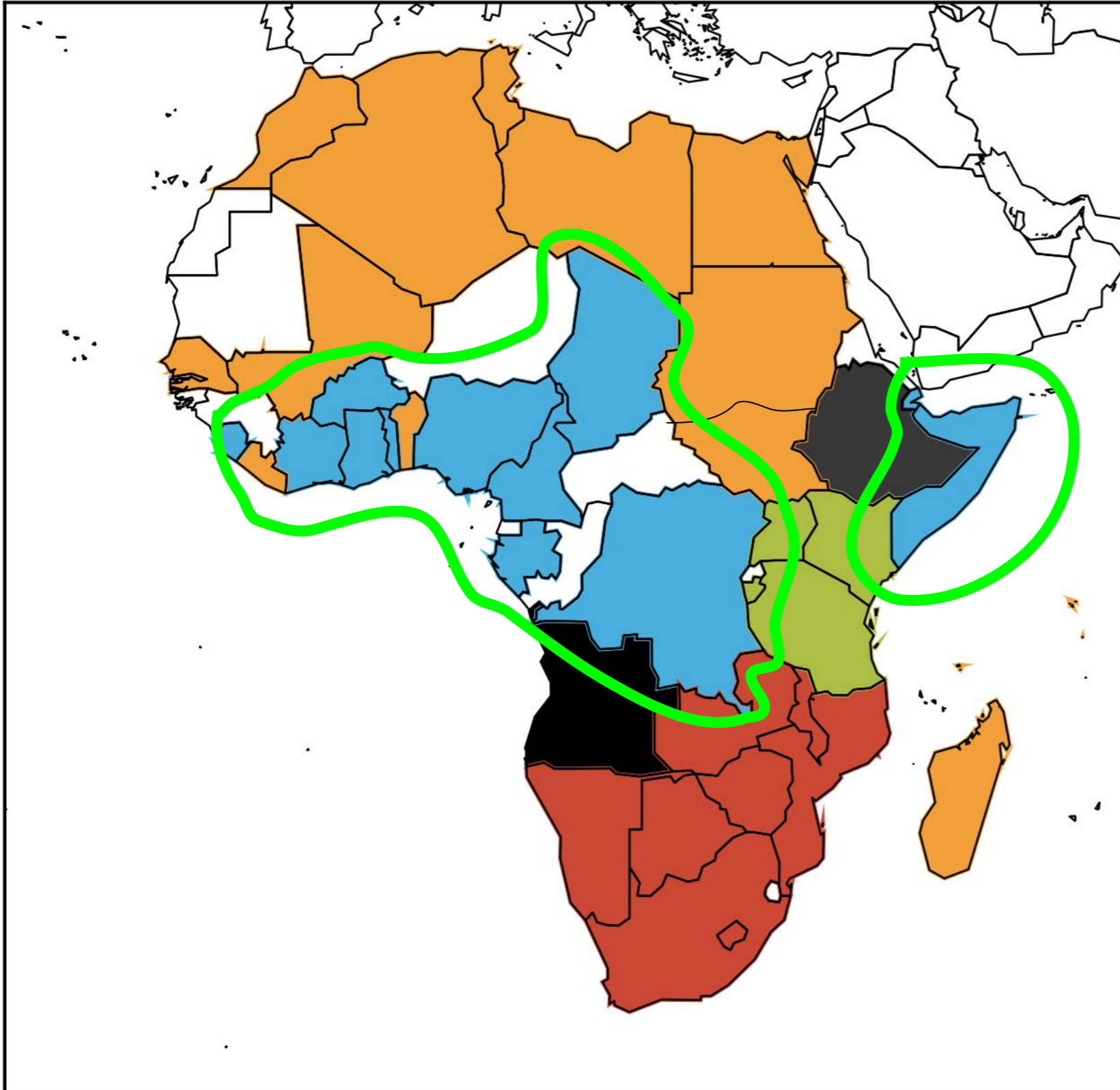
- **Senegal, Liberia and Benin on the West coast, in Northern cluster**
- Madagascar, Seychelles, islands of the Indian Ocean, clustered alongside countries in the North
- Somalia, on the East coast, is clustered with countries on the West coast.

Unusual Cases in Latency Clusters



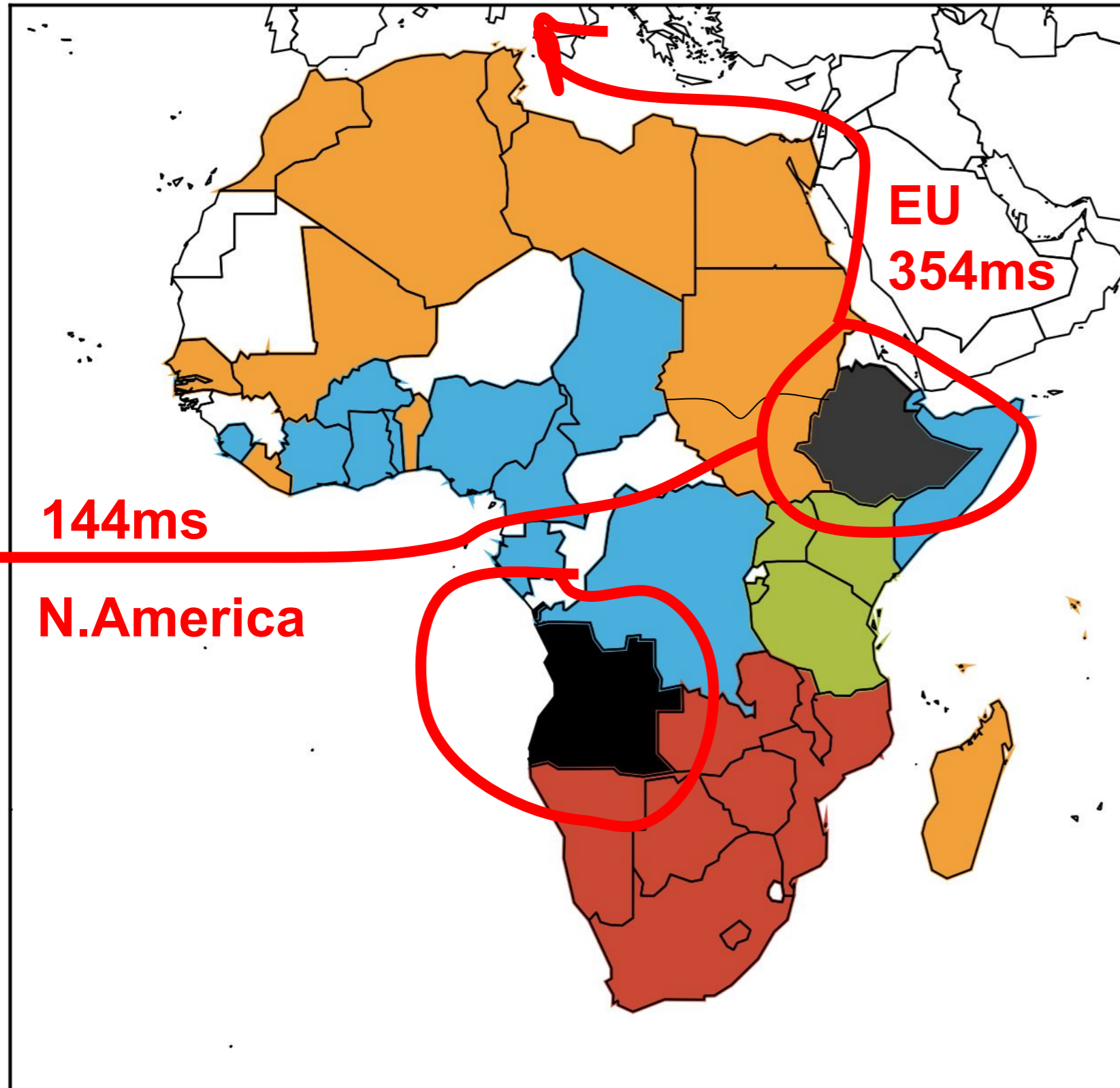
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Angola & Ethiopia unclustered

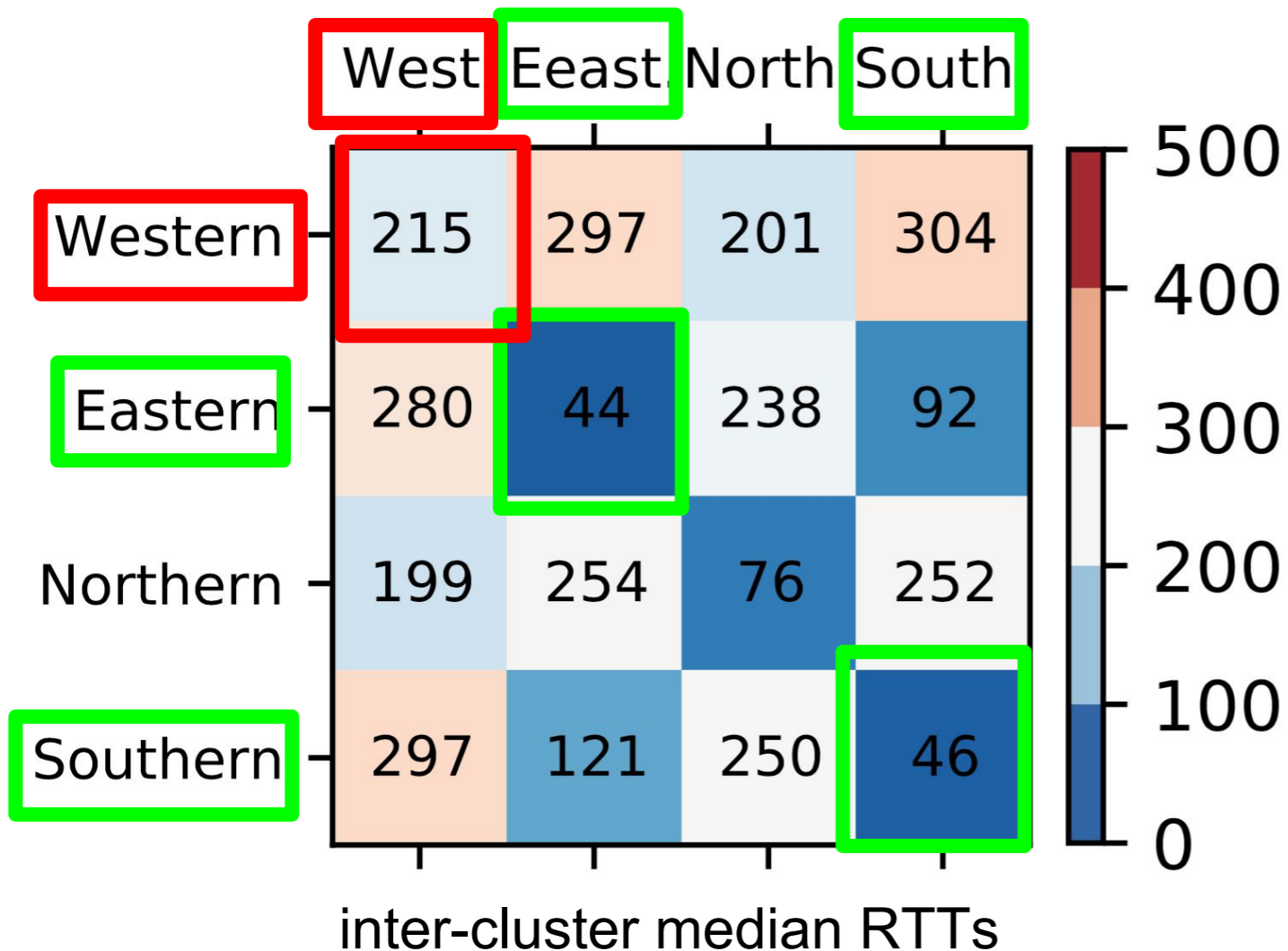


Ethiopia Upstream
100% Overseas



Angola Upstream
50% Overseas*
***16% Southern -> Europe**

Inter-cluster Latencies



Southern and Eastern

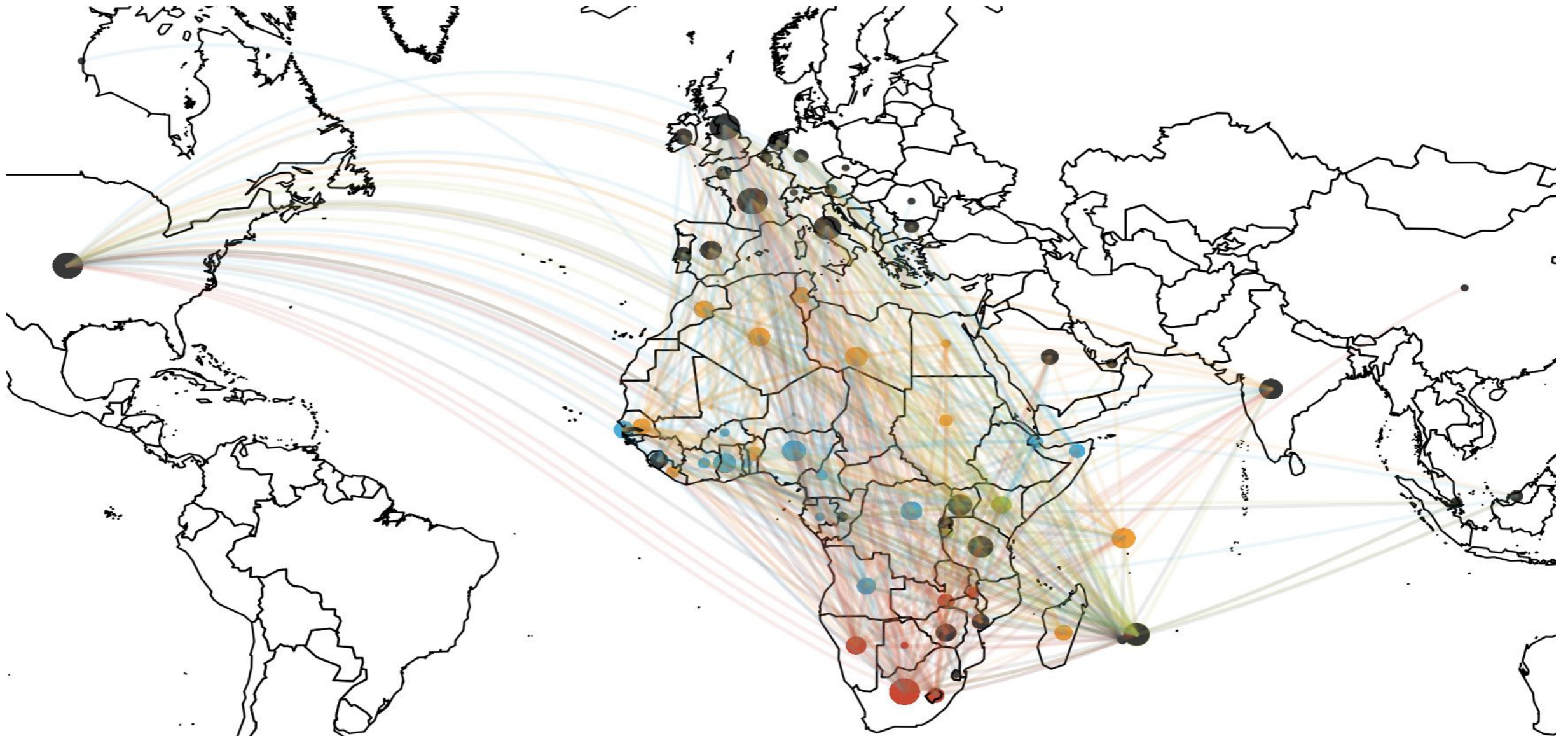
- Lowest inter-cluster delay ~ **92ms**
- Lowest intra-cluster RTTs individually

Western cluster has the **highest intra-cluster** RTTs

Inter-cluster delays are mostly exceeding **200ms**

EXPLORING THE UPSTREAM

Africa's upstream providers



- **37.8%** of *traceroute* paths transit (1st AS hop) outside of Africa
- **6.6%** through SA and **4.5%** through Mauritius (WIOCC)

Africa's Top 10 Upstream Providers

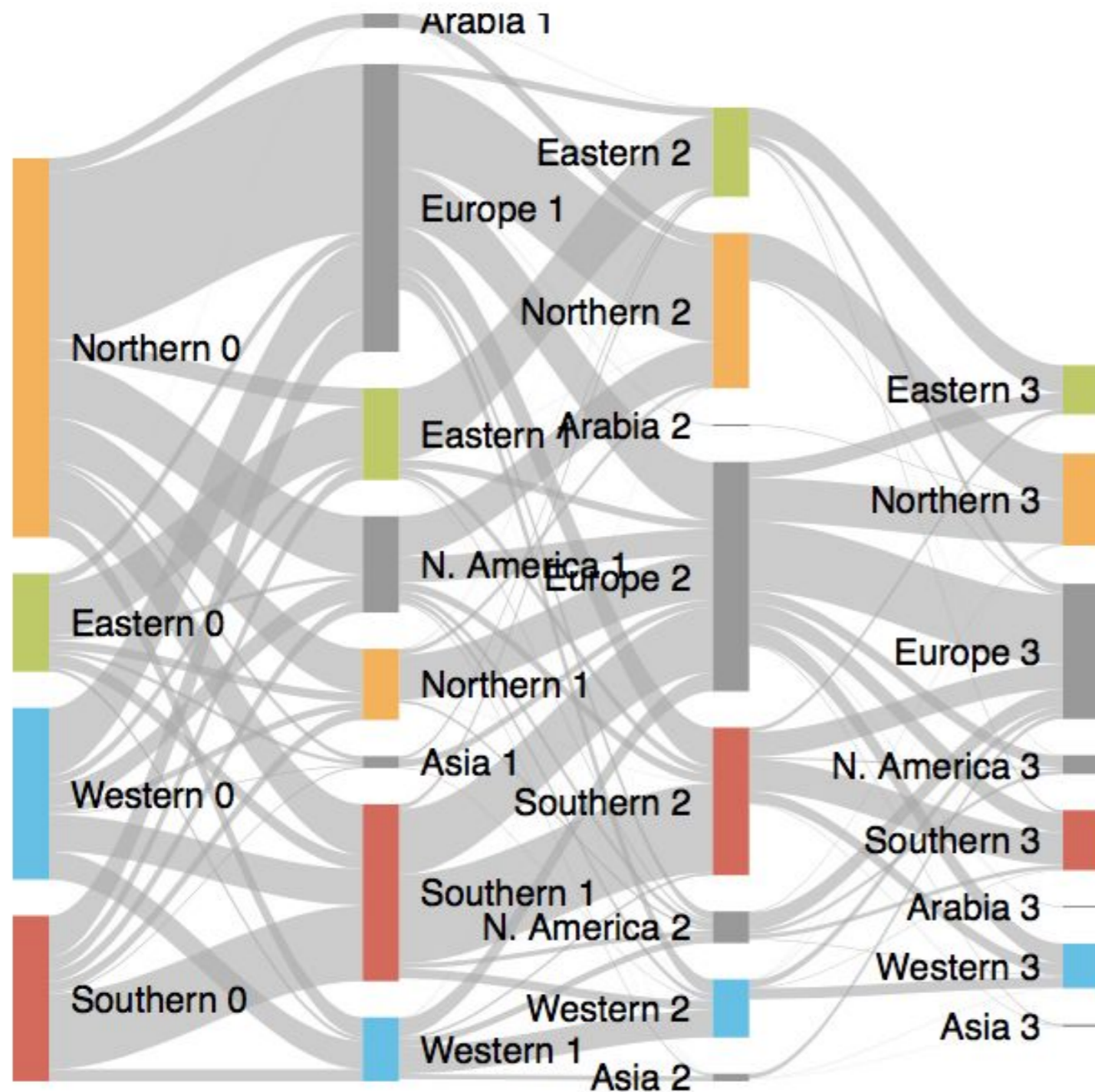
Rank	ASN	Network info.	Perc.	Centrality
1	174	Cogent Communications	10.3%	0.095
2	3356	Level 3 Communications	7.4%	0.087
3	37100	SEACOM	7.1%	0.065
4	6762	Sparkle (TIM Group)	6.6%	0.071
5	30844	Liquid Telecom	5.9%	0.137
6	5511	France Telecom (Orange)	3.9%	0.044
7	57023	Oranlink	2.3%	0.003
8	6453	TATA COMMS. - US	2.2%	0.013
9	16637	MTN	2.1%	0.029
10	5713	Telkom SA Ltd	2.0%	0.019
Sum			49.7%	

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France Telecom (Orange) accounts for **17%** for French speaking countries in West Africa

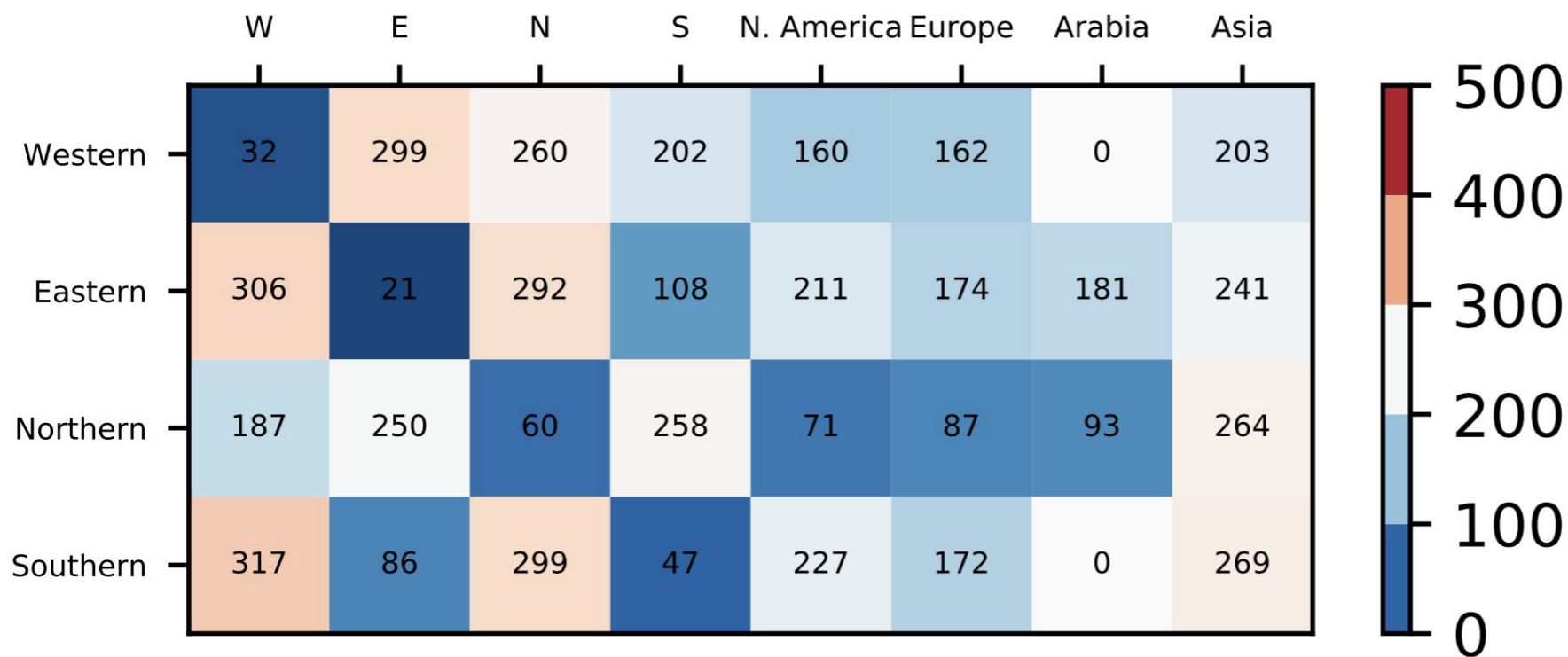
Utilisation of upstream providers by cluster



50%
have hops
overseas
(Europe)

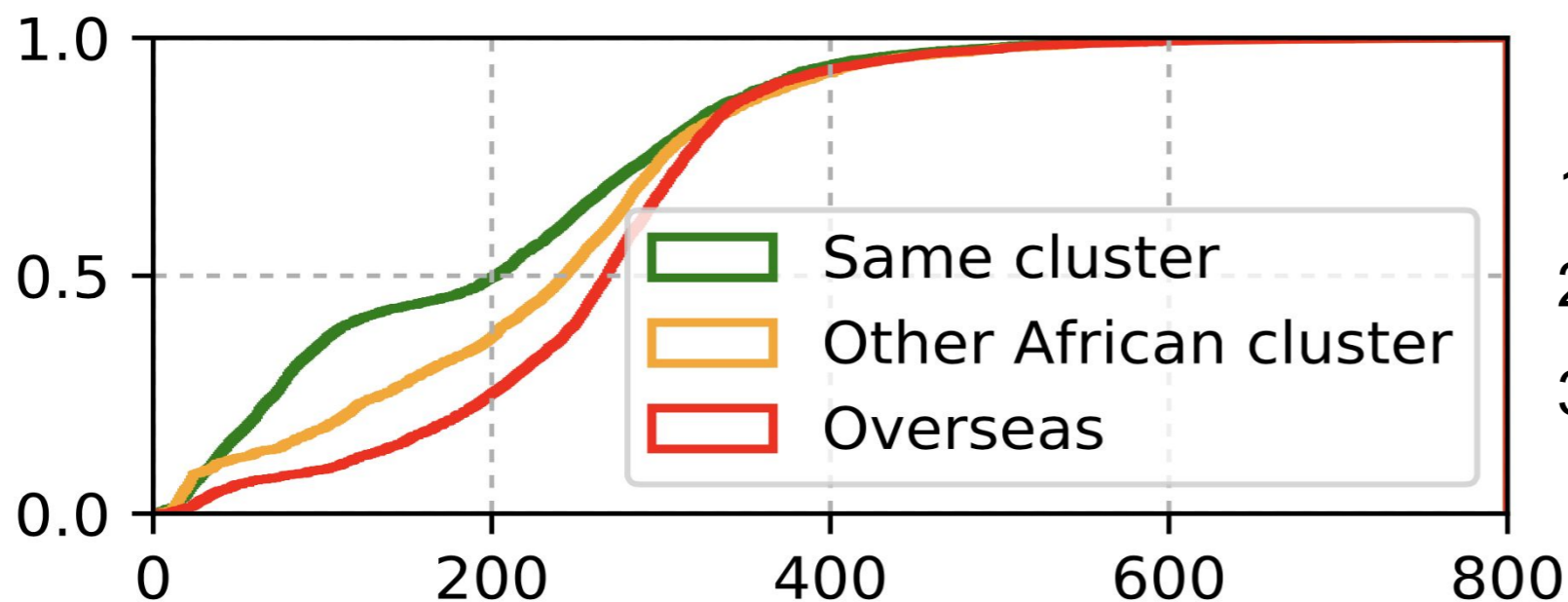
14%
with 4+
hops before
Africa

Latency to Upstream providers



Northern ⇒ North America: **71ms**
 Southern ⇒ North America: **227ms**

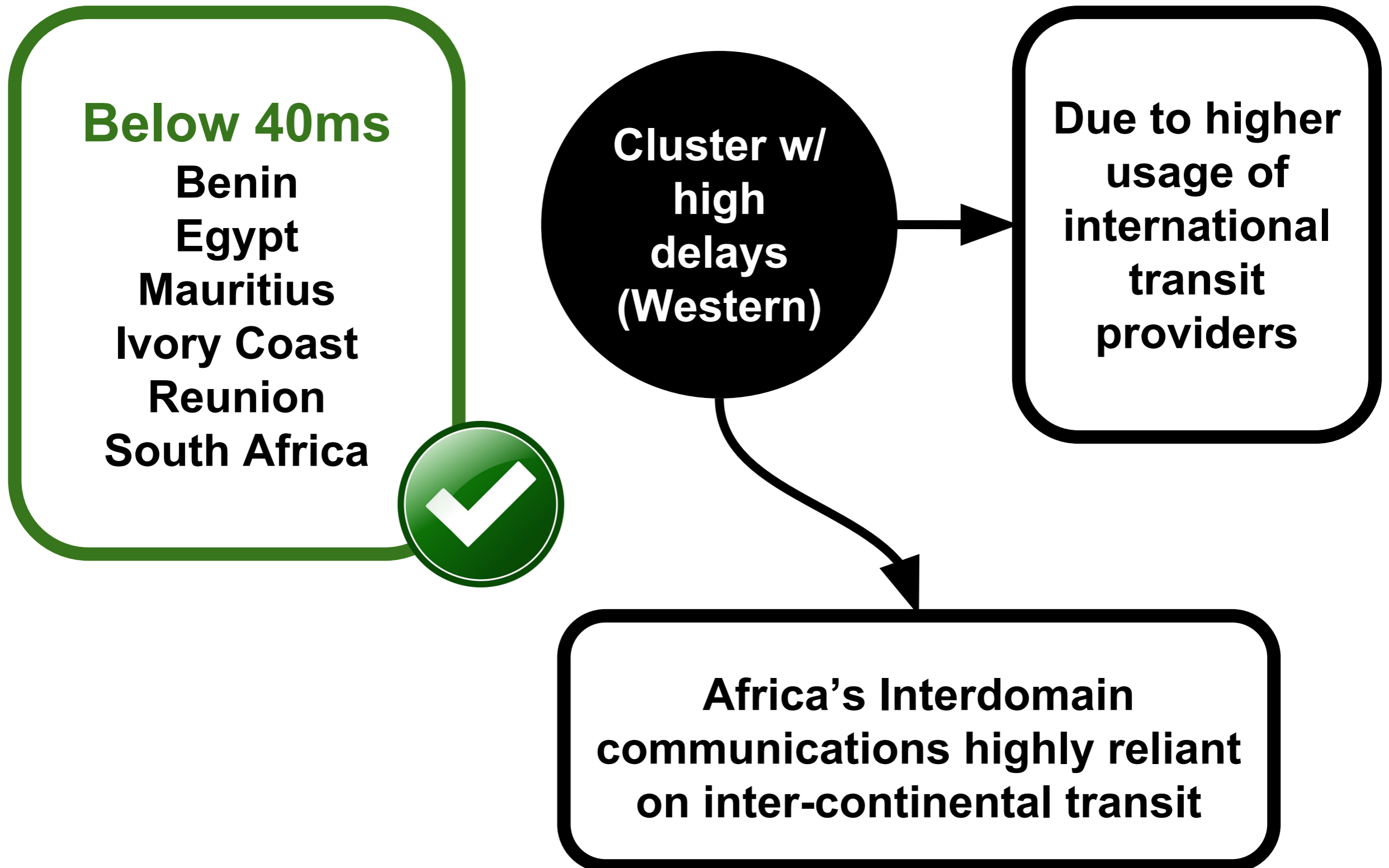
RTT to the first AS hop



1. Same cluster **203ms**
2. Other African Cluster **243ms**
3. Overseas **268ms**

CDF of RTTs grouped by location of upstream providers

Take-aways

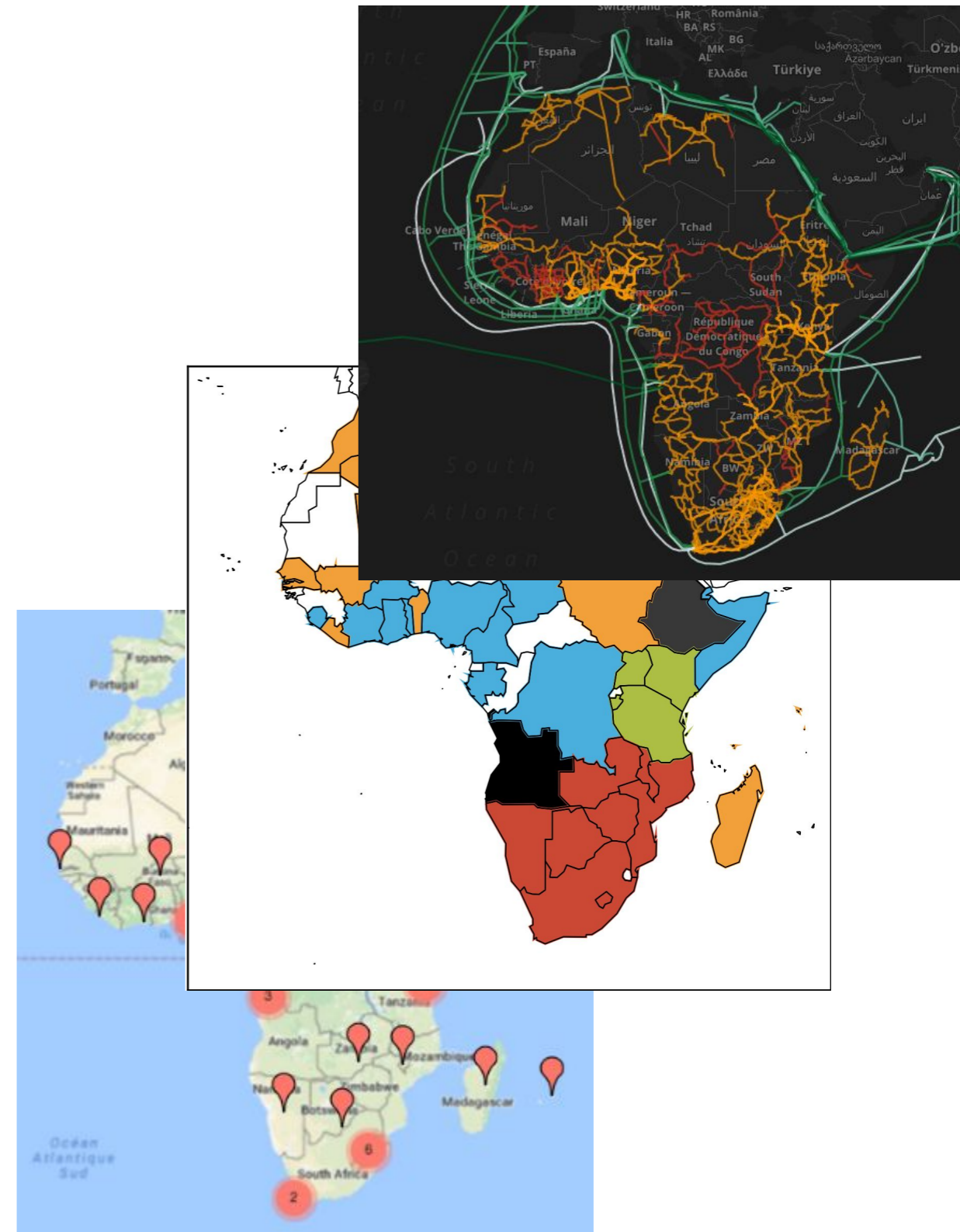


Implications for GAIA

- Access
- Affordability
- Performance
- Peering fabric
- Local content/CDN/caching

Future work

- Correlation with Physical infrastructure, IXP presence in African countries and Peering relationships
- Investigating delays between countries and popular web/content infrastructure
- Linking the findings to regional Internet development strategies (e.g., deployment of IXPs)



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Questions?

THANK YOU!