August 2022

QRATOR LABS

Measuring Internet region: Africa

Eugene Bogomazov

QRATORLABS

About Us

- Qrator Labs
  - DDoS mitigation company
  - 10+ years in business
  - Global anycast network
- Radar
  - Research unit
  - Largest BGP collector
  - Monitoring connectivity and security incidents (product)

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

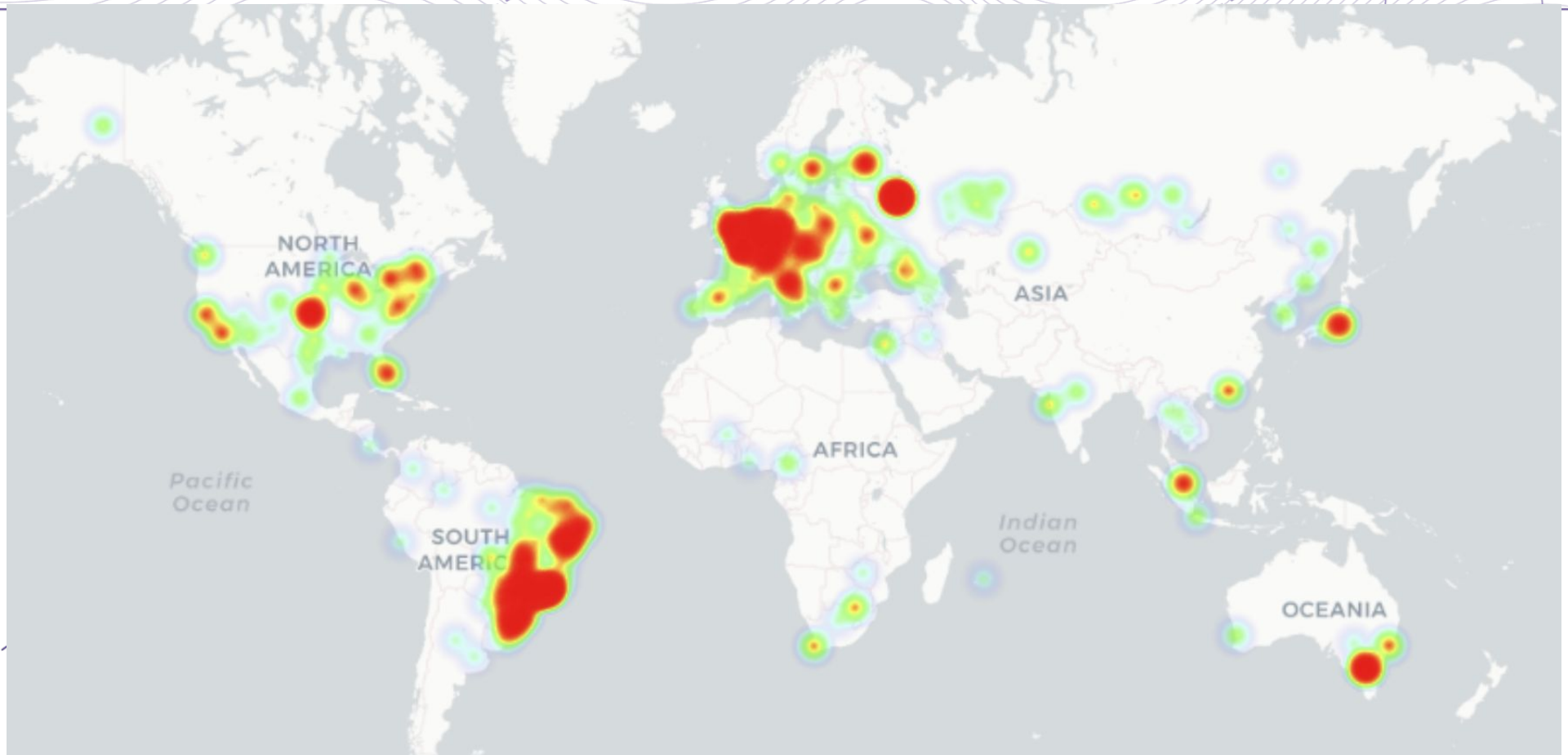
QRATORLABS

About measurements

How to measure – what data sources to use for measurements

What to measure – what algorithm to use

How to visualize – what aspects we want to study


NORTH AMERICA
ASIA
AFRICA
Pacific Ocean
SOUTH AMERICA
Indian Ocean
OCEANIA

Sad But True

800 + BGP session in total

Only ~15 Sessions in Africa

- Not enough local PoP
- Worse peering links coverage
- Worse local prefix coverage

Additional sources

- AS info db
- Route objects
- ROA
- Geo info

- RIPE db
- Afrinic IRR
- RPKI validator
- MaxMind/RIPE

100+ different ways

** If we consider only graph ranking*

What to Measure

There is no universal and best rating system

- You can choose measurements that have a logical explanation
  - And add weights to the nodes
- Or create your own measurements

QRATORLABS

Ways of comparison

- Metric overview
- How region is compared to the rest of the world
- Ranking inside the region
- Overview of the most interesting cases

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

How big is ISP community

- We will look at number of ISPs
  - Registered in IRRs
  - Still Active
- It gave an overview on diversity and competitiveness of local market

General Overview...

		#Registered ASNs			#Announced ASNs			#Announced Prefixes		
iso	name	Value	Percentage	Place	Value	Percentage	Place	Value	Percentage	Place
US	United States	29499	27.39%	1	17915	24.28%	1	305483	27.44%	1
BR	Brazil	8946	8.30%	2	8150	11.04%	2	97251	8.74%	2
RU	Russian Federation	5893	5.47%	3	5029	6.81%	3	46403	4.17%	4
IN	India	3563	3.31%	4	2493	3.38%	4	45556	4.09%	5
DE	Germany	3009	2.79%	6	2116	2.87%	6	16535	1.49%	15
ZA	**South Africa**	**709**	**0.66%**	**30**	**535**	**0.72%**	**29**	**12839**	**1.15%**	**19**
NG	**Nigeria**	**230**	**0.21%**	**52**	**189**	**0.26%**	**51**	**2397**	**0.22%**	**53**
KE	**Kenya**	**155**	**0.14%**	**67**	**120**	**0.16%**	**65**	**1995**	**0.18%**	**59**
GH	**Ghana**	**95**	**0.09%**	**84**	**83**	**0.11%**	**80**	**594**	**0.05%**	**105**
TZ	**Tanzania, United Republic of**	**89**	**0.08%**	**85**	**72**	**0.10%**	**86**	**681**	**0.06%**	**98**
EG	**Egypt**	**82**	**0.08%**	**88**	**65**	**0.09%**	**89**	**7730**	**0.69%**	**30**
AO	**Angola**	**60**	**0.06%**	**96**	**51**	**0.07%**	**95**	**335**	**0.03%**	**124**
UG	**Uganda**	**51**	**0.05%**	**101**	**41**	**0.06%**	**102**	**688**	**0.06%**	**96**
RW	**Rwanda**	**21**	**0.02%**	**137**	**18**	**0.02%**	**128**	**349**	**0.03%**	**122**

QRATORLABS

Too Much Information?

- ~54 countries to display
  - Differ from individual country reports
- Either aggregation or top displaying is needed

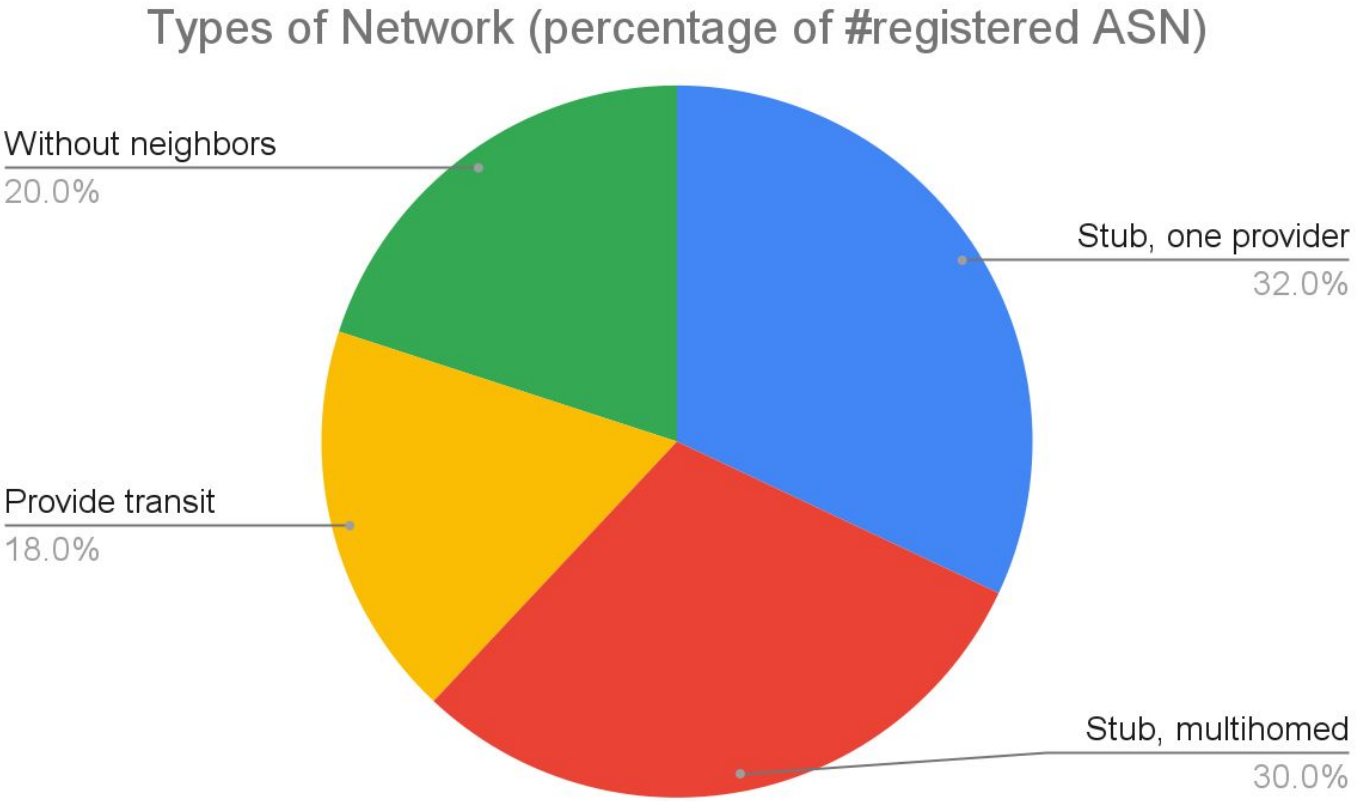
General overview (second attempt)

- Top 3 countries by number of ISPs:
  - South Africa
  - Nigeria
  - Kenya
- Only about 80% of all ASs are still in operation.
  - Compared to 70% for the rest of the world
- Number of prefixes to ASN is average
  - Excluding Egypt, Cote d'Ivoire and Sudan

Types of operators

- Stubs - don’t provide transit to others
  - Multihomed - have two or more providers
  - Clear stub - have only one provider
- Transit networks - provide transit to others
  - Differs in size and traffic volume

ISP types


Types of Network (percentage of #registered ASN)
Without neighbors
20.0%
Stub, one provider
32.0%
Provide transit
18.0%
Stub, multihomed
30.0%

Big fish

- Biggest Tier-1s - Cogent (AS174), Telia(AS1299), Level3(3356)
- Biggest Regional Providers - ?
  - Consumer cone analysis not working (Tier-1 will overtake it)
  - We will try to use flow analysis
- The border of the regions was taken from the African Union

Flow analysis

- Each country's ISP has a default weight
  - Weight can be as a number of Prefixes/PTRs/clients/etc
  - **All country ISPs have equal weight** in our case
- The transit provider will get the extra weight of their customers
  - All weights in = All weights out
  - The client gives each provider the same part of its own weight
  - Similar to PageRank

Top Regional Tier-2

- South + East - Seacom(AS37100), Liquid(AS30844), WIOCC(AS37662)
- North - TE-AS(AS8452)
- West - Mainone(AS37282), Dolphin-Telecom-AS(AS37613)
- Central - CamNet-AS(AS15964)

Flow diversity

- About half of the countries have at least 1 ISP with more than 50% flow control.
- Most of them are countries with 10 or fewer ISPs.
- The most notable exceptions are:
  - Egypt - TE-AS(AS8452) (65 ASNs, ~52%)
  - Angola - ANGOLA-CABLES(AS37468) (51 ASNs, ~70%)
- A notable example of flow diversity:
  - Seychelles - most ISPs are directly connected to Tier-1s

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

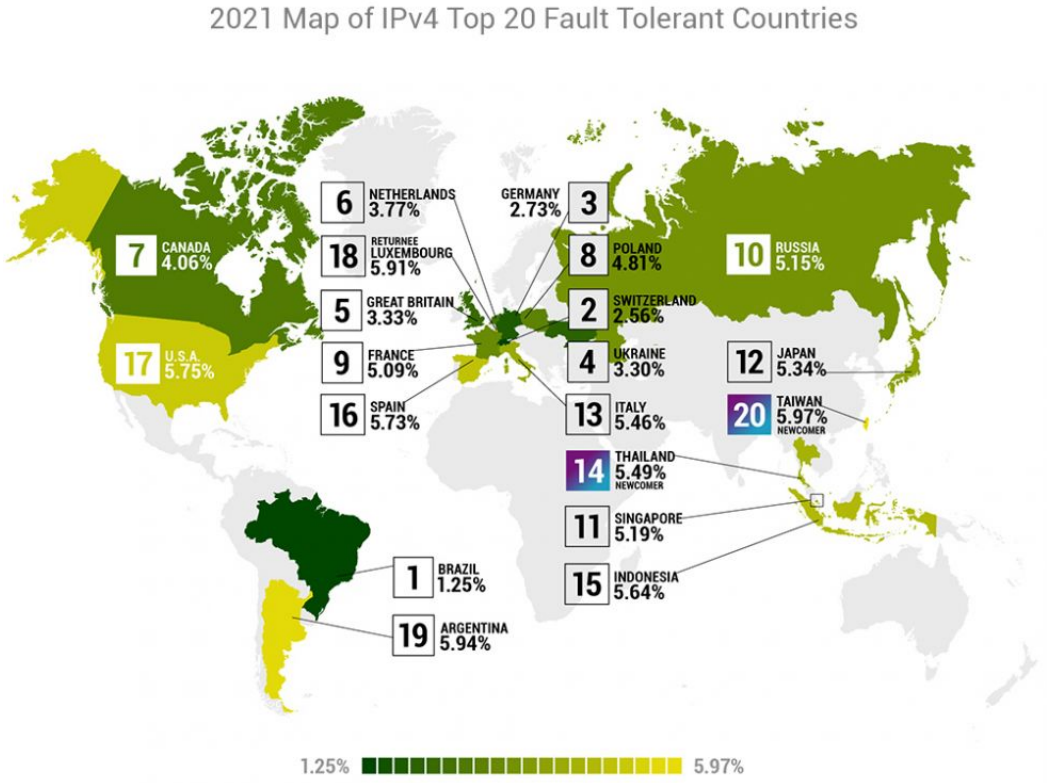
QRATORLABS

Stability overview

- Measurement was created several years ago
  - And is updated on a regular basis
- Allows a single point of failure
- Finds which part of country will be isolated

Last Year Example

- The main PoF is usually the main stub provider.
- More ASNs - less default weight for each one
- It is also necessary to take into account the general connection with the backbone



Stability in Africa

iso	name	World_Place	Regional_Place	Critical ASN	#Depended ASNs	Critical %	Partial %
BR	Brazil	1		61832	127	1.54%	0.28%
DE	Germany	2		3320	53	2.49%	0.33%
RU	Russian Federation	12		12389	272	5.39%	0.67%
SC	**Seychelles**	**13**	**1**	**50673**	**2**	**5.41%**	**0.00%**
KE	**Kenya**	**33**	**2**	**33771**	**10**	**8.26%**	**1.65%**
MU	**Mauritius**	**48**	**3**	**33764**	**3**	**11.11%**	**7.41%**
ZA	**South Africa**	**61**	**7**	**37100**	**69**	**12.87%**	**2.43%**
NG	**Nigeria**	**76**	**9**	**37282**	**29**	**15.34%**	**1.59%**
RW	**Rwanda**	**83**	**11**	**16637**	**3**	**16.67%**	**0.00%**
EG	**Egypt**	**96**	**12**	**8452**	**13**	**20.00%**	**1.54%**
AO	**Angola**	**150**	**33**	**37468**	**20**	**39.22%**	**0.00%**

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

QRATORLABS

Who is a legitimate sender?

- IRR
  - Worked on AS_SET + route objects basis
  - Routes are usually filtered by prefix whitelist of created Customer Cone
  - Is needed for global connectivity
- ROA/RPKI
  - Worked as <Prefix, origin ASN> pair check
  - Is needed to prevent others from malicious activity
  - Has a side question - which maxLength to use?

QRATORLABS

Validation Statuses

- Valid - <prefix, origin ASN> is covered by legitimate object
- Unknown - there is no legitimate object for a prefix
- Invalid - prefix belonged to another origin ASN

Validation stats

What to measure - the percentage of prefixes?

	prefixes	route_valid	route_unknown	route_invalid	roa_valid	roa_unknown	roa_invalid
All countries	1118441	82.75%	8.54%	8.71%	35.06%	58.35%	**6.59%**
Africa	40535	91.87%	4.68%	3.45%	15.79%	75.50%	**8.71%**
Without ZA	27632	89.71%	6.24%	4.05%	14.52%	85.04%	0.43%

What are you trying to measure?

- Routes can be crafted
  - By BGP Optimisers or by similar tools
- Routes can be local
  - And accidently be leaked to BGP collector
- Routes can be filtered locally
  - And they will not be seen by other projects

Validation stats [2]

Same metrics after filtering low visible routes

seen by at least 10 different ASNs

	prefixes	route_valid	route_unknown	route_invalid	roa_valid	roa_unknown	roa_invalid
All	965536	86.07%	6.53%	7.40%	38.32%	61.09%	**0.58%**
Africa	33532	91.27%	5.33%	3.40%	18.57%	81.09%	**0.34%**
Without ZA	26813	90.34%	6.03%	3.63%	14.63%	84.99%	0.38%

Problems with prefix validation

- Most hijackers are not real hijackers
- Data scrubbing required
- Real analysis needs AS_PATH
  - The problem was highlighted on ENOG a few years ago (link)

QRATORLABS

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

IPv6 average adoption

only ~35% ASNs announced IPv6 prefixes

(compared to IPv4)

QRATORLABS

IPv6 adoption stats

		# Registered ASNs			# Announced ASNs			
iso	name	Value	Percentage	Place	Value	Percentage	Place	Rate v6/v4
BR	Brazil	8946	8.30%	2	6227	21.02%	1	76.40%
US	United States	29499	27.39%	1	3921	13.24%	2	21.89%
DE	Germany	3009	2.79%	6	1429	4.82%	3	67.53%
ZA	**South Africa**	**709**	**0.66%**	**30**	**226**	**0.76%**	**24**	**42.24%**
NG	**Nigeria**	**230**	**0.21%**	**52**	**39**	**0.13%**	**62**	**20.63%**
KE	**Kenya**	**155**	**0.14%**	**67**	**34**	**0.11%**	**70**	**28.33%**
TZ	**Tanzania, United Republic of**	**89**	**0.08%**	**85**	**31**	**0.10%**	**72**	**43.06%**
SC	**Seychelles**	**55**	**0.05%**	**100**	**18**	**0.06%**	**87**	**48.65%**
AO	**Angola**	**60**	**0.06%**	**96**	**13**	**0.04%**	**95**	**25.49%**
MU	**Mauritius**	**47**	**0.04%**	**106**	**12**	**0.04%**	**96**	**44.44%**
GH	**Ghana**	**95**	**0.09%**	**84**	**12**	**0.04%**	**97**	**14.46%**
EG	**Egypt**	**82**	**0.08%**	**88**	**11**	**0.04%**	**101**	**16.92%**
MA	**Morocco**	**24**	**0.02%**	**127**	**10**	**0.03%**	**106**	**50.00%**
UG	**Uganda**	**51**	**0.05%**	**101**	**10**	**0.03%**	**108**	**24.39%**
RW	**Rwanda**	**21**	**0.02%**	**137**	**3**	**0.01%**	**160**	**16.67%**

Other interesting IPv6 changes

- Main Tier-1 provider changed from Cogent to HE
- Large number of connections to HK-IX (opaque IX)
- The flow stream diversity - big ISPs take smaller part. Reasons:
  - More providers per customer
  - Direct connections to Tier-1

Validation stats [6]

	prefixes	route_valid	route_unknown	route_invalid	roa_valid	roa_unknown	roa_invalid
All	241798	83.14%	7.74%	9.12%	29.76%	53.62%	**16.62%**
Africa	2076	87.24%	8.82%	3.95%	37.52%	61.61%	0.87%
Without ZA	1261	84.93%	12.37%	2.70%	19.98%	79.78%	0.24%

IPv6 prefix validation stats

Without/With filtration by threshold propagation

	prefixes	route_valid	route_unknown	route_invalid	roa_valid	roa_unknown	roa_invalid
All	168478	78.80%	10.26%	10.95%	40.39%	58.82%	**0.78%**
Africa	1732	85.28%	10.05%	4.68%	29.85%	69.75%	0.40%
Without ZA	1217	84.72%	12.49%	2.79%	19.64%	80.12%	0.25%

Plan of the report

About measurements

General overview

Stability overview

Prefix violation (Hijacking)

IPv6 adoption

Final remarks

In future plans:

- Add IX Analysis
- Highlight the difference of coastline availability
- Create more explicit country and ISP metrics
- Include your ISP knowledge in the future region overview

Final words

If you have:

- Question about the position of your ISP or your country
- Suggestions for what else you would like to see at country/provider level
- Suggestions for what can be improved/corrected

or you want to set up a BGP session with our BGP collector, I'm here or you can find me at the conference.


Questions?
radar.qrator.net
radar@qrator.net