DATE

EVENT

MIRA: A framework to measure Internet Resilience

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“Meaningful Connectivity - A4AI”

Regular Internet Access

An Internet **which is not subject to frequent disruption** (accidental or intentional) and which provides daily access to perform normal activities i.e. for work, education and communication purposes.

A fast Internet connection

For a smooth online experience, users needs to a decent connection to be able to use currently available services. **At least a 4G mobile connection.**

Unlimited connectivity

An Internet which is uncapped, affordable and **accessible at all times** will provide unlimited potential to users.

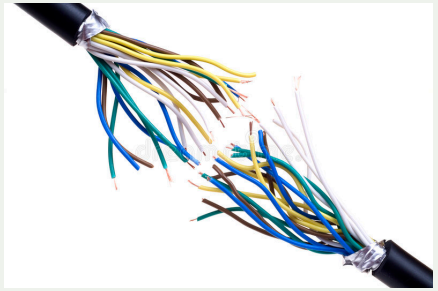
An appropriate device

A smartphone provides the functionality to create and consume Internet content and allows Internet Access everywhere.

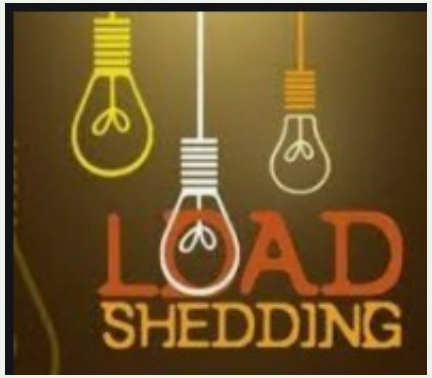
https://a4ai.org/meaningful-connectivity/

Our reality

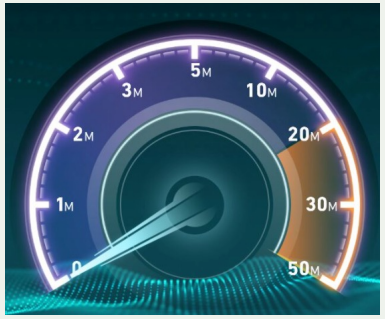
Internet disruptions



Unreliable access to electricity



Under provisioned networks



Lack of redundancy

Source: https://www.online-tech-tips.com/

Internet Resilience Index

The Internet Resilience Index (IRI) is a composite indicator that measures a country's performance against the key pillars of a robust Internet ecosystem

Theoretical framework

4 Pillars, 11 Dimensions, 30 Indicators

- Currently there is no composite indicator for Internet Resilience, which is a complex concept
- Inspired from existing indices such as MCI (Mobile Connectivity Index by GSMA), Global Cybersecurity Index (ITU)

Infrastructure

- Cable ecosystem
- Mobile connectivity
- Enabling infrastructure

Performance

- Fixed networks
- Mobile networks

Enabling technologies and security

- Enabling technologies
- DNS Ecosystem
- Routing Hygiene
- Security threat

Local ecosystem & Market readiness

- Market structure
- Traffic localization

Data Selection

Selection Criteria

- IRI is an input index therefore each indicator much be an input indicator (as opposed to an output indicator)
- We based our selection on a set of criteria as guided by the EU Joint Research Centre (JRC) and OECD
- As much as possible we make use of “hard” indicators e.g. measured/empirical data rather than qualitative data
- Whenever a direct indicator cannot be obtained, we used a proxy e.g. E-Government development index for local conte

Relevance

The indicator should work towards showing a increase or decline in the resilience of the Internet in a selected country.

Accuracy

The indicator should correctly estimate or describe the quantities or characteristics they are designed to measure.

Coverage

The data should cover as many countries as possible, as the Index is intended to be a global index. An indicator is not included if there is missing data on more than 25% of countries in the Index.

Timeliness

The data should be collected consistently and systematically over time.

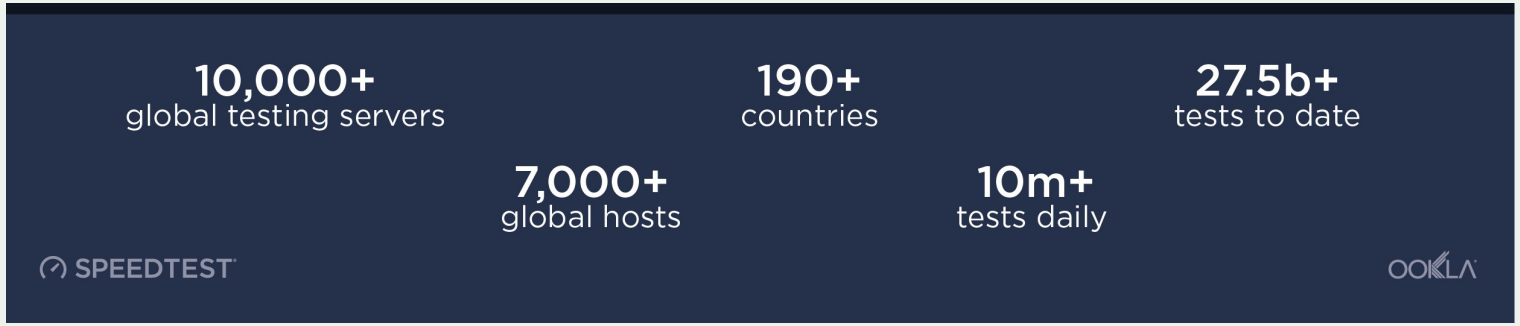
Infrastructure

Dimension	Indicator	Unit of measurement	Source
Cable ecosystem	Number of international gateways	Number	Afterfibre
	10-km fibre reach	% of population	ITU
	Power-availability	% of population	World Bank
Mobile connectivity	Network coverage	Calculated %	GSMA
	Spectrum allocation	Calculated %	GSMA
Enabling infrastructure	Number of IXPs	IXPs per 10 million	PCH/PeeringDB
	Number of datacentres	Datacenters per 10 million	Datacentermap

Performance

Dimension	Indicator	Unit of measurement	Source
Fixed Networks	Average Upload Speed	Mbps	Ookla
	Average Download Speed	Mbps	Ookla
	Latency	ms	Ookla
Mobile Networks	Average Upload Speed	Mbps	Ookla
	Average Download Speed	Mbps	Ookla
	Latency	ms	Ookla

OOKLA for Good™



Enabling technologies & Security

Dimension	Indicator	Unit of measurement	Source
Enabling technologies	IPv6 adoption	Country %	APNIC
	HTTPS	% of websites	Mozilla
DNS Ecosystem	DNSSEC Validation at country-level	Calculated %	APNIC
	DNSSEC Adoption by ccTLDs	Calculated %	ICANN
Routing Hygiene	MANRS Scores includes: (1) Filtering, (2) Coordination, (3) Global Validation IRR, (4) Global Validation RPKI, ~~(5) Anti-spoofing~~.	Aggregated %	ISOC
Security Threat	Secure Internet servers	Servers per 1 million	World Bank
	Global Cybersecurity Index	Index %	ITU
	DDOS Potential	TBit/sec	Cybergreen
	Spam infections	% of networks infected	Spamhaus

Local Ecosystem and Market Readiness

Dimension	Indicator	Unit of measurement	Source
Market Structure	Affordability	Country %	ITU
	Market concentration	HHI (Herfindahl–Hirschman Index)	APNIC
	AS Hegemony	GINI coefficient (inequality)	IIJ
Traffic Localization	Peering efficiency	% of ASNs peering	PCH/PeeringDB
	Domain count	Domains per 1 million	Zonefiles.io
	Popular Local content	Index %	Tranco List
	E-Government Development Index	Index %	UN

Weighting and Aggregation

Weighting

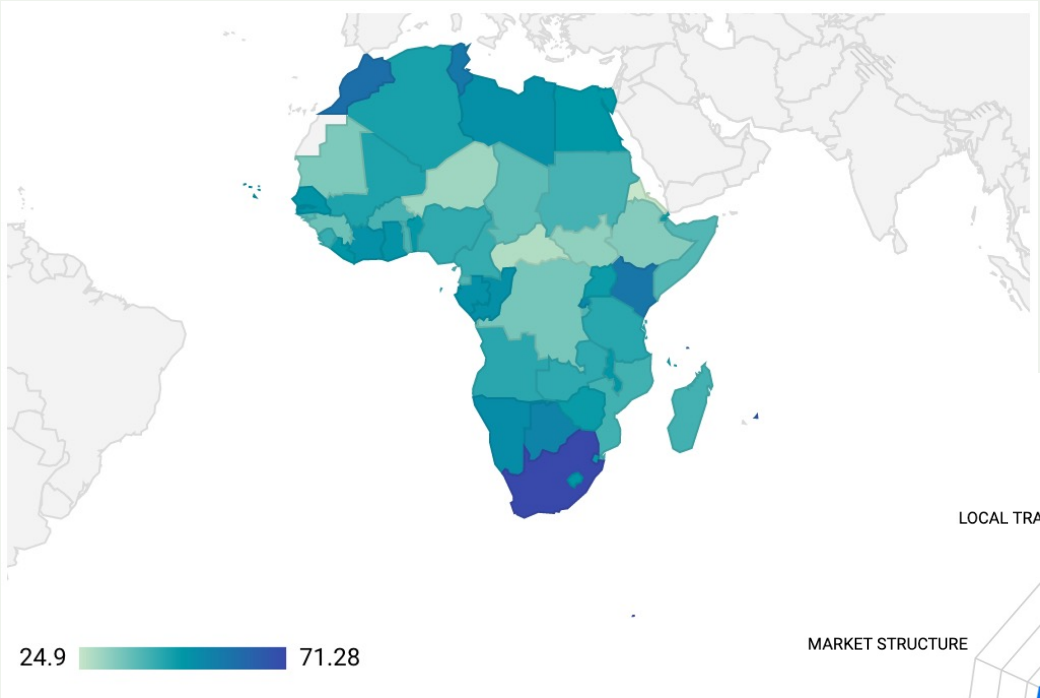
- Statistical relationship between indicators
- Principal Component Analysis
- **Qualitative approach and surveys**
- **Gathered expert opinions**

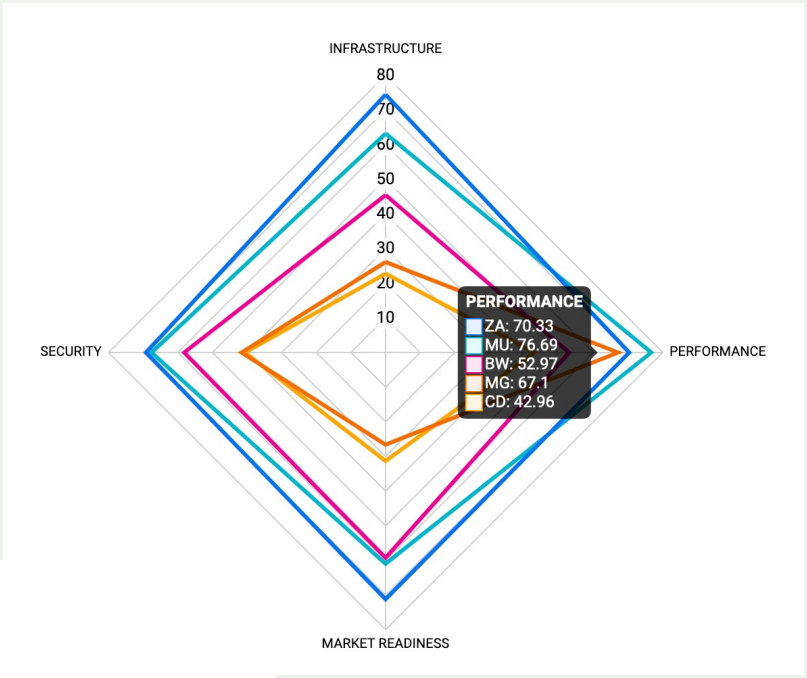
Pillar	Weight	Dimension	Weight
Infrastructure	25 %	Cable ecosystem	40%
		Mobile connectivity	40%
		Enabling infrastructure	20%
Performance	25 %	Fixed networks performance	50 %
		Mobile networks performance	50 %
Enabling technologies and security	30 %	Enabling technologies	20%
		DNS ecosystem	20 %
		Routing hygiene	30 %
		Security threat	30 %
Local Ecosystem and Market readiness	20 %	Market structure	60 %
		Traffic Localization	40 %

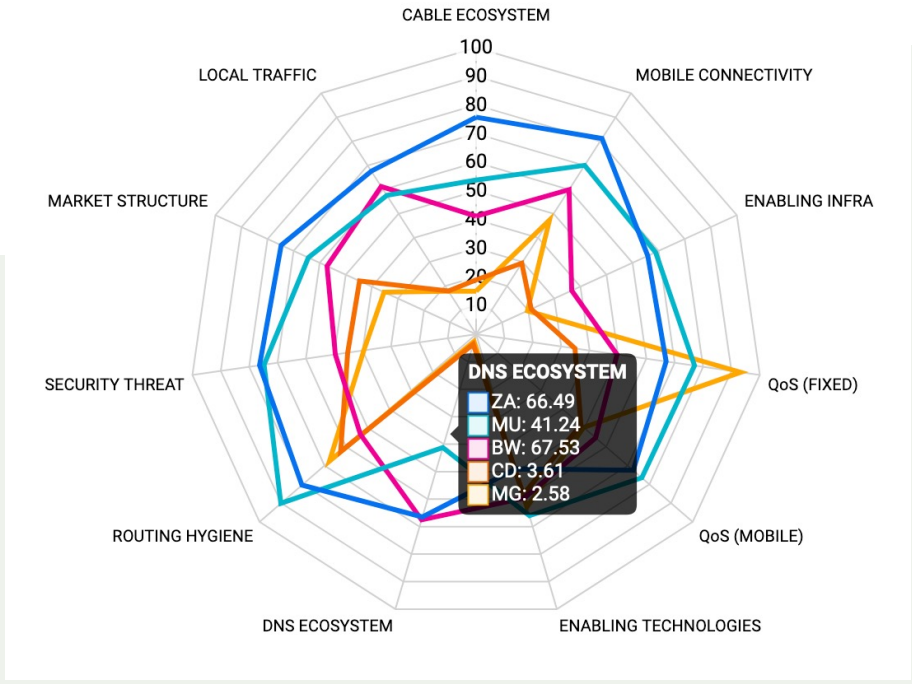
Aggregation

- Once the weights are assigned to the indicators, dimensions and pillars, they need to be aggregated.
- Depends on whether indicators are substitutable e.g. high market concentration but at very affordable prices
- Two aggregation methods
  - Arithmetic aggregation (substitutable)
  - Geometric aggregation (+/- substitutable)
- When comparing the list of indicators, there is a greater degree of substitutabiity as opposed to at the “dimension” or “pillar” level.

Internet Resilience Index



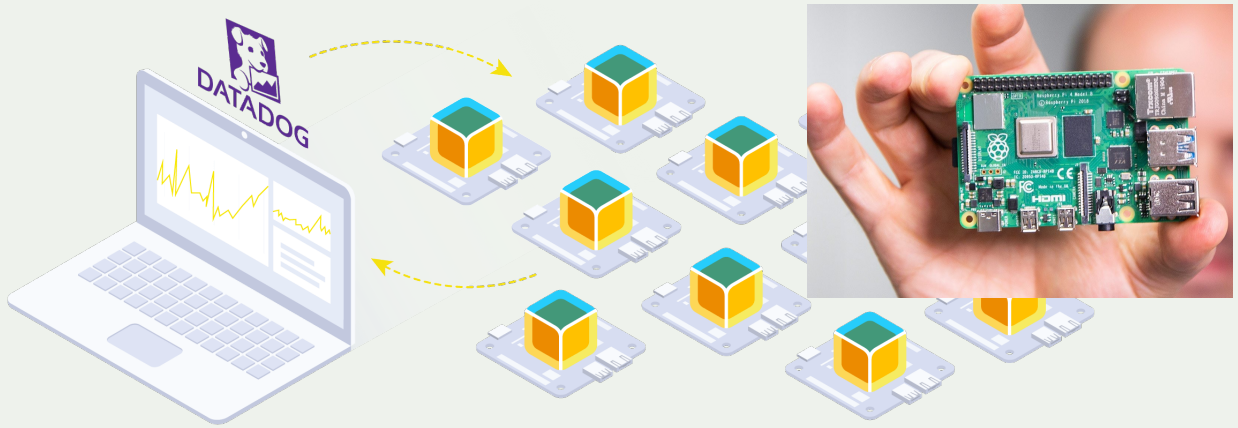




Active measurement infrastructure

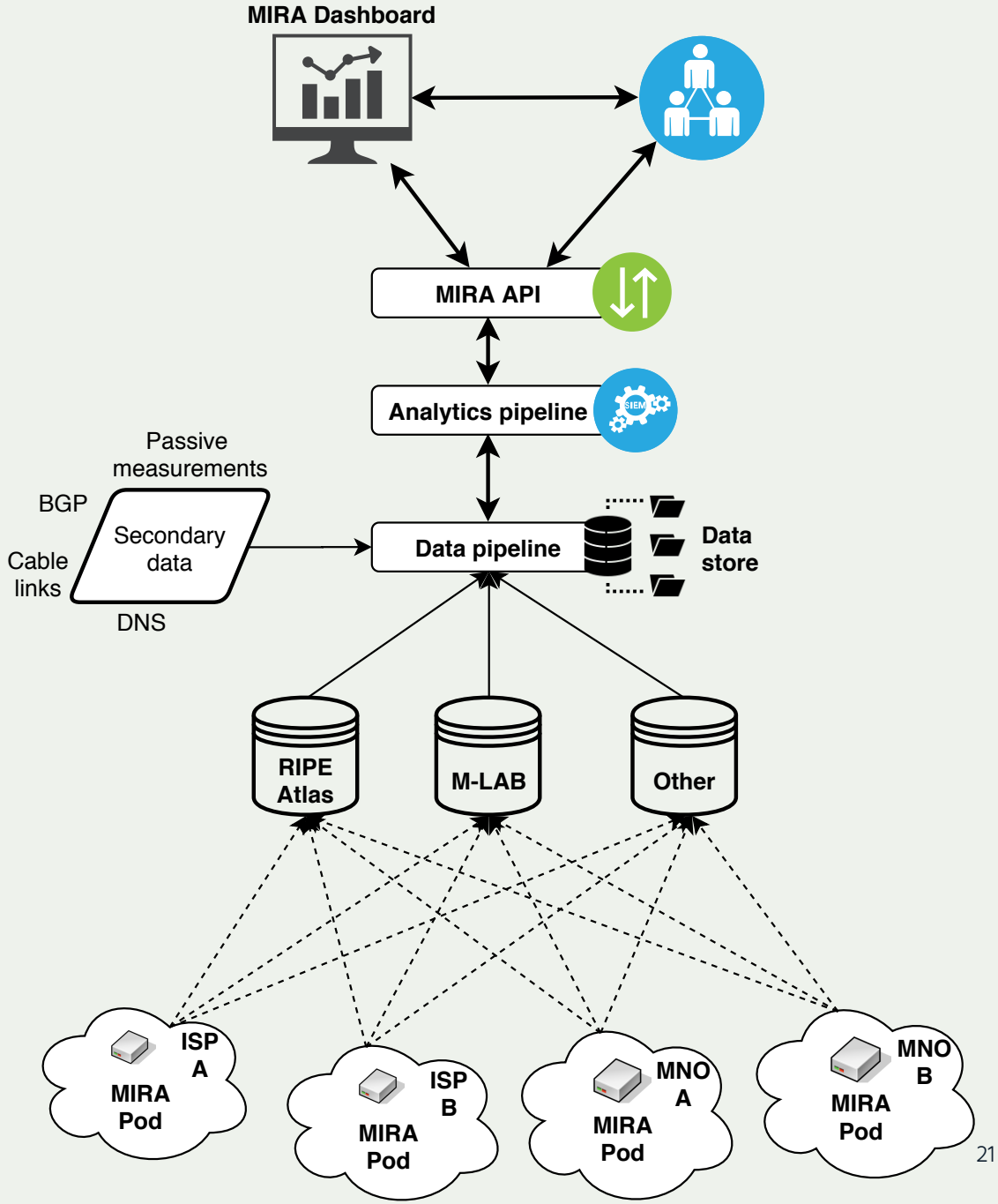
MIRA Pods

- Use of Raspberry PIs as hosts to run the RIPE Atlas & M-Lab clients on Balena OS
- RIPE & M-Lab software clients/servers to be used in the 10 countries
- Measurements will be done in a phased manner and more data sources can be incorporated moving forward



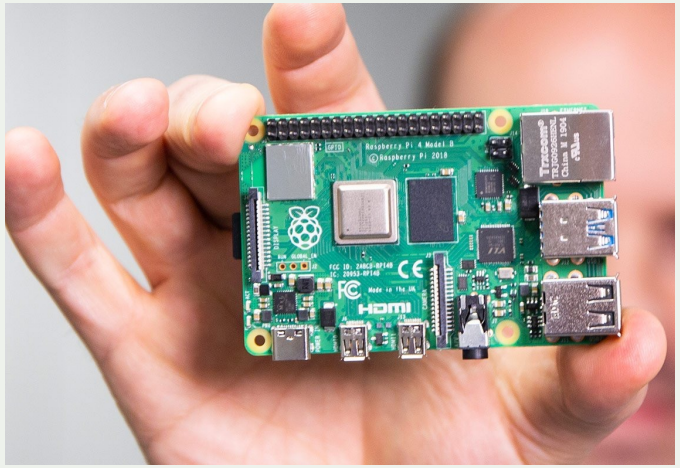
Data pipeline

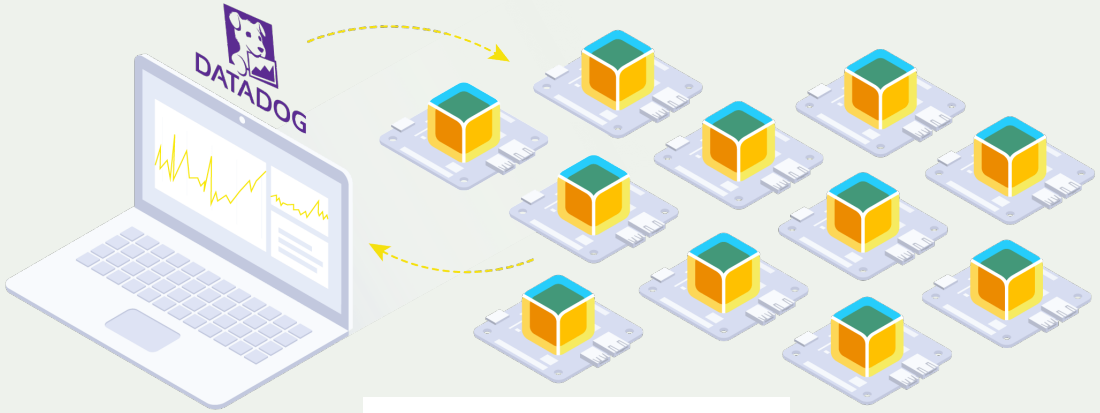
- Primary data sources (MIRA Pods)
- Secondary data sources (BGP, Fibre cables, IXP, market, etc)
- Data pipeline
- Analytics pipeline
- Dashboard and API



Technologies

- Balena OS for Pods orchestration
- Google cloud for data storage
- Google BigQuery for data retrieval
- DataStudio for visualization
- Some on Pulse



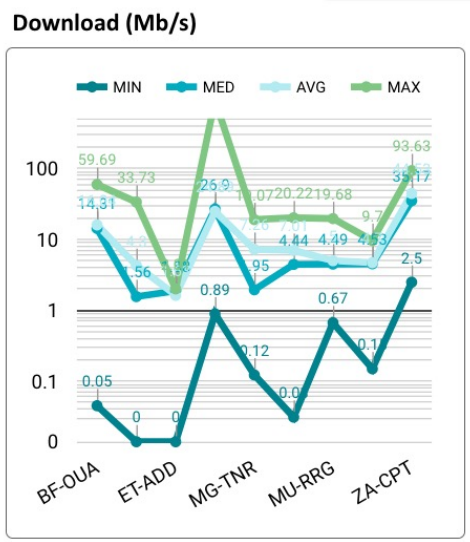


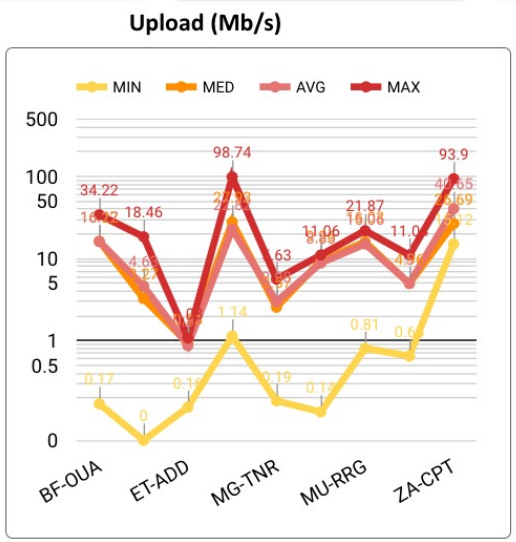
balena

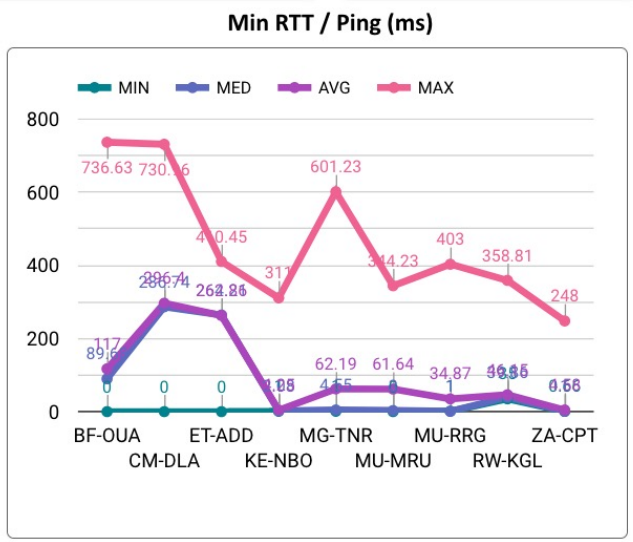
Google Cloud

BigQuery

Live measurements data

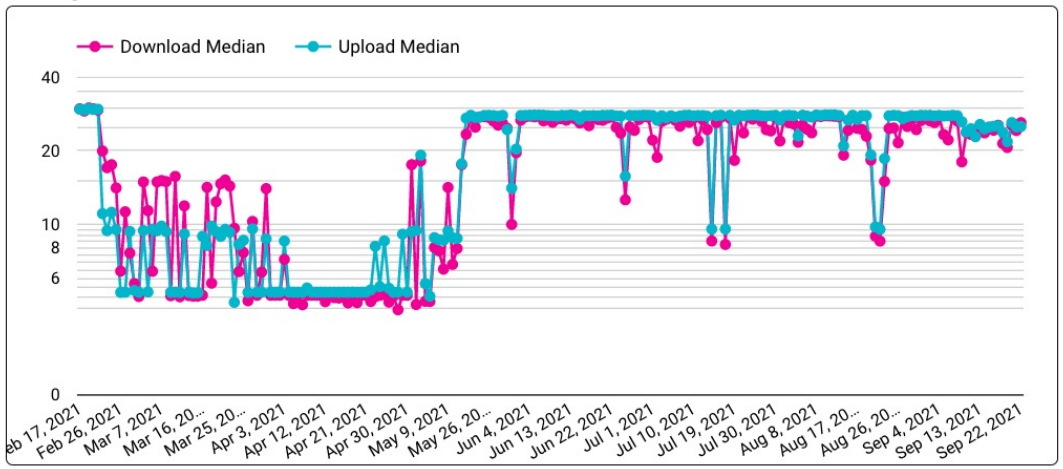






Measurements By:

Day



Test	Server Network/H...	ServerLocati...
ndt7	Telecom Malagasy	Antananarivo, ...
ndt7	Vodafone Group PLC	Lisbon, PT
ndt7	Tunisia BackBone AS	Tunis, TN
ndt7	TATA COMMUNICATI...	Lisbon, PT
ndt7	TENET (The UNINET ...	Cape, ZA
ndt7	TATA COMMUNICATI...	Dallas, US
ndt7	Level 3 Parent, LLC	Lisbon, PT
ndt7	TENET (The UNINET ...	Johannesburg, ...
ndt7	Kenya Education Net...	Nairobi, KE
ndt7	MTN NIGERIA Comm...	Lagos, NG

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NDT7:

- Latency
- Download
- Upload

RIPE ATLAS:

- Ping
- Traceroute
- DNS

Custom:

- Page load time

Upcoming plans

- Visualizing Internet Resilience Index & MIRA pods on ISOC's Pulse platform: – Q4 2021
- Build an interactive dashboard for the Internet Resilience Index
- Expanding partnerships
- Continuing improvements to the Murakami client with the help of M-Lab
- Adding new measurement types and platforms (in the long term)

Thank you.

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