Towards Comprehensive Mapping of Africa's Internet Infrastructure

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Africa's connectivity landscape

Fast-growing user base and infrastructure expansion.

- Data-centres doubled (2017-2024).
- User base grew 285 M → 570 M (2015-2022).
- Cellular coverage gap ↓ 46 % → 13 % in the last decade.
- Heavy reliance on IXPs, mobile ASNs, subsea cables, anycast.

Fine-grained network measurement strategies are needed to steer investment and yield fruits of digital tranformation.

Network measurement approach

Network measurement typically done by sending active probes to IP-"hitlists" to infer topology.

We evaluate hitlists from the following popular measurement setups;

- CAIDA IPv4 Routed /24 Topology Dataset
- ANT internet address hitlist
- Yelling at Random Routers Progressively (YARRP) traceroutes to global BGP routing table (IPV4) from AS 6447

Datasets

Our analysis is based on the following datasets

- CAIDA IPv4 Routed /24 Topology Dataset – 3,908,236 IPs
- ANT IPv4 Hitlist – 5,999,014 IPs
- YARRP traceroutes to global BGP routing table (IPV4) from AS 6447 – 766,263 IPs
- MaxMind Geolite2
- AfriNIC delegated statistics
- IXP data from PCH, Hurricane Electric, and PeeringDB

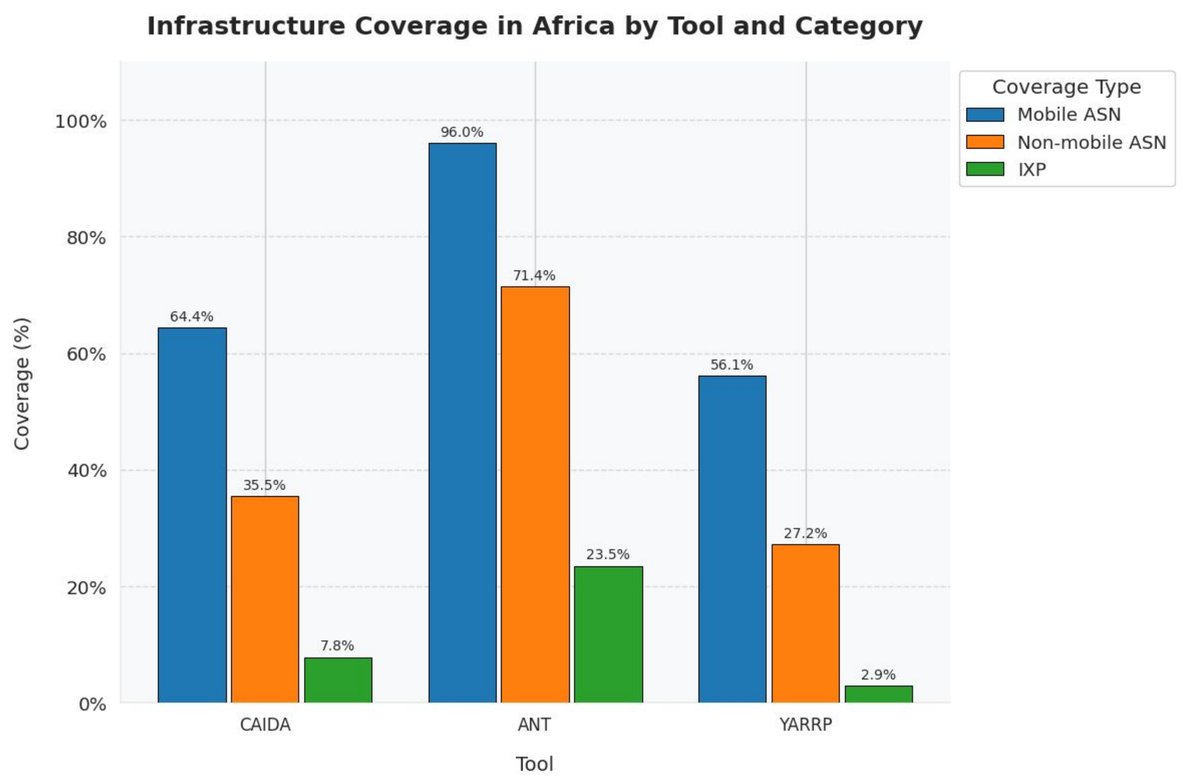
Methodology

1. ***Pre-process every list***
   - Map IP → ASN and geolocate with MaxMind GeoLite2
   - Filter to African space using AfriNIC delegated stats.
2. ***Classify infrastructure***
   - Mobile ASN: Cloudflare Radar with ≥ 65 % mobile-originated traffic.
   - IXP: Peering-LAN prefixes from PCH & PeeringDB directories.
   - Other: all remaining ASNs.
3. ***Compute coverage per class***

Coverage = |observed ASNs| / |known ASNs|.

4. ***Evaluate coverage for African regions***

Infrastructure coverage per tool

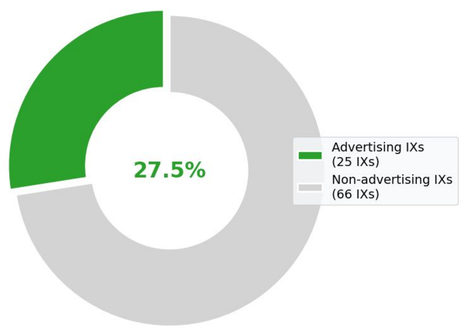


Empirical motivation

The results from the analysis reveal consistently low IXP coverage.

- ANT ≤ 23.5 % IXP coverage; other tools lower.
- Such biases in hitlists can skew the outcomes of measurement campaigns.

Why low IXP coverage



Only 27.5% of African IXP prefixes visible in global BGP tables (used by measurement tools)

Peering LAN prefixes shouldn't be visible as best routing practice.

Towards IXP visibility

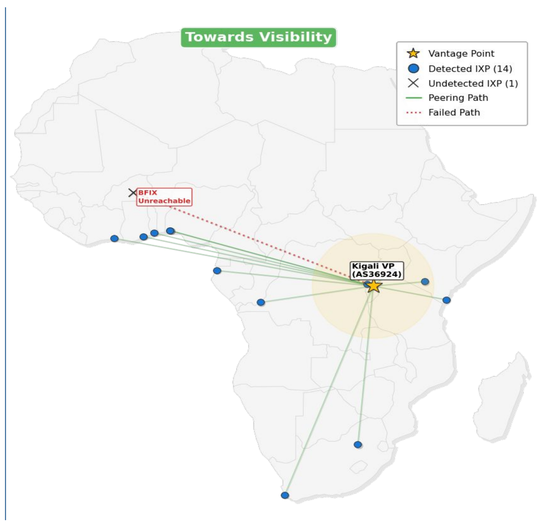
1. ***Target selection***
   - Probe IPs of resources hosted inside IX fabric such as CDN cache.
2. ***Vantage point selection***
   - Probe location rule: ASNs that already peer at the target IXP (or whose immediate upstream does), ensuring the path lands directly on the exchange fabric.
   - Efficiency rule: use a greedy set-cover to pick the smallest such ASN

Primary validation

Vantage point deployed in AS36924, an ISP that peers at 15 African IXPs

Traceroutes from this single node detected 14 / 15 IXPs

18 RIPE Atlas probes with 66.2% African IXP coverage



Future works

Broaden analysis scope to cover other critical infrastructure:

- Submarine cables
- Anycast networks

Ultimately extend analysis to an in depth and comprehensive coverage of Africa's infrastructure.