

# **‘La Terre est Ronde’**: Some Challenges and Contradictions in the Quest for Content Locality

**Innocent Ndubuisi-Obi Jr(He/Him)**

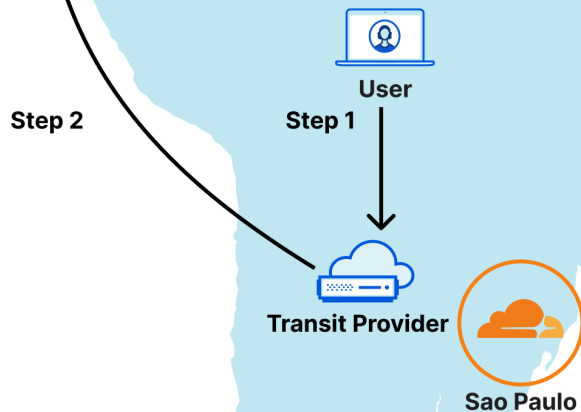
IEFT GAIA  
July 2023

# The content locality problem

“For example, over 50% of the top domains in Brazil and India are hosted in the United States, [...] About half of Kenyan paths to the top domains traverse the United States and Great Britain (but the same half does not traverse both countries). Much of this phenomenon is due to “**tromboning**”, whereby an Internet path starts and ends in the same country, yet transits an intermediate country; [...] Infrastructure alone is not enough. ISPs in respective regions need better incentives to interconnect with one another to ensure that local traffic stays local.”

## Impacts of Tromboning

**Step 1: Congestion on ISP PNI link causes ISP traffic to connect to Cloudflare via transit**  
**Step 2: Transit provider sends traffic to US before returning to Cloudflare**



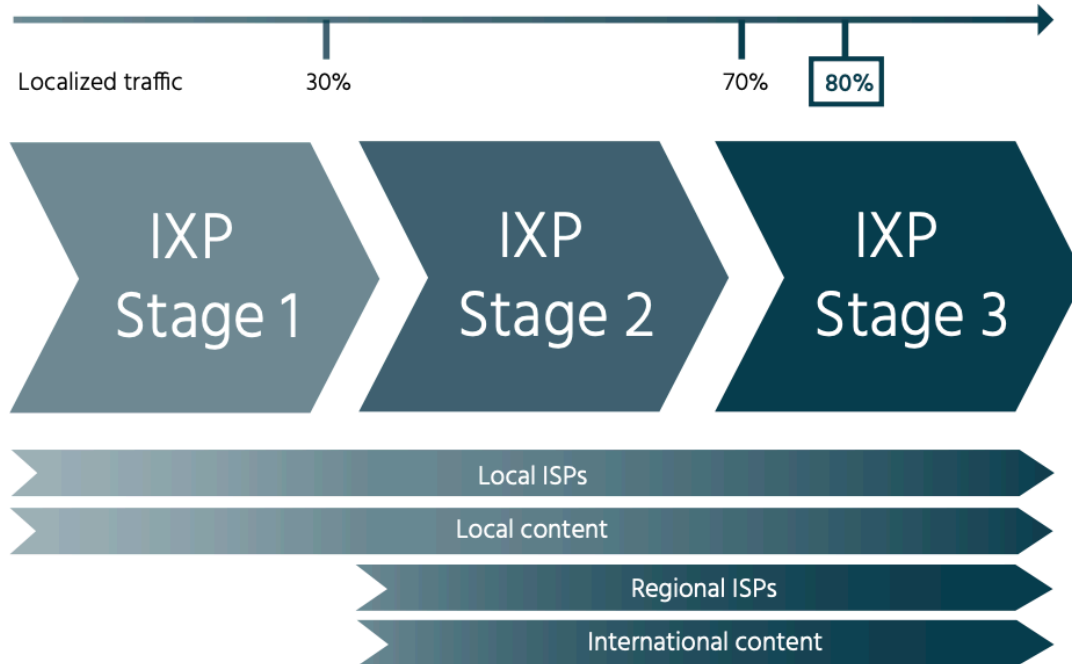
**Source:** <https://blog.cloudflare.com/two-weeks-later-finding-and-eliminating-long-tail-latencies/>

Takeaway I

**Tromboning is a significant issue in the Majority World.**

# The promise of peering: A 'Flat' Internet

Figure 2. Stages of Internet Ecosystem Development



**Source:** Kende, Michael. Anchoring the African Internet Ecosystem: Lessons from Kenya and Nigeria's Internet Exchange Point Growth. 2020. Internet Society

**Internet flattening** refers to a reduction in the number of intermediary organizations on Internet paths[ ...] [T]he Internet becomes flatter when a major content provider expands its own network to bypass transit providers and connect directly with eyeball networks [...] Internet flattening is routinely conflated with the trend towards *more peering*. Indeed, peering relationships are commonly established to bypass transit providers and thus reduce the number of organizations on end-to-end paths

## What is Internet flattening?

more peering = flatter Internet

**Source:** Castro, Ignacio et al. “Remote Peering: More Peering without Internet Flattening.” Proceedings of the 10th ACM International on Conference on emerging Networking Experiments and Technologies (2014)

**Innocent:** **Wait... but is this the correct measure of flattening? It's got a strong layer-3 smell!**

**Everyone:** **Shusssh! Its okay. Nothing to worry about**

# The promise of peering: A 'Flat' Internet

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1

CDNs might want to lower costs and encourage direct and settlement-free traffic exchange.

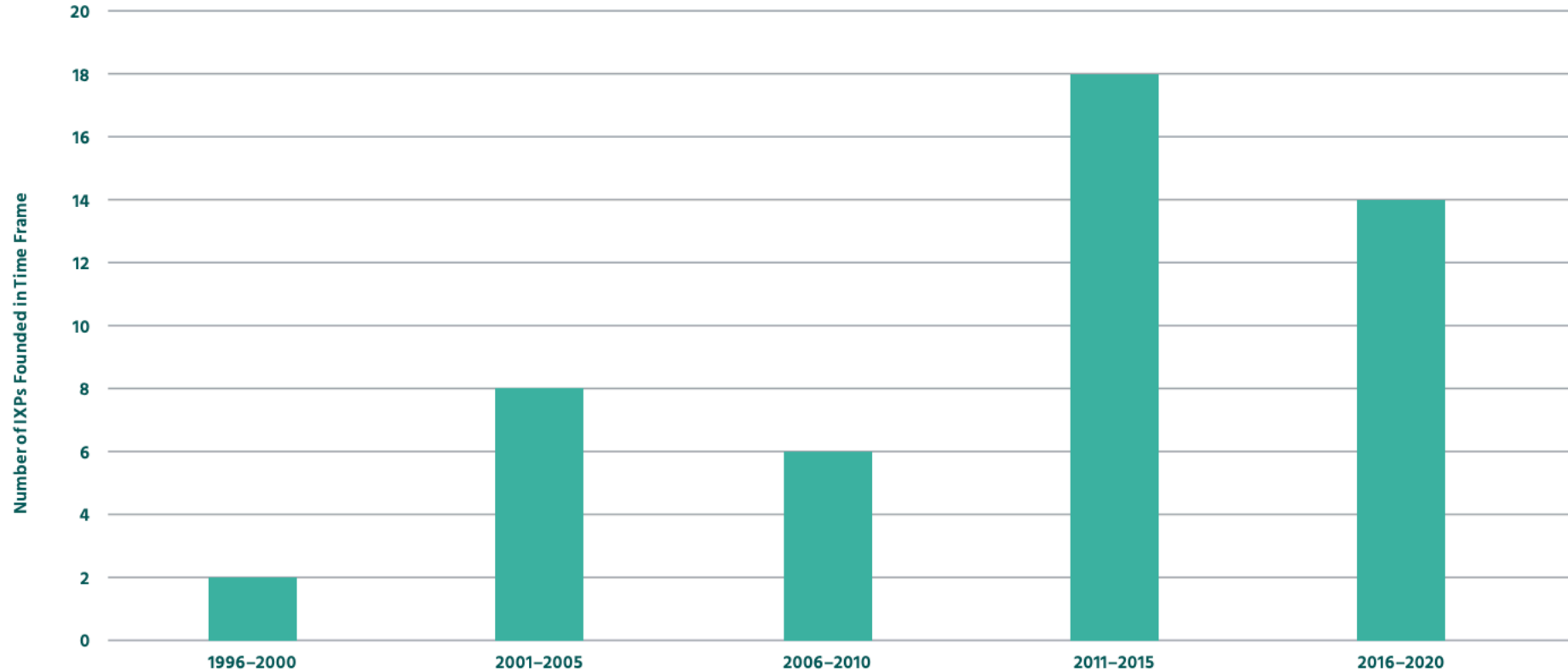
2

ISP with lots of eyeballs may want to connect directly to other large ISPs

3

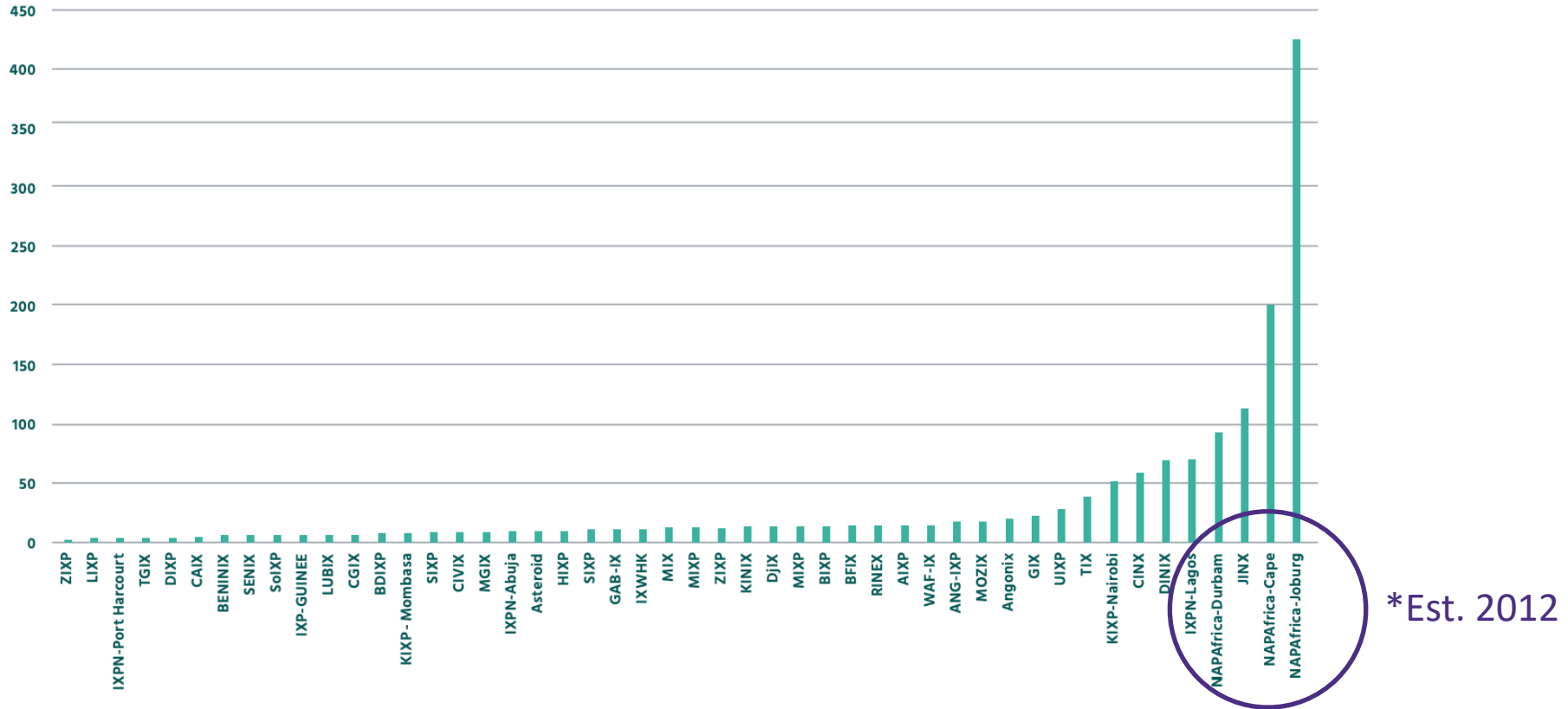
Transit networks may want to sell services to ISPs

Figure 5. African IXPs: Years Founded (Source: Af-IX, 2020)



Source: Kende, Michael. Moving Toward an Interconnected Africa: The 80/20 Initiative. 2021. Internet Society

Figure 6. Number of Connected Networks (Source: IXP surveys, IXP websites, 2020)



Source: Kende, Michael. Moving Toward an Interconnected Africa: The 80/20 Initiative. 2021. Internet Society

Takeaway II

**Peering at IXPs can keep traffic local.**

# Caches + PoPs at IXPs. Win!?

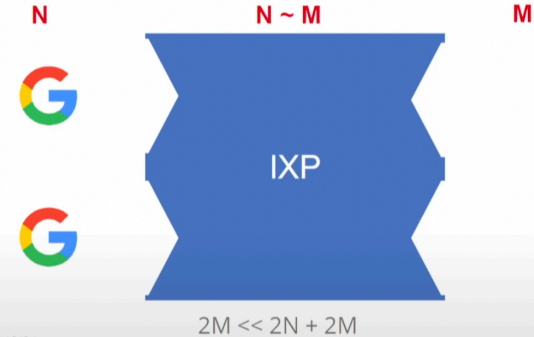
Developing the environment - Low developed markets, low traffic

Interconnection was already solved - New IXP doesn't add value



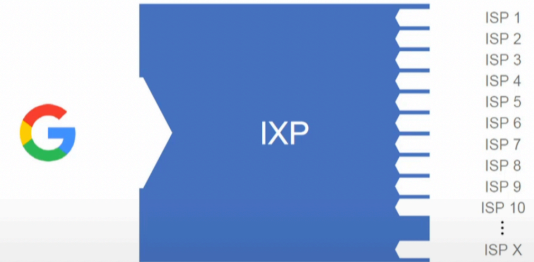
Flowcharts & Diagrams

Big ISPs - Duplication of ports, miss-use of transmission

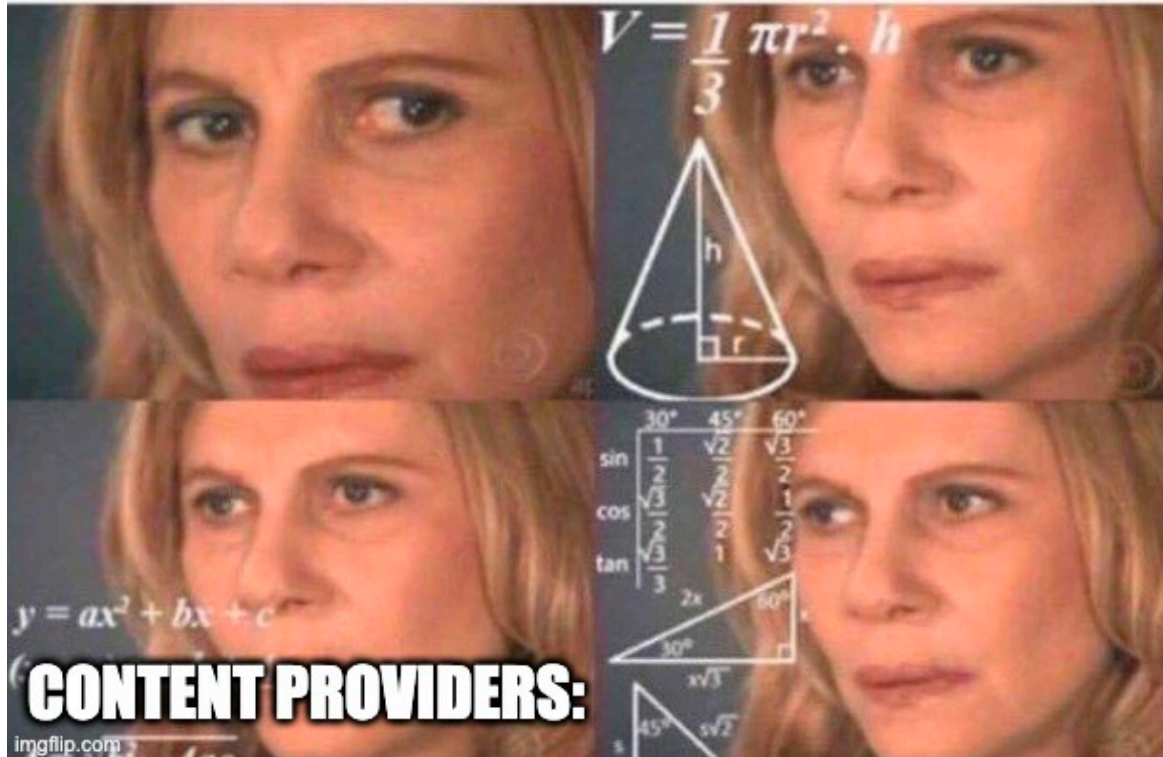


Well developed, High traffic, too many ISPs

Optimizing use of Ports - Well developed markets, high Traffic

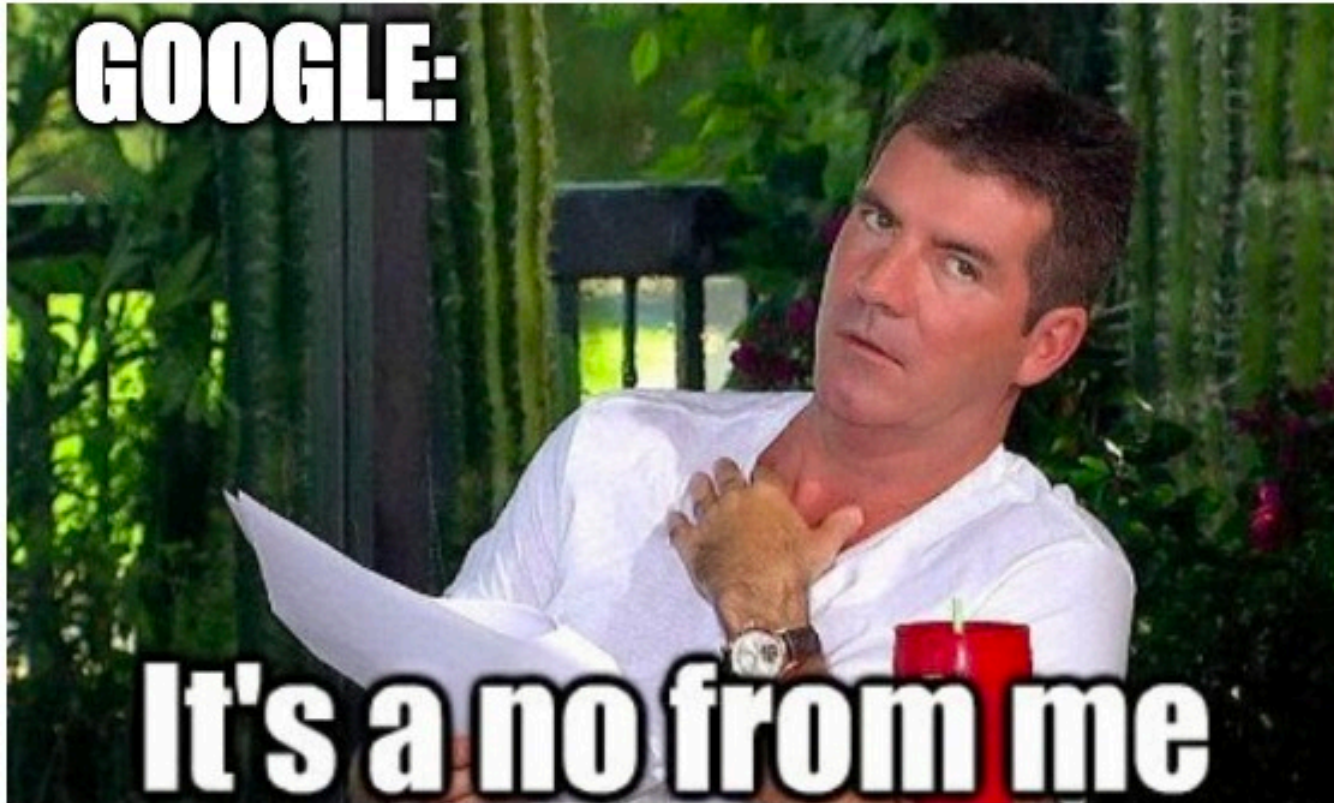


# ISP: CAN WE PLEASE GET A CACHE?

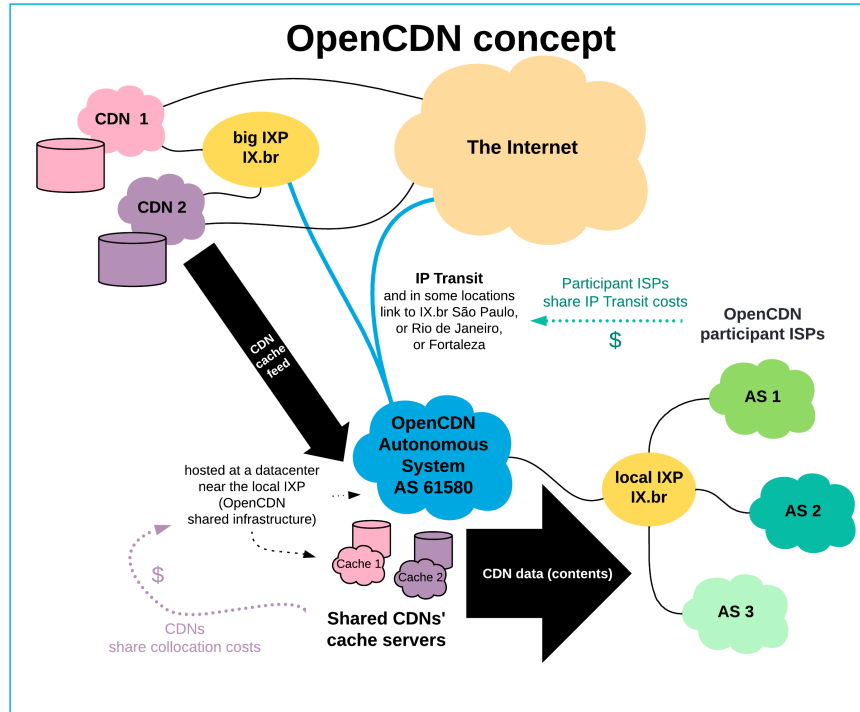


**CONTENT PROVIDERS:**

imgflip.com



# So, let's just share a cache?



OpenCDN is a **shared infrastructure initiative** that helps **CDNs to reach Brazilian Internet users with low delay and high quality**. It does that lowering the barriers to the CDNs to install their own cache servers in shared infrastructures, that are connected to a growing number of IX.br's IXPs

# Cache games



## REQUEST FOR PROPOSAL

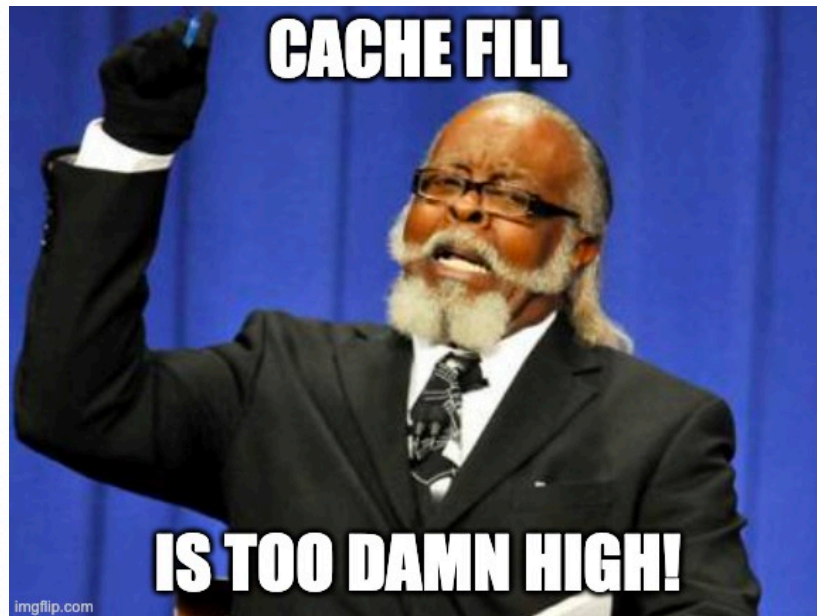
**Request for proposals from Internet Peering Communities in Africa for supplementary funding toward Internet Transit connectivity and capability to be used for downloading content onto CDN Cache(s) connected to the IXP, for the benefit of the participating Peers.**

### Background

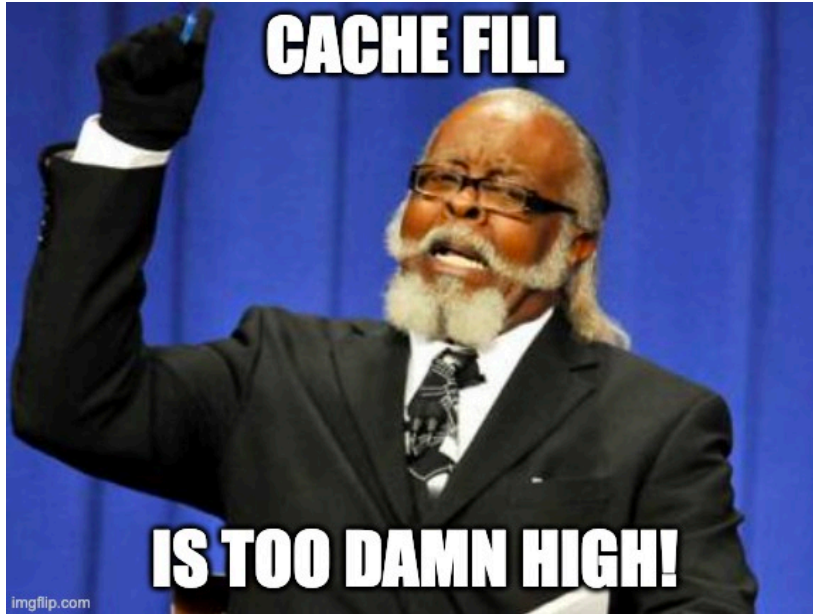
At the end of 2018, there were 45 IXPs located in 40 cities across 33 countries in Africa. Many of these IXPs were established within the last decade and have demonstrated significant growth during this period in connecting traditional operators. The next phase of IXP growth will require even more innovative approaches to attract non-traditional operators and in particular content producers who are unaware of their value proposition in the Internet interconnection ecosystem.

As a way forward, IXP operators will need to enhance their level of collaboration and cooperation with their members, partners and community as a whole, to address some of the barriers that may inhibit content creation and localization.

In this regard, the Internet Society in partnership with Facebook are aiming to support at least five internet peering communities (coordinated through IXP representatives) in Africa with supplementary funding for Internet Transit connectivity to be used to connect and serve **ANY** CDN Cache(s) connected to the IXP.

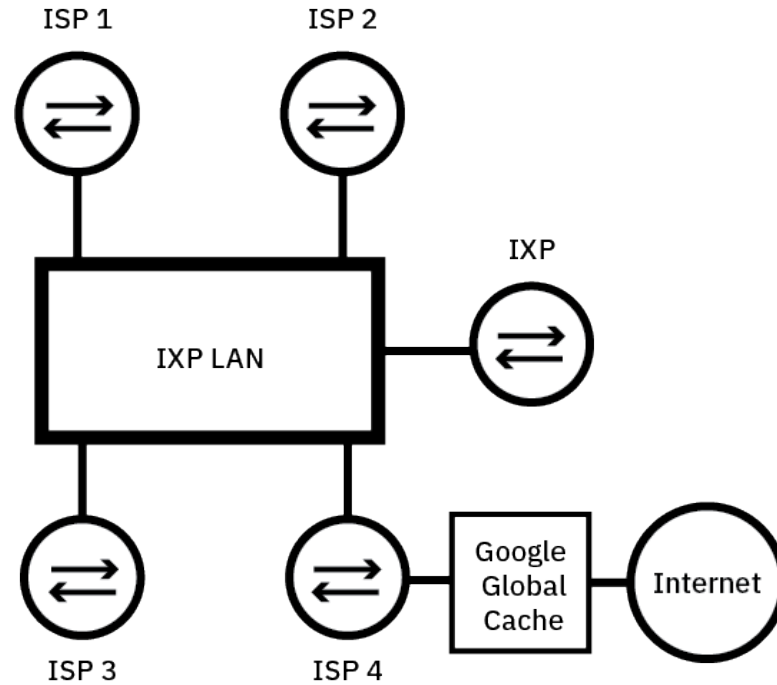


# Cache games

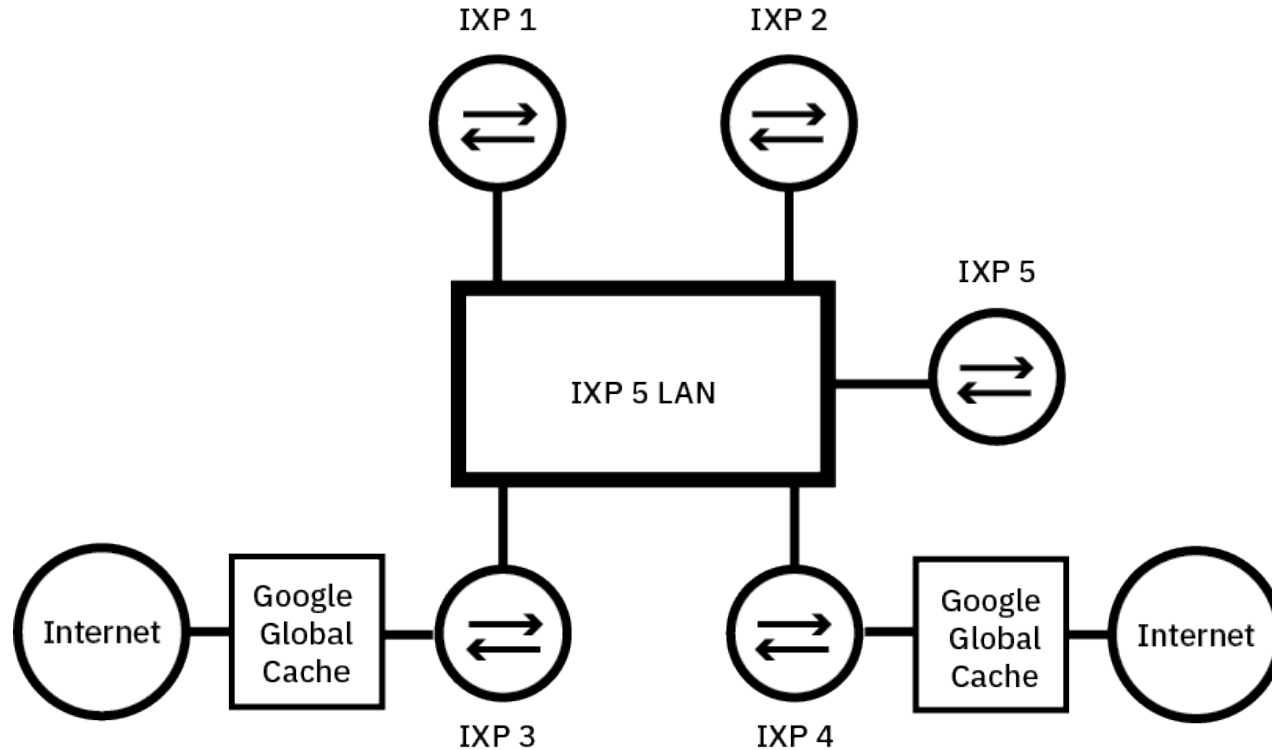


- Off-nets exist but many networks do not have enough eyeballs to warrant an edge cache
- Recent proposals to share cache infrastructure
- However, when caches are behind a peer's network there is instability which requires incentive alignment
- We identify two types of games

## Problem A: The Inter-ISP Cache Sharing Game

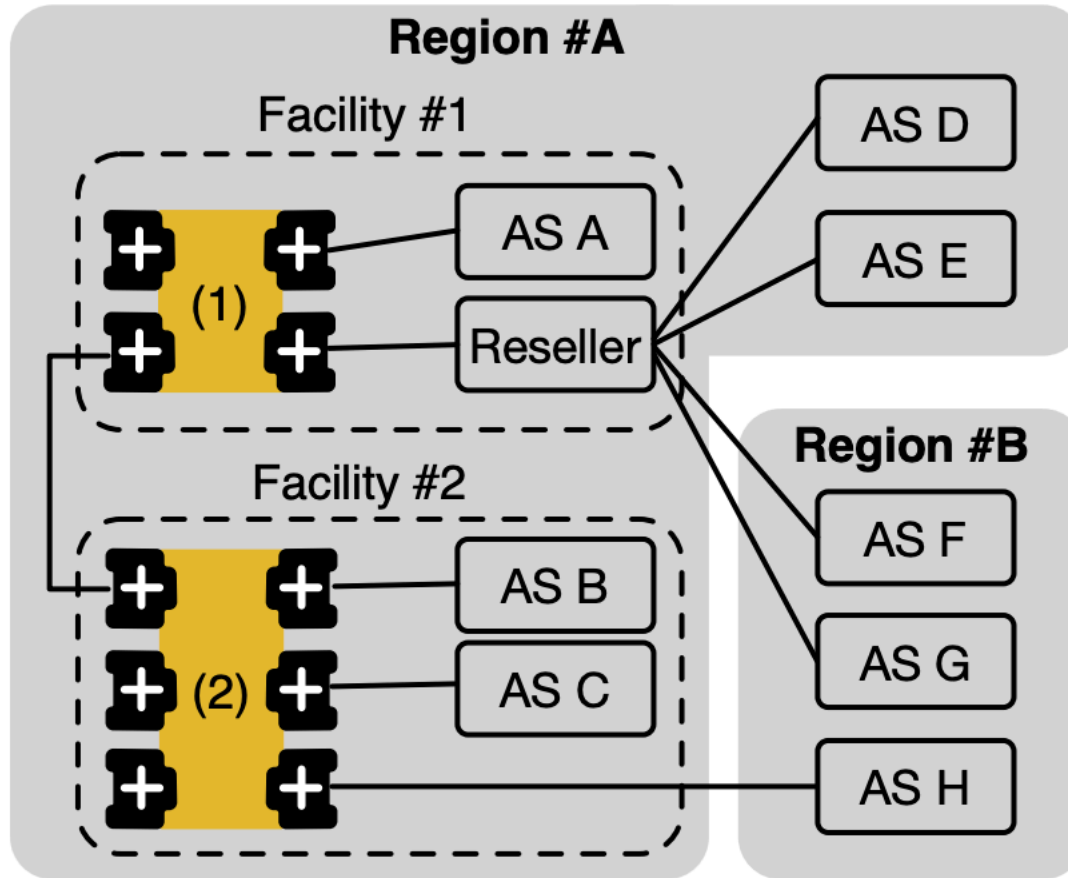


## Problem B: The Inter-IX Cache Sharing Game



### Takeaway III

**Coordination and cooperation is still difficult even in the presence of IXPs.  
The ‘content problem’ is also relational.**



## The reality of peering

ISPs connect to an IXPs without having **physical presence** at their switching infrastructure

- Its very common
- Drive IXP growth
- Very contentious

**Source:** Mazzola, Fabrício M. et al. "On the Latency Impact of Remote Peering." *Passive and Active Network Measurement Conference* (2022).

| IXP       | Reseller RP latency |               | Geographical RP latency |               |
|-----------|---------------------|---------------|-------------------------|---------------|
|           | Remote lower        | Transit lower | Remote lower            | Transit lower |
| PTT-SP    | 8,886 (74.2%)       | 3,085 (25.8%) | 5,657 (72.0%)           | 2,205 (28.0%) |
| LINX      | 10,342 (77.7%)      | 2,973 (22.3%) | 2,724 (71.0%)           | 1,108 (29.0%) |
| AMS-IX    | -                   | -             | 2,651 (57.6%)           | 1,950 (42.4%) |
| NAPAfrica | -                   | -             | 1,787 (98.1%)           | 35 (1.9%)     |
| PTT-RJ    | 1,929 (64.9%)       | 1,045 (35.1%) | 1,113 (59.6%)           | 754 (40.4%)   |
| PTT-CE    | 3,014 (71.7%)       | 1,190 (28.3%) | 2,648 (71.3%)           | 1,065 (28.7%) |
| Eq-Ash    | -                   | -             | 708 (28.9%)             | 1,740 (71.1%) |
| Eq-Chi    | -                   | -             | 1,204 (94.6%)           | 69 (5.4%)     |

Table 6: Latency comparison between remote peering or transit, showing the number of prefixes with lower latency. For Reseller RP, in four IXPs, at least 64.9% of the prefixes had lower latency via Reseller RP routes than via transit. For Geographical RP, seven of eight IXPs had at least 57.6% of prefixes with lower latency via remote peering routes than via transit.

# Epsilon Extends Remote Peering To South Africa With NAPAfrica

PRESS RELEASE

## Epsilon Extends Remote Peering To South Africa With NAPAfrica

July 23, 2020

July 23, 2020

## Remote NAP Africa Ports



In addition to Network Platforms' peering at NAPAfrica, JINX, DINX, CINX, LINX, AMS-IX and DE-CIX we offer our clients the opportunity for remote peering to any of these peering exchanges without having to invest in infrastructure costs in these locations.

The partnership enables Epsilon customers across the globe to efficiently expand their network presence in South Africa within the Teraco-hosted IX

Read time: 3 minutes

# SEACOM introduces NAPAfrica remote peering service

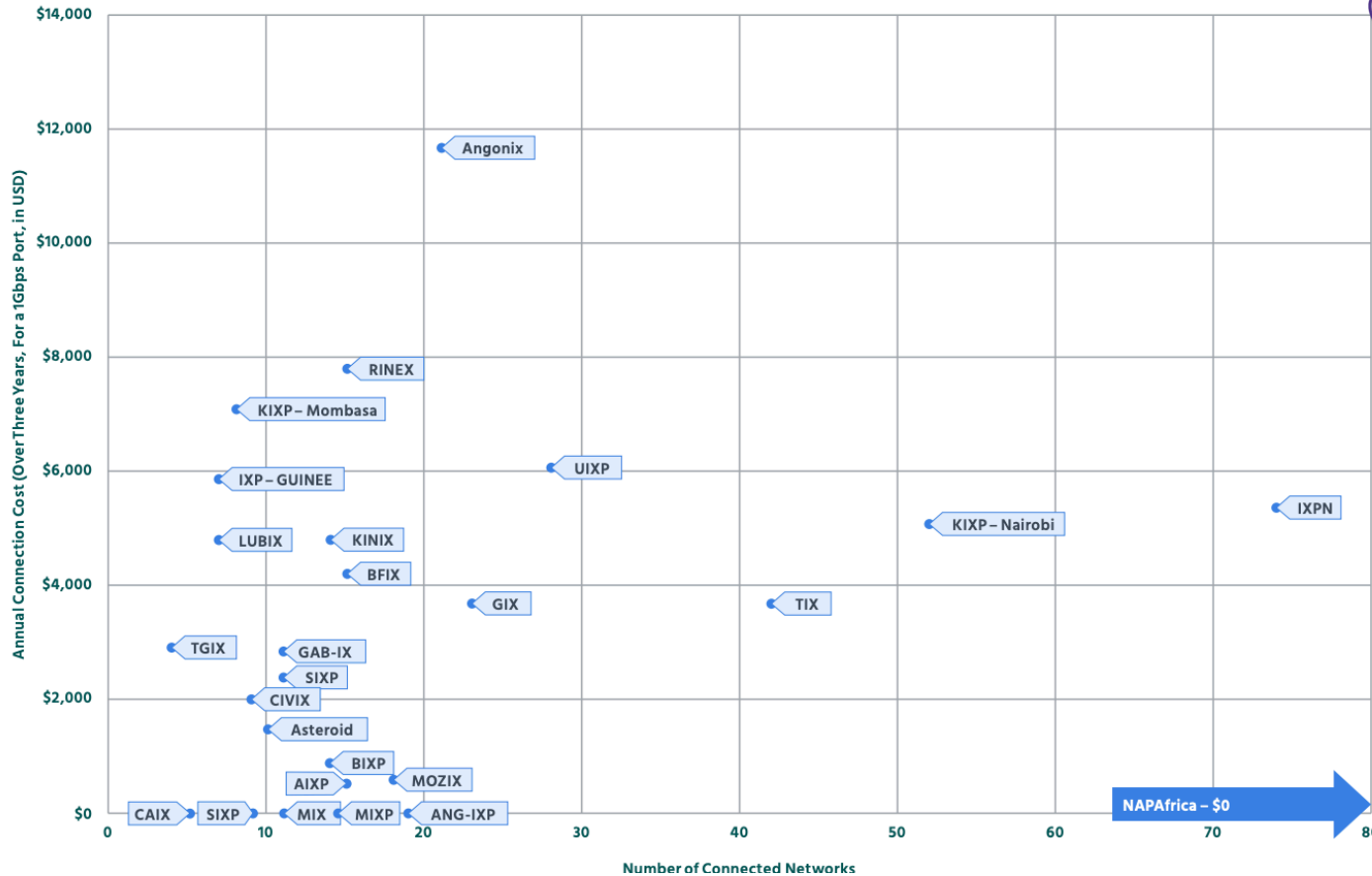


By Staff Writer



Africa, 16 Sep 2014

SEACOM introduces NAPAfrica remote peering service



**What is going on behind the scenes?**


# Decisions, Decisions!

1

to BGP,  
all\* paths are local.

2

```
if transit then:  
    send packettransit  
else peering:  
    if local then:  
        send packetlocal  
    else remote  
        send packetremote
```

we know, partially:  
latency(  ,  )

we don't know, :  
latency(  ,  )

\* Routes exchange via peering with a route server or with peers at an IX

Takeaway IV

**Wait, so what does this mean?**

# Vantage points and our measures

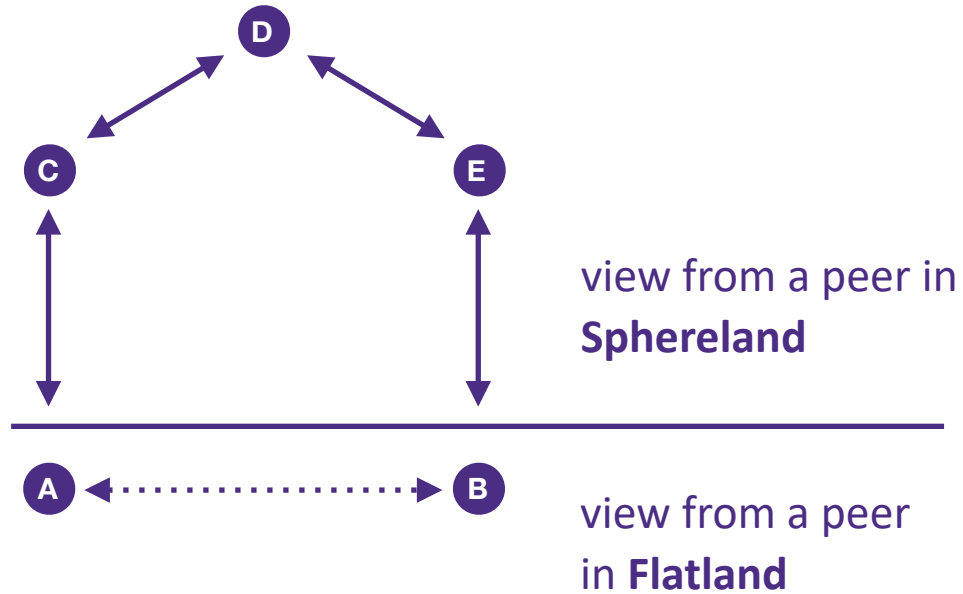
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- > State-of-the-art measurement are developed around Western networks
- > What does this mean at the level of content traffic for the Global CDNs?
- > What does this mean for the story of ‘local content’? Is ‘cheaper’ now synonymous for ‘local’?

Takeaway V

**You can't fix what you can't measure.**





# Flatland: A Romance of Many Dimensions

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## 1. Of the Nature of Flatland

I CALL our world Flatland, not because we call it so, but to make its nature clearer to you, my happy readers, who are privileged to live in Space. Imagine a vast sheet of paper on which straight Lines, Triangles, Squares, Pentagons, Hexagons, and other figures, instead of remaining fixed in their places, move freely about, on or in the surface, but **without the power of rising above or sinking below it, very much like shadows - only hard and with luminous edges - and you will then have a pretty correct notion of my country and countrymen.** Alas, a few years ago, I should have said "my universe": but now my mind has been opened to higher views of things.

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**Thanks for listening! Thoughts?**

**W**