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State of The Art of Internet Exchange Points

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***Abstract*:** *Internet exchange points (ixps) are critical components of the Internet infrastructure that affect its performance, evolution, security and economy. During our research some long-standing questions have been addressed, namely whether there are methods capable of detecting ixps. How to do it between a source and a destination on the Internet. However, the architecture of the Internet has been changed in recent years due to the rapid evolution of the infrastructure (ixps) which have implemented a new policy called peering .This paper highlights an approach based on methods to help detect Ixps on the traceroute path, as network administrators and researchers want to know where Internet data is transiting. Some researchers have developed methods for detecting ixps . But with the rapid evolution of the ixp ecosystem these methods have shown their limitations . Our contribution for this paper is to present the various previous studies that address the problems of IXPS*

Keywords: *Detection, IXP, Measurement Tools*

1. Introduction

Previous studies have examined the problem of mapping traceroute paths to AS-level paths. This mapping of IP addresses to ASes is not straightforward, as routers may respond with numbered source IP addresses from a third-party AS. These addresses are used to number the interfaces of BGP routers connected to the IXP subnet, and it is difficult to identify the AS to which they belong. Other approaches have also been used to detect IXP and its connected members . In this paper, we will present the different approaches that deal with the detection of IXP and their connected members

2. How IXPS Work

For an IXP to work, it needs switches, routers, servers, a neutral location, appropriate power sources, cooling, security and a technical community of experts to operate and manage the IXP

2.1. Topology of IXPS

A computer network topology is the architecture (physical, software or logical) of the network, defining the links between network devices and any hierarchy between them. IXPs generally provide a Layer 2 structure to member networks

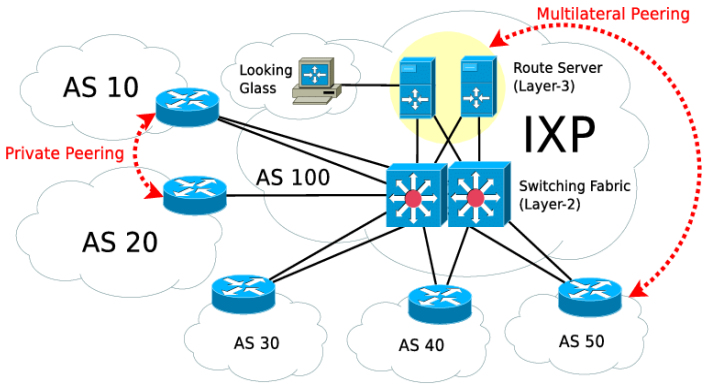

Fig 1 is an architecture of an ixp network with 5AS doing public and private peering

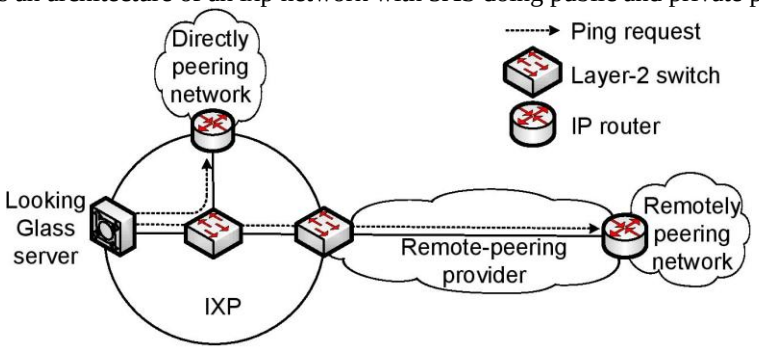

Fig 2: Remote pairing at an ixp

2.2. Analysis of the Largest National Internet Exchange Point Ecosystems

Based on the BGP data of all the mirror servers of the exchange point in Brazil(IX.br) some researcher like. Bucke Brito, SH, Silva Santos, MA, dos Reis Fontes, R Lachos Perez, DA, Lourenço da Silva, H., & Esteve Rothenberg, in their research work have provided an in-depth analysis how to identify the largest set of public IXPs in Brazil. They demonstrated that the Brazilian public peering ecosystem has more than 25 IXPs maintained by a global project called IX.br and that its ixps follow a non-profit model to facilitate multilateral agreements. From a national perspective by inspecting the properties of connectivity graphs and the distribution of IPv4 and IPv6 prefixes. Their contribution is to Telnet to the looking glass servers. A comparative study was possible between the Brazilian exchange point in relation to the different exchange points such as AMS-IX, DE-CIX, LINX and MSK -IX.

Algorithm 1 Script to collect raw data from IXPs.

Input: *code*[**ixp1, ixp2, ixp3, ... , ixp25**] in

LOOP Process

1: **for** $i = code[1]$ to $code[25]$ **do**
2: telnet lg.$code[i]$.ptt.br
3: $code[i]$-IPv4.txt ← sh ip bgp
4: $code[i]$-IPv6.txt ← sh ipv6 bgp
5: $code[i]$-Paths.txt ← sh ip bgp paths
6: $code[i]$-Comm.txt ← sh ip bgp community
7: *quit telnet session*
8: **end for**

Fig 3: Script for collecting raw IXP data

Figure 3 shows an algorithm that collects raw ixps data from a Looking Glass (LG) server using Telnet [RFC8522].

TABLE I: shows the different Brazilian ixps with the different members

#	City	State	Code	Avg Gbps	Members
01	Belem	PA	**BEL**	0.41	14
02	Belo Horizonte	MG	**MG**	2.33	33
03	Brasilia	DF	**DF**	6.18	31
04	Campina Grande	PB	**CPV**	0.62	10
05	Campinas	SP	**CAS**	4.98	36
06	Cuiaba	MT	**CGB**	0.78	9
07	Caxias do Sul	RS	**CXJ**	0.93	5
08	Curitiba	PR	**PR**	16.66	67
09	Florianopolis	SC	**SC**	1.32	35
10	Fortaleza	CE	**CE**	3.21	30
11	Goiania	GO	**GYN**	1.06	24
12	Lajeado	RS	**LAJ**	0.14	8
13	Londrina	PR	**LDA**	2.85	31
14	Manaus	AM	**MAO**	0.03	9
15	Maringa	PR	**MGF**	0.42	21
16	Natal	RN	**NAT**	0.32	13
17	Porto Alegre	RS	**RS**	36.39	122
18	Recife	PE	**PE**	1.26	17
10	Rio de Janeiro	RJ	**RJ**	61.70	73
20	Salvador	BA	**BA**	2.39	48
21	Sao Carlos	SP	**SCA**	0.00	3
22	Sao Jose dos Campos	SP	**SJC**	0.06	13
23	Sao Jose do Rio Preto	SP	**SJP**	0.03	11
24	Sao Paulo	SP	**SP**	550.68	686
25	Vitoria	ES	**VIX**	0.70	21

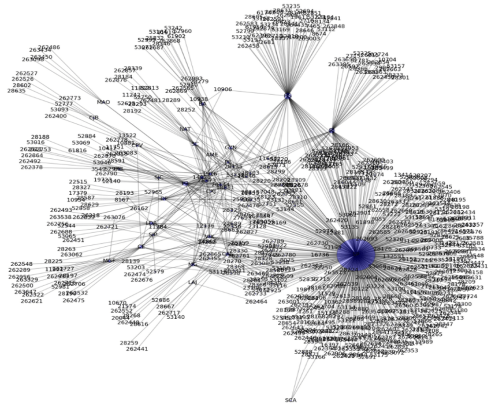

Fig 4 presents a mapping of Brazilian ixps with a strong relationship of SAs around

2.3. Measuring the influence of a pandemic on the Internet peering ecosystem

The corona virus has been an indicator for some computer science research. During the covid a finding was made in the PeeringDB dataset between January 2020 and June 2020 to determine the drivers of the increase in ixp capacity LOYE Justin, MOUYSSET Sandrine, and JAFFRÈS-RUNSER Katia during their research on the Internet during containment. A large part of their study was essentially based on PeeringDB which presents the global interconnection of networks at the level of Internet exchange points (ixp). Their analysis then illustrated some relevant features in the evolution of ixps. From an analysis of the reduced Google matrix it reveals an increase in the capacity deployed by large content delivery networks such as Netflix or Facebook to ISPs in Spain, Brazil, India, Poland or Italy.

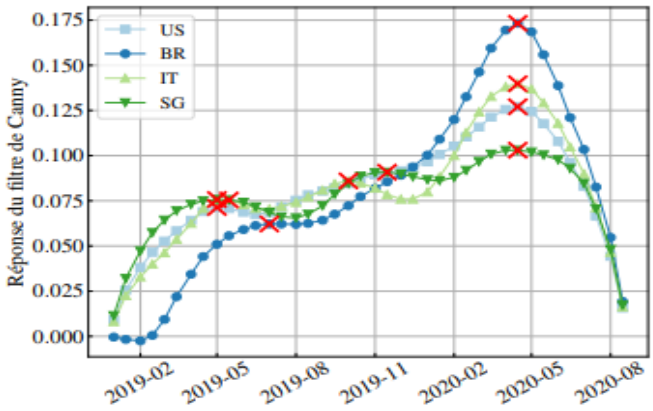

Fig 5: Response of the canny filter

Figure5 reveals the increase in capacity deployed by large networks

TABEII: Best PageRank and Inverse PageRank from PDB c-graph

	PageRank graphe pDB	PageRank graphe de [NSD17]	PageRank Inversé graphe pDB
1	IX.br São Paulo	IX.br São Paulo	IX.br São Paulo [+0]
2	DE-CIX Frankfurt	DE-CIX Frankfurt	DE-CIX Frankfurt [+0]
3	AMS-IX	AMS-IX	**Facebook [+0]**
4	LINX LON1	LINX LON1	AMS-IX [+0]
5	**Amazon**	EPIX.Katowice	**Akamai [+0]**
6	Equinix Singapore	NAPAfrica IX	**Netflix [+2]**
7	NAPAfrica IX	IX.br Rio	LINX LON1 [+0]
8	SIX Seattle	SIX Seattle	**Google [-2]**
9	IX.br Rio	France-IX Paris	**Microsoft** [+1]
10	NL-ix	NL-ix	**Apple [-1]**

Table2 makes a score ranking thanks to the PageRank algorithm

3. Internet-Wide Traceroute Study

Despite the critical role of ixps in the world, little is known about them in terms of peering matrices (i.e., who is peering with whom at which IXP) this problem was addressed by Brice Augustin, Balachander Krishnamurthy, Walter Willinger in their study for the ixps detection mechanism on traceroute. Their method for detecting ixps is based on traceroute. To illustrate their method they explain from Fig 6.

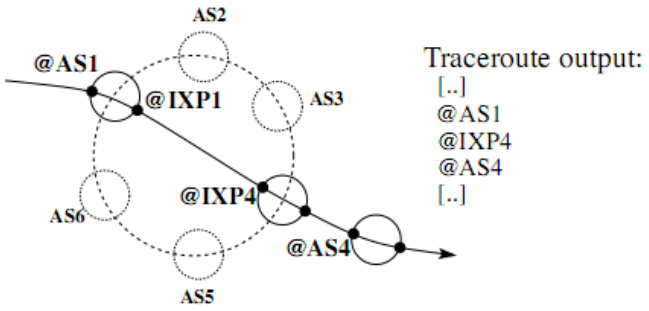

Fig 6: A Typical IXP Architecture With 6 AS Members. Subnetwork

In Figure 6, the interface IP addresses facing the ixps for AS1 and AS4 are designated @ixp1 and @ixp4, respectively. This general practice is crucial for identifying the IXPs in a traceroute path.

3.1. D. References

Internet exchange points (or ixp) are critical elements of the current Internet architecture [1], [2], [3]. During this time some institutions like PCH PeeringDB have databases to allow researchers to know their number [4], [5]. Different approaches have also used methods to detect ixp [6], [7]. Our paper aims to make a comparative study between traIXroute [8] and Burkina traIXroute [9]. Most of the measurement tools work as traceroute code and use traceroute and scamper in the background . Our contribution to ixp detection has led to the integration of new databases MaxMind and IP2location . The IPV6 system is advancing rapidly and our tool is intended to support its functionality

4. Conclusion

In conclusion, our review of the state of the art on IXPs has enabled us to gain a better understanding of the importance and operation of these Internet exchange points. We have studied various publications, articles and research on the subject, which has enabled us to highlight the following key points:

- IXPs play a crucial role in improving Internet connectivity by enabling Internet Service Providers (ISPs) and networks to connect directly to each other, thus promoting the local exchange of Internet traffic. In summary, our state of the art has enabled us to see the importance of IXPs in the Internet infrastructure and to highlight the different detection approaches used. This in-depth knowledge will serve as a solid basis for our own research and our contribution to improving IXP detection.

5. Acknowledgment

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KIENTEGA Raoul was born in BURKINA FASO. Research professor in computer science, specializing in networks and computer systems. Author of several scientific articles published in International Multidisciplinary Information Technology and Engineering Conference (IMITEC) ,Journal of Advances in Computer Networks (JACN) . enrolled in the laboratory of computer mathematics at the Norbert ZONGO University .KIENTEGA Raoul works on measurement tools .his first IXP detection tool is available to enable the researcher to make measurements. tool is free and available on github.com