Comparative Study between TraIXroute and Burkina TraIXroute on the Way to Traceroute

KIENTEGA Y. Raoul, OUEDRAOGO T Fréderic, BIKIENGA Moustapha, SIDIBÉ Moustapha

***Abstract*—The Internet is a worldwide computer network that allows its users, called Internet users, to communicate with each other on a global scale. Consisting of a multitude of interconnected networks, distributed throughout the world, each network is attached to its own entity called an Autonomous System (AS) that uses the BGP routing protocol to communicate. Autonomous Systems (AS) meet at an ixp point via agreements called peering. Methods have been developed to detect these peering points commonly called ixp. Our tool Burkina traIXroute proposes a better detection of ixp among many others. The purpose of our article is to make a comparative study between traIXroute and Burkina traIXroute in order to position our tool at the international level. Our tests carried out on the networks of our different operators to identify ixps were positive Figure 4. Our tool in its latest version integrates a good ergonomics to attract users. On a sample of 1000 IP addresses tested between a source and a destination we were able to detect a large number of ixps on the traceroute path in ipv4 and ipv6. In its results, it appears a strong concentration of ixps in European countries than in African countries 5% against 95%. A delay in terms of migration of ipv4 prefixes to IPV6 hinders the migration and evolution of the African ixp ecosystem. Our results were possible thanks to our Burkinabe tool TraIXroute which is a corrected version of traIXroute that became obsolete due to a bad construction of the cffi, the cryptography.**

***Index Terms*—Comparison Tool, Burkina TraIXroute, TraIXroute**

I. Introduction

Our motivation for this paper is to make a comparative study between Burkina TraIXroute and TraIXroute. In this comparison we will propose an algorithm that corrects TraIXroute as well as other elements that will show the difference between the two tools.

A. How IXPS Work

Taking a route that takes you across town and back to your neighbor's house is neither fast nor efficient to get there. And yet, in many parts of the world, this is often what happens with Internet traffic. An email you send to your neighbor may travel through entirely different countries, even continents, before it reaches his or her inbox. This happens when the infrastructure that would allow your email to travel to your neighbors using the shortest route is not in place. IXPs help create shorter, more direct routes for Internet traffic. They offer a more affordable alternative to sending local Internet traffic overseas, only to send that traffic back via an international link, which can be an expensive undertaking.

B. Topology of Ixps

The topology of an ixp has been a hot research topic in recent years. A structural interpretation In this section, we will present the general architecture of ixps that can be found on the web and study their characteristics. Figure 1 shows a structure where we notice an ixp that does private and public peering with some AS. This peering relationship is an important element for the growth of the ixp.

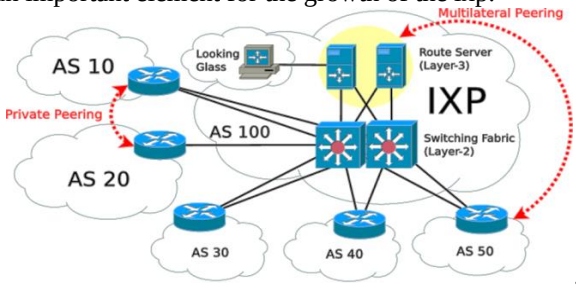

Fig. 1. 5 AS connected to an ixp. (https://www.researchgate.net/publication/309457954_An_Analysis_of_the_Largest_National_Ecosystem_of_Public_Internet_eXchange_Points_The_Case_of_Brazil)

II. Presentation of TraIXroute

TraIXroute is a tool that detects if and where a traceroute path crosses an IXP fabric. It uses the standard traceroute tool or the scamper tool in the background, which implements the Paris traceroute technique to deal with inaccurate paths due to load balancers. It is open source under GPLv3.

A. Mechanism of Detection of ixps by TraIXroute

Previous studies have examined the method of detection of ixps by TraIXroute. This method has made us retain some important points. TraIXroute uses three large databases (PCH, PeeringDB, Route Views) which are its strong points to validate its output. But before TraIXroute detects an ixp, it must validate some rules:

- It retrieves the information from Traceroute in a first table to make a treatment
- Then it exploits information about the IP addresses of the BGP router interfaces connected to the IXP subnet. This data also

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allows us to associate IP addresses with ASes and ixps using the Route Views database, which allows us to view global Border Gateway Protocol routing information from the perspective of other locations on the Internet.

- To finalize its detection, TraIXroute checks whether the ASes before and after the IXP IP address are members of the candidate IXP based on the IXP membership data of PCH and PDB.

B. Relationships between IP and AS

The relationship between AS and IP address is an indicator element for our results. Table 1 shows an example of the relationship between AS and IP address (AS ⟶ I P)

TABLE I: RELATION IP ADDRESSES AND AS

IP1	IP2	IP3	IPn
AS^1	AS^2	AS^3	AS^n

C. Special Case on the Traceroute Path

The result of a simple traceroute in some cases can make it look like we are traversing an ixp. Our example in Figure 2 shows IXP connected to four ASes. The dotted traceroute path may include a response with an IP address of the IXP, even if the IXP is not traversed.

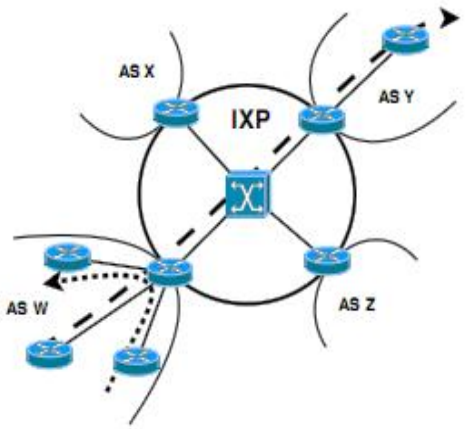

Fig. 2. 4 AS connected to an ixp. (https://d3i71xaburhd42.cloudfront.net/cfe8e0c6ef822ca3b4f9ef1d079dba84d948ddef/3-Figure1-1.png)

D. Rules of Comparison between AS

To know if one crosses an ixp at a jump certain rules must be highlighted as shown in our table by making the comparison between AS to give the success rate to cross an ixp.

TABLE II: COMPARISON BETWEEN ACES TO DETECT IXPS

Conditions	Comparison	Rate
ASN1et ASNn €à ixp	if ASN1= ASN2≠ ASNn	15%
ASN1 ASN2 ASNn €à ixp	if ASN1≠ ASN2≠ ASNn	80%
ASN1 ASN2 ASNn € à ixp	if ASN1≠ASN= ASN2	5%

Low détection rate

Burkina TraIXroute is a tool that detects if and where a traceroute path crosses an IXP structure. Following the work of George Nomikos (2016) .Burkina TraIXroute is a more user-friendly tool that can be used with good ergonomics for better data visualization.

III. PRESENTATION OF BURKINA TRAIXROUTE

A. Characteristics of Burkina TraIXroute

TraIXroute is a tool capable of detecting IXPs when tracing. Therefore, we have improved its algorithm to detect IXPs. And make contributions, to improve its databases with new ones such as IP2LocationDB and MaxMind Geo2LiteDB to improve its ability to do Geolocation. This method allowed us to find some ASNs on our way. This allowed us to map the ixps. In addition, the software displays the statistics of the ixp flows on its path for a better analysis. The application supports IPv6 addresses and integrated additional local databases that can be updated manually to get accurate results. Downloading before each trace has been disabled to prioritize time efficiency so that all operations are performed locally on the PC. The source code of Burkina TraIXroute is open source .

B. Method of Detection of Burkina TraIXroute

BURKINA TraIXroute uses Traceroute in the background for the detection of ixp after having made a text processing in a table as shown in our Table III. This table shows how Burkina traIXroute makes its first processing it recovers the ip addresses in a table

TABLE III: RESULT OF TRACEROUTE IN AN ARRAY

Col1	Col2
1	@Ip1
2	@Ip2
3	@Ip3
4	@Ip4
n	@Ipn

After the construction of our first table above (tablau3) BURKINA TraIXroute thanks to its databases which are in local (IP2LocationDB, MaxMind, Geo2LiteDB, Route Views) seeks the BGP information in real time on the routing system starting from the database of Route Views. To create a relation AS and IP. Fig. 3 shows the different databases of Burkina traIXroute. This database is localized with update options. Thanks to these databases have reduced the stars at the AS level in the previous results of traIXroute.

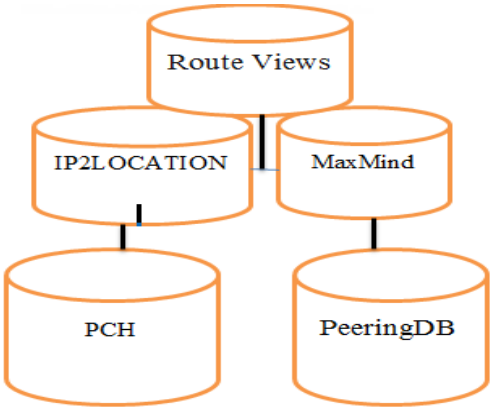

Fig. 3. The different databases of Burkina traIXroute

C. Connections between IP and AS

For a better detection of ixps Burkina traIXroute uses a good method to facilitate the processing of data it creates a set of data in a table to create a relationship ip and AS our Table IV illustrates its mechanism

TABLE IV: RELATIONSHIP BETWEEN AS AND IP FROM THE ROUTE VIEWS

Col1	Col2	Col3
1	@Ip1	As1
2	@Ip2	As2
3	@Ip3	As3
4	@Ip4	As4
n	@Ipn	AsN

TABLE V: COMPARISON TABLE BETWEEN AS TO DETERMINE THE PEERING LINKS

Col1	Col2	Col3
1	If the AS between the jumps are identical As1= As2= As3= Asn	NO PEERING
2	If AS at jump 1 is different from all other ASAs1≠ As2= As3= Asn	peering realise
3	If AS at jump 2 is different from all other ASAs2≠ As1= As3= Asn	peering realise
n	If AS at jump n is different from all other ASAs2≠ As1≠ As3≠ Asn	peering realise

TABLE VI: RESULT ON THE BACKGROUND OF BURKINA TRAIXROUTE

Col jump	Col AS	Col IP
1	ASN1	IP1
2	ASN2	IP2
3	ASN3	IP3
n	ASNN	IPn
Ixp Name	ASN	IP ixp

TABLE VII: COMPARISON RESULT

Burkina TraIXroute	TraIXroute
Language used for its design C-sharp and python Languages C#56,5 % Python42, 1 % Shell1, 4	Language used for its design python. Python languages 98, 0 % Shell 1, 7 Docker file 0, 3
Ergonomic with the option interfaces to facilitate its use. Text Shell and Graphic Shell	Not ergonomic Text shell
Path taken by the standard traceroute tool or the ipv6 traceroute tool,	Borrowed path the standard traceroute tool or the scamper tool, which implements the Paris traceroute technique to handle inaccurate paths due to load balancers.
Local database with update option	Database uploaded before any processing
The different databases: GeoLite2-ASN, IP2LOCATION-LITE-ASN, Routeviews, RIPE NCC PeeringDB, Packet Clearing House	The different databases of PeeringDB, Packet Clearing House and RouteViews.
Automatic dependency management	Dependencies fixed in the source code

D. Comparison between AS

Burkina traIXroute to detect IXPs looks for peering links between AS in the PeeringDB database before concluding if one crosses an ixp on the traceroute. Our Table V shows on which criterion we can say if there is peering or not

After cross-referencing in the table5 Burkina TraIXroute will be interested in the relationship that exists between the AS to check the membership of each AS to ixp in the PCH database.

E. Burkina TraIXroute Output on the IPV6 Traceroute Path

Burkina TraIXroute has proven itself in the detection mechanism of ixps. it gives a more concrete result thanks to its databases. (IP2LocationDB, MaxMind, Geo2LiteDB) figure4 shows an example of ipv6 trace.in this figure we notice that the results are without star and in ipv6.

Fig. 4. Output BURKINA TRAIXROUTE in ipv6

F. Summary between Burkina traIXroute and traIXroute

The design of Burkina traIXroute was made with its certain module of traIXroute in the background but there is a difference between the two tools as illustrated in our Table VII.

G. Algorithms

The Burkina traIXroute algorithm is composed of several functions. To be more explicit in our paper we propose algorithm1 which describes our tool. Algorithm1 takes care of the traceroute6 problems that traIXroute could not do.

ALGORITHM1: MAIN ALGO OF BURKINA TRAIXROUTE

```
Classes :
        IP : Ipaddress, ASnum
        LOCATION : ASN, IP, lat, lon
Functions :
Void Main()
{
Scan input as address
If address == IPV6
        chaine_de_charactere urlApi= https://www.ipaddressguide.com/traceroute6
        HTTPClient client = Open(urlApi)
//Ouvrir et obtenir le contenu HTML
        Var reponse= client.getStringAsync(client)
        //Rechercher le champs de text et le boutton
        Var texte = getHTMLTag(''form'').getHTMLTage(''text'')
Var button = getHTMLTag(''form'').getHTMLTage('button)
        //Inserer l'addresse
        texte.setText(addresse)
        //Lancer le trace
        Button.Click()
        //Attendre quelque secondes
        client.await(10)
        reponse= client.getStringAsync(client)
        //Rechercher le champs de reponse
        Var tableau = getHTMLTag(''tbody'')
        Chaine_de_charactere resultat = null
        Pour_chaque tr dans tableau :
        //Ajouter le contenu de la ligne au resultat
        resultat = resultat + contenu_de_tr
        //Lancer burkina Traixroute avec resultat en input, geolocaliser et afficher resultat
        BFTrace(resultat) (1)
Terminal1 = new Terminal('ping address')
Terminal1.Open()
        If(Ping(address))==successfull
                Start(address)
        Else
                Display('Le teste du ping a echoue')
Terminal1.Close()
}
Void Start(address)
{
        Terminal2 = new Terminal('traixroute address')
        Terminal2.Open()
        Output=Terminal2.Result
        ListIP = new List()
        Foreach Line in Output
        {
                If( Line[0].IsNumber() )
                {
                        Line.Remove(number + ')  ' )
                        ASnum = Line.Split('  ')[0]
        Ipaddress = Line.Split('  ')[2]
        ListIP.Add(ASnum, Ipaddress)
}
        }
        ListLoc = new List()
        CheckMaxmind()
        CheckIp2Location()
}

Void CheckMaxmind()
{
        Foreach IP in ListIP
{
        If(GEO2LITE.DATABASE.Contains(IP.ASnum))
        {
                Lat = GEO2Lite.DATABASE.GetLaltitude(IP.ASnum)
                Lon = GEO2Lite.DATABASE.GetLongitude(IP.ASnum)
                ListLoc.Add(IP.ASnum, IP.Ipaddress , lat, lon)
        }
        Else If(GEO2LITE.DATABASE.Contains(IP.Ipaddress))
        {
                Lat = GEO2Lite.DATABASE.GetLaltitude(IP.Ipaddress)
                Lon = GEO2Lite.DATABASE.GetLongitude(IP.Ipaddress)
                ListLoc.Add(IP.ASnum, IP.Ipaddress, lat, lon)
        }
}
}
Void CheckIp2Location()
{
        Foreach loc in ListLoc
{
Reader = File.Open('IP2LOCATION.CSV')
```

```
While( Reader !=EndOfStream)
{
        Line = Reader.ReadLine()
        col= Line.Split(‘,’)
        If(loc.ASN = col[0] OR loc.IP = col[1])
        {
If( loc.ASN.Contains(‘*’) OR loc.IP.Contains(‘*’))
                {
                        loc.ASN=col[0]
                        loc.IP=col[1]
                        loc.lat=col[2]
                        loc.lon=col[3]
                }
                Loc.ISP=col[4]
                }
        }
}
```

IV. Data Coverage and Hit Rates

PeeringDB is a freely accessible, user-maintained database of networks. PCH also maintains a directory of all Internet exchanges in the world .And finally RouteViews gives a Pairing Status Report.

V. Statistics of the Different Databases

Burkina traIXroute uses certain databases in its IXP detection mechanism the information on its bases is important that our study proposes to present them in Table VIII. Table VIII gives the latest information from all its databases

TABLE VIII: THE DIFFERENT PUBLIC IXPS DATABASES

PeeringDB	950 Échanges 24529 Réseaux 4607 Lieux d'installation 43944 Connections to Exchanges 39128 Connections to Facilities 5083 Automated Networks 39703 Registered Users 22988 Organisations
PCH	PCH also maintains a directory of all Internet exchanges in the world in the IXP directory which currently has 1119 IXPs:
routeviews	Number of pairing sessions: 953 Number of AS: 342 Number of routes: 321 345 331

VI. Citing Related Work

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 [10], [11] and use traceroute and scamper in the background [12] [13]. Our contribution to ixp detection has led to the integration of new databases MaxMind [14], [15] and IP2location [16], [17], [14], [18]. The IPV6 system is advancing rapidly [19], [20] and our tool is intended to support its functionality.

VII. Conclusion

Burkina TraIXroute is a tool that detects if and where a traceroute crosses an IXP fabric. It is based on the TraIXroute tool with some additional features. Following the work of George Nomikos (2016), it seems interesting to focus on the conditions and constraints of his research. Moreover, the Burkina TraIXroute tool is a more user-friendly tool that can be used with a user interface for better data visualization. the problems of traIXroute such as dependency management and lack of information at the level of its database allowed us to correct its problems and release another version of tool for detecting IXPs on the IPV6 traceroute path. We use additional databases such as IP2LocationDB and MaxMind Geo2LiteDB to improve our ability to detect AS and IXP by our tool.

Conflict of Interest

the research work was done with a very dynamic team. the research team contributes equally to all the charges a very good collaboration. Authors declare no conflict of interest.

Author Contributions

The project is an idea of doctoral student Raoul Kientega of the University Norbert Zongo in Burkina Faso who

proposed Burkina traixroute algorithm and make measurement tests with both tools before making a conclusion, under the supervision of Dr. Frederic Ouedraogo and Dr. Moustapha bikienga. The code was written by Moustapha Hadji Sidibe, a student of the University of Liaoning Shihua in China. all authors approved the final version of the article

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