BGP Traffic Engineering: Understanding South America Traffic Patterns to improve decision-making

Márcio A. de Deus, Paulo H. P.Carvalho, João Paulo Leite

Abstract — The importance of the traffic control is a huge paradigm on the Internet. The AS by definition assumes no external control, this could be an enormous problem when the traffic is asymmetric and the inbound is the higher portion. The problem is very often in networks hosted in South America countries because their high level dependence to North American ASes. Some real South America networks will be analyzed, characterized to help in Decision-Making.

Keywords: Internet Traffic; BGP policies; BGP; Traffic Engineering; Planning; Characterization; Forecasting; Decision Maker

I. INTRODUCTION

The understand of how the physical process works is the first way to plan, implement, operate and optimize the network.

The South America dependence of US hosted services makes the traffic control very hard task. Because the relation between AS assumes no possibility to external control. In Fig.1. one example of how the South America ASes [1] are connected to US. The control when a congestion is detected is difficult, because the South America has no priority to change the AS source of traffic paths, and even when prepending, the lack of characterization do not able the optimized solution. Because that the knowledge of these environment is crucial to make the South America Internet as better as possible.

Another important knowledge about Internet traffic resides on asymmetrical traffic. On [2] the routing asymmetry is defined as different path for forward and reverse considering A and B as endpoint. Some authors propose a quantitative evaluation to provide a way to measure the difference between forward and reverse path. The conclusion is that 90% of all Internet traffic is asymmetric; but many of the traffic solutions are built on symmetric conditions, in terms of transport, normally only the last or “first” mile is asymmetric such as ADSL or mobile upstream/downstream data channels. The asymmetry is also important when analyzing the traffic per link itself.

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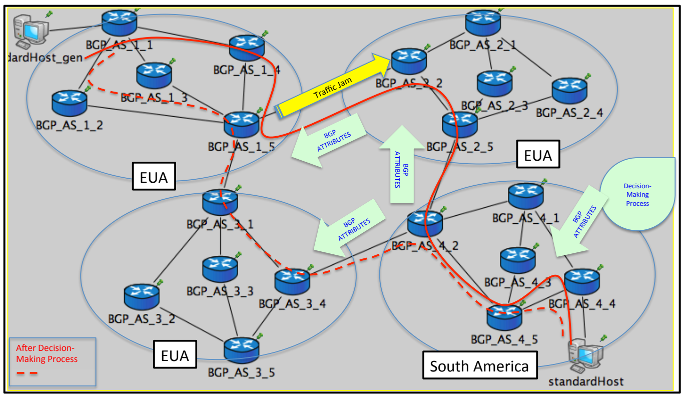

Fig. 1. Network sample. The destination traffic South America. Dotted line means after Decision-Making Process because traffic congestion.

The South America network topology, by country has no many different ASes to insert many different paths, when observing AS to AS interconnection, in this case considering AS to AS with no different paths. This condition determinates that in South America even when the forward and reverse are the same it’s easy to see asymmetry [3] on a per link perspective itself. This is very common when an AS is a non-content provider for the most accessed services. This condition is often observed, as Fig.2. and Fig.3. shown in South America countries such as Brazil, Colombia and Venezuela.

II. TRAFFIC CHARACTERIZATION

Starting the understand the traffic, the incoming traffic means the direction to Brazil, Colombia and Venezuela and the outgoing means the direction to EUA corresponding to the content source. In the perspective of the Service Providers, the South inbound traffic is dominant in a rate of more than (n:1, n>2) this means mostly requisitions from egress direction. In Fig.2 and Fig.3 some traffic traces were collected from a carrier that is responsible for Internet transport from South America countries to US and the opposite direction.

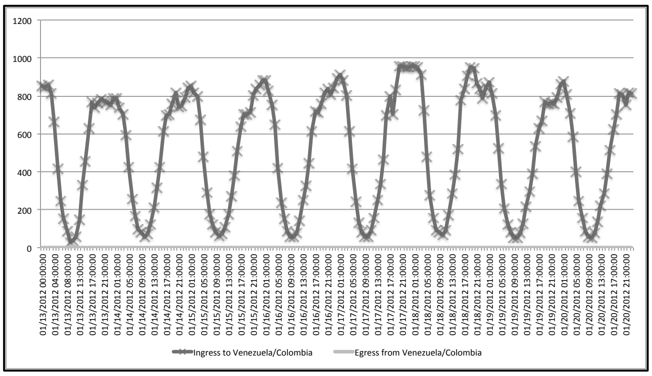

Fig. 2. Hourly real traffic US to/fromVenezuela and Colombia in Mbps(Because non-disclosure agreement the real values are divided by an integer n, n ≥ 1) May, 2012.

This situation is often and represents an additional issue in terms of traffic control because in this situation the AS will receive more traffic from one or more source AS. In Fig.3 the traffic is between Brazil and EUA. A high degree of asymmetric traffic [3] is also shown (per link). If the path between source and destination have more than one link and will not be able to primary define the best, even to balance the traffic between different paths the conclusion is a non-optimized traffic control.

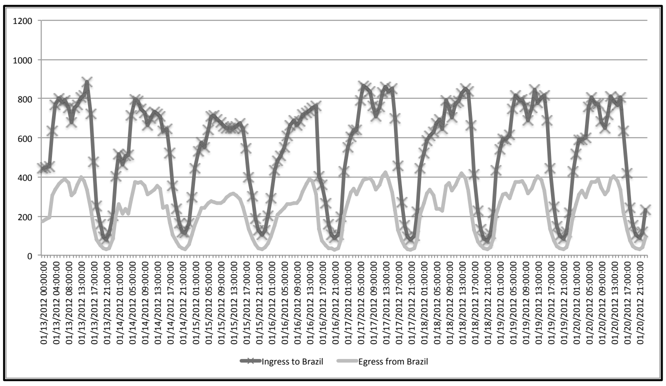

Figure 3. Hourly real traffic US to/from Brazil in Mbps (Because non-disclosure agreement the real values are divided by an integer n, n ≥ 1) May, 2012. (Per Link)

Other conclusion about the asymmetric nature of this traffic resides in the fact that theses countries are extremely dependent of US content sources or hosting in case of internal sources of traffic hosted in US, economics and financial can also be used to explain because hosting prices are less expensive, but this will not be evaluate in this paper.

A. Multifractal Characterization.

The Fig. 4A and 4B are showing the characterization of the nature of traffic about the Venezuela and Colombia samples as Fig.2 shown. The Legendre spectrum and Hölder Interpolation functions can be used to characterize these samples as multifractal. The multifractal analysis is intent to explain the singularities behavior of a sampled statistics. As described by [4], [5] a chaotic dynamics and random processes govern the scalar properties of network packet traffic, this is intuitive to the existence of various behaviors for different scales and for different instants of time. Due to the extremely irregular behavior assumed by Hölder exponents in multifractal processes, geometric and statistical approach these shows to be more efficient. The Legendre spectrum is a way to show The Hölder exponents geometrical statistics distribution. This presents a concave profile, down to values, on the ordinate variants from 0 to 1, where the abscissa represents the exponents of Hölder represented by (α), and the ordinate axis represents to some extent, the probability of a given value of exponent Hölder occur, where a unit value of $f(\alpha)$, (spectrum in the y-axis) indicates that the figure has a great chance to come along in traffic, and small values of $f(\alpha)$ represent points lower occurrence. In this way a process is said multifractal [4] if satisfied:

$$E(|X(t)|^q) = c(q)t^{\tau(q)+1} \tag{1}$$

Where, $t \in T$ and $q \in Q$, T and Q are intervals of the Real line, $\tau(q)$ and $c(q)$ are functions from Q domain. Assuming that T e Q have positive length and $0 \in T$, $[0,1] \subseteq Q$.

The is the scaling function [5],[6] or partition function (2), while c(q) is the factor of time of a process. If q is linear, the process is said monofractal, otherwise multifractal. The Legendre Multifractal Spectrum [5] is defined as:

$$f_L(\alpha) = \tau^*(\alpha) \tag{2}$$

Where $\tau^*(\alpha)$ is the Legendre transform of the partition function. In Fig. 4. and Fig. 5. The real sample traffic from South America were analyzed and characterized as multifractal.

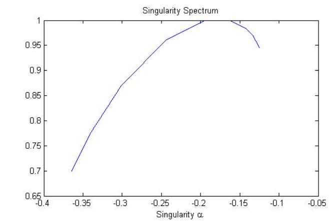

Figure 4A. Multifractal Analysis [7], Legendre Spectrum from Ingress Fig.2.

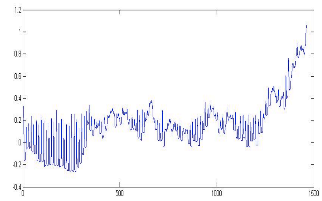

Figure 4B. Hölder Function [7] from Ingress Fig.2.

The self-similar and multifractal analysis has been used from [7]. The South America Traffic collection of traffic is shown on Fig. 4. and Fig. 5. These samples were collected in the first months of 2012 and the direction is from USA to Venezuela and Colombia

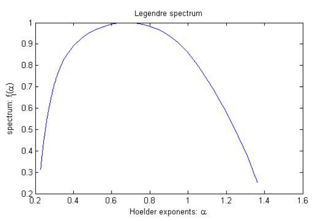

Figure 5A. Multifractal Analysis [7], Legendre Spectrum from Egress Fig.2.

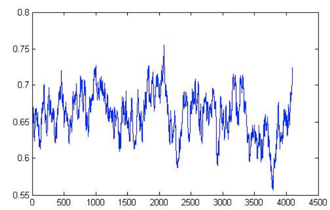

Figure 5B. Hölder Function [7] from Egress Fig.2.

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III. The BGP Characterization: 1[ST] Step to Decision-Making Process

The BGP Best Path Selection Process is defined with some external dependence, depending what kind of policy is used. According [8], [9] two different kind of policy can be found: external or internal, is shown that the Local attributes as shown in Fig. 4 have more priority than other attributes.

Atribute	Priority
Local Preference	Highest Priority
Shortest ASPATH	Traffic Engineering Tentative
Lowest MED	
iBGP < eBGP	
Lowest iGP Cost to BGP egress	
Lowest Router ID	Lowest Priority

Figure 4. BGP Condensed Priority Decision Making Preferences

In the same way the import routing policy ($\wp_{in}$) or the ($\wp_{out}$) can be defined as scalar filters applied on Graph on equation (1) as shown in [10] as a way to control the advertised routes inbound or outbound direction.

$$G=(V, E, B) \qquad (1)$$

The routing policy will define if a route will be announced or acquired in terms of table. The G_{pol} is the Graph after an inbound or outbound filter. The $\wp_{in}$ or $\wp_{out}$ can be written as a scalar.

$$G_{pol}=(V,E,B) * \wp_{in}(G) \quad \text{for ingress} \qquad (2)$$

$$G_{pol}=(V,E,B) * \wp_{out}(G) \quad \text{for egress} \qquad (3)$$

$\wp_{in}$(G) assuming discrete values of “0” to block or “1” to accept a route set.

$\wp_{out}$(G) assuming discrete values of “0” to not advertise or “1” to advertise a route set.

This is a way to make a police controlled system with a possibility to insert filters. This makes an ingress traffic change by the destination a hard task, because AS_PATH attribute is the first external to be considered and is only the fourth in order of preference [11], [12]. This decision process can be divided in three different layers. The local preference is the highest priority parameter and internally controlled only. There are also the Traffic Engineering purpose parameters used as a tentative of traffic control by an external AS, these are always used when a someone wants to try to interfere in the internal decision making process. The lowest router ID is the lowest priority followed by iGP cost, iBGP learned, eBGP learned, MED, ASPATH Local Preference as the higher.

As described in [9],[12],[13] the hot potato routing can interfere in terms of routing convergence. By other side, if the hot potato do not lead to new BGP update messages, some delay increment can occurs inside AS [4].

A. The Internet Radius Characterization.

The Internet radius for decision-making process can be defined as the path count number. On the Bellmand criterion [13] a vertex $v \in V$ lies on a shortest path between vertices $s,t \in V, if\ and\ only\ d_G(s,t) = d_G(s,v) + d_G(v,t)$.

Algorithm:

Get a full routing table T=$d_G(s,t)$

For Subnet S_j

For Path$_{Sj}$={AS_0, AS_1; AS_{j-1}; AS_j}

Aggregate { Path$_{Sj}$}

Min {Path$_{Sj}$}

Count j

{S_j} ∈ AS_k

$r_{ASk} = j$

end

end

Using this algorithm in weka project [weka] as the tool to find the AS Radius with a full table routing as shown in Fig.5

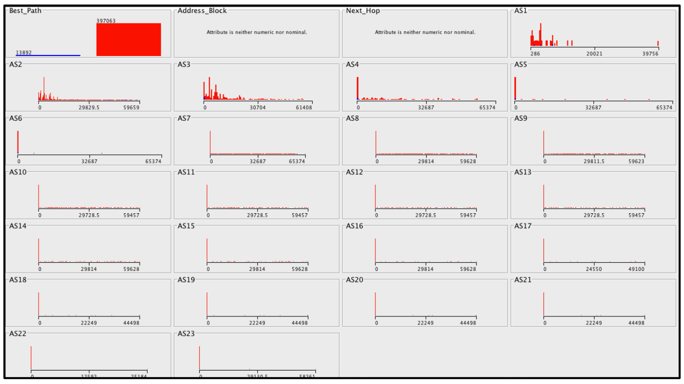

Fig.5. The Internet radius r. Each n ASn denotes the Internet radius using weka [14]

In Fig.5 Measured using internet full table (400k+ routes) information from potaroo [18] routeviews [19] using weka [14] to filter.

The radius can be used as a marker of the probability to achieve any external control in a specific route. As long is an specific radius as more difficult to achieve the desirable control [15], [16] because more ASes will need to be controlled accepting external parameters such as ASPath for prepend purpuses.

In Fig.5 after sample analysis from real South America networks, also extracted from [18] and [19] using [14], the distribution of advertised blocks are shown, for IPv4 the needs to have more control per subnet is clear. Today, more than 50% of all number of routes is /24, the impact of the address ending for IPv4 is one answer and the other the needs for traffic engineering.

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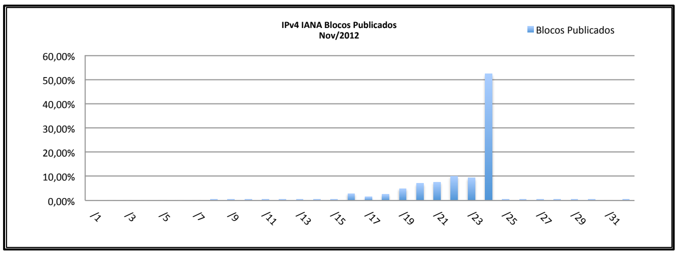

Fig.5. Advertised blocks analyzed using Weka [14]

IV. CONCLUSION

In this article some important samples of the South America Internet traffic were analyzed. The traffic is mostly asymmetric even when in the same link, because the huge dependence of content from South America to US. This also can be explain because the facilities low prices in US hosting services when compare to South America. The traffic is multifractal and because that the forecasting must to use this model to represent future needs. Anyway, the traffic optimization is a huge task even when the task is internal only, considering the whole Internet environment makes this task much difficult because by definition any AS is itself managed, with own policies and procedures. All of these entities are interconnected using The BGP protocol, which is a path vector protocol, used to carry routing information between autonomous systems [1], [12], [15]. The BGP protocol exchange routing information based on RFC 4271 [1], although the most important definition is about the non-possibility to direct external control. The internal policies can only allow, with some degree of confidence, the possibility to use external parameters in a decision-making event as an additional variable. This means an external parameter will only direct affect an internal or egress point in a lower priority. To improve or optimize a decision, the routing process need use, at least, two different approaches as discussed. The decision-making process can be optimized with more knowledge of the network; the characterization is a way to achieve this knowledge.

In future works a way to use the characterized information will be discussed, trying to induce the process combining specialist knowledge with the existing mechanism and of course inserting more understand of characterization process of the internet networks. Using OMNET [17] many simulations were performed to better understand and improve traffic management. Many full routing table information [18], [19] needs to be analyzed to achieve a better knowledge of the Internet behavior and traffic engineering feasibility.

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