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Research paper

Optimal Performance Analysis of iBGP and eBGP in Internal and External WAN

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Abstract

BGP is a protocol responsible to provide communications between different autonomous systems and employed in internet. Demand for BGP performance is growing as the internet evolves. The execution of IP systems relies upon a wide assortment of self-motivated circumstances. Transportation changes, gear disappointments, arranged upkeep, and topology changes in different parts of the Internet would all be able to debase execution. To keep up great execution, organize administrators should constantly reconfigure the steering conventions. Administrators arrange BGP to control how traffic streams to neighboring Autonomous Systems (ASes), and in addition how traffic navigates their systems. BGP is a good choice for use to inter-domain routing between different ASes using eBGP, it is not the best choice for use within the same AS using iBGP but it is still valid to use. It is a mandatory for use to carry the internet routing table through the AS.

Index Terms*: BGP, IP, Internet, Topology and Networks*

1. Introduction

BGP is the default buries self-ruling framework steering convention, which is utilized to trade directing data among switches in various self-sufficient frameworks (ASes), a lot of switch under a solitary specialized organization unit [1] [2].
Outskirt Gateway convention empowers web access suppliers (ISPs) to set up directing among one another and utilizes the steering data to keep up a database of system reachability data, which it trades with supplementary BGP frameworks [2] [3].
For this BGP utilizes the dependable transport convention TCP since this fulfills the majority of its vehicle necessities and is accessible on all hosts and switches today. After a BGP session among two switches has been built up utilizing TCP (port 179) they at first trade their full directing tables. Since BGP is a gradual convention further messages concerning directing data are just directed on variations [4].
BGP utilizes a calculation which can't be named an unadulterated "Separation Vector", or unadulterated "Connection State". It is a way vector steering convention as it characterizes a course as an accumulation of various AS that is goes through from source AS to goal AS. This rundown of ASes is called AS_PATH and is utilized to dodge eBGP steering circle [2][11]– [16].
Switches that utilization BGP are called BGP speakers. Two BGP speakers that take an interest in a BGP session are called neighbors or friends [5].
Two sorts of connections To interface between friends are iBGP Peers (BGP neighbors inside the equivalent independent framework) and eBGP Peers (BGP neighbors associating separate self-governing frameworks) [4]
BGP treats refreshes from inside companions uniquely in contrast to refreshes from outside friends. Before any BGP speaker can peer with a neighbor switch, that neighbor must be statically characterized. Companion switches trade four kinds of messages: open, refresh, notice, and keep alive. The refresh message conveys directing data while the staying three messages handle the session the executives [5]
The execution of Global Routing System is critical for every one of the substances working the self-ruling frameworks, which makes up the web. BGP empowers the traffic spill out of one point to another associated with the web [2].
As the internet still growing with demands increasing with newer services and heavy loaded applications and services like VoIP and Video Traffic. BGP needs to be better with performance and security. BGP is a slow protocol as it is made with having focus on Internet. But with the high speed networks today, bgp updates to its neighbors are still not as fast as needed in today's financial and stock related customers' environment where every second is important. It takes around 5 to 15 minutes to update the full routing table. Also the peer authentication mechanism in BGP is also quite straightforward and needs to be much better for security purpose [2].
When we take a gander at the web we couldn't care less as much as to locate the most brief way, having the capacity to control traffic ways is unquestionably increasingly essential. There is just a single directing convention we as of now use on the Internet which is BGP [6].
BGP be that as it may, chooses the best way dependent on a rundown of qualities. On the Internet, it's increasingly imperative that you have grainy command over how you forward your traffic and to which self-governing frameworks rather than simply going for the briefest way dependent on a measurement [6][8]–[10].

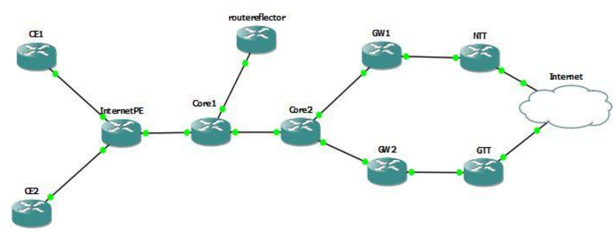
In BGP, the path was selected as the best path based on the following attributes:

Priority	Attribute
1	Weightiness
2	Homegrown Favorite
3	Initiate
4	AS path length
5	Source code
6	MED
7	eBGP path over iBGP path
8	Direct IGP path to BGP next hop
9	Eldest path
10	Router ID
11	Neighbor IP address

2. Performance analysis of iBGP and eBGP on Internet Service Provider

Potential and packet loss:
eBGP:
BGP courses traffic through the briefest AS-way without thinking about basic system execution markers, for example, inertness and parcel misfortune
Some policies can be applied to achieve a better performance such as as-path prepend, med, local preference.
iBGP:
BGP sessions convergence and update triggers are very slowly, which means that iBGP is not an optimal solution for use to inter-domain routing within AS.
We can depend on IGP for next-hop resolving and tracking to any failure which might be happened to external wan and fasting to recalculate a better path for the traffic to avoid any latency/packet loss which may happen [17].

Throughput:
eBGP, iBGP: BGP will never take into considerations link bandwidths when deciding on the best path. However, we should use the BGP attributes utility to administrivaly obtain the best and highest bandwidth paths.
Routing traffic
eBGP:
Subnets can be divided into multiple groups. Prefer each group to one of upstream providers and backup it into other upstream providers, As-path prepend could accomplish this scenario. This will allow to route traffic through multiple paths across the Internet each path carry some networks.
iBGP:
It may be difficult within AS to propagate the full internet routing table through it. Default route may be injected and some summary of important subnets only. So, it would be difficult to load share traffic to multiple gateways, unlike what happened in eBGP case. Traffic engineering may be used to get a better performance [18].

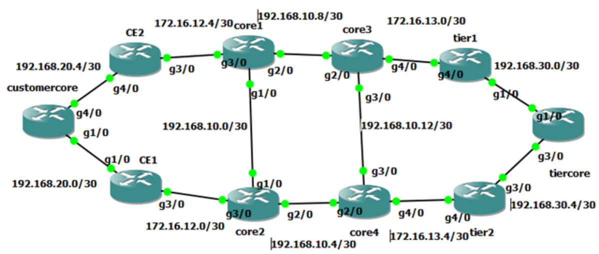


While studying the BGP performance for a service provider network, we found that it is a mandatory to establish eBGP sessions between the provider gateways and its upstream service providers as well as eBGP sessions between the provider Internet PEs and its customers.
It’s mandatory for a service provider to establish iBGP sessions between its gateways and its PEs within its autonomous system core network [19].
Service provider uses the utility of iBGP route reflector mechanism to overcome iBGP split horizon rule which states that iBGP update couldn’t be advertised into other iBGP peer to guarantee that iBGP updates propagate normally through all iBGP peers within its core network.

3. Wide Area Network using BGP protocols:

The following figure shows the Project topology that is mainly consisting of 3 autonomous systems. Each AS use iBGP as its internal routing protocol. Routing between autonomous systems using eBGP. The 3 Autonomous systems are classified as below
1- TIER AS
It’s an Internet tier AS
Its customers are service provider customers
It used to provide the providers with the full reachability to the Internet routing table (in our project we used subnets 24.0.0.0/8 – 28.0.0.0/8 as well as a default route)
Its AS is 3
2- Provider AS
It’s a service provider AS
Its customers are Internet customers and it get an Internet reachability from a tier provider.
Its AS is 8100

It has a public subnet 217.139.0.0/16 to provide its customer with it to access the Internet.
3- Customer AS
It is an Internet Customer; it has a public subnet from its provider.
It has a private AS 65500.



The following table shows IP Structure of the topology set-up

	AS	LoopBack Subnets	Public Subnets	Internal peers Subnets
Tier	3	30.30.30.0/24	24.0.0.0/8 - 28.0.0.0/8	192.168.30.0/24
Provider	8100	10.10.10.0/24	217.139.0.0/16	192.168.10.0/24
Customer	65500	20.20.20.0/24	217.139.16.64/29	192.168.20.0/24

As our purpose of that project is to focus on optimal performance analysis of iBGP , eBGP in internal and external wan , so the chosen routing for the connected device of the below topology is BGP , iBGP within the same AS and eBGP between ASs.

4. Configuration of BGP protocols:

4.1 iBGP configuration:

In each router configure the iBGP protocol by applying the following steps that are iBGP configuration within AS#65500 to the first router (customer core router)

```
router bgp 65500
    neighbor 192.168.20.1 remote-as 65500
    neighbor 192.168.20.1 description Main BGP Gateway Peer
    neighbor 192.168.20.5 remote-as 65500
    neighbor 192.168.20.5 description Backup BGP Gateway Peer
```

Where define the AS number for each router and enter IP address for all neighbors in the same AS, repeated these steps for all routers design according the following neighbor table

AS Number	Router Name	Neighbor
65500	CE1	192.168.20.2
	CE2	192.168.20.6
8100	Core 1	192.168.10.2
		192.168.10.10
	Core 2	192.168.10.1
		192.168.10.6
	Core 3	192.168.10.9
		192.168.10.14
	Core 4	192.168.10.5
		192.168.10.13
3	Tier core	192.168.30.1
		192.168.30.5
	Tier 1	192.168.30.2
	Tier 2	192.168.30.6

4.2 eBGP configuration

eBGP configuration between different AS's.

AS Number	Router Name	Neighbor
65500 , 8100	CE1	172.16.12.1
	CE2	172.16.12.5
	Core 1	172.16.12.6
	Core 2	172.16.12.2
8100 , 3	Core 3	172.16.13.1
	Core 4	172.16.13.5
	Tier 1	172.16.13.2
	Tier 2	172.16.13.6

After applying the mentioned configuration iBGP and eBGP sessions have been established successfully. It was the time that each AS start to advertise its subnets. The below verification will show that sessions are established successfully.

```
customercore# show ip bgp summary
BGP router identifier 20.20.20.3, local AS number 65500
BGP table version is 5, main routing table version 5
9 network entries using 1080 bytes of memory
12 path entries using 624 bytes of memory
4/2 BGP path/best path attribute entries using 496 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory

Neighbor      V  AS     MsgRcvd  MsgSent  TblVer  InQ  OutQ  Up/Down   State/PfxRcd
192.168.20.1  4  65500  79       77       5       0    0     01:11:15  5
192.168.20.5  4  65500  85       83       5       0    0     01:17:05  5
```

To inject routes into BGP table we need to configure network command below in the BGP configuration as below
network 217.139.16.64 mask 255.255.255.248 on the customer core router.
This route will not be advertised into BGP table until it is existing in the routing table as IGP route so we need to configure static routing to the subnet 217.139.16.64/29 on the customer core router as below
ip route 217.139.16.64 255.255.255.248 Null0
The same scenario has been applied on the core1 router for subnet 217.139.0.0/16 and has been applied on the tier core router for subnets 24.0.0.0/8 – 28.0.0.0/0 as well as default route 0.0.0.0/0. Subnets advertised successfully but there were some issues to achieve a full reachability between customer LAN network to the tier core network which we are going to discuss the reasons and how we overcame them to achieve reachability. The below verification will show the BGP table and lets discuss some points on it.

```
customercore# show ip bgp
BGP table version is 5, local router ID is 20.20.20.3
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
          r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

  Network          Next Hop          Metric  LocPrf  Weight   Path
* i10.10.10.1/32    172.16.12.1        0       100     0      8100 i
* i                 172.16.12.5        0       100     0      8100 i
* i10.10.10.2/32    172.16.12.1        0       100     0      8100 i
* i                 172.16.12.5        0       100     0      8100 i
* i10.10.10.3/32    172.16.12.5        0       100     0      8100 i
* i10.10.10.4/32    172.16.12.1        0       100     0      8100 i
*>i20.20.20.1/32    192.168.20.1       0       100     0           i
*>i20.20.20.2/32    192.168.20.5       0       100     0           i
*> 20.20.20.3/32    0.0.0.0            0     32768                 i
* i217.139.0.0/16   172.16.12.5        0       100     0      8100 i
* i                 172.16.12.1        0       100     0      8100 i

*> 217.139.16.64/29 0.0.0.0            0     32768 i
```

On the customer core router, it seems that it has received provider subnets * i217.139.0.0/16 but it is not best and it couldn't use it on the routing table as shown below:

```
customercore# show ip route bgp

    20.0.0.0/32 is subnetted, 3 subnets
B      20.20.20.1 [200/0] via 192.168.20.1, 00:54:35
B      20.20.20.2 [200/0] via 192.168.20.5,
```

Because it is an iBGP update received from the customer edge routers and as we now BGP is AS to AS routing protocol and the iBGP peer doesn't know the P2P WAN subnet between its edges router. We have overcome this issue by applying the next-hop-self on the edge routers iBGP configuration. The Same scenario has been applied on the provider iBGP configuration and Tier iBGP configuration. Let's see the difference after applying this feature on the

```
customercore# show ip route bgp
    20.0.0.0/32 is subnetted, 3 subnets
B      20.20.20.1 [200/0] via 192.168.20.1, 00:10:03
B      20.20.20.2 [200/0] via 192.168.20.5, 00:09:57
B   24.0.0.0/8 [200/0] via 192.168.20.1, 00:09:18
    10.0.0.0/32 is subnetted, 4 subnets
B      10.10.10.2 [200/0] via 192.168.20.1, 00:09:48
B      10.10.10.3 [200/0] via 192.168.20.5, 00:09:27
B      10.10.10.1 [200/0] via 192.168.20.1, 00:09:48
B      10.10.10.4 [200/0] via 192.168.20.1, 00:09:18
B   28.0.0.0/8 [200/0] via 192.168.20.1, 00:09:18
    30.0.0.0/32 is subnetted, 1 subnets
B      30.30.30.3 [200/0] via 192.168.20.1, 00:09:18
B*   0.0.0.0/0 [200/0] via 192.168.20.1, 00:09:18
B   217.139.0.0/16 [200/0] via 192.168.20.1, 00:09:48
```

Now subnets are best and valid for use it also received tier subnets as the provider core network has been overcame next hop issue too.

5. PROJECT RESULT:

We have achieved an optimal routing solution with three different autonomous systems, iBGP protocol has been configured within the same AS and eBGP protocol has been configured between different ASes. AS#65500 this autonomous system represents a customer side with core router and 2 edges to its service provider. iBGP sessions has been established between core router and the two edges. eBGP has been established between the two edges and their two links to their service provider

```
customercore#show ip bgp
BGP table version is 20, local router ID is 217.139.16.65
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
          r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
  Network          Next Hop          Metric LocPrf Weight Path

*>i0.0.0.0          192.168.20.1        0   100    0 8100 3 i

* i                 192.168.20.5        0    50    0 8100 3 i

*>i10.10.10.1/32    192.168.20.1        0   100    0 8100 i

* i                 192.168.20.5        0    50    0 8100 i

* i10.10.10.2/32    192.168.20.5        0    50    0 8100 i

*>i                 192.168.20.1        0   100    0 8100 i

*>i10.10.10.3/32    192.168.20.5        0    50    0 8100 i

*>i10.10.10.4/32    192.168.20.1        0   100    0 8100 i

*>i20.20.20.1/32    192.168.20.1        0   100    0 i

*>i20.20.20.2/32    192.168.20.5        0   100    0 i

*> 20.20.20.3/32    0.0.0.0             0  32768 i
*>i24.0.0.0         192.168.20.1        0   100    0 8100 3 i
* i                 192.168.20.5        0    50    0 8100 3 i
*>i28.0.0.0         192.168.20.1        0   100    0 8100 3 i
* i                 192.168.20.5        0    50    0 8100 3 i
*>i30.30.30.3/32    192.168.20.1        0   100    0 8100 3 i
* i                 192.168.20.5        0    50    0 8100 3 i

*>i217.139.0.0/16   192.168.20.1        0   100    0 8100 i
* i                 192.168.20.5        0    50    0 8100 i
*> 217.139.16.64/29 0.0.0.0             0  32768 i
```

From the shown customer core BGP table, we can deduce the below results: -

Redundancy

BGP is the perfect choice when redundant service is needed. As BGP attributes are helpful to network administrators to choose the preferred path over more than one link.

Customer core router receives provider and tier subnets for the two edges through the iBGP sessions which are established with them. A lower local preference value has been set on the CE2 eBGP session with its provider edge router. This policy has been set to influence the upload traffic of the customer to prefer always CE1. Once the link between CE1 and core2 is going down, eBGP session between them will be gone down too. The upload traffic of the customer will be forwarded to the CE2 till the issue between CE1 and Core2 is fixed. In the download traffic of the customer, other BGP attribute has been used to control the download of the traffic to the main link. AS path prepending has been set on the CE2 to advertise customer subnets to core1 prepended with multiple as path 65500 values, this will influence the download traffic from the service provider side through the main link. Hence redundancy has been achieved for the customer easily and in a dynamic way

```
core1#show ip bgp neighbors 172.16.12.6 routes
BGP table version is 13, local router ID is 10.10.10.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
        r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

  Network          Next Hop        Metric  LocPrf  Weight  Path
*> 20.20.20.2/32   172.16.12.6          0               0 65500 65500 65500 65500 i
*  20.20.20.3/32   172.16.12.6                          0 65500 65500 65500 65500 i
*  217.139.16.64/29 172.16.12.6                         0 65500 65500 65500 65500 i

Total number of prefixes 3
```

Packet loss and latency

Main link of the customer may suffer from packet loss or latency issues due to different reasons such as link errors or link utilization.

Administrators can handle this situation with different scenarios.

In case that the link is suffering from physical errors, traffic can be forwarded to the backup link using local preference and as path prepending to be more preferred over the backup link.

In case that the link is suffering from utilization issue, traffic can be divided over the two links. For example, customer subnet can be subneted to two subnets and prefer each one over one link. Traffic will be routed with a load-sharing mechanism to overcome the utilization issue.

In case that customer has some applications, which are sensitive to latency such as voip application. Subnet of this application can be routed over the backup link using a better local preference and path attributes for it through the backup link

Hence BGP is supporting a variety of utilities to perform an optimal routing scenario to different emergency cases to deliver a perfect service and reachability.

6. Conclusion:

BGP routing protocol is the best choice to use over the Internet. It supports multiple path attributes to control the traffic of the Internet. iBGP can be used between routers within the same AS, eBGP can be used between different ASes. BGP table can carry huge number of updates and routes, its scalability is a wide to carry the full Internet routing table. As BGP is designed to route between AS as it is AS to AS routing protocol. So gateways iBGP peers should provide a route to next hop of the peer AS to their Internal routers to overcome in access next hop issue, next hop self is enough. eBGP sessions can't accept an update once they see there AS in the AS path list, it is a good way for a loop prevention. iBGP also take cares of loop detection using split horizon rule, route reflector mechanism can be used to avoid full mesh iBGP sessions internally through AS. BGP attributes enable network administrators to overcome any operational issues which might be happened. Hence iBGP and eBGP is the optimal choice to route traffic over the Internet.

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