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Increasing Path Diversity using Route Reflector

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ABSTRACT: *In the Internet there are many autonomous systems. Autonomous System refers to a collection of IP prefixes which are controlled by common network operator. To communicate with the other autonomous system BGP is required. The Border Gateway Protocol (BGP) is a routing protocol designed for inter-autonomous systems that uses TCP sessions. Normally within an autonomous system all the BGP speakers are fully meshed. This requirement of full-mesh configuration in an autonomous system, leads to scalability problem. However, to deal with this problem route reflectors are used. Any BGP router in an autonomous system is selected as route reflector. The job of the route reflector is to forward the update message received from BGP router, among the other iBGP speakers. This eliminates the need of having full-mesh configuration. A route reflector may receive multiple paths from other BGP routers but it forwards only the best path to its clients. However to provide fast failure recovery, load balancing and traffic engineering, it is desirable to have path diversity. Path diversity means that client should know alternate paths to reach a particular destination but the route reflector always forwards the best selected path.*

In this work, authors have proposed a method through which the path diversity in a network may be increased. This could be done using well-engineered route reflector.

Keywords: *Path Diversity, route reflector, diverse-path route reflectors.*

I. INTRODUCTION *(BGP & ROUTE REFLECTOR)*

The Border Gateway Protocol (BGP) is a routing protocol that is designed for inter-autonomous systems. It makes the routing decisions based on its routing table called Loc-RIB (Local Routing Information Base). Normally in an autonomous system all the BGP routers are connected to each other in a full-mesh fashion. This means each router is a peer to every other router. For each peer, BGP router maintains two additional tables: (1) Adj-RIB-in (Adjacent Routing Information Base, incoming), keeps the reachability information received from its peers and (2) Adj-RIB-out (Adjacent Routing Information Base, outgoing), keeps the reachability information to be sent to its peers. When the BGP session is created between the peers in an autonomous system it is called iBGP (Internal Border Gateway Protocol) session. When it is created between different autonomous systems, it is called eBGP (External BGP) session. The announcement of each route is sent on eBGP session, to any router in the autonomous system. Once any router in a full-mesh iBGP configuration receives this announcement, it retransmits this information on iBGP session to its peers. Hence, each route to any destination is available to every router in the autonomous system. Using this information each router can select its best path to reach the destination.

The major drawback of using full-mesh iBGP configuration is the scalability problem. As it require n*(n-1)/2 iBGP sessions for an autonomous system having n BGP routers. This is practically not a good thing as the no. of sessions each router has to maintain is very large, which can degrade its performance. To avoid the problem of scalability due to full-mesh configuration there can be two solutions: Route Reflector [9] and AS Confederation [8].

The route reflector is mostly deployed. Instead of announcing the route to each peer, the reachability information is provided only to the route reflector. For this any router in the autonomous system is selected as route reflector. The route reflector is connected to other routers in the autonomous system by setting-up iBGP session. Each iBGP router sends update message[10] to the route reflector. Route reflector receives multiple update messages from various iBGP routers. The route reflector saves the reachability information. The route reflector selects the best path for a destination from various paths it has received through iBGP sessions. It mentions only the best path in its routing table and forwards this to all its clients. Hence, all its clients receive a single best path for a destination. It is the route reflector which is solely responsible to receive and reflect the reachability information, there is no requirement for the iBGP routers to be in full-mesh configuration. There is a reduction in the no. of iBGP session. Hence, the scalability problem is eliminated.

Although route reflector is a better alternative over full-mesh iBGP, yet there are many issues with it. In the case of full-mesh iBGP, if a router fails there is minimal effect on the entire network. But using a route reflector in an autonomous system can lead to single point of failure. If the selected route reflector fails, no other iBGP router in the autonomous system may know the reachability information as the iBGP routers totally depend

on route reflector for the same. However to eliminate this problem multiple route reflectors can be selected in an autonomous system.The convergence of full-mesh iBGP is smaller in comparison to the network with route reflectors. In the network
that is fully meshed the exchange of update message is really fast as each router is connected to every other router. Hence, it can reach in one hop but in the case of route reflection, the update message has to travel more and it takes quite a time to reach the iBGP router. Hence, the convergence is longer.
Another issue is the path diversity. Using route reflector there is no option for the path diversity as the route reflector always select and forwards the best path to its clients. All the clients follow the best route selected by the route reflector even if there is another shortest path to the destination. But what if there is there is a link failure on the best path selected. It would take long to notice this and recalculation of alternative paths, then forwarding the best path would even add up the delay. In order to provide robustness against failure, load balancing and fully utilizing traffic engineering, an increase in path diversity is required.

II. RELATED WORK

The Border Gateway Protocol [10] is a touting protocol that is used for inter- autonomous systems. Normally there is a requirement of having all the BGP routers in full-mesh configuration. This requirement leads to scalability problem. T. Bates, E. Chen and R. Chandra has provided route reflector [9] as an alternate to full-mesh configuration. Route reflectors forward the reachability information to all its clients so there is no need for the routers to be in full mesh. The network using route reflector has partial visibility [7]. This problem of partial visibility is discussed by Simon Balon and Guy Ledue. Route reflectors reduce the number of iBGP sessions, reduce the operational cost, reduces the RIB-in size, reduces the number of BGP updates. Route reflector does not provides robustness. Its convergence is longer. It does not provide path diversity [2]. To increase path diversity R. Raszuk et al. proposed to use route relectors in parallel planes. Through this approach hierarchy of route reflector was introduced. This means that the distance to a reach a destination becomes longer. Diverse-path route reflectors can also be used to increase the path diversity [11]. A diverse-path route reflector is used to provide alternate paths apart from the best path selected by the primary route reflector. This increases path diversity but the additional diverse- path route reflector would add on the total cost of the network. The authors have proposed a solution to through which path diversity is increased without configuring extra hardware in the network.

III. DESCRIPTION OF BGP ROUTING

A. Full- Mesh Configuration:

In the full-mesh configuration of BGP routers all the routers are required to be connected to each other. That means each router is a peer to every other router. The full-mesh configuration of BGP routers is shown in fig 1. Here, every update is announced to every other peer in the configuration. Since, each router is a peer to every other router there is no need to re-advertise the announcement. The problem with full-meshed BGP is the scalability. In order to place an additional router each previously existing router has to be reconfigured.

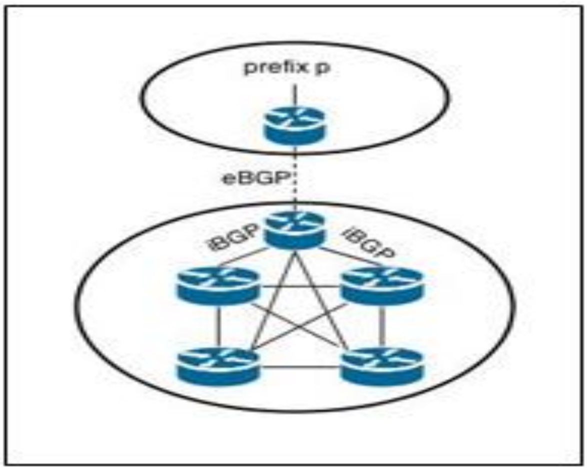

Figure 1 (a)

B. Route Reflector:

In order to eliminate the scalability problem route reflectors are used. The job of the route reflector is to forward the update message received from BGP router, among the other iBGP speakers. This eliminates the need of having full-mesh configuration. A route reflector may receive multiple paths from other BGP routers but it forwards only the best path to its clients.

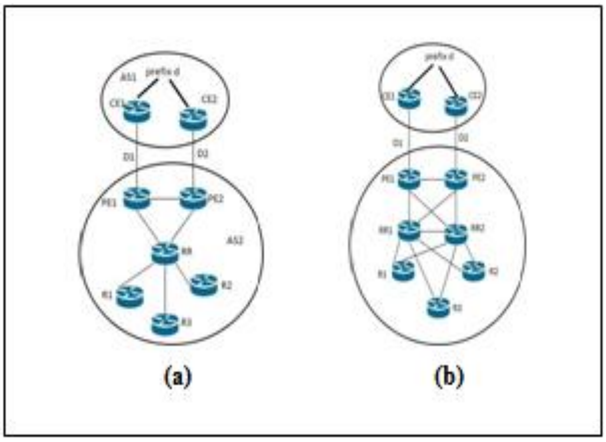

Figure 2

Figure 2(b) shows two autonomous systems AS1 and AS2. Suppose R3 needs to know the route to reach destination d. As we can see, D1 and D2 are different paths to reach the destination d. D1 is the path to reach destination d via PE1 and CE1. Similarly, D2 is the path to reach destination d via PE2 and CE2.Let us say path D2 is the optimal path as it has higher local preference and less MED. Through the eBGP session, PE1 receives path D1 as the path to reach destination d from CE1. Similarly PE2 receives path D2 from CE2. PE1 and PE2 forward their reachability information to route reflector RR. The route reflector (RR) has received two different paths to reach the destination d. The job of the route reflector is to select and forward the best path. RR will select D2 as the best path because it has higher local preference and less MED. It forwards the best selected path (D2) to all its client routers including R3. Hence R3 receives the best route to reach destination d. In such a case, where routers totally depend on route reflector to reach a destination, there exists a problem of single point of failure. It is clear from the figure that if RR fails the other routers have no option to reach any destination.

In order to make the system little more robust duplicity of route reflectors is done. This not only introduces robustness but also provide multiple paths. The setup in figure 2(b) shows a network with multiple route reflectors. Here, PE1 receives path D1 as the path to reach destination d from CE1. Similarly PE2 receives path D2 from CE2. PE1 and PE2 forward their reachability information to both route reflectors (RR1 and RR2). It's time for the route reflectors to select the best path. Both RR1 and RR2 will select D2 as the best path (since it has higher local preference and low MED) and reflect it to R3. R3 will receive two announcements of the route D2.One from each route reflector. As only the best path is propagated by the route reflectors, R3 will not get to know about the alternate path D1. In this case the problem of single point of failure is eliminated. But there exists a problem that both the route reflectors reflect the same path. If a link fails in between the best selected route, then to recalculate the alternative path is time taking.

C. Diverse-Path Route Reflector:

In figure 3(a) a diverse-path route reflector [11] is used for every route reflector in the autonomous system. This diverse-path route reflector will act exactly like the route reflector. It will receive all the announcements. But instead of selecting the best path, it will select the second best path. This increases path diversity. The diverse-path route reflectors not only make system robust from failures but also provide backup path for load balancing.

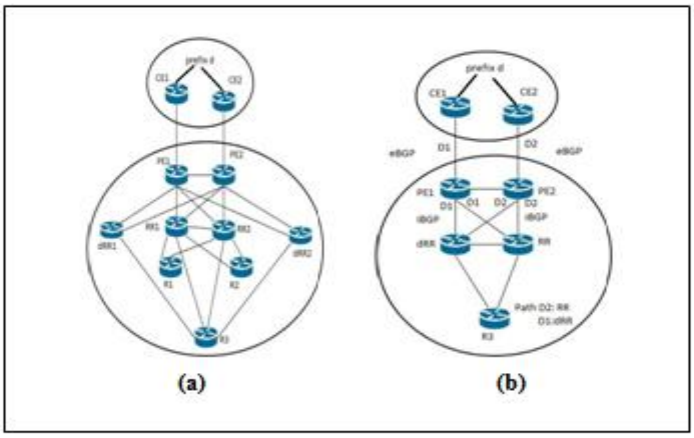

Figure 3

Figure 3(b) shows the operation of diverse-path route reflector. PE1 announces to route reflector (RR) and diverse-path route reflector (dRR) that destination d can be reached through D1. Similarly, PE2 announces to RR and dRR that destination d can be reached through D2. RR reflects D2 as the best path if R3 wants to reach destination d whereas dRR selects D1as the second best path to reach destination d. R3 receives two diverse routes to reach destination d. Hence path diversity is increased.

IV. PROBLEM DOMAIN

The main motto of author is to propose a method to increase path diversity of a network in the presence of route reflector. The requirement to have a back-up path if link failure occurs, has led to the need of increasing path diversity.

V. PROPOSED METHOD

When we use diverse-path route reflectors apart from the primary route reflectors in our network the diversity of paths is increased. However, this way we need to do additional hardware implementation throughout the network. More connections are even required. To eliminate this extra cost, in this paper a method is proposed. If the route reflector is configured in a way that it not only forwards the best path but also announces the alternate paths, the path diversity would be increased without making any major changes in the network. The route reflector only needs to be reconfigured.

The idea behind this proposal is that any organization spends millions of currency on the ISPs so that their link is always up. There is a very rare chance of an outrage in the network. To have a diverse-path route reflector apart from the primary route reflector is too costly. Instead, a route reflector can be engineered in a manner that it provides the alternate paths too. The route reflector is connected to other routers in the autonomous system by setting-up iBGP session. Each iBGP router sends update message [10] to the route reflector. Route reflector receives multiple update messages from various iBGP routers. The route reflector saves the reachability information. The route reflector selects the best path for a destination from various paths it has received through iBGP sessions. It mentions only the best path in its routing table and forwards this to all its clients. Hence, all its clients receive a single best path for a destination. It is the route reflector which is solely responsible to receive and reflect the reachability information.

Normally the route reflector forwards its routing table to its clients for the best path to a destination. To provide alternate paths there is a need of diverse-path route reflector. Here, we propose that the route reflector should forward its BGP table instead of its routing table. This means that the route reflector would not only forward the best path but also all the iBGP announcements received, to its clients. Having received the BGP table, a client would get the best path selected by the route reflector and the list of alternate paths as well. So, the route reflector is itself configured to send best and alternate paths. This way the route reflector can be configured to increase the path diversity. There is no need of implementing any extra hardware. Hence, this proposed method is cost- effective than the method of using diverse-path route reflector.

VII. CONCLUSION

The BGP is a protocol used in inter-autonomous systems. Typically, there is a full-mesh configuration of all BGP routers in inter-autonomous systems. This requirement of full-mesh configuration has led to a serious scalability problem. This problem was eliminated with the use of route reflector. Instead of having full-meshed configuration route reflector was used to forward the best path to its clients. The clients depend on route reflector for the reachability information. The path diversity was the main issue as route reflector only selects and forwards the best path. The authors have proposed an approach to increase path diversity using well-engineered route reflector. The route reflectors can be reconfigured to forward its BGP table. Doing this all its clients would receive the best path and the alternate paths as well. Using this approach there is no extra hardware implementation required and load on network would also not increase.

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