TEAS Working Group
Internet Draft

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Intended status: Experimental Track
Expires: July 24, 2018

January 25, 2018

PCE in Native IP Network
draft-wang-teas-pce-native-ip-07.txt

Status of this Memo

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Abstract

This document defines the framework for CCDR traffic engineering within Native IP network, using Dual/Multi-BGP session strategy and PCE-based central control architecture.

The proposed central mode control framework conforms to the concept that defined in RFC " An Architecture for Use of PCE and the PCE Communication Protocol (PCEP) in a Network with Central Control".

The scenario and simulation results of CCDR traffic engineering is described in draft "CCDR Scenario, Simulation and Suggestion".

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1. Introduction

Draft [I-D.draft-wang-teas-ccdr] describes the scenario and simulation results for the CCDR traffic engineering. In summary, the requirements for CCDR traffic engineering in Native IP network are the following:

1) No complex MPLS signaling procedure.
2) End to End traffic assurance, determined QoS behavior.
3) Identical deployment method for intra- and inter- domain.
4) No influence to existing router forward behavior.
5) Can utilize the power of centrally control(PCE) and flexibility/robustness of distributed control protocol.
6) Coping with the differentiation requirements for large amount traffic and prefixes.
7) Flexible deployment and automation control.

This document defines the framework for CCDR traffic engineering within Native IP network, using Dual/Multi-BGP session strategy and CCDR architecture, to meet the above requirements in dynamical and central control mode. Future PCEP protocol extensions to transfer the key parameters between PCE and the underlying network devices(PCC) are provided in draft [draft-wang-pcep-extension-native-IP]

2. Dual-BGP framework for simple topology.

Dual-BGP framework for simple topology is illustrated in Fig.1, which is comprised by SW1, SW2, R1, R2. There are multiple physical links between R1 and R2. Traffic between IP11 and IP21 is normal traffic, traffic between IP12 and IP22 is priority traffic that should be treated differently.

Only Native IGP/BGP protocol is deployed between R1 and R2. The traffic between each address pair may change timely and the corresponding source/destination addresses of the traffic may also change dynamically.

The key idea of the Dual-BGP framework for this simple topology is the following:

1) Build two BGP sessions between R1 and R2, via the different loopback address lo0, lo1 on these routers.
2) Send different prefixes via the two BGP sessions. (For example, IP11/IP21 via the BGP pair 1 and IP12/IP22 via the BGP pair 2).
3) Set the explicit peer route on R1 and R2 respectively for BGP next hop of lo0, lo1 to different physical link address between R1 and R2.

So, the traffic between the IP11 and IP21, and the traffic between IP12 and IP22 will go through different physical links between R1 and R2, each type of traffic occupy the different dedicated physical links.

If there is more traffic between IP12 and IP22 that needs to be assured , one can add more physical links on R1 and R2 to reach the loopback address lo1(also the next hop for BGP Peer pair2). In this cases the prefixes that advertised by two BGP peer need not be changed.

If, for example, there is traffic from another address pair that needs to be assured (for example IP13/IP23), but the total volume of assured traffic does not exceed the capacity of the previous appointed physical links, then one need only to advertise the newly added source/destination prefixes via the BGP peer pair2, then the traffic between IP13/IP23 will go through the assigned dedicated physical links as the traffic between IP12/IP22.

Such decouple philosophy gives the network operator more flexible control ability on the network traffic, get the determined QoS assurance effect to meet the application's requirement. No complex MPLS signal procedures is introduced, the router need only support native IP protocol.

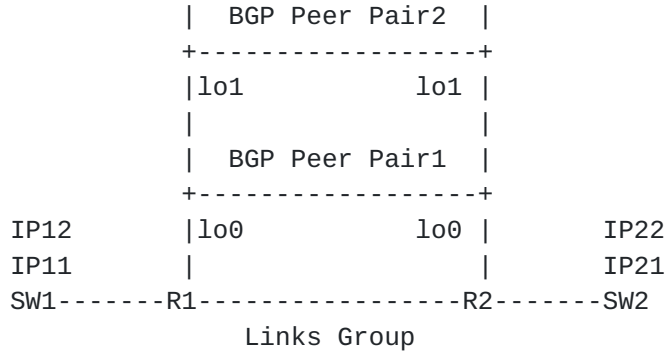
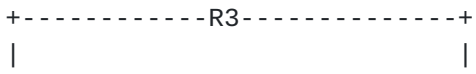


Fig.1 Design Philosophy for Dual-BGP Framework

3. Dual-BGP in large Scale Topology

When the assured traffic spans across one large scale network, as that illustrated in Fig.2, the dual BGP sessions cannot be established hop by hop especially for the iBGP within one AS. For such scenario, we should consider to use the Route Reflector (RR) to achieve the similar Dual-BGP effect, select one router which performs the role of RR (for example R3 in Fig.2), every other edge router will establish two BGP peer sessions with the RR, using their different loopback addresses respectively. The other two steps for traffic differentiation are same as one described in the Dual-BGP simple topology usage case.

For the example shown in Fig.2, if we select the R1-R2-R4-R7 as the dedicated path, then we should set the explicit peer routes on these routers respectively, pointing to the BGP next hop (loopback addresses of R1 and R7, which are used to send the prefix of the assured traffic) to the actual address of the physical link



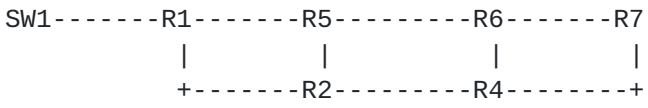


Fig.2 Dual-BGP Framework for large scale network

4. Multi-BGP for Extended Traffic Differentiation

In general situation, several additional traffic differentiation criteria exist, including:

- o Traffic that requires low latency links and is not sensitive to packet loss
- o Traffic that requires low packet loss but can endure higher latency
- o Traffic that requires lowest jitter path
- o Traffic that requires high bandwidth links

These different traffic requirements can be summarized in the following table:

Flow No.	Latency	Packet Loss	Jitter
1	Low	Normal	Don't care
2	Normal	Low	Dont't care
3	Normal	Normal	Low

Table 1. Traffic Requirement Criteria

For Flow No.1, we can select the shortest distance path to carry the traffic; for Flow No.2, we can select the idle links to form its end to end path; for Flow No.3, we can let all the traffic pass one single path, no ECMP distribution on the parallel links is required.

It is difficult and almost impossible to provide an end-to-end (E2E) path with latency, latency variation, packet loss, and bandwidth utilization constraints to meet the above requirements in large scale IP-based network via the traditional distributed routing protocol, but these requirements can be solved using the CCDR architecture since the PCE has the overall network view, can collect real network topology and network performance information about the underlying

network, select the appropriate path to meet the various network performance requirements of different traffic type.

5. CCDR based framework for Multi-BGP strategy deployment.

With the advent of SDN concepts towards pure IP networks, it is possible now to accomplish the central and dynamic control of network traffic according to the application's various requirements.

The procedure to implement the dynamic deployment of Multi-BGP strategy is the following:

1) PCE gets topology and link utilization information from the underlying network, calculate the appropriate link path upon application's requirements.
2) PCE sends the key parameters to edge/RR routers(R1, R7 and R3 in Fig.3) to build multi-BGP peer relations and advertise different prefixes via them.
3) PCE sends the route information to the routers (R1,R2,R4,R7 in Fig.3) on forwarding path via PCEP, to build the path to the BGP next-hop of the advertised prefixes.
4) If the assured traffic prefixes were changed but the total volume of assured traffic does not exceed the physical capacity of the previous end-to-end path, then PCE needs only change the related information on edge routers (R1,R7 in Fig.3).
5) If volume of the assured traffic exceeds the capacity of previous calculated path, PCE must recalculate the appropriate path to accommodate the exceeding traffic via some new end-to-end physical link. After that PCE needs to update on-path routers to build such path hop by hop.

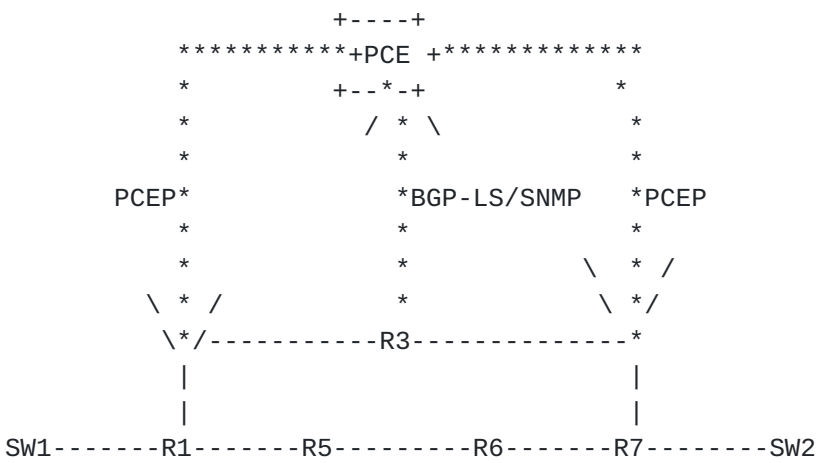


Fig.3 PCE based framework for Multi-BGP deployment

6. PCEP extension for key parameters delivery.

The PCEP protocol needs to be extended to transfer the following key parameters:
1) BGP peer address and advertised prefixes.
2) Explicit route information to BGP next hop of advertised prefixes.

Once the router receives such information, it should establish the BGP session with the peer appointed in the PCEP message, advertise the prefixes that contained in the corresponding PCEP message, and build the end to end dedicated path hop by hop. Details of communications between PCEP and BGP subsystems in router's control plane are out of scope of this draft and will be described in separate draft.[draft-wang-pce-extension for native IP]

The reason why we selected PCEP as the southbound protocol instead of OpenFlow, is that PCEP is suitable for the changes in control plane of the network devices, there OpenFlow dramatically changes the forwarding plane. We also think that the level of centralization that requires by OpenFlow is hardly achievable in many today's SP networks so hybrid BGP+PCEP approach looks much more interesting.

7. CCDR Deployment Consideration

CCDR framework requires the parallel work of 2 subsystems in router's control plane: PCE (PCEP) and BGP as well as coordination between them, so it might require additional planning work before deployment.

8.1 Scalability

In CCDR framework, PCE needs only to influence the edge routers for the prefixes differentiation via the multi-BGP deployment. The route information for these prefixes within the on-path routers were distributed via the traditional BGP protocol. Unlike the solution from BGP Flowspec, the on-path router need only keep the specific policy routes to the BGP next-hop of the differentiate prefixes, not

the specific routes to the prefixes themselves. This can lessen the burden from the table size of policy based routes for the on-path routers, and has more scalability when comparing with the solution from BGP flowspec or Openflow.

8.2 High Availability

CCDR framework is based on the traditional distributed IP protocol. If the PCE failed, the forwarding plane will not be impacted, as the BGP session between all devices will not flap, and the forwarding table will remain the same. If one node on the optimal path is failed, the assurance traffic will fall over to the best-effort forwarding path. One can even design several assurance paths to load balance/hot standby the assurance traffic to meet the path failure situation, as done in MPLS FRR.
From PCE/SDN-controller HA side we will rely on existing HA solutions of SDN controllers such as clustering.

8.3 Incremental deployment

Not every router within the network support will support the PCEP extension that defined in [draft-wang-pce-extension-native-IP] simultaneously. For such situations, router on the edge of sub domain can be upgraded first, and then the traffic can be assured between different sub domains. Within each sub domain, the traffic will be forwarded along the best-effort path. Service provider can selectively upgrade the routers on each sub-domain in sequence.

8. Security Considerations

TBD

9. IANA Considerations

TBD

10. Conclusions

TBD

11. References

11.1. Normative References

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11.2. Informative References

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12. Acknowledgments

The authors would like to thank George Swallow, Xia Chen, Jeff Tantsura,Scharf Michael,Daniele Ceccarelli and Dhruv Dhody for their valuable comments and suggestions.

The authors would also like to thank Lou Berger, Adrian Farrel, Vishnu Pavan Beeram, Deborah Brungard and King Daniel for their suggestions to put forward this draft.

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