Basic Requirements for IPv6-only Provider Edge Routers

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Cong Li, Chongfeng Xie @China Telecom

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Background

- With the rapid growth of IPv6 traffic gradually in some networks, there is a growing need to consider the transition from IPv4/IPv6 dual-stack networks to IPv6-only networks.
- Running an IPv6-only network would reduce operational cost and optimize operations as compared to an IPv4/IPv6 dual-stack environment.
- Provider Edge (PE) devices are the edge routers located at the boundary between an IPv6-only network with other networks(such as its customer networks, other IPv4 networks or IPv6-only access networks) in a multi-domain environment.
- This documents describes the Basic Requirements for IPv6-only Provider Edge Routers, **aiming to provide a general recommendation for vendors and network operators for IPv6-only network deployment.**

Scope of this Document

- Provider Edge (PE) devices are the edge routers located at the boundary of an IPv6-only network, and play an essential role for IPv6-only deployment, in terms of IPv4-as-a-Service and interworking other neighbor networks.
- This document outlines the necessary functions and capabilities that PE devices should possess to operate effectively in a multi-domain IPv6-only Network environment.

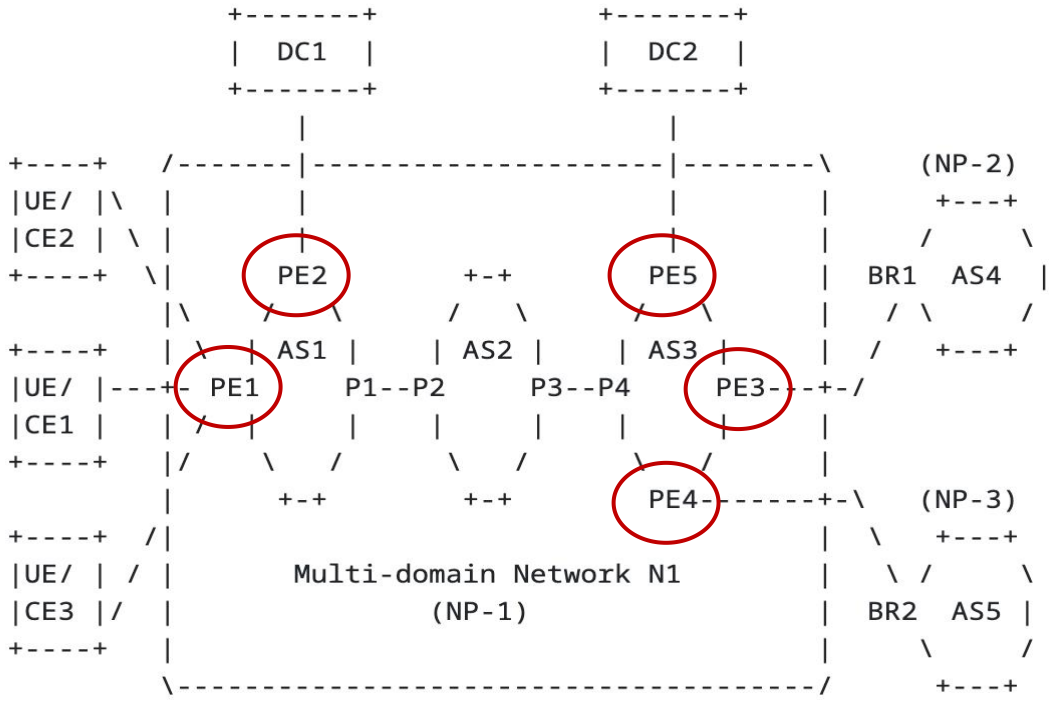

Figure 1： An Example of Multi-domain Underlay Network

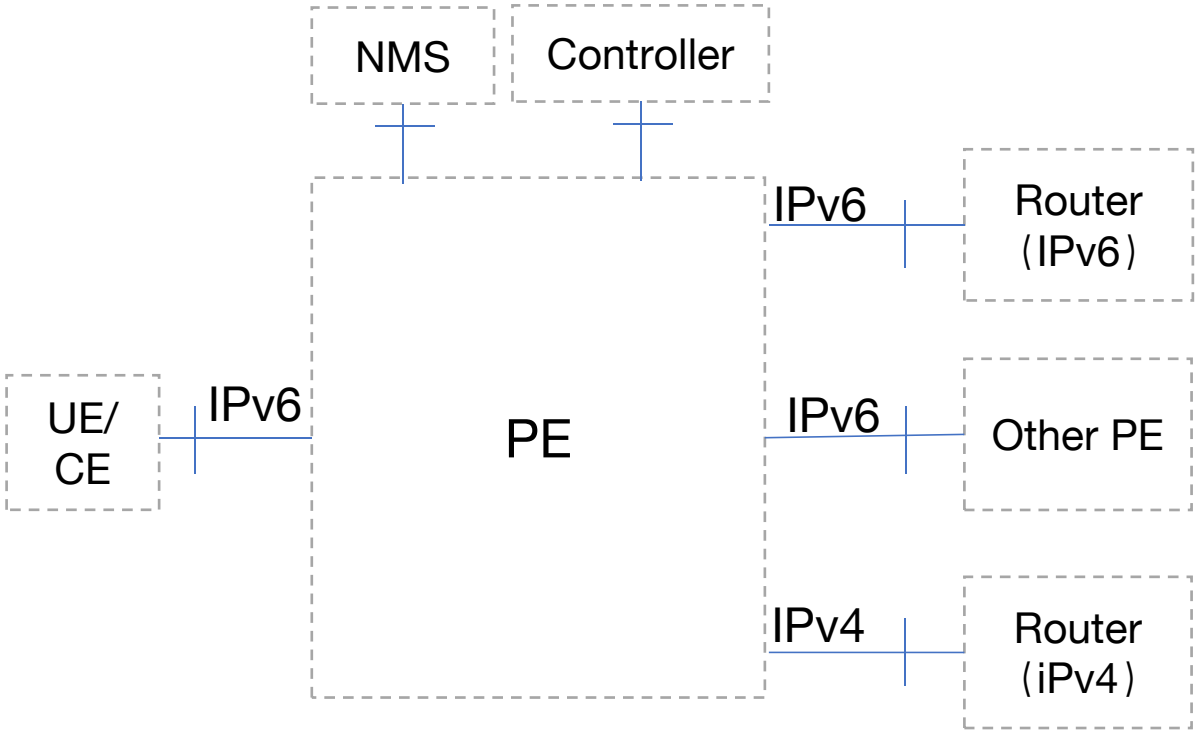

Figure 2： Key Interfaces of PE

Requirement 1: IPv6 Base Protocols Support

- **IPv6 Addressing**
  - PE devices must support **RFC8200** and correctly handle different IPv6 address formats
  - The representation of IPv6 addresses should follow the standard notation defined in **RFC5952**
- **IPv6 Routing Protocols**
  - IGPs: PE devices must support at least one IGP protocols (such as IS-IS(RFC5308), OSPFv3(RFC 5340), etc.), though the specific protocol employed is at the operator's discretion. This document provides no specific recommendations in this regard.
  - EGP: PE devices shall support Multi-Protocol Border Gateway Protocol (MP-BGP). PE routers shall use MP-BGP to exchange routing information with other autonomous systems. They should be able to establish MP-BGP sessions with peer routers in other domains, advertise and receive IPv6 routes, and apply appropriate routing policies.
- **Internet Control Message Protocol version 6 (ICMPv6)**
  - PE devices must fully support ICMPv6 as defined in **RFC 4443**

Requirement 2: MP-BGP Extension Requirements

- **Route Type**
  - **PE routers must support the new route types defined for the MP-BGP extension related to 4map6 as specified in *draft-ietf-idr-mpbgp-extension-4map6***
  - These route types are used to carry information about the mapping between IPv4 addresses and IPv6 addresses.
- **Attribute Support**
  - **PE devices need to support the specific MP-BGP attributes for IPv4/IPv6 mapping advertisement defined for 4map6.**
  - These attributes carry additional information related to the 4map6 translation and encapsulation process.
- **Route Advertisement and Withdrawal**
  - **PE routers should be capable of accurately advertising 4map6 - related routes to other routers in the network.**
  - This ensures that the network's routing tables are always up - to - date and that traffic is routed correctly.

Requirement 3: Encapsulation and Translation

- **Encapsulation Function**
  - PE devices must support the encapsulation of IPv4 packets within IPv6 packets.
  - The PE router encapsulates this IPv4 packet from cuetomer‘s network within an IPv6 packet. The IPv6 packet is then routed through the service provider's IPv6-only network until it reaches the appropriate egress PE router.

- **Translation Function**
  - PE devices must support the stateless translation mechanism as defined in **RFC 7915.**
  - When an IPv4 packet arrives at a PE router in an IPv6-only network, the router should be able to translate the IPv4 packet into an IPv6 packet. This involves translating the IPv4 header fields, such as source and destination addresses, into their equivalent IPv6 format.

Requirement 4: Stateful NAT64

- PE routers shall support Stateful NAT64(RFC6146) to connect with the customer network and enable IPv6-only users to access IPv4 services over IPv6-only network.
- NAT64 is important for providing backward compatibility and enabling the continued use of legacy IPv4 applications.
- If an IPv6-only mobile device in a customer's network tries to access an IPv4 - based website, the PE router serving that customer will perform the IPv6-to-IPv4 translation. It will select an available IPv4 address from its pool, and create a stateful NAT64 IP address translation state.

Requirement 5: Configuration and Management Considerations

- PE router shall accept centralized policy scheduling from the network controller and implementing automated configuration through the NETCONF protocol/YANG model.

- PE routers shall support syslog and SNMP Trap alarm mechanisms.

Other Considerations

SRv6 Functionality Considerations

- SRv6 is a form of segment routing that uses IPv6 as the underlying technology.In a multi-domain IPv6-only Network, SRv6 can be used to provide efficient traffic engineering, simplify network operations, and support new services.
    - SRv6 Endpoint Function
    - SRv6 Policy Support
    - SRv6 - related Routing Information Exchange

Note

- PE devices play a vital role in connecting different networks and facilitating the exchange of traffic. It is essential to clearly define the requirements for PEs for building a stable and reliable IPv6-only network.

- This draft on IPv6-only PE requirements is a starting point, it will **be refined based on broader feedback in the future, your comments are highly welcome.**

Moving forward

- The next version of the draft will be revised based on the comments from Brian and Gyan.

- More comments and suggestions are welcome!

Thank You!