IPv6 Multihoming with Route Aggregation
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Status of this Memo

Abstract

   With the growing requirements for reliable Internet connectivity,
   increasing number of enterprises choose to acquire Internet
   connectivity from more than one Internet Service Providers (ISPs) for
   the purpose of connectivity redundancy and traffic load distribution.

   The potential of large number of multi-connection sites impose direct
   challenge on routing aggregation and consequently on scalability of
   the global Internet routing. Hence a solution is highly desirable
   which provides the benefit of multi-connection as well as the better
   scalability of the global routing system. In addition, such solution
   needs to be simple enough to be operationally manageable. With the
   fast growth of ISP networks as well as enterprise networks, network
   manageability is becoming an increasingly important requirement. This

document describes a solution which achieves the stated goals.

1. Motivations

With the growing requirements for reliable Internet connectivity, increasing number of enterprises choose to acquire Internet connectivity from more than one Internet Service Providers (ISPs) for the purpose of connectivity redundancy and traffic load distribution.

This type of Internet connection arrangement is referred to as multihoming and such enterprise network is referred to as multi-homed site.

Large numbers of Multi-homed sites impose a direct challenge on routing aggregation and consequently on global Internet routing scalability. As is well known, the keys to scaling of huge global Internet routing system including routing information abstraction and aggregation. The IPv6 unicast address format described in [1] enables the strategy of allocating a large block of IPv6 address space to a service provider and letting the service provider further assign sub-blocks of the IP addresses to its customers. This provider based IP address assignment strategy makes it possible for route aggregation at the provider level and thus facilitates the scaling of the global Internet routing system.

However, the current common mechanism to route to a multi-homed site is to make the route specifically associated with the site visible in the global Internet routing system. This practice prevents route aggregation at the provider level and imposes challenge to a scalable global routing. Therefore, a solution is needed for IPv6 multihoming which provides the desired benefits of a multihoming connection such as redundancy and load sharing, and at the same time, enables better scaling of the global global routing system. In addition, such a solution needs to be simple enough to be operationally manageable. With the fast growth of ISP networks as well as enterprise networks, network manageability is becoming an increasingly important requirement. In today's Internet, manageability of a solution should be one of the top considerations.

This document describes a scheme that supports IPv6 multihoming and also achieves the followings:

   a. Providing redundancy and load sharing for the multi-homed sites

   b. Facilitating the scalability of the global IPv6 Internet routing table

   c. Simple and operationally manageable

This mechanism is a routing approach for multihoming. It uses existing routing protocol and implementation thus no new protocol or changes are needed.

The mechanism described in this document can also be applied to IPv4 Internet.

2. The Multihoming Mechanism

Multihoming connections in general can be categorized into two different types: a) a site multi-homed to a single ISP, commonly at different geography locations and b) a site multi-homed to more than one ISPs.

In scenario a), the specific routes associated with the multihomed site will not be visible outside of the particular ISP network and thus there is no real impact on the global routing. Therefore, no special mechanism is needed for multihoming in this scenario. The mechanism described in this document addresses the situation of a multi-homed site connects to more than one ISPs.

The mechanism is described with an example of a multi-homed site with two ISPs connections since two-connection multihoming represents the majority of the multihoming cases and it simplifies the discussion. The mechanism, however, can be extended to apply to multi-homed sites with more than two ISP connections.

2.1. Address Assignment

To obtain IP addresses, a multi-homed site will designate one of its ISPs as its primary ISP and receive IP address assignment from the primary ISP's IPv6 aggregation block.

Figure-1 illustrates an example of a multi-homed site (Customer-A) with connectivity to ISP-1 and ISP-2. ISP-1 is chosen as the primary ISP for customer-A and assigns Addr-1-A from its address block (Addr-1) to the customer.

```
                    ISP-3 ---- ISP-4
                     |      /   |
                     |    /     |
                     |  /       |
                    ISP-1 ---- ISP-2
                      \        /
            link-1  \      /  link-2
                  Customer-A
```
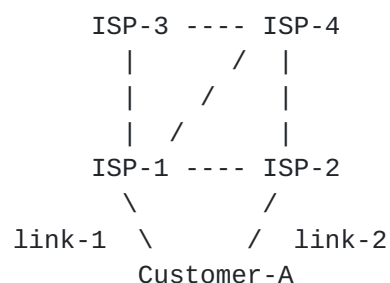
Figure 1: Example of Multihomed Site

2.2. Routing

In order for Internet traffic destinated to Customer-A to reach the
targeted destinations, Customer-A will advertise addr-1-A to ISP-1
and ISP-2 respectively. ISP-2 will advertise Addr-1-A to ISP-1 and to
ISP-1 only. ISP-1 will, of course, advertise its own aggregation
Addr-1 to the entire Internet.

As a result of this routing advertisement, inbound traffic destinated
to Customer-A and originating within ISP-1 or ISP-2 will be forwarded
to Customer-A using link-1 or link-2 respectively. Traffic originated
from anywhere else in the Internet will first be forwarded to ISP-1
since it advertises the route to Addr-1 which contains Addr-1-A.
ISP-1 will then forward the traffic destined to Customer-A via its
connection(s) to ISP-2 and/or via its direct link to customer-A,
according to the preset routing polices. The commonly used policy is
to use the shortest exit by utilizing IGP metric as a tier break in
BGP route selection process. By using both connections to forward
traffic to Customer-A, load sharing among the multiple links used by
Customer-A for connecting to the Internet is achieved.

For outbound traffic originated from Customer-A, ISP-1 and ISP-2
would announce default route and/or a selected set of specific
prefixes to Customer-A based on the requirements of Customer-A. As a
result of the advertisement, traffic originated from Customer-A to
the Internet will be forwarded accordingly and load sharing can be
accomplished.

In the aspect of redundancy, when the link between customer-A and
ISP-2 (link-2 in Figure 1) fails, all traffic will go in and out via
the connection between Customer-A and ISP-1 (i.e. via link-1 as shown
in Figure 1). Likewise, when link-1 is experiencing an outage, link-2
will be used for transmitting the traffic. This is because ISP-1 will
continue announcing its aggregate block Addr-1 to the entire Internet
and ISP-2 will still advertise Addr-1-A to ISP-1. All of the inbound
traffic to the customer will utilize link-2 by taking the path of
ISP-1 -> ISP-2 -> Customer-A. Outbound traffic from Customer-A will
automatically fall to link-2. This way, when one of the two links
fails, the other will be used for traffic in and out from the multi-
homed site. Redundancy is thus accomplished.

As one would observe, with this mechanism, the specific route
associated with the multi-homed site is only visible to ISP-1 and
ISP-2 in the example. Only the multi-homed sites directly connected
ISPs, not the rest of the Internet will have to obtain the specific
route(s) associated with a multi-homed site. This results in better

scaling of the global Internet routing.

The same mechanism can be extended to sites multihoming to more than two ISPs. Again, only those ISPs that the customer directly connected to would carry the more specific prefix assigned to the multi-homed customer.

[3]. Discussions

Characteristics of a multihoming mechanism described in this document include:

   - Improved scaling of the global routing system without loosing the benefits expected from multihoming.

   - Does not require new protocol or routing software changes to deploy the scheme.

   - Simple and thus manageable. In addition, operationally, it has less chances of generating errors compared to more complicated solutions.

   - Due to its simpleness, the requirement of having sophisticated network administrator onsite is greatly reduced, which can be an attractive choice for a variety of multi-homed sites.

   - The primary ISP of a multi-homed site such as ISP-1 in Figure-1 would need to do more work in terms of distributing traffic among the other ISP the multi-homed site directly connect to and its direct link to the site. It will also carry more traffic for the multi-homed customer. However, this can be considered as a value added service from the ISP to the customer and the primary ISP could charge for such services accordingly.

   - If the two involved ISPs has no direct connection, the more specific route associated with the multi-homed site would need to be carried by other ISP(s) in the path thus it would result in less effective aggregation. However, it seems to be lesser of a problem since ISP assigned with an Internet visible aggregate block or Top Level Aggregator (TLA) usually are top tiered ISPs and all such ISPs generally have direct connections to each other either via private peering or public peering points.

   - The primary ISP is the sole interface for the multi-homed customer to the Internet with the exception of the ISPs the customer has direct connection with. Outages such as one between ISP-1 and ISP-4 in Figure-1 would impact the reachability from

        customers of ISP-4 to Customer-A even though ISP-2 still has good
        connection to ISP-4.

    However, if the primary ISP is a good quality ISP, this sort of
    situation should rarely happen. It's common practice that an ISP,
    especially a good quality one, to have multiple connections to other
    big ISPs at different geographical locations. Good quality ISPs also
    have robust internal network design to prevent any failure from
    impacting the entire network. Choosing a good quality ISP as primary
    ISP is a good practice for multi-homed sites adopting this solution.

4. Conclusions

    It wouldn't be hard to understand that even those enterprises
    desiring multiple Internet connections may have different criteria
    and resource constraints for implementing such connection. Some may
    require absolute redundancy while most may only desire reasonable
    redundancy. This document offers a viable multihoming solution for an
    enterprise to choose based on its particular requirements and
    constraints. The multihoming mechanism described in this document is
    applicable to various multihoming scenarios, the most suitable
    environment for deploying it are:

        a. ISPs serving the multi-homed site have direct connection(s) to
        each other. Although such direct connection is not required, it
        would make arrangement simpler and will also improve aggregation
        by limiting specific routes visible only to ISPs serving the
        multi-homed site.

        b. Enterprises with requirements for good redundancy but not
        absolute redundancy.

        c. Enterprises with limited to resource for onsite sophisticated
        network administrators

        d. Enterprises able to choose a robust ISP as primary provider.

    Although not the main focus, the mechanism described in this document
    can also be used to improve routing scalability within networks
    shares one aggregation block or Top Level Aggregator (TLA).

5. Security Considerations

    BGP security applies to the work presented. No added security risk is
    known.

6. Acknowledgements

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7. Reference

[1] R. Hinden, M. O'Dell and S. Deering, "An IPv6 Aggregatable Global Unicast Address Format." RFC2374, July 1998. ftp://ftp.isi.edu/in-notes/rfc2374.txt

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