Applications of IPv6 Anycasting

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Abstract

Today, the use of IPv6 anycast is limited. One of the main reasons is because the usage (in other words, application) of IPv6 anycasting still unclear. This document tries to describe some applications to
which IPv6 anycasting intends to resolve. We also discuss functionalities on anycast nodes needed to realize such applications.
1. Introduction

Anycast is defined as one of new IPv6 features, which supports service-oriented address assignments in IPv6 networks. Anycast address is not determined by the location of node, but by the type of service presented at the node. In anycast communication, the client can automatically locate the appropriate node corresponding to a specific service without knowledge of the location of the server. This appropriateness is determined by routing protocols’ measure of distance.

However, anycast is hardly used (except for MIPv6 HA address) now. This is because there are several technical problems, which were described in [ANALYSIS]. Another reason is that the usage of anycast is still unclear.

In this document, we clarify the usage of anycast with some examples. Then, we show the applications suitable for anycast and analyze the functionalities of anycast.

Scope of this Document

The notion of anycast is not only limited to the network (i.e., IP) layer, but can also be achieved in other (e.g., application) layers. In this document, we focus on network-layer anycast, which is defined in IPv6 specification [ADDR-ARCH].

2. Characteristics/Observations of Anycast

The motivation for anycast, described in [ANYCASTING], is that it simplifies the task of finding an appropriate server. One of the questions we try to answer is "What is the merit of using anycast?" In the following sections, we first present several scenarios where anycast is suitable to use. Next, we show some advantages of using anycast. After that, we list what kinds of functionalities are required to realize these scenarios.

2.1 Application Scenarios

As already discussed in [ANYCASTING], one of the major applications of anycasting is to establish a server/service discovery. Mirrored FTP sites can share a single anycast address, and users would simply perform an FTP to the anycast address to reach the nearest server. By controlling routing mechanism appropriately, the anycast initiator can communicate with an optimal (e.g., minimum delay or high throughput) anycast receiver chosen from multiple anycast members by specifying the anycast address. Additional examples listed below clearly demonstrate characteristics of anycasting.
2.2 Advantages of Anycasting

Auto configuration through anycasting is quite effective during the primitive setup phase (e.g., DNS server cannot be used). When a host is plugged in, its IPv6 address is configured automatically. However, to achieve true plug&play, various settings are necessary (e.g., configuring unicast addresses of DNS server). If a well-known anycast address is installed in the hardware beforehand, end users can utilize DNS service without complicated configuration. It would be sufficient to send a query to a well known DNS anycast address.

Moreover, in the current P2P application, the peer needs to know the IP address (i.e., unicast address of a peer) to connect the logical network prior to participating in the service. However, with
anycasting, each peer only specifies the anycast address to participate in the logical network. The advantage of this model is that all processes are completed within its own protocol.

Like above examples, only anycasting has the following advantages that existing application-layer technologies cannot realize.

- **Transparency**

  Anycast addresses are allocated from the unicast address space. Thus, anycast addresses are syntactically indistinguishable from unicast addresses. So, the clients do not need to know whether the destination address is unicast or anycast. Only anycast receivers are explicitly configured to know that it is an anycast address. This obviates the need to change of client and server applications.

  Moreover, in application-layer anycasting, to realize the access to appropriate server providing specific service, service location tools (i.e., directory server) are necessary. However, even if the server works correctly, trouble of the directory server can cause unreachable to the server.

  On the other hand, network-layer anycasting can help realize appropriate server selection by only specifying an IP address. The directory server is no longer necessary to discover services.

- **Separation of application and routing policy**

  Each application has different appropriateness. In application-layer anycasting, this application-dependent information managed for each application is required to realize appropriate server selection. So, different routing architecture is required for each application to support different appropriateness.

  On the other hand, network-layer anycasting reduces this troublesome task and can be used for all applications. Each appropriateness can be mapped to one criterion, and the routing architecture of network-layer anycasting works based on the criterion. Then, each application can use the routing architecture to support different appropriateness. Anycasting relaxes the routing architecture from the application-dependent information.

### 2.3 Functionalities for Anycast Applications

#### 2.3.1 Basic Functionality
Before considering each application, we show the basic (i.e., minimum) functionalities to realize anycast communications.

- **Supporting unicast forwarding**

  Anycast addresses are syntactically indistinguishable from unicast address. Then,

  - if the receiving packet is not an anycast packet, each anycast router MUST forward the packet as a unicast packet.

  Moreover, this functionality is necessary to retain backward compatibility. So,

  - if we replace existing routers with anycast routers, they MUST do all tasks of existing routers.

- **Reachability to the server**

  To ensure reachability to the server, it is necessary for routers to forward the packet destined to the anycast address. To forward packets,

  - anycast routers SHOULD have routing entry of receiving anycast packet.

  If the router does not have the routing entry for the receiving packet in the routing table, it simply discards the packet.

  Moreover, only anycast receivers can identify the anycast address, because it is not identified by address itself. So, anycast routers cannot identify anycast address unless the anycast receivers notify them. Then,

  - each anycast receiver MUST notify a neighbor router of its membership information.

  Above two functionalities are not necessary only when the anycast address is subnet anycast.

### 2.3.2 Functionalities to Realize Advantages of Anycasting

In this section, we show what kinds of functionalities are required to realize the advantages of anycasting.

- **Transparency**

  Following functionalities are required to realize the
transparency.

- If an anycast router receives an anycast packet, the router MUST forward it to one anycast receiver.

If multiple packets are sent to an anycast address, multiple reply packets may be delivered to the anycast initiator. This does not give much transparency to the initiator because the client application cannot decide the appropriate server.

Of course, if the anycast router keeps only one routing entry for receiving packet, the router simply forwards the anycast packet according to the entry. However, if there are multiple candidate entries for receiving anycast packet, following functionalities are necessary.

* Anycast routers SHOULD have anycast selection criteria.
* Anycast routers SHOULD have the knowledge to select one entry.
* Anycast receivers MAY notify a neighbor router of its preference value (e.g., metric).

These are unique functionalities for anycast communication.

- Well-known anycast address MAY be defined.

To discover specific servers without directory servers, defining well-known anycast address is needed for each service. It can be done by IANA.

o Separation of application and routing policy

Following functionalities are required to realize this advantage.

- Anycast Receivers MAY notify a neighbor router of its preference value (e.g., metric).

2.3.3 Other Functionalities

Moreover, following functionality is required to realize anycast communication.

o Introducing Scope

As described in [ANALYSIS], the use of anycast addresses may lack scalability. To improve scalability of routing protocol, it is necessary to limit the range of sending route information to an
anycast address. Then,
  - anycast routers MAY handle scope to limit the range of sending
    routing information.

3. Security Considerations

This draft does not include any security issues of anycast. Other
security descriptions about anycast are shown in [ANALYSIS].
4. References

4.1 Normative References


4.2 Informative References


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