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Anycasting – One-To-One-Of-Many Communication Method in IPV6

SANTOSH SHARMA
Department of Computer Application, Graphic Era University
Bell Road, Clement Town, Dehradun
santosh.sharma.ddn@gmail.com

AJAY RAWAT
Department of Computer Engineering, University of Petroleum and energy studies
Bidholi Campus Office Energy Acres, P.O. Bidholi
Dehradun-248007
rawat.ajay@hotmail.com

SUSHIL CHAMOLI
Department of Computer Application, Graphic Era University
Bell Road, Clement Town, Dehradun
sushilchamoli@gmail.com

Abstract- On the Internet today, anycasting is used to balance the connection load across multiple Web servers sharing the same content. Anycasting communication is a new "one-to-one-of-many" communication method in Internet Protocol version6 (IPv6) networks. With the help of this technology, it becomes a virtual watch to find the best server, which respond to a request of the client. Due to issues which are not resolved and very slow deployment of IPv6, anycast communication of network-layer is still not a reality. But in recent years so many researchers took their interest in the area of IPv6 anycast communication. It guarantees a look at the state and direction of the ideas in this area. In This paper we have discussed some of the major difficulties with network-layer anycast communication. We also focused on the possible solutions of the problems with IPv6 anycast communication, as well as some optimizations and applications that have been developed recently.

Keywords: Anycasting, IPV6, Communication, network-layer

1. INTRODUCTION

In the older version of internet protocol (IPv4) three types of delivery modes are possible: *unicasting, multicasting* and *broadcasting*. In unicast delivery mode, a connection is "one-to-one" and end (process) to end (process), which is central to most activities across the Internet. In multicast, "one-to-many" communication exist where the data packet is transmitted to selected group of machines and in broadcast delivery mode, "one-to-all" communication exist where the data packet is transmitted to all machines in that network. With the vast development of Internet computing and networking tools and technologies, new application paradigms are invented by which the model of data delivery across the Internet is changing and developing. The future Internet has been anticipated as a much larger-scale network than today's Internet with the support of the next version of the Internet Protocol (IPv6). IPv6 provides

1. Larger number of addresses
2. End-to-end connectivity
3. Efficient routing
4. Auto-configuration
5. Integrated security
6. Mobility and multicast enhancements and
7. Quality-of-service support

Apart from this it also provides new delivery modes such as *anycast*.

1.1 Anycast

Anycast is a paradigm for communicating with one member of a group. An anycast service, when implemented at the network layer, is called *Network-layer anycasting* or simply *IP Anycast*. IP anycast delivers packets destined to an anycast address to a member of the anycast group, typically the one which is closest to the sender in terms of the metrics used by the routing protocol. In other words, it is a mechanism which is used to deliver a data packet to one of many hosts in the network. The idea of anycast delivery was originally proposed by Partridge *et al.* in RFC 1546 [1]. In this technique there is an anycast address (in RFC2373) which is defined by IPv6. This address is assigned to possibly one or more separate nodes. A packet which is intended for an anycast address will be routed to one of the separate hosts with that address. Ideally the packet is delivered to the nearest host. Thus, IP anycasting may be defined as "a service which provides a stateless effort delivery of an anycast datagram to at least one host, and preferably only one host, which serves the anycast address" [1].

Anycast is generally considered to be routable as if it were unicast. The routing algorithms, which are underlying, are dependent on to find out the accurate destination for an anycast addressed packet. It is desired that these algorithms, which are already implemented and used frequently, could be used with small changes. And once these algorithms can find the minimum cost path to the destination end, the packet whose destination is an anycast address should always be delivered to the suitable destination end. When a host machine begins receiving packets on an anycast address, then the routers will simply update their routing table's entries, by using the route to this new destination if it is less expensive. A router would see a new host which responds to an anycast address simply as another route to the same unicast destination. This process is already possible and prevalent in the unicast paradigm due to multihoming. The router will make an easy choice of which path to use and need not concern itself to determine whether the address actually belongs to one, two, or more hosts.

However, the report of IPv6 and anycast is something complicated. In the standards, an anycast address is specified as a unicast address which is assigned to more than one host. Therefore, by looking at the address, it is not possible to know whether it is unicast address or anycast address. As R.M. Hinden points out in [10], interfaces, which are using an anycast address as an alias, must know that this address is in fact an anycast address for functioning properly. And this is important because the handling of certain situations must be different for anycast than for unicast. Further some constraints have been placed on anycast in IPv6 network [9]. According to this this address is not included in the source address field of a packet and also it is to be assigned to routers but not hosts. Research on anycast can be classified into two categories: network-layer anycasting and application-layer anycasting. This article focuses on some of the challenges and possible solutions surrounding the technology.

1.2 Applications

1. The area of server selection is the most popular accepted application of anycasting. As we know that day by day the Internet is scaling up. So to choose one of many machines, which are functionally identical, have been and will continue to be a major issue. The load of a server must be must be spread throughout multiple servers to effectively respond to requests from clients in a sensible amount of time. One of the simple and basic techniques is to use simple mirroring where a client has to choose one mirror among the list of mirrors. This process (mirroring) is not transparent and dependent on the user to choose an appropriate server. There is another technique also: Domain Name Service (DNS). Content delivery networks use this tricks to direct clients to the best destination. But there is a problem in this method in determining the best server because it has only the knowledge about the location of the client's name resolver, not of the client itself.

With the help of an anycast server selection technique the above problems could be solved. In this technique anyone can use the same address from anywhere in the world and the best destination for the client would be picked automatically by the routing subsystem. In general terms, it can be said that anycast is a very intelligent technique for selecting the best and easy server to download a file from a very popular or general site and load distribution. Because in this technique a user could easily request a file with the help of that site's anycast address and the network would automatically choose and locate the best possible mirror, from where the file would be downloaded.

2. We can also use anycast mechanism in locating services. Anycast can make high availability of services and fault tolerance nearly trivial and there is no need to find the closest service provider. In place of depending on detailed failover techniques and Domain Name Service to provide backups to recover from failures, a user need only have systems which respond to the same anycast address. In this case the clients just need to know only one address, and communication between devices could continue without any interrupt regardless of any number of network or hardware failures. Increasing availability could be as simple as adding another host to the network. This process becomes very important and popular in a mobile ad hoc network or sensor network where the topology changes quickly. In mobile ad hoc network or sensor network the members of the network move around where new hosts/sensors join the network and, old hosts/sensors leave the network dynamically. In this type of network, where an environment changes dynamically, providing and discovering services are difficult, and again availability is a major concern. Wu and Zitterbart propose a scheme that uses anycast concepts to simplify the discovery and persistent provision of services in mobile ad hoc networks [5]. In their proposed system to services are assigned by unique IDs and then uses an ad hoc anycast routing process to allow hosts access to services even if some of the providers drop from the network.

2. CHALLENGES WITH ANYCAST

Following are the challenges with anycast:

2.1 Global Routing

Global routing is the big issue or challenge with general use of anycast. The concept of anycast handily fails the benefits of aggregated routing where routers can cut down a lot of entries of routing table with the same destination to a single entry with a prefix mask. This technique becomes more beneficial since a lot of addresses are combined into a single route. But global anycast ruin route aggregation because it allows the same address to be reachable in many different subnets. Among of them only one subnet is selected in which an anycast address resides. This subnet will have a matching prefix and it will be able to be aggregated by routers. All other places of that anycast address must have individual entries in the routing table. If anycast addresses are assigned to many hosts in an uncontrolled way, the routing tables will grow unexpectedly and routing speed will be significantly affected. Site local anycast address advertisement enforces some of the same problems, but it is sometimes feasible due to the size constraints of the network. However, at the global level, routes to host anycast addresses cannot be safely advertised without a new system for routing. Following are two possible solutions for global routing.

2.1.1 Global IP-Anycast — Global IP-Anycast (GIA) [2] is a new technique for anycasting at network-level. GIA takes advantage of properties which are specific to anycast to make routing more efficient and scalable. The developers of Global IP-Anycast have determined that with the help of anycasting along with a new routing model, the scalability of anycast can be greatly improved to make global-scale anycasting a feasible technology in the Internet.

The GIA system solves the problem of rout aggregation with the assumption that anycast simply provides improved service, and requests routed to a non ideal server will still be processed just the same. The home network for a given anycast address is defined and worked as the network which shares a prefix with the address. Hence, each and every anycast address includes a home network into which the anycast address is aggregated in typical Classless Inter Domain Routing (CIDR) manner. So, as a worst case, a packet could be routed toward previously defined home network and still finish at a suitable anycast destination address. With this actualization, only aggregated routs could be promoted by routers and passing on those local anycast destination addresses that do not share a network prefix as internal routes. The anycast destination is yet reachable at its home network. The routing infrastructure is not overloaded with extra load. However, this process suffers from the property of anycast to find the nearest destination. To add the locality characteristic to GIA, a router looks after the requests that pass through it. When a router finds out that a particular anycast destination address is popular, it will try to locate a nearer node than the home network. It will send a new BGP (Border Gateway Protocol) packet which is determined as an anycast search packet. This BGP packet will get passed between routers until the TTL (time to live) dies or a router responds to the anycast search request when router knows that a route to an anycast node less expensive than the route to its home network. After receiving this new route the searching router will edit its anycasting table. Then a tunnel between itself and the responding router will be created by searching router. Packets which are intended for the given anycast address are then tunneled to this router instead of being forwarded to the home network. So if we will use this method, then there is no need for the anycast routes to be propagated to all other routers. Every boundary router simply caches tunnels for delivering packets to popular anycast destination addresses. In this way, unicast routing is not influenced by anycast routing. And off-course, at the same time, anycast packets are always delivered to a reasonable destination, although not necessarily the best possible destination.

2.2 Internet Indirection Infrastructure

The infrastructure of Internet is very effective at delivering unicast packets to their single destination from their single source. However, anycast, which is a new routing and delivery methods, require new infrastructure support and careful deployment to be effective and widely available. A new solution, Internet Indirection Infrastructure (i3) [4] has been proposed that could provide these new services with small impact on the existing infrastructure. This solution provides a way where the packets are addressed without proper knowledge of their actual destination. A server or network of servers becomes a central location for mappings from IDs to IP addresses. In this infrastructure, when a sender wants to establish a connection with a receiver, it sends the packet to the I3 network along with the destination ID. After that the i3 network is responsible for finding the IP address of the last receiver and delivering the packet to that receiver.

I3 includes a characteristic called *inexact matching* where the destination ID of an incoming packet need only match a certain amount of a mapped ID to be considered a complete match. This technique could be used to provide anycast in i3. All the anycast group members choose the destination IDs with a common prefix. After that an incoming packet is delivered to the anycast destination whose ID is most closer to the packet's destination ID. In this way i3 could be the good solution to the global routing.

2.3 Supporting Stateful Connections

State-full connections, just similar to those of TCP, only function properly when each end has sufficient information about the other end and the communication that has taken place thus far. For example, TCP needs to know the address and port number of end-points as well as the size of the buffer or window size of the other end along with other pieces of information. Without proper knowledge, the protocol will terminate the connection. Clearly, it is very important that the endpoints of a state-full communication stay in synch and in order to keep both ends satisfied, all packets of a connection must arrive at the same destination. Since any two packets with anycast address may arrive at different destinations, we cannot use a state-full connection without some modification. To support these connections, we need some way to guarantee the destination of a packet stream after the first packet establishes the appropriate end host.

As a simple solution would be possible if we use stateless protocols like UDP (User Datagram Protocol) rather than state-full protocols with anycast addresses. If a state-full connection is required, perhaps a stateless protocol could determine an appropriate address. For example, a UDP packet could be sent to an anycast address and some known port. Any time a host gets the UDP packet on that port, it simply responds with another UDP packet along with its unicast address. This address could then be used for future state-full communication.
More complicated solutions exist that attempt to bypass the need for an initial stateless communication.

2.3.1. Five-Way Handshake

Every host which responds to an anycast address should also have a unicast address for use in normal communication. Thus, any time a request arrives in on the anycast address, the host can just respond with its unicast address, and communication can begin as normal. In this way anycast addresses are used for initial contact and unicast addresses are used for further communication. Therefore there is no need to modify the protocols to ensure that communication works properly.
There are several ways to implement this exchange. One method uses a little modification to the semantics of starting a TCP connection [1]. Any time a host sends the SYN packet to start a connection with an anycast address as the destination; it will leave a wild card in the destination field of the local state for that connection. The returning packet along with SYN+ACK will have the destination's unicast address in the source field. Then the initiating client stores this unicast address in the local state and continues the connection as normal.
We could use a five-way handshake by adding two step in typical TCP three-way handshake as following figure-

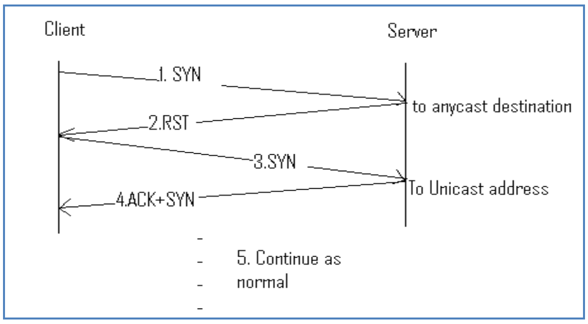

Fig 1

1. The initiator would send a SYN packet to an anycast destination.
2. The destination would reply with a RST packet, using its unicast address as the source.
3. The initiator would then send a SYN packet to the unicast address.
4. The returning packet SYN+ACK will have the destination's unicast address in the source field.
5. Then the initiating client stores this unicast address in the local state and continues the connection as normal.

However, these methods need changes to TCP at both endpoints of the connection.

2.3.2 Source Identification Option

Shah and Sanghi gave a different solution on the same problem [12]. It builds on a previous idea for both anycast and mobility support in IPv6. The basic idea is to use an IP header option which is labeled the source-id and contains an alternate address for the source of a packet. The anycast address is placed in this extra header option so that the destination knows the anycast address is suitably related with the packet. This source-id is applied to a TCP connection as follows:
1. A SYN packet is sent to an anycast destination.
2. The destination will respond with a SYN+ACK packet. It uses its own unicast address as the source and putting the anycast address in a source-id header option by. With the help of this anycast address it was contacted.
3. When the initiator of the connection gets the SYN+ACK packet, it will look for a matching connection first with the source address (unicast address) and then with the address in the source-id header (anycast address). If there is a perfect match of source-id address, it will be stored, and the unicast source address will be used for future communication over the connection. Thus in this way, all packets will be delivered to only one destination address, and a state-full connection can be maintained safely. Further a flag must be used to find out whether the other end understands the source-id method or not because both sides must be updated to properly handle this technique. If the flag is not set, an RST packet is sent. Both the works (appending source-id header and changing of the source address to a unicast address) are done in the networking code so there is no need to modify the user applications. The appropriate unicast address which is used in further communication is determined automatically by searching the addresses which are registered on the system.

2.3.3Source Route Option

R. Engel *et al.* proposed another solution to this problem [8]. In this technique the existing source route option is used to pin all the packets in a connection to a specific route. Assuming hosts already support this option, only minor modifications are required at the server side to add and handle the option suitably. This technique works as follows-

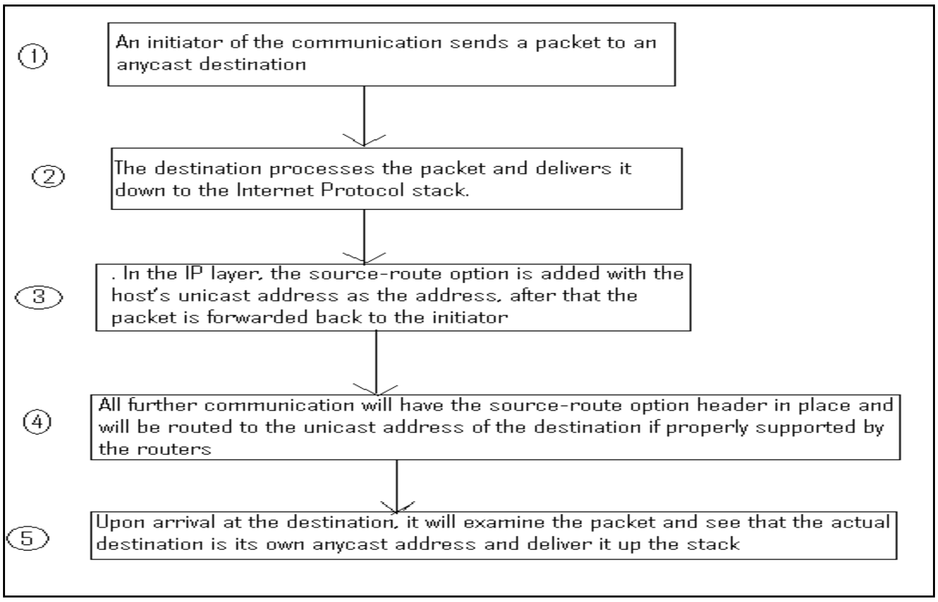

Fig 2

This solution also needs the server to be able to distinguish an anycast address. However, a major drawback of this idea is that the server uses its anycast address in the source field of the packet which is specifically not allowed in IPv6 because it is nondeterministic. If the packet finds error along its path, an ICMP (Internet Control Message Protocol) error message may be generated and forwarded to the source. If the source is an anycast address, then it may be possible that the receiver of the ICMP error message be different from the sender of the troubled packet.

2.3.4. Anycast Address Mapper

There is another solution Anycast Address Mapper proposed by M. Oe and S. Yamaguchi [6]. Instead of modify the TCP and IP stacks; it uses an external mapper library which is responsible for finding the unicast address associated to an anycast destination before real communications starts. This is achieved through the use of ICMP ECHO messages and this technique works as follows-

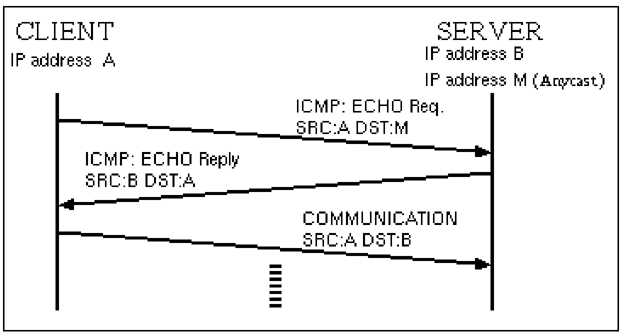

Fig 3

1. An initiator of the communication sends ICMP ECHO request to the anycast destination addresses
2. The destination will send an ICMP ECHO reply from its related unicast address after receiving the request.
3. The original source then uses this unicast address to start state-full communication.

In this model a participating application must be modified to use the anycast address mapper to resolve an address before beginning communication with a host. And there is no need to modify the protocol stack.

For state-full communication to be used with anycast, it seems one of the above solutions or something similar will need to be implemented and released.

3. IMPROVING ANYCAST

Following are two approaches given for improving the performances of anycasing----

3.1. Jia *et al.* proposed an integrated routing algorithm for effective delivery of anycast packets [13]. This algorithm two routing algorithms: single-path routing (SPR) and multipath routing (MPR) are merged. In SPR, the same path is always taken as long as a specific path exists between source and destination. And MPR selects routes dynamically based on network load. However, the choice is not quite so clear. SPR is faster than MPR, but it cannot route around big traffic. MPR can avoid temporary congestion, but it is much more costly to operate due to its complexity. The main idea behind the proposal of integrated routing is that the best features of both MPR and SPR can be kept while minimizing the effect of their disadvantages. A few more costly MPR routers can be used to help direct traffic around congestion, while the rest can be cheaper faster SPR routers.

3.2. Another approach, which is proposed by Miura and Yamamoto, would use routers (active) to direct the delivery of anycast packets [7]. Its concept is dubbed *active anycast* and relies on a set of active routers to more intelligently direct traffic. The process works as follows--

1. When a packet which is destined for an anycast address, arrives at an active router.
2. Then the router chooses a destination. This destination is based on some probability and previously measured metrics.
3. Once this destination has been successfully chosen, the incoming packet is rewritten with the unicast address of the destination machine substituted for the anycast address.
4. After that the unicast addressed packet is forwarded to its destination as normal.

An active router counts the round-trip time (RTT) to a server when it forwards a client request. The RTT will include both the network delay and the server processing delay to give a better model for the response time of a server. The model is modified each time a new request/reply packet pair travels through an active router. The closer the first active router is to the client, the better the results yielded, as it is more likely to choose a destination appropriate for the client and not just itself.

CONCLUSION

This paper presents popular application paradigms of anycast. It has surveyed few problems faced by network-layer anycast. Solutions to these problems are available in the form of Global IP-Anycast and source routing, among others. Techniques for improving anycast performance, including integrated routing and active routing have been presented. As ubiquitous computing becomes more prevalent, it will become necessary to address devices by class rather than individually. The possibilities presented by the availability of anycast have just been touched on.

REFERENCES

[1] C. Partridge, T. Mendez, and W. Milliken, “Host Anycasting Service,” RFC 1546, Nov. 1993.

[2] D. Katabi and J. Wroclawski, “A Framework for Scalable Global IP-Anycast (GIA),” *Proc. ACM SIGCOMM*, Sept. 2000, pp. 3–15.

[3] E. Zegura *et al.*, “Application-Layer Anycasting: A Server Selection Architecture and Use in A Replicated Web Service,” *IEEE/ACM Trans.Net.* vol.8, no.4, Aug.2000, pp.455– 66.

[4] I. Stoica *et al.*, “Internet Indirection Infrastructure,” *Proc. ACM SIGCOMM*, Aug. 2002, pp. 73–88.

[5] J. Wu and M. Zitterbart, “Service Awareness and Its hallenges in Mobile Ad Hoc Networks,” *Wksp. omp.Science 2001: Mobile Commun. over Wireless LAN:Research and Apps.*, Sept. 2001, pp. 551–57.

[6] M. Oe and S. Yamaguchi, “Implementation and Evaluation of IPv6 Anycast,” *Proc. 10th Annual Internet Soc. Conf.*, 2000.

[7] M. Yamamoto *et al.*, “A Network Supported Server Load Balancing Method: Active Anycast,” *IEICE Trans. Commun.*, Special Issue on New Development on QoS Technologies of Information Networks, E84-B, no. 6, June 2001.

[8] R. Engel *et al.*, “Using IP Anycast for Load Distribution and Server Location,” *Proc. 3rd Global Internet Mini-Conf.*, Nov. 1998, pp. 27–35.

[9] R. Hinden and S. Deering, “Internet Protocol, Version 6 (IPv6) Addressing Architecture,” RFC 3513, Apr. 2003.

[10] R. M. Hinden, “IP Next Generation Overview,” *Commun.ACM*, vol. 39, no. 6, 1996, pp. 61–71.

[11] S. Deering and R. Hinden, “Internet Protocol, Version 6 (IPv6) Specification,” RFC 2460, Dec. 1998.

[12] S. Shah and D. Sanghi, “Host Anycast Support in IPv6,” *Proc. 5th Int’l. Conf. Adv. Comp.*, 1997.

[13] W. Jia, D. Xuan, and W. Zhao, “Integrated Routing Agorithms for Anycast Messages,” *IEEE Commun. Mag.*, vol. 38, no. 1, Jan. 2000, pp. 48–53.