Making practical use of IPv6 anycasting: Mobile IPv6 based approach

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IPv6 Anycast
- Defined in IPv6 specification
- Supports service-oriented address assignment
  - Anycast address is assigned to multiple nodes which provide the same service
  - Appropriateness depends on the routing protocol
- Shares address space with unicast
- Existing unicast services can be switched to anycast services with the same address

Object of address assignment
- A node
- A group of nodes
- A service

Candidate for receiver
- Single
- Multiple

Communication form
- Point to Point
- Point to Multipoint

Address space
- Unicast address
- Multicast address
- Anycast address

Advantages of Anycast
- Provides a fixed address for a service
  - Client only has to know the anycast address to get the service
- Enables client nodes to connect to appropriate server without care
  - The appropriate server is selected by the routing mechanism
- Provides robust availability of the services
  - When a server breaks down, anycast packets are delivered to another working server

Current Usages of Anycast
- Only a few services use global anycast
- Current global anycast services are achieved via service-specific methods
- Current anycasting cannot provide stateful communication (e.g. TCP)
Objectives

- to achieve service-independent global anycast service
- to provide stateful communication in anycasting

Difficulty of Anycast Routing

- Anycast addresses are location-independent
  - Locations of anycast responders cannot be identified from anycast addresses
  - Need to associate the locations of anycast responders with anycast addresses
  - Mobile IPv6 (MIPv6) resolves the same difficulty
    - We utilized MIPv6 for proposed architecture

Analogies between MIPv6 and Global Anycast

<table>
<thead>
<tr>
<th>MIPv6</th>
<th>Global Anycast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Node (MN) has a location-independent address Home Address (HoA) and a location-dependent address Care-of Address (CoA)</td>
<td>ARs have a location-independent address Any and a location-dependent address PUA</td>
</tr>
<tr>
<td>MN uses HoA to communicate with Correspondent Node (CN) regardless of the network where MN exists</td>
<td>ARs use Any to communicate with AI regardless of the network where ARs exist</td>
</tr>
</tbody>
</table>

Proposed Architecture

- Mobile IPv6-based IPv6 Global Anycast (MGA)
- Two models
  - Basic model: Utilizes MIPv6 architecture as is
  - Advanced model: Extends MIPv6 architecture to resolve the differences between MIPv6 and global anycast

Communication in MIPv6

- Decapsulation
- Encapsulation
- Transmits packet to CN
- Initiates packet addressed to HoA
- Tunneling
- Reverse tunneling

Communication in MGA Basic Model

- Decapsulation
- Encapsulation
- Transmits packet to AI
- Initiates packet addressed to Any
- Tunneling
- Reverse tunneling
- Anycast
Keeping a Stateful Communication

- Various anycast responders update binding caches in home anycast agent
  - Change corresponding anycast responder
  - May destroy stateful sessions
- We utilized Route Optimization procedure defined in MIPv6
  - Switch communication paths not through HAA

Difference between MIPv6 and Global Anycast

MIPv6
Home Address is possessed by a single Mobile Node

Global Anycast
Anycast Address is shared by multiple Anycast Responders

The difference causes some limitations in MGA basic model

Limitations in MGA Basic Model

- Cannot distribute anycast packets to multiple ARs at one time
  - Only a single PUA can be bound with a single AR
- Stateful communication may be destroyed
  - When AI cannot execute route optimization
- Traffics are centralized in a HAA
  - More typically than the case in MIPv6

MGA Advanced Model

- Multiple binding cache entries for a single anycast address
- Distribute anycast packets to multiple ARs
- Stateful communication provided by HAA
  - Achieve stateful communication without route optimization
- Distributed deployment of multiple anycast agents
  - Balance the anycast traffics

Multiple Binding Cache Entries for Single Anycast Address

- We extend binding cache to maintain multiple entries and metrics
- We extend binding update message to transmit some metrics
  - Metric: hop count, server resource, etc.
- HAA refers metric in anycast binding cache to select a corresponding AR
Stateful Communication Provided by HAA

- HAA maintains correspondence information between AI and AR for a certain period
- HAA forwards anycast packets according to correspondence information table

<table>
<thead>
<tr>
<th>Source</th>
<th>Corresponding PUA</th>
<th>Exp. Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI1</td>
<td>PUA1</td>
<td>1</td>
</tr>
<tr>
<td>AI2</td>
<td>PUA2</td>
<td>1</td>
</tr>
<tr>
<td>AI3</td>
<td>PUA3</td>
<td>1</td>
</tr>
<tr>
<td>AI4</td>
<td>PUA4</td>
<td>1</td>
</tr>
</tbody>
</table>

Example of correspondence information table

Distributed Deployment of Multiple Anycast Agent

- Multiple nodes (named Midway Anycast Agent: MAA) balance the anycast traffics
- Multiple MAAs are deployed around the Internet
- MAAs capture anycast packets in its scope (e.g., an ISP), and transmits them to selected AR
- HAA captures anycast packets not captured by MAAs and transmits them to selected AR

Conclusions and Future Topics

- Conclusions
  - Anycast routing architecture based on MIPv6
    - Can provide service-independent anycasting
    - Can keep stateful communication
- Future topics
  - Implementation and evaluation of MGA advanced model

Thank you.