Design a Novel Scheme for Dual-Stack Cloud File Service Discovery Based on Distributed Hash Table

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Abstract—Cloud services attract some attention in recent years, the information connection devices of organizations or enterprises with one another distributed around the world using networking systems. Cloud services also provide variety services for users, including virtual hosting services, storage services and web application services, etc. Because of the rise of cloud computing, users can directly enjoy the benefits of distributed computing. The high throughput of computing power and large storage space can be ubiquitous when users connect to the Internet. Two important elements behind clouds computing include distributed computing and peer-to-peer network. However, the huge numbers of information devices today bring forth some new problems. The lack of IPv4 protocol addresses is one of the serious problems. Therefore, the IPv6 protocol was proposed, and during the transitional period form pure IPv4 to pure IPv6, IPv4 and IPv6 will coexist in the Internet. To link independent dual-stack p2p networks around the world, we hereby propose a mechanism to improve the service discovery in dual-stack cloud file service in hope of decreasing the count of protocol translation so as to improve the efficiency of the bandwidth and load balance.

Keywords—Service Discovery, Peer-to-Peer, DHT, Cloud Computing, IPv6

I. INTRODUCTION

After the rise of the Internet, people start their communication through the network, including using BBS, E-Mail and World Wide Web. After a few years, in addition to providing static information storage and advertising services, network services also provide multiple user interactive functions, and design the Web Service protocol for remote process call. As a result, the programmer can easily call up the remote hosts to provide resolutions. Based on these service, the large amounts of devices deployed around the world provide network services become the cloud service[1].


Because of the great number of information devices, the issues about the lack of IPv4 network address were therefore brought forth. NAT (Network Address Translator) is one technology for a template solution, but because of NAT technology using private IP addresses, many P2P software can’t directly connect with each other. To solve these problems, using Dual-Stack IPv4 / IPv6[6] co-exist network and support P2P system will be an important research topic.

In figure 1, as the word indicates, dual-stack mechanisms include two protocol stacks that operate in parallel and allow network nodes to communicate via IPv4 or IPv6[7]. They can be implemented in both end system and network node. In end systems, they enable both IPv4 and IPv6 applications to operate at the same time. The Dual-stack capabilities of network nodes support the transport of both IPv4 and IPv6 packets.
II. BACKGROUND AND RELATED WORK

A. Cloud Computing

Cloud computing provides resources like storage computing as a service, user can just choose what they want and how they use it.

B. P2P File Share

Peer-to-peer is a service model that the participants share resources with each other. Most p2p protocol usually have some common features, every peer have a unique identifier and support some type of message-routing capability.

C. DHT and Chord Protocol

Distributed Hash Table[8] is one class of distributed system, a DHT system separate the keyhashed value pairs information to distributed peers.

Chord [9] uses consistent hashing [10] to assign keys to its peers. Consistent hashing is designed to let peers enter and leave the network with minimal interruption. In a steady state, for N peers in the system, each peer maintains routing state information for about only O (logN) other peers (N number of peers in the system). This may be efficient but the performance degrades greatly when that information is out-of-date.

D. IPv6

Because of the lack of IPv4 addresses, IPv6 protocol is proposed for a solution. The address range of IPv6 is 2^{128}, so that it can meet the requirement of people for a long time.

E. Dual-Stack P2P

Some researches aimed to design a p2p system that can make IPv4 peers and IPv6 peers connect with each other. When a peer needs to connect with another peer with a different IP version, it may use p2p application gateway (ALG) [11] or other transition mechanism.

III. MECHANISM IMPROVEMENT FOR DUAL-STACK CLOUD FILE SERVICE DISCOVERY

For the dual-stack cloud computing architecture, we can build a single area P2P overlay network in office or lab as a “single area dual-stack P2P network model”. Between multi-areas such like between different companies or server clusters as “multi-area dual-stack P2P network model”. When starting a dual-stack cloud file services discovery, there may be following issues :

i. Dual-stack peer IPv6/IPv4 registers twice and have two Node-ID and twice loading
ii. How to choose super peer
iii. How to choose data translation path

A. System Architecture

■ Single Area Network Model

In an office or a lab, IPv4 and IPv6 network may coexist in a local area. Some devices only support IPv4 protocol, some devices only support IPv6 protocol, and other devices can support dual-stack (IPv4 and IPv6) protocol. Pure IPv4 devices join local IPv4 P2P overlay network, and pure IPv6 devices join local IPv6 P2P overlay network. We call a device which joined the p2p overlay network as a peer and, therefore, simply address IPv4 peer as v4 peer, IPv6 peer as v6 peer. After a peer joins the p2p overlay network, the peer will get a Node-ID hashed by their IP Address. When a device support dual-stack, we will call it a dual-stack peer; the dual-stack peers can join IPv4 overlay network and IPv6 overlay network. Hence, we unanimously use its IPv6 address hashed for Node-ID to avoid registering with two Node-IDs.

Form Figure 2, we can know that peer A, B and Y belong to IPv4 DHT overlay network as v4 peers. The Peer X, Z and G belong to IPv6 DHT overlay network as IPv6 peers. The peer S1, S2 and S3 also join IPv4 and IPv6 overlay networks as dual-stack peers, because of dual-stack peers only use their IPv6 address for their Node-ID, so they only need to burden one part of job.

■ Multi-Area Network Model

Cloud services may be organized by many networks around the world, and there may have some networks only support IPv4 and the others only support IPv6. Figure 3 is a multi-area dual-stack P2P network model. In this figure, every cycle means a single area p2p overlay network with IPv4 or IPv6 protocol. Between nearby networks, they can use dual-stack peers for communication. We will propose our mechanism about how to use dual-stack peers to support cross multi-area service discovery and data exchange between peers in next section.

Figure 2. Single area dual-stack P2P network

Figure 3. Multi-area dual-stack P2P network
B. Type of Peer

- **Normal Peer**
  1) Record other peer route information (chord protocol).
  2) Share information and resources with other peers.
  3) May only have low computing power and low bandwidth.
  4) Need to use super peer (a dual-stack peer to choose services to other peers) to communicate with peers in other networks.

- **Super Peer**
  1) Supports common normal peer functions.
  2) Connects to other group’s super peers and exchanges data between groups.
  3) Higher bandwidth and computing power.

- **Super Peer Selection**
  In each area of network, there must be one peer responsible for the keyword “superpeerinfo”, we call this peer as a savepoint. The savepoint will record super peer information about the bandwidth, response time and loading. When a dual-stack peer join local p2p overlay network, the new peer will provide its information to savepoint. Then the savepoint will decide if the new peer becomes a super peer or not according to the following rules:

  - **Rule 1**: The new peer should be capable of supporting dual-stack communication. (necessary conditions).
  - **Rule 2**: The new peer is the only dual-stack peer (and satisfies rule 1).
  - **Rule 3**: Any existing super peer loading more than 5 normal peers (and satisfies rule 1).
  - **Rule 4**: Any existing super peer bandwidth should be less than the new peer. (and satisfies rule 1)

  Any peer that satisfies any one of the rules (rule 2 or rule3 or rule 4) can become a superpeer.

C. Resources Discovery in Single Group Network

We will give an example using figure 2, to illustrate the process of single area dual-stack P2P network service discovery:

1) IPv4 peer A discovers resource “R7” (using chord protocol) in IPv4 network but can’t find target resource.

2) IPv4 peer a request super peer s1 starting a resource discovery in IPv6 network.

3) Super peer s1 starts a discovery in IPv6 overlay network, and then finds the v6 peer X has the target resource “R9”.

4) Super peer s1 returns the result to IPv4 peer A.

5) Because the upload bandwidth of super peer s2 from IPv6 network to IPv4 network is higher than other super peers, so v6 peer X chooses super peer s2 for uploading data to IPv4 network.

6) IPv4 peer A will use super peer s1 as a relay peer for uploading data to v6 peer X, and v6 peer X will use super peer s2 as a relay peer for uploading data to v4 peer A.

D. Resources Discovery in Multi-Area Networks

We will explain an example using Figure 3, to illustrate the process of multi-area dual-stack P2P network service discovery:

In Figure 3, any area belongs to IPv4 will name by lower case letter, for example: “cloud a” is an IPv4 area. Then the IPv6 area will be named by upper case letter, for example: “cloud A” is an IPv6 area.

Super peer will have a front name which was combined by both names of these super peers in the two areas, and the last name was, on the other hand, combined by letter ‘s’. For example: super peer “Ec s1” is between “v6 cloud E” and “v4 cloud c”.

1) IPv4 peer a2 in cloud requests super peer Aa s1 to start a cross-area discovery resource “R9”.

2) Before starting the discovery, super peer Aa s1 will get super peer information from savepoint v4 a1.

3) Super peer Aa s1 get 3 super peer information - Aa s1 (itself), Ba s1 and Ca s1, and then Aa s1 check to see if all super peers are connected to different areas.

4) Super peer Aa s1 requests these 3 super peers, Aa s1, Ba s1 and Ca s1 to start a discovery into their remote network, and the request packet will record the start peer information and the information from all super peers which is used in our path when the discovery goes on.

5) These 3 super peers will start resource discovery in remote area, Aa s1 discovers V6 cloud A, Ba s1 discovers V6 cloud B, and Ca s1 discovers V6 cloud C for resource “R9”.

6) If none of these 3 super peers can find resources “R9” in remote area, they will continue further discovery.

7) We will now only aims to use super peer Ba s1 to locate the target resources. Since we did not find the required resources, we would use another super peer Ba s1 and go back to the second step to continue the resource discovery again.