v6ops
Internet-Draft
Intended status: Informational
Expires: May 3, 2012

Z. Li
China Mobile
Q. Zhao
X. Huang
Y. Ma
Beijing University of Posts and Telecommunications
X. Xu
Huawei Technologies Co.,Ltd
October 31, 2011

Analysis on Load Balancing Requirement in IPv4/IPv6 Transition
draft-li-v6ops-load-balancing-requirement-02

Abstract

This document first analyzes the critical issues of bottlenecks in existing tunneling and translation technologies, which can be solved by proper load balancing mechanisms(e,g., scalability, availability, and single point of failure). Then, several key factors in designing a valid load balancing mechanism are described. Solutions to specific load balancing requirements can be drawn out by considering these factors. At last, current efforts about load balancing are introduced.

Table of Contents

1. Introduction 4
2. Requirements Language 4
3. Terminology 4
4. Problems of Bottlenecks 5
5. Keys To the Load-balancing Solutions 6
  5.1. Target Device 6
    5.1.1. Tunnel End-Point 6
    5.1.2. Translation Gateway 6
  5.2. Selection Policy 6
    5.2.1. Anycast-Based Selection Policy 6
    5.2.2. Source-Based Selection Policy 6
    5.2.3. Destination-Based Selection Policy 7
    5.2.4. Round-Robin Selection Policy 7
    5.2.5. Subscriber-Based Policy 7
    5.2.6. Dynamic Selection Policy 7
  5.3. Transport Protocol 7
    5.3.1. DNS 7
    5.3.2. DHCP 7
    5.3.3. ICMPv6 7
    5.3.4. RADIUS 8
  5.4. Load-balancer Location 8
    5.4.1. Terminal/Host 8
    5.4.2. Access Gateway 8
    5.4.3. Network Servers 8
6. Where Are We Now 8
  6.1. Work Done 8
    6.1.1. 6RD 8
    6.1.2. BIH 9
  6.2. Work In Progress 9
    6.2.1. NAT64 9
  6.3. Work To Be Done 9
    6.3.1. IVI 9
    6.3.2. DS-Lite 9
    6.3.3. 4RD 10
7. Security Considerations 10
8. IANA Considerations 10
9. Other Authors and Contributors 10
10. References 11
  10.1. Normative References 11
  10.2. Informative References 11
Authors' Addresses 12

1. Introduction

Since the depletion of IPv4 address, IPv6 is being introduced into existing networks and IPv4 will be gradually replaced by IPv6.

The Current Internet is almost fully built on IPv4. IPv6 is fundamentally incompatible with IPv4. The smooth and incremental transition from IPv4 to IPv6 is vital to IPv6's success. IPv6 transition technologies are generally classified into three catigories: dual stack, tunneling (e.g., 6RD[RFC5969], DS-Lite[I-D.ietf-softwire-dual-stack-lite]) and translation (e.g. , NAT64[RFC6146], IVI[RFC6219], BIH[I-D.ietf-behave-v4v6-bih]).

Dual stack technology can gradually steer traffic from IPv4 network to IPv6 network by using the address selection policy that generally "IPv6 prior to IPv4", as specified in [RFC3484].

Both tunneling and translation technologies introduce traffic concentration points, the tunnel end-point in tunneling technology and the translation gateway in translation technology. When the scope of IPv6 deployment continuously expands and the traffic of IPv6 business gradually grows, traffic concentration points usually bare very heavy work load. These concentration points will become bottlenecks and the sources of the single point of failure. To address such issues,load balancing mechanism should be considered.

This document firstly analyzes these problems caused by the centralized points imposed in the current tunneling and translation solutions. These problems are expected to be solved by proper load balancing mechanisms. Secondly, several key factors in designing such load balancing mechanisms are analyzed. Finally, current efforts about load balancing are analyzed and concluded.

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Terminology

The terminology used in this document is consistent with 6rd[RFC5969], NAT64[RFC6146], IVI[RFC6219], DS-Lite[I-D.ietf-softwire-dual-stack-lite]. Besides, the following terminology is defined.

Load-balancer: A system which distributes users' workload across multiple devices providing identical services.

Target Device: The device to which a load-balancer distributes workload. That is the concentration points of the tunneling and translation technologies.

Selection policy: The Policy by which the load-balancer selects target device.

Transport protocol: The protocol the load balancer uses to delivery information of selected target device to user.

4. Problems of Bottlenecks

During the coexistence of IPv4 and IPv6, more and more IPv6 traffic will be carried on IPv4 network or IPv4 Internet in the form of 6in4 tunnel such as 6RD[RFC5969]. Similarly, more and more IPv4 traffic will be guided to IPv6 network or IPv6 Internet in the form of 4in6 tunnel such as DS-Lite [I-D.ietf-softwire-dual-stack-lite]. Both DS-Lite and 6RD concentrate all the tunnel traffic at the tunnel end-points in the service provider network. These tunnel end-points are traffic concentration points which are potential bottlenecks.

During the evolution from IPv4 to IPv6, IPv6 users will communicate with IPv4 network or IPv4 Internet in the form of 6->4 translation such as NAT64[RFC6146]. Similarly, some IPv4 users will visit IPv6 network or IPv6 Internet in the form of 4->6 translation such as IVI[RFC6219]. Both NAT64 and IVI convert all the translation traffic at the translation gateways in service provider network. These translation gateways are traffic concentration points or potential bottlenecks.

There are many problems about bottlenecks.

1. The performance of a single concentration point cannot satisfy the increasing workload.

2. Drive traffic through roundabout path.

3. Involve a single point of failure.

In order to avoid becoming bottleneck, traffic concentration point should be distributed to multiple parallel points. Each parallel point performs the same operations. There must be some load-balancing mechanisms to make parallel points collaborate with one another stably, smartly and efficiently.

5. Keys To the Load-balancing Solutions

In order to keep transition technology always available when traffic growing from small to large scale, some load balancing approaches should be applied at IPv4/IPv6 conjunction points. There are four categories requirements for load balancing scheme. Different solutions or mechanisms may be concluded when necessary to meet the requirements of each. The four categories requirements are: Target Device, Selection policy, Transport protocol and Load-balancer location.

5.1. Target Device

As mentioned above, the target device can be tunnel end-point or translation gateway in service provider network.

5.1.1. Tunnel End-Point

Tunnel End-Point can be stateful (like DS-Lite) or stateless (like 6RD). In DS-Lite, such device is AFTR (Address Family Transition Router element) which is 4in6 tunnel concentration point and NAPT44 address port translator. In 6RD, such device is BR (Border Relay) which is only a 6in4 tunnel concentration point.

5.1.2. Translation Gateway

Translation Gateway can be stateful (like NAT64) or stateless (like IVI). Either MAY introduce Application Layer Gateway (ALG) into it. In NAT64, such device is stateful NAT64 device which is IPv6 to IPv4 protocol address translator. In IVI, such device is stateless IVI translator which is the mapping and translation gateway.

5.2. Selection Policy

[I-D.zhang-behave-nat64-load-balancing] has proposed some kinds of prefix64 selection policies for NAT64 load balancing. Those policies can also be applied to general load balancing selection policy in addition to Subscriber-Based Policy.

5.2.1. Anycast-Based Selection Policy

It requires a load-balancer to select target device according to whether target device and involved routers support anycast[RFC4291].

5.2.2. Source-Based Selection Policy

It requires a load-balancer to select target device according to the IPv6 address of user device.

5.2.3. Destination-Based Selection Policy

It requires a load-balancer to choose target device according to e.g., the FQDN, the IPv4/IPv6 address, or other identifiers of destination servers.

5.2.4. Round-Robin Selection Policy

It requires a load-balancer to select target device and destination servers circularly according to the arrival request.

5.2.5. Subscriber-Based Policy

It requires a load-balancer to choose target device according to the subscriber's information, which can be stored in AAA servers, for example.

5.2.6. Dynamic Selection Policy

It requires a load-balancer to select target device according to the real-time status of target device.

5.3. Transport Protocol

According to the selection policy, one or more target devices may be chosen by load-balancer. There are different protocols can be used to transport the results to user device.

5.3.1. DNS

DNS protocol carries response results to DNS queries. If result is IPv6 address with network specific IPv6 prefix, traffic can be lead to relevant translation gateway. If result is IPv6 address of tunnel end-point in service provider network, traffic can be lead to relevant tunnel concentration point.

5.3.2. DHCP

DHCPv4 or DHCPv6 protocol sends network configuration parameters to user device. The parameters may contain network specific IPv6 prefix or tunnel end-point address.

5.3.3. ICMPv6

ICMPv6 protocol can broadcast RA (Router Advertisement) message and options to user device. The options may contain network specific IPv6 prefix or tunnel end-point address.

5.3.4. RADIUS

RADIUS protocol[RFC2865]] can transport subscriber's information to network servers such as DHCP or DNS server. The subscriber's information may contain selected network specific IPv6 prefix or tunnel end-point address. The network servers then can distribute the prefix or address to user device.

5.4. Load-balancer Location

The load-balancer can be implemented in different locations or different devices.

5.4.1. Terminal/Host

Terminal/Host can be modified to balance the load to target devices. The terminal/host should use the selection policy in 5.2 to choose a target device and make its traffic go through it.

5.4.2. Access Gateway

Access gateway can be modified to balance the load on target devices. The access gateway should use the selection policy in 5.2 to choose a target device and make user traffic go through it.

5.4.3. Network Servers

Network servers include DHCP server, DNS server, RADIUS server and so on. They should use the selection policy in 5.2 to choose a target device. Then, they delivery the results to user device and user device will make its traffic go through the target device.

6. Where Are We Now

At present, some transition technologies have specified their own load balancing solutions, some transition technologies' load balancing solutions are in discussion and the others' are still waiting to be focused on.

6.1. Work Done

6.1.1. 6RD

Target Device is BR, the tunnel end-point.

Selection Policy is Anycast.

Transport Protocol can be DNS, DHCPv4, PPP, or manual configuration etc. DHCPv4 is recommended in [RFC5969].

Load-balancer Location is in network server. DHCPv4 server is recommended in [RFC5969].

6.1.2. BIH

BIH is described in [I-D.ietf-behave-v4v6-bih].Since BIH is NOT REOMMENDED to use together with a NAT64, there is no traffic concentration point for the BIH per se. So BIH does not need any load-balancing mechanism.

6.2. Work In Progress

6.2.1. NAT64

Target Device is the NAT64 translator.

[I-D.xu-behave-stateful-nat-standby] defines a framework for ensuring redundancy for stateful Network Address Translators (NAT),including NAT44, NAT64 and NAT46, which mainly tries to solve the single point of failure problem. Three redundancy modes are described in the document: the cold standby, the hot standby and the partial hot standby modes.

[I-D.zhang-behave-nat64-load-balancing] is considering NAT64 load-balancing mechanism. But no solution is recommended at present.

6.3. Work To Be Done

6.3.1. IVI

Target Device is the IVI translator.

The load-balancing mechanism is not mentioned in the specification of IVI[RFC6219].

6.3.2. DS-Lite

Target Device is AFTR, the tunnel end-point.

Although the load-balancing of AFTR can be done by using the FQDN option defined in [I-D.ietf-softwire-ds-lite-tunnel-option] and DNS, this point is not explicitly described in the specification of DS-lite [I-D.ietf-softwire-dual-stack-lite].

6.3.3. 4RD

Target Device is BR, the tunnel end-point.

The load-balancing mechanism is not mentioned in the specification of 4RD [I-D.murakami-softwire-4rd].

7. Security Considerations

The potential security problem should be considered in the specific load balancing mechanism designed for the specific transition technology.

8. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

9. Other Authors and Contributors

The following individuals have contributed to this document:

Gang Chen
China Mobile
Unit2, Dacheng Plaza, No. 28 Xuanwumenxi Ave, Xicheng District
Beijing 100053
P.R. China

Email: chengang@chinamobile.com

Dacheng Zhang
Huawei Technologies Co.,Ltd
KuiKe Building, No.9 Xinxi Rd.,Haidian District
Beijing 100085
P.R. China

Email: zhangdacheng@huawei.com

10. References

10.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

10.2. Informative References

[I-D.ietf-behave-v4v6-bih]
Huang, B., Deng, H., and T. Savolainen, "Dual Stack Hosts Using "Bump-in-the-Host" (BIH)", draft-ietf-behave-v4v6-bih-06 (work in progress), August 2011.

[I-D.ietf-softwire-ds-lite-tunnel-option]
Hankins, D. and T. Mrugalski, "Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual- Stack Lite", draft-ietf-softwire-ds-lite-tunnel-option-10 (work in progress), March 2011.

[I-D.ietf-softwire-dual-stack-lite]
Durand, A., Droms, R., Woodyatt, J., and Y. Lee, "Dual-Stack Lite Broadband Deployments Following IPv4 Exhaustion", draft-ietf-softwire-dual-stack-lite-11 (work in progress), May 2011.

[I-D.murakami-softwire-4rd]
Murakami, T., Troan, O., and S. Matsushima, "IPv4 Residual Deployment on IPv6 infrastructure - protocol specification", draft-murakami-softwire-4rd-01 (work in progress), September 2011.

[I-D.xu-behave-stateful-nat-standby]
Xu, X., Boucadair, M., Lee, Y., and G. Chen, "Redundancy Requirements and Framework for Stateful Network Address Translators (NAT)", draft-xu-behave-stateful-nat-standby-06 (work in progress), October 2010.

[I-D.zhang-behave-nat64-load-balancing]
Zhang, D., Xu, X., and M. Boucadair, "Considerations on NAT64 Load-Balancing", draft-zhang-behave-nat64-load-balancing-03 (work in progress), July 2011.

[RFC2865] Rigney, C., Willens, S., Rubens, A., and W. Simpson, "Remote Authentication Dial In User Service (RADIUS)", RFC 2865, June 2000.

[RFC3484] Draves, R., "Default Address Selection for Internet Protocol version 6 (IPv6)", RFC 3484, February 2003.

[RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", RFC 4291, February 2006.

[RFC5969] Townsley, W. and O. Troan, "IPv6 Rapid Deployment on IPv4 Infrastructures (6rd) -- Protocol Specification", RFC 5969, August 2010.

[RFC6146] Bagnulo, M., Matthews, P., and I. van Beijnum, "Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers", RFC 6146, April 2011.

[RFC6219] Li, X., Bao, C., Chen, M., Zhang, H., and J. Wu, "The China Education and Research Network (CERNET) IVI Translation Design and Deployment for the IPv4/IPv6 Coexistence and Transition", RFC 6219, May 2011.

Authors' Addresses

Zhenqiang Li
China Mobile
Unit2, Dacheng Plaza, No. 28 Xuanwumenxi Ave, Xicheng District
Beijing 100053
P.R. China

Email: lizhenqiang@chinamobile.com

Qin Zhao
Beijing University of Posts and Telecommunications
Information Network Center, No. 10 Xitucheng Road, Haidian District
Beijing 100876
P.R. China

Email: zhaoqin@bupt.edu.cn

Xiaohong Huang
Beijing University of Posts and Telecommunications
Information Network Center, No. 10 Xitucheng Road, Haidian District
Beijing 100876
P.R. China

Email: huangxh@bupt.edu.cn

Yan Ma
Beijing University of Posts and Telecommunications
Information Network Center, No. 10 Xitucheng Road, Haidian District
Beijing 100876
P.R. China

Email: mayan@bupt.edu.cn

Xiaohu Xu
Huawei Technologies Co.,Ltd
KuiKe Building, No.9 Xinxi Rd., Haidian District
Beijing 100085
P.R. China

Email: xuxiaohu@huawei.com