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Deployment Considerations for Lightweight 4over6
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Abstract

Lightweight 4over6 is a mechanism which moves the translation function from tunnel concentrator (AFTR) to initiators (B4s), and hence reduces the mapping scale on the concentrator to per-customer level. This document discusses various deployment models of lightweight 4over6. It also describes the deployment considerations and applicability of the lightweight 4over6 architecture.

Status of this Memo

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1. Introduction

Lightweight 4over6 [I-D.cui-softwire-b4-translated-ds-lite] is an extension to DS-Lite which simplifies the AFTR module [RFC6333] with distributed NAT function among B4 elements. The Initiator in lightweight 4over6 is provisioned with an IPv6 address, an IPv4 address and a port-set. It performs NAPT on end user's packets with the provisioned IPv4 address and port-set. IPv4 packets are forwarded between the Initiator and the Concentrator over a Softwire using IPv4-in-IPv6 encapsulation. The Concentrator maintains one mapping entry per subscriber with the IPv6 address, IPv4 address and port-set. Therefore, this extension removes the NAT44 module from the AFTR and replaces the session-based NAT table to a per-subscriber based mapping table. This should relax the requirement to create dynamic session-based log entries. This mechanism preserves the dynamic feature of IPv4/IPv6 address binding as in DS-Lite, so it won't require to couple IPv4 and IPv6 address schemas as MAP [I-D.mdt-softwire-mapping-address-and-port] requires. This document discusses various deployment models of Lightweight 4over6. It also describes the deployment considerations and applicability of the lightweight 4over6 architecture.

Terminology of this document follows the definitions and abbreviations of [I-D.cui-softwire-b4-translated-ds-lite].

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. Case Studies

Lightweight 4over6 can be either deployed in a standalone way, or incrementally coexistent with DS-Lite[RFC6333]. It is suitable for operators who would like to keep IPv6 and IPv4 addressing separated. The dynamic feature of IPv4 address and port-sets provision makes more efficient usage of IPv4 resource. For operator who only have many small and discontinuous IPv4 blocks available to provide IPv4 over IPv6, this mechanism won't require to administrate and manage many IPv4 and IPv6 mapping rules planning in CPE or MAP domains in the network.

3.1. case 1: Standalone Deployment Scenario

Lightweight 4over6 can be deployed in a new residential network (depicted in Figure1). In this scenario, an Initiator would acquire port-restricted IPv4 address after user authentication process and IPv6 provisioning process. It then uses IPv4-in-IPv6 tunnel to build a softwire to deliver IPv4 services to the Concentrator in the network. The Concentrator supports only Lightweight 4over6 which keeps the mapping between Initiator's IPv6 address and its allocated IPv4 address + port set. There is no need to interact with other transition techniques. More detailed considerations would be discussed in section 4.

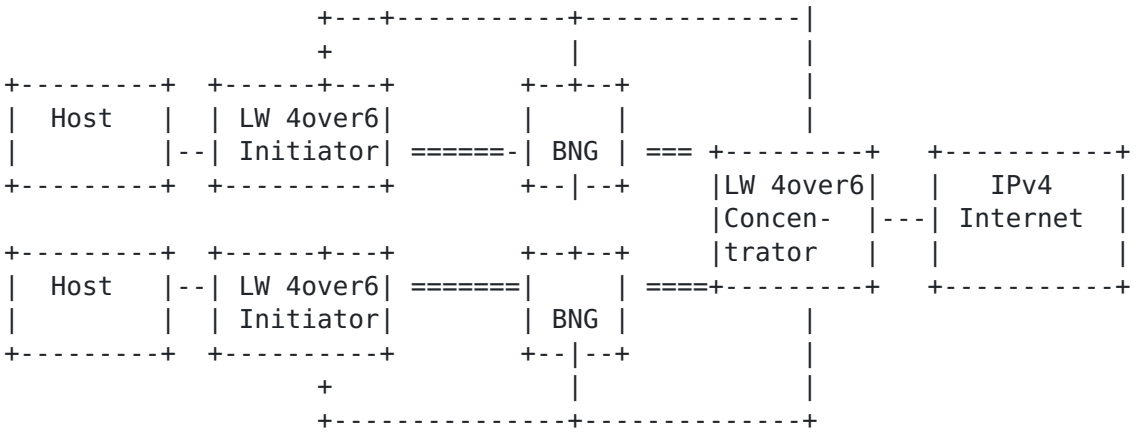

Figure 1 Standalone Deployment Scenario

3.2. case 2: DS-Lite Coexistent scenario with Integrated AFTR

Lightweight 4over6 can be deployed incrementally in existing DS-Lite network architecture(depicted in Figure2). In this case, DS-Lite has been deployed in the network. Later in the deployment schedule, the operator decided to introduce Lightweight 4over6 Concentrator in the same AFTR. Therefore, the same concentrator needs to identify the

two distinct mechanisms based on encapsulated subscriber's IPv4 address. Lightweight 4over6 and DS-Lite would use the same addressing scheme, routing policy, user management policy, etc., and they can use the same DHCPv6 option [RFC6334] to inform the FQDN of concentrator.

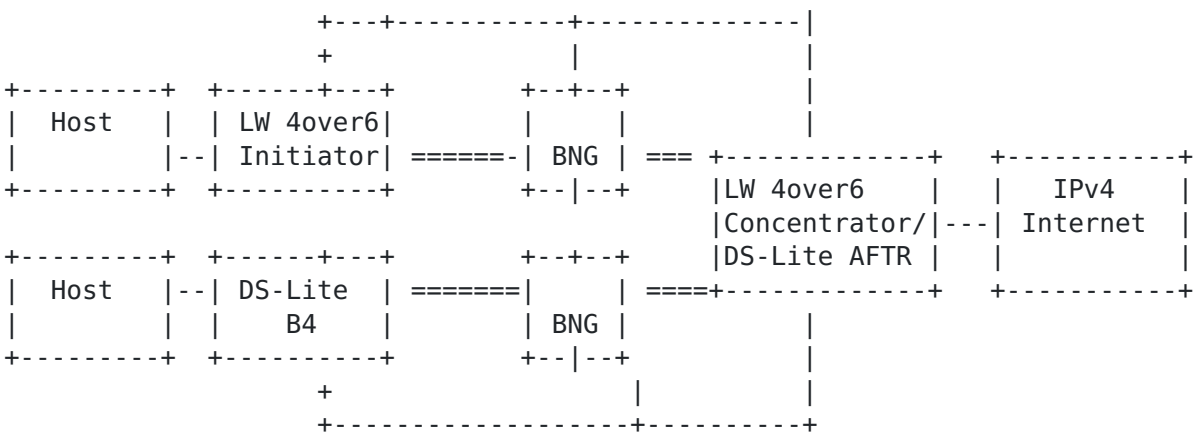

Figure 2 DS-Lite Coexistence scenario with Integrated AFTR

3.3. case 3: DS-Lite Coexistent scenario with Seperated AFTR

Lightweight 4over6 can be also deployed incrementally in existing DS-Lite architecture, but not coupled tightly with DS-Lite AFTR (depicted in Figure3). For example, DS-Lite AFTR might be deployed distributed in access routers, while lightweight 4over6 concentrator might be deployed centralized in a MAN. This deployment model has the advantage of high flexibility. However, since there are distinct addresses for DS-Lite AFTR and lightweight 4over6 concentrator, seperated tunnel end-point discovery mechanisms should be introduced.

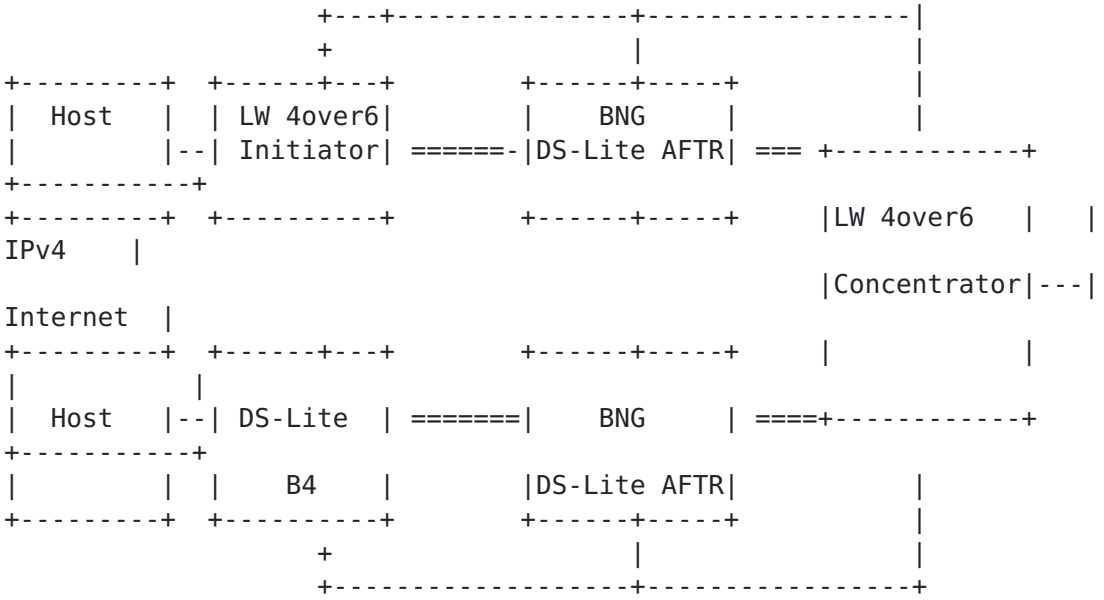

Figure 3 DS-Lite Coexistence scenario with Integrated AFTR

4. Overall Deployment Considerations

4.1. Addressing and Routing

In lightweight 4over6, it is suggested to adopt separated IPv4/IPv6 addressing schemes. IPv4 address pools are configured centralized in concentrator for IPv6 subscribers. These IPv4 address routing entries also should be imported into IPv4 Internet accordingly.

For IPv6 addressing and routing, there are no additional addressing and routing requirements. The process of IPv6 address assignment and routing announcement can be integrated with existing IPv6 address allocation process, e.g. using PPPoE or IPoE, etc. IPv6 address pools are configured in DHCPv6 server. No extra routing requirement is needed to taken into consideration.

4.2. Port-set Management

In lightweight 4over6, each initiator will get its restricted IPv4 address and a valid port-set. This port-set assignment should be synchronized between port management server and the concentrator. Normally, port management server is responsible for allocating port restricted IPv4 address to initiator. It can be located in the concentrator itself or relayed by the concentrator to pass through port restricted parameters. Different mechanisms including PCP-extended protocol [I-D.tsou-pcp-natcoord], DHCP-extended protocol or IPCP-extended protocol, etc., can be applied.

- DHCP-based mechanism is usually designed for stable port management, which means only static port set can be allocated at one time. In this case, the DHCPv4 protocol should be extended to support port-set allocation process [I-D.bajko-pripaddrassign]. Besides, with the concentrator acting as the DHCP server or relay, DHCPv4 should be performed over IPv6 [I-D.ietf-dhc-dhcpv4-over-ipv6].

- PCP-based mechanism is usually more flexible. An initiator can launch multiple PCP requests simultaneously to acquire a number ports within the same IPv4 address, or use [I-D.tsou-pcp-natcoord] for one-time port-set allocation.

- IPCP-based mechanism[RFC6431] is more suitable for concentrators deployed in BNG.

4.3. Concentrator Discovery

A lightweight 4over6 initiator should discover the concentrator's IPv6 address during startup. This IPv6 address can be learned

through a variety of methods, ranging from an out-of-band mechanism, manual configuration, to a DHCPv6 option. For case 1 and case 2 in the above section, lightweight 4over6 can make use of existing DS-Lite discovery mechanism as defined in [RFC6334]. For case 3, we suggest that a new DHCPv6 option should be defined to carry the concentrator's IPv6 address.

5. Concentrator Deployment Consideration

5.1. Common considerations with DS-Lite deployment

As lightweight 4over6 is an extension to DS-Lite, some considerations in terms of Interface consideration, MTU, Fragment, Lawful Intercept Considerations, Blacklisting a shared IPv4 Address, AFTR's Policies, AFTR Impacts on Accounting Process, etc., in [I-D.ietf-softwire-dslite-deployment] can also be applied here. In this document, we only discuss some considerations specific to lightweight 4over6.

5.2. Logging at the Concentrator

In lightweight 4over6, only subscriber-based logging records including IPv4 address, IPv6 address and port set should be sent to a centrilized syslog server. Since this mechanism reduces the number of simultaneous address mappings of each customer on concentrator to one, it makes concentrator logging much more feasible. The port set algorithm implemented in lightweight 4over6 concentrator should be syncronized with the one implemented in logging system.

5.3. Reliability Considerations of Concentrator

In lightweight 4over6, port set allocation should be conducted before packet processing. As a result, when one concentrator encountered a failure, a backup concentrator should either have the binding record beforehand, or trigger a port management echo to the initiator. The first choice is a hot standby mode, while the second can be achieved by sending an ICMPv6 error request on getting an un-established binding record from the initiator.

5.4. Placement of AFTR

Normally, the concentrator can be deployed in either a "centralized model" or a "distributed model".

In the "centralized model", the concentrator could be located at the higher place, e.g. at the exit of MAN, etc. Since the concentrator has good scalability and can handle numerous concurrent sessions, we recommend to adopt the "centralized model" for lightweight 4over6 as it is cost-effective and easy to manage.

In the "distributed model", concentrator is usually integrated with the BRAS/SR. Since newly emerging customers might be distributed in the whole Metro area, we have to deploy concentrator on all BRAS/SRs. This will cost a lot in the initial phase of the IPv6 transition period.

5.5. Port set algorithm consideration

Since port randomization algorithm must use ports within the port set, it may cause the port randomization algorithm more predictable. Therefore, non-continuous port set algorithms (e.g. as defined in [I-D.mdt-softwire-mapping-address-and-port]) can be introduced to further improve the security.

6. Initiator Deployment Consideration

6.1. Bridging mode and routing mode

In routing mode, the initiator runs a standard NAT44 [RFC3022] using the allocated public address as external IP and ports via DHCPv6 option. When receiving an IPv4 packet with private source address from its end hosts, it performs NAT44 function by translating the source address into public and selecting a port from the allocated port-set. Then it encapsulates the packet with the concentrator's IPv6 address as destination IPv6 address, and forwards it to the concentrator.

For the bridging mode, end host should run a software performing initiators' functionalities. In this case, end host gets public address directly. It is also suggested that the host run a local NAT to map randomly generated ports into the restricted, valid port-set. Another solution is to have the IP stack to only assign ports within the restricted, valid range to applications. Either way the host guarantees that every source port number in the outgoing packets falls into the allocated port-set.

6.2. ALG consideration

In lightweight 4over6, the initiator is responsible for performing ALG functions (e.g., SIP, FTP), as well as supporting NAT Traversal mechanisms (e.g., UPnP, NAT-PMP, manual mapping configuration). This is no different from the standard IPv4 NAT today.

Since there is no address and port mapping in the concentrator, the ALG is no longer needed in the carrier-side network.

7. Acknowledgement

TBD

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1. Appendix:Experimental Result

We have deployed lightweight 4over6 in our operational network of HuNan province, China. It is designed for broadband access network, and different versions of initiator have been implemented including a linksys box, a software client for windows XP, vista and Windows 7. It can be integrated with existing dial-up mechanisms such as PPPoE, etc. The major objectives listed below aimed to verify the functionality and performance of lightweight 4over6:

- Verify how to deploy lightweight 4over6 in a practical network.
- Verify the impact of applications with lightweight 4over6.
- Verify the performance of lightweight 4over6.

1.1. Experimental environment

The network topology for this experiment is depicted in Figure 2.

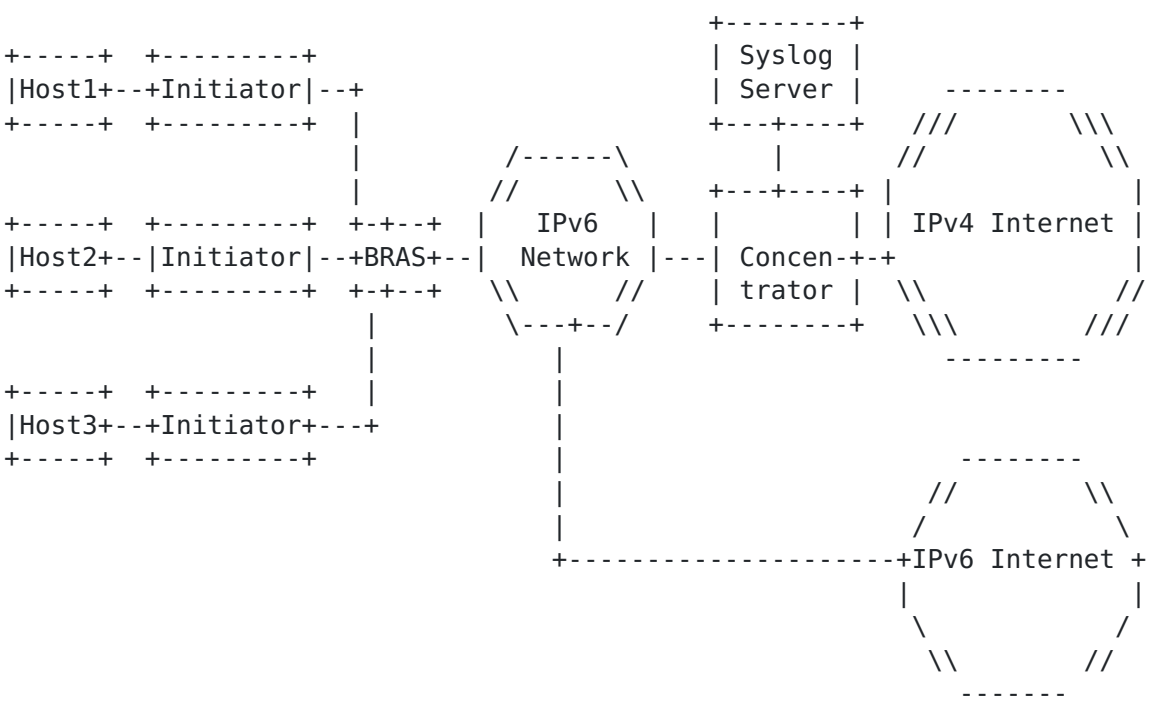

Figure 2 Lightweight 4over6 experiment topology

In this deployment model, concentrator is co-located with a extended PCP server to assign restricted IPv4 address and port set for initiator. It also triggers subscriber-based logging event to a centrilized syslog server. IPv6 address pools for subscribers have

been distributed to BRASs for configuration, while the public available IPv4 address pools are configured by the centralized concentrator with a default address sharing ratio. It is rather flexible for IPv6 addressing and routing, and there is little impact on existing IPv6 architecture.

In our experiment, initiator will firstly get its IPv6 address and delegated prefix through PPPoE, and then initiate a PCP-extended request to get public IPv4 address and its valid port set. The concentrator will thus create a subscriber-based state accordingly, and notify syslog server with {IPv6 address, IPv4 address, port set, timestamp}.

1.2. Experimental results

In our trial, we mainly focused on application test and performance test. The applications have widely include web, email, Instant Message, ftp, telnet, SSH, video, Video Camera, P2P, online game, voip and so on. For performance test, we have measured the parameters of concurrent session numbers and throughput performance.

The experimental results are listed as follows:

Application Type	Test Result	Port Number Occupation
Web	ok IE, Firefox, Chrome	normal websites: 10~20 Ajex Flash webs: 30~40
Video	ok, web based or client based	30~40
Instant Message	ok QQ, MSN, gtalk, skype	8~20
P2P	ok utorrent,emule,xunlei	lower speed: 20~600 (per seed) higher speed: 150~300
FTP	need ALG for active mode, flashxp	2
SSH, TELNET	ok	1 for SSH, 3 for telnet
online game	ok for QQ, flash game	20~40

Figure 3 Lightweight 4over6 experimental result

The performance test for concentrator is taken on a normal PC. Due to limitations of the PC hardware, the overall throughput is limited to around 800 Mbps. However, it can still support more than one hundred million concurrent sessions.

1.3. Conclusions

From the experiment, we can have the following conclusions:

- Lightweight 4over6 has good scalability. As it is a lightweight solution which only maintains per-subscriber state information, it can easily support a large amount of concurrent subscribers.

- Lightweight 4over6 can be deployed rapidly. There is no modification to existing addressing and routing system in our operational network. And it is simple to achieve traffic logging.

- Lightweight 4over6 can support a majority of current IPv4 applications.

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