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# Use case and consideration experiences of IPv4 to IPv6 transition draft-matsushima-v6ops-transition-experience-02

## Abstract

Service Providers will apply their use case when conducting IPv6 transition and determine helpful solutions with the assistance of the IPv6 transition guideline document. More than one solution is possible, and decisions must be made from not only the technical point of view, but also from the economic point of view. This document describes the conclusions reached by one operator based on their considerations and their plans for IPv6 transition so as to assist others who may have similar circumstances.

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## 1. Introduction

IPv4 to IPv6 transition solutions are becoming more converged. Given the variety of operators involved, various use-case scenarios exist and efforts are underway to clarify them. Since the first group addressing IPv6 transition are technically inclined, the economic analyses needed for creating business plans are often delayed. One key factor impacting the business plan is architecture. The solution will be considered and then adopted so as to implement the most efficient architecture for each operator. In other words, the Service Provider who wants to ensure long-term viability must place greater emphasis on the economic impact of IPv6 transition. The author expect that IETF has great interest in this approach given its engineering and standardization work. Moreover, sharing the considerations described in this document would be helpful to operators who are in similar circumstances.

## 2. Transition overview and current status

Various transition use-cases have been published.

[I-D.huang-v6ops-v4v6tran-bb-usecase]
[I-D.lee-v6ops-tran-cable-usecase]
[I-D.tsou-v6ops-mobile-transition-guide] [I-D.sunq-v6ops-ivi-sp]

IPv6 transition guideline document
[I-D.arkko-ipv6-transition-guidelines] presents four deployment models. As our ultimate goal is the IPv6 only network, our strategy to achieving it is: (1) provide IPv6 connectivity to the existing IPv4-Only network, (2) build new IPv6-Only network, (3) migrate our customers from the IPv4-Only network to the IPv6-Only network. Along with the guideline, we had studied the "Crossing IPv4 Islands" model in the guideline to realize (1), while performing (2) in parallel. Subsequently, we started studying the "IPv6-Only Core Network" model to achieve (3). Research into a deployment model for our mobile network is now in progress.

## 3. Experience of IPv4-only Network and Assessment Approach

Our starting point is ensuring that the IPv4-Only network can provide IPv6 connectivity. Since our final goal is to build a IPv6-only network and migrate all customers to the network, we will not have to accommodate new customers beyond current capacity in the existing IPv4-only network. This means two things for the IPv4-only network; one, "minimized additional resources will provided to keep the network" and two, "there is less need to conserve IPv4 addresses in

the network". As the guideline document pointed out, many "IPv6 over IPv4 tunneling" solutions have already been developed. Our criterion for adopting the best solution involves not only technical pros/cons, but also the cost efficiency of providing IPv6 connectivity to all customers in the IPv4-only networks.

When the total capital and operational expense of the system is represented as "Q", and the number of customers that can be served by the system as "T", the metric of cost efficiency, "S", is given by the following simple formula:

S=Q/T

We gathered the S values of all candidate products and solutions, and decided to adopt the solution that had the lowest S value. Ignoring the price difference between the products, the stateful solutions have S values that are significantly different from those of the stateless solutions. In stateful solutions, T is the total number of system capable sessions divided by the number of sessions per customer. In stateless solutions, on the other hand, T is the total amount of system bandwidth capacity divided by the bandwidth consumption per customer.

From our experience, S(A) < S(B), that is, S(A) is always more efficient than S(B) (note S(A) is stateless, S(B) is stateful). We consequently adopt 6rd [RFC5969] for IPv4-only network. As the guideline document points out, it is not productive to implement an optimal IPv6 transition system as a temporary solution with goal of rich functionality. Many service providers hope that by allocating more resource they can increase network performance, bandwidth capacity, and the coverage of their network. In other words, we, as a service provider, want to minimize the resources allocated to such temporary solutions.

## 4. Considerations for IPv6-Only network

Our considerations suggest that a stateless solution should be adopted for the IPv6-only network to minimize overall resource allocation and to allocate resources to the more productive areas. In one of IPv6-only network deployment scenario, routing and addressing lie outside our control except for our own prefix, which is assigned to the customers who connect to the network. It seems like relation of operators among wholesale and retail. In that network, it is difficult to avoid assigning well known and other operator owned IPv4 prefixes if the stateless solution uses the 32bit IPv4 address to IPv6 address mapping technique. The solution must meet the requirements of: (1) The routing path for IPv4 should match

the optimized IPv6 routing path, (2) It should be capable to share one IPv4 address among customers since the number of IPv4 addresses is insufficient, (3) It must be stateless. We will adopt the solution that satisfies these three requirements. According to [I-D.sun-intarea-4rd-applicability], there are significant characteristics in particular these three requirements are satisfied. It is noted that since some customers require a service which no address sharing, a non-address sharing solution is also needed, but this does not need to be the same as the address sharing solution.

The guideline document describes that Dual-Stack-lite [I-D.ietf-softwire-dual-stack-lite] is recommended only as a transition solution on the way to the IPv6-only network. Compared to other deployment scenarios such as crossing IPv4 island and IPv6-only deployment, there are several candidate solutions for each deployment model but only one solution for the scenario. It is noted that the solutions not mentioned in the guideline are discussed in [I-D.dec-stateless-4v6], which adopt 4rd [I-D.despres-intarea-4rd] and dIVI [I-D.xli-behave-divi].

## 5. Considerations for Mobile network

We believe that the requirements explained in the previous section should be applied to the mobile network as well. [TR23.975], has clarified the IPv6-only deployment model in the guideline as a IPv6 transition scenario. As [I-D.arkko-ipv6-only-experience] pointed out, the operators' policy of service quality assurance may require the solution of avoiding the IPv4 referral issue [I-D.ietf-behave-v4v6-bih]

It is interesting that stateless address mapping techniques exist for both encapsulation/decapsulation and translation in the case of IPv4 crossing IPv6-only network model. This means that, the requirements listed in previous section could be achieved for the mobile network.

## 6. Conclusions

One of most significant areas that remain to be investigated is the physical resources of our network. We also need to minimize the investments needed to secure the IP transition (i.e. the temporary solutions) because we believe that the ultimate goal of the transition must be the long-term viability of the Internet and also the provision of our services. To ensure that, our considerations yielded the conclusion that the stateless solution should be specified for all deployment models in the guideline document. It is recommended that IETF standardize on stateless solutions for not only

the IPv4-only network, but also both the IPv6-only network and Ipv6-only deployment models in the guideline.

## 7. Security considerations

A stateless solution without the appropriate implementation and operation techniques would be vulnerable to denial of service attacks, routing loops, spoofing, and other such malicious acts. To eliminate these security vulnerabilities, a stateless solution, like 6rd, which is capable of validating consistency of IPv6 source address with IPv4 source address, can be used to avoid these vulnerabilities, based on its address mapping rule. If a stateless solution supports IPv4 address sharing, it must take into account the issues described in [I-D.ietf-intarea-shared-addressing-issues]. If an operator is concerned about the unnecessary bandwidth consumption created by unwanted packets from the outside, one recommended solution is to implement appropriate firewall protection for not only v4v6 transition solution, but also both native IPv4 and IPv6 networks.

## 8. Acknowledgements

The authors would like to thank the guideline document of IPv6 transition [I-D.arkko-ipv6-transition-guidelines], which guides us through the transition way, and has motivated the authors to write this document. We also would like to thank Miwa Fujii for her helpful suggestions and supports to share our experience with many people.

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