               The Applicability Index of IPv4/IPv6 Encapsulation
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Abstract

   The Softwire working group is currently discussing both encapsulation
   and translation based stateless IPv4/IPv6 solutions in order to be
   able to provide IPv4 connectivity to customers in an IPv6-Only
   environment.

   The purpose of this document is to describe the basic issues and key
   elements of the IPv4/IPv6 encapsulation, and presents its
   applicability index that would help the operators decide on the
   development scheme for their IPv6 transition.It could lead to
   significant operational benefits and potential savings for the
   operators.

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1. Introduction

   The Softwire working group is currently discussing both encapsulation and translation based stateless IPv4/IPv6 solutions developed for the purposes of offering IPv4 connectivity to the customers in an IPv6-Only environment.

   Generic mechanism for IPv4/IPv6 encapsulation mechanismsare specified in [RFC2529], [RFC3056], [RFC4380], [RFC4659], [RFC5214], [RFC5569], [RFC5747], [RFC6333], [RFC7040], etc. With the diverse characteristics and transition requirements of practical networks and the lack of overall transition architecture, the selection and deployment of IPv6 transition mechanisms are very difficult.

   In an effort to push forward the IPv6 transition process, this document describes the basic issues and key elements of encapsulation mechanisms, and presents the applicability index that would help the operators decide on the development scheme for their IPv6 transition.It could lead to significant operational benefits and potential savings for the operators.

2. The Basic Issues and Key elements of Encapsulation Mechanisms

    Encapsulation mechanisms can achieve communications between IPv6
    networks/hosts across an IPv4 network (IPv6-over-IPv4), and
    communications between IPv4 networks/hosts across an IPv6 network
    (IPv4-over-IPv6).

2.1. Basic Issues

    Its basic operations include encapsulation/de-encapsulation and route
    discovery between tunnel endpoints. Encapsulationoperation only
    affect the network layer:

    a. The basic data operation Encapsulation/de-encapsulation is the
        basic data plane operation. For IPv6 transition usage, the
        encapsulation manners such as IP-IP, GRE (Generic Routing
        Encapsulation) L2TP (Layer Two Tunneling Protocol), MPLS
        (Multiple protocol Label Switching), IPsec (Internet Protocol
        Security) can all be adopted.For a wide selection, network
        operator can make the decision to select suitable transition
        mechanism.

    b. The basic control operation The basic control plane operations
        include the routing interaction across heterogeneous network, the
        route discovery between tunnel endpoints, and the encapsulation
        address mapping by a particular address scheme or address/prefix
        binding.

2.2. Key Elements

    a. Transition equipment In encapsulation mechanisms, the tunnel
        endpoints are the transition equipments. They need to support
        dual-stack which can be an AFBR (Address Family Border Router) or
        host equipments. They should support encapsulation/
        deencapsulation and routing forward across heterogeneous network
        and the route discovery between tunnel endpoints. They also
        maintain the encapsulation address mapping by a particular
        address scheme or address/prefix binding. Thus, the tunnel
        transition equipment has requirements in the use of bandwidth,
        computing and finding, storage.

    b. Encapsulation/de-encapsulation Encapsulation makes the IPv4/IPv6
        packet as a payload of the other IP protocol. It retains the
        integrity of IP packet information. But it adds the size of
        packet and may create the fragment reassembly problem.

    c. The routing across heterogeneous networks Encapsulation
        mechanisms need to support the routing forward across

heterogeneous networks. And the border routers should maintain
the binding and realizes the transparent data transmission.
Thus, encapsulation is stateless and lightweight.

   d.   The routing discovery between tunnel endpoints In encapsulation
mechanisms, the tunnel endpoints need to discover each other.
And it involves some problems, such as the selection and dynamic
or static configuration of tunnel endpoint, state maintenance.

3. Applicability Index of Encapsulation

   There are applicability index which need to be analyzed by the
   operator when choosing which transition technology option they would
   like to deploy. The applicability index in terms of sustainable,
   applications, performance and development. This section describes
   some of those considerations.

3.1. Sustainable Index

   Sustainable index would include:

   a.   The scenarios and function of transition represents whether meet
the needs of transitional scenario.

   b.   Both (a)the coupling degree between IPv4 address and (b) IPv6
address and the reuse rate of IPv4 addresses resource represent
whether promote the deployment and usage of IPv6.

3.2. The Support Degree of Business Application Index

   The support degree of business application index would include:

   a.   The support degree of IPv4 application represents the impact on
the IPv4 business application.

   b.   The support degree of IPv6 application represents the impact on
the IPv6 business application.

3.3. The Preformance Index

   The preformance index would include:

   a.   The performance requirements of tunnel endpoint can be divided
into (a)The maintenance and finding of state or mapping table and
(b) the routing discovery, which represents the capacity of
bandwidth, computing and finding, storage.

b. The routing scalability can be divided into (a) the independence
    between IPv4 and IPv6 routing and (b) the aggregation of IPv6
    addresses, which represents the impact on the scope of
    deployment.

c. Robustness represents the capacity of redundancy backup.

3.4. The Development Index

The cost of development index would include:

a. Technological and industry maturity represent the support degree
    of standard.

b. The update cost can be divided into (a) the impact on application
    layer, (b) the impact on network layerand and (c) the impact on
    end users layer, which represent the impact on the present
    network.

c. The cost of operation, management and maintenance represent the
    impact on the operator.

d. The problem of fragmentation and restructuring.

3.5. The Security Index

The security index includes the security issues and concerns.

4. Conclusions

For the consideration of deployment scenarios and address format,
numerous encapsulation transition mechanisms have been proposed in
the past ten years. However, due to a wide range of mechanisms and a
lot of overlap and similar functions, no one encapsulation mechanism
can be used in all transition scenarios.

The applicability index of IPv4/IPv6 encapsulation described in this
document have highlighted the applicability of all encapsulation
transition mechanisms to help the operators decide on the development
scheme for their IPv6 transition.

5. Acknowledgements

6. IANA Considerations

This memo includes no request to IANA.

7. Security Considerations

    All drafts are required to have a security considerations section.

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