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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Frameworks and functional architecture models

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Roadmap for IPv6 migration from the perspective of the operators of next generation networks

Recommendation ITU-T Y.2058

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Recommendation ITU-T Y.2058

Roadmap for IPv6 migration from the perspective of the operators of next generation networks

Summary

Recommendation ITU-T Y.2058 specifies multiple phases for next generation network (NGN) operators to migrate from an Internet protocol version 4 (IPv4)-based NGN to an Internet protocol version 6 (IPv6)-based NGN. The migration includes five phases from a pure IPv4-based NGN to a pure IPv6-based NGN. General functional requirements of migration are given as are specific functional requirements for each phase.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.2058	2011-11-29	13

Keywords

IPv6, IPv6-based NGN, IPv6 migration, NGN, NGN operator.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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1 Scope

The objective of this Recommendation is to specify multiple phases for NGN operators to migrate from an IPv4-based NGN to an IPv6-based NGN.

The scope of this Recommendation includes:

– identification of IPv6 migration phases for NGN operators;

– IPv6 migration scenarios of each phase for NGN operators;

– functional requirements of each phase for NGN operators.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN.*

[ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks.*

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2006), *Functional requirements and architecture of the NGN release 1.*

[ITU-T Y.2053] Recommendation ITU-T Y.2053 (2008), *Functional requirements for IPv6 migration in NGN.*

[ITU-T Y.2091] Recommendation ITU-T Y.2091 (2007), *Terms and definitions for Next Generation Networks.*

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 host [b-ITU-T Y.1540]: A computer that communicates using the Internet protocols. A host implements routing functions (i.e., it operates at the IP layer) and may implement additional functions including higher layer protocols (e.g., TCP in a source or destination host) and lower layer protocols (e.g., ATM).

3.1.2 router [b-ITU-T Y.1540]: A host that enables communication between other hosts by forwarding IP packets based on the content of their IP destination address field.

3.1.3 IPv6-based NGN [b-ITU-T Y.2051]: This refers to NGN that supports addressing, routing protocols, and services associated with IPv6. An IPv6-based NGN shall recognize and process the IPv6 headers and options, operating over various underlying transport technologies in the transport stratum.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 carrier grade NAT (CGN): A network address translation (NAT) device deployed in a carrier network. It translates packets between different IP address namespaces. It may be integrated with tunnel functions too.

3.2.2 dual-stack NGN: This refers to an NGN that supports addressing, routing protocols, and services associated with both IPv4 and IPv6. A dual-stack NGN shall recognize and process both IPv4 and IPv6 headers and options, operating over various underlying transport technologies in the transport stratum. Translation services may be provided in a dual-stack NGN to enable intercommunication between IPv4 and IPv6.

3.2.3 NGN operator: An entity that provides NGN connections. It provides and maintains NGN infrastructure. Either, an IPv4-based NGN, an IPv6-based NGN, or both may be provided.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

6PE IPv6 Provider Edge Router

CGA Cryptographically Generated Addresses

CGN Carrier Grade NAT

DNS Domain Name System

IPSec Internet Protocol Security

IPv4 Internet Protocol version 4

IPv6 Internet Protocol version 6

MPLS Multi-Protocol Label Switching

NAT Network Address Translation

NGN Next Generation Network

5 Conventions

None.

6 Features of IPv6 migration in NGNs

The primary purpose of IPv6 migration solutions is to allow NGN operators to provide IPv6 networks and IPv6-based services whilst ensuring the continuation of IPv4 networks and IPv4-based services. They also allow IPv4 and IPv6 networks to communicate with each other.

6.1 Communication scenarios in IPv6 migration for NGN operators

During the IPv6 migration period, NGN operators need to support the following communication scenarios, in addition to some basic IPv6 communications. Some of these scenarios may be optional during the different migration phases, which are described in clause 6.

– Scenario A: A legacy IPv4 host communicates with a legacy IPv4 host or an IPv4 application on a dual-stack host. It should continue to receive support until phase 4, when the network has fully migrated to an IPv6-based NGN. The basic function requires IPv4 routing and forwarding.
– Scenario B: An IPv6-only host communicates with an IPv6-only host or an IPv6 application on a dual-stack host. It should be supported throughout IPv6 migration starting from the beginning, phase 1. The basic function requires IPv6 routing and forwarding.
– Scenario C: A legacy IPv4 host communicates with a legacy IPv4 host or an IPv4 application on a dual-stack host through an IPv6 network. It should be supported in phase 3, and may be supported in phase 2. The basic function requires IPv4-over-IPv6 tunnelling.
– Scenario D: An IPv6-only host communicates with an IPv6-only host or an IPv6 application on a dual-stack host through an IPv4 network. It should be supported in phase 1, and may be supported in phase 2. The basic function requires IPv6-over-IPv4 tunnelling.
– Scenario E: An IPv6-only host communicates with an IPv4-only host. It should be supported in phases 1, 2, 3 and 4. The basic function requires the translation of addresses and protocols.
– Scenario F: A legacy IPv4 host communicates with an IPv6-only host. It should be supported in phases 1, 2, 3 and 4. The basic function requires the translation of addresses and protocols.

6.2 Available transition mechanisms for NGN operator deployment

6.2.1 Available transition mechanisms

[ITU-T Y.2053] describes three basic approaches for interworking and migration: dual IP layer (dual stack), configured tunnelling and network address and protocol translation. Additionally, application level gateways or proxy servers can be adopted based on each application. These basic transition mechanisms meet different requirements and scenarios during the migration phases. NGN operators may deploy the different combinations of these existing transition mechanisms in their NGN according to their requirements in each phase.

Furthermore, the exhaustion of global public IPv4 addresses is getting closer and closer. Many network operators are already suffering from the shortage of global public IPv4 addresses. Many NAT devices have been deployed so that private IPv4 addresses are used more extensively. The usage of private IPv4 addresses does not solve the address exhaustion issue. It may slow the exhaustion but with many side effects and issues. However, during the IPv6 migration, private IPv4 addresses may be used to provide IPv4 access services. CGNs can be deployed in the NGN so that public IPv4 addresses can be shared.

6.2.2 Combined transition mechanisms for NGN operators deployment

The combination of existing transition mechanisms can be deployed in the NGN to simplify the operation of end user services during the IPv4/IPv6 migration phases. The functions can be integrated with CGNs and deployed on the network side and managed/maintained by NGN operators.

In phases 1 and 2, as shown in Figure 1, IPv6-over-IPv4 tunnelling may be integrated with the CGN and translation function between IPv6 and IPv4. The integrated devices can be deployed at the border between the IPv4-based NGN and the IPv6-based NGN. When a dual-stack CGN receives a data packet from a dual-stack host, it firstly checks whether the packet is a normal IPv4 packet or an IPv6-over-IPv4 tunnel packet. For a normal IPv4 packet, the CGN translates the packet source address from a CGN-scoped private IPv4 address into a public IPv4 address, and then sends it to an IPv4-based NGN. The CGN should record the IPv4-IPv4 address mapping information for inbound packets, just like a normal NAT. For an IPv6-over-IPv4 tunnel packet, the CGN needs to de-encapsulate it into the original IPv6 packet and then send it to an IPv6-based NGN. If the destination address of the original IPv6 packet is an IPv4-embedded address, this IPv6 packet is forwarded to a translation function between IPv6 and IPv4; after translation, new IPv4 packets are sent to the IPv4-based NGN.

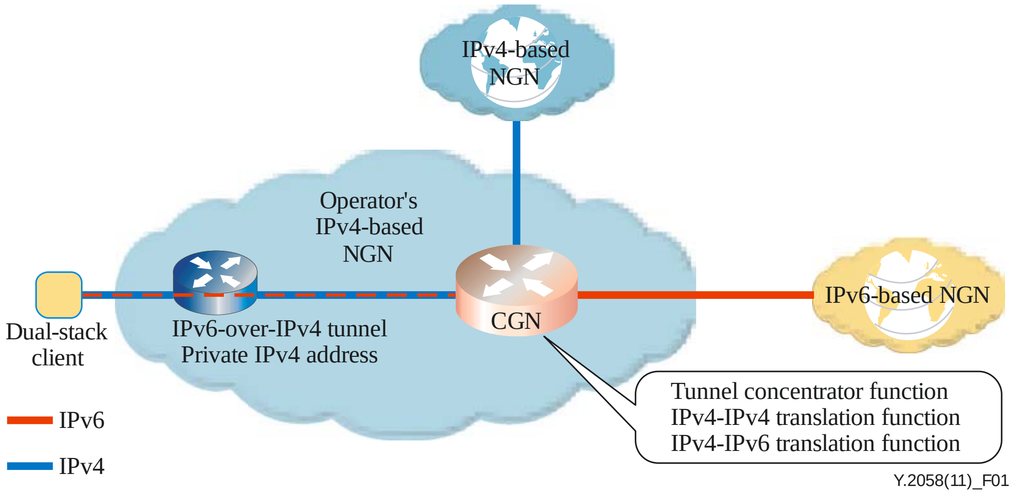

Figure 1 – The combination of IPv6-over-IPv4 tunnel, IPv4-IPv4 CGN and IPv6/IPv4 translation

In phases 2 and 3, as shown in Figure 2, IPv4-over-IPv6 tunnelling may be integrated with the CGN and translation function between IPv6 and IPv4. The integrated devices can be deployed at the border between the IPv4-based NGN and the IPv6-based NGN. When a dual-stack CGN receives a data packet from a dual-stack host, it firstly checks whether the packet is a normal IPv6 packet or an IPv4-over-IPv6 tunnel packet. For a native IPv6 packet, the CGN simply forwards it to an IPv6-based NGN. For an IPv4-over-IPv6 tunnel packet, the CGN first de-encapsulates it obtaining the original IPv4 packet, then translates the packet source address from a CGN-scope private IPv4 address into a public IPv4 address, and then sends it to an IPv4-based NGN. The CGN should record both the IPv4-over-IPv6 tunnel information and the IPv4-IPv4 address mapping information for inbound packets. If the destination address of the original IPv4 packet points to a translation function between IPv6 and IPv4, then, after translation, new IPv6 packets are sent to the IPv6-based NGN.

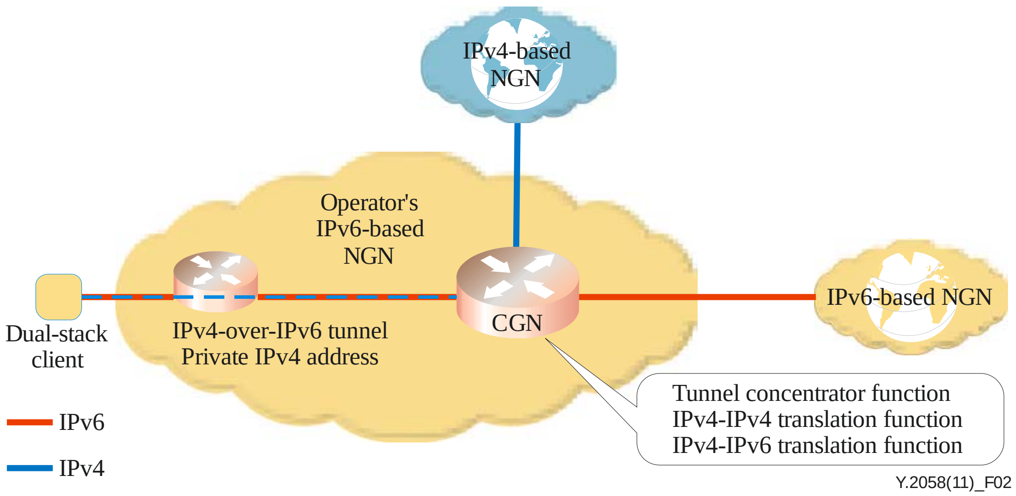

Figure 2 – The combination of IPv4-over-IPv6 tunnel, IPv4-IPv4 CGN and IPv6/IPv4 translation

6.3 Function architecture of NGNs in the IPv6 migration period

Figure 3 shows the functional architecture of NGNs in the IPv6 migration period.

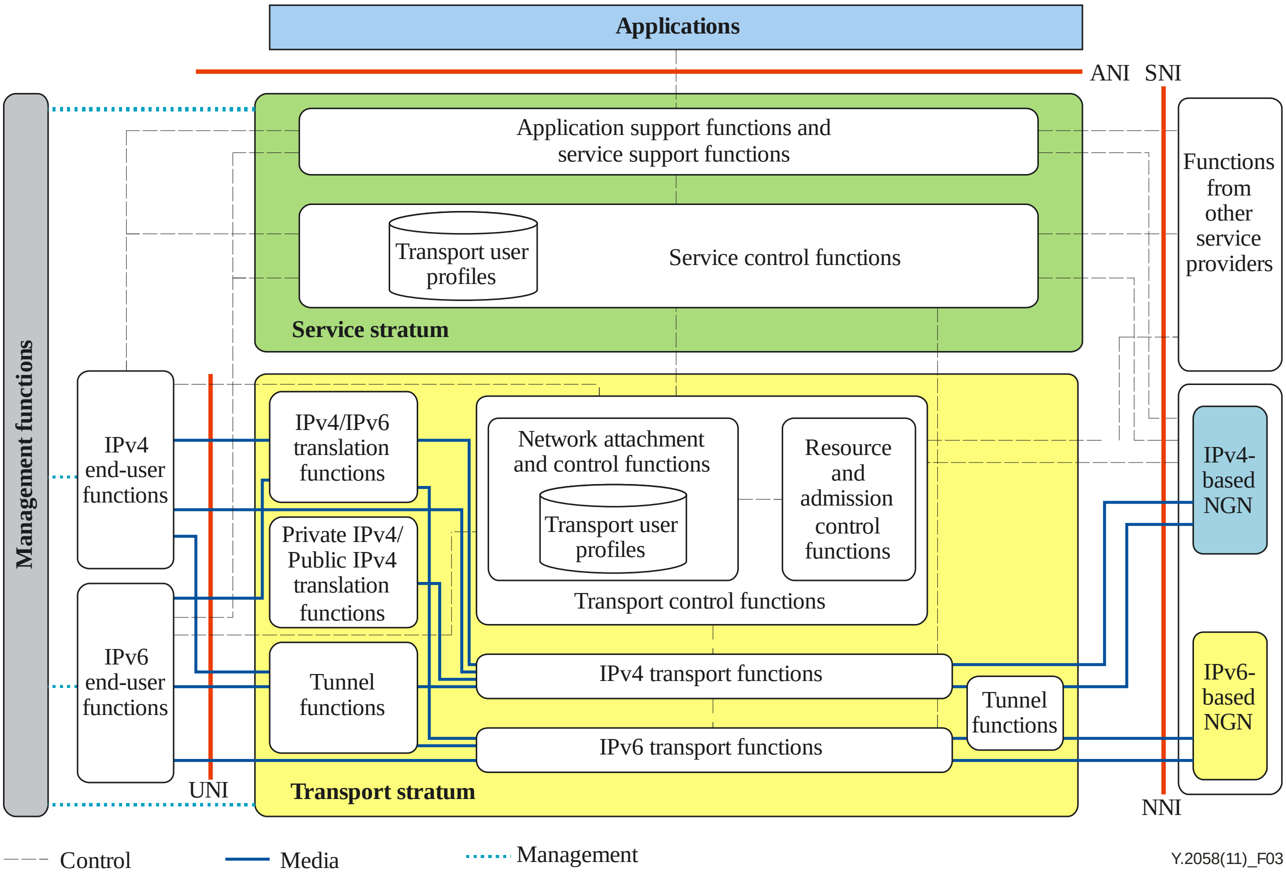

Figure 3 – Function architecture of NGNs in the IPv6 migration period

As shown in Figure 3, several functions are involved in the IPv6 migration period. These are IPv4 end-user functions, IPv6 end-user functions, IPv4/IPv6 translation functions, private IPv4/public IPv4 translation functions and tunnel functions.

IPv4 end-user functions can directly connect to IPv4 transport functions, and IPv6 end-user functions can directly connect to IPv6 transport functions. IPv4/IPv6 translation functions may translate IPv4 media into IPv6 media and forward them to IPv6 transport functions, or translate IPv6 media into IPv4 media and forward them to IPv4 transport functions. Private/public IPv4 translation functions translate IPv4 media with private IPv4 addresses into IPv4 media with public addresses. This can extend IPv4 address space. Tunnel functions may encapsulate IPv4 media into IPv6 packets that will be forwarded by an IPv6 transport function, or encapsulate IPv6 media into IPv4 packets that will be forwarded by an IPv4 transport function. These packets need to be de-encapsulated before being diverted to applications/services or other NGNs. It is worth emphasizing that the IPv4/IPv6 translation functions, the private IPv4/public IPv4 translation functions and the tunnel functions are optional, depending on the different phases of IPv6 migration in NGNs.

In the IPv6 migration period, NGNs may have IPv4 or IPv6 transport functions, or both, depending on the different phases of IPv6 migration in NGNs.

7 Phases of IPv6 migration in NGNs

Currently, NGNs are based on IPv4, as are current user access requirements. In the near future these networks would be replaced by IPv6-based NGNs. However, given the enormous scale of the Internet, the migration period from the legacy IPv4-based NGNs to all IPv6-based NGNs is expected to be long. Hence, a prudent approach is to deploy IPv6 incrementally while keeping IPv4 access available. During the transition period, IPv6 migration would start from relatively small areas first, then, stretch into the core of the Internet; while at the same time, IPv4 networks will become smaller and smaller until they vanish.

Figure 4, taken from [ITU-T Y.2051], shows the relationship of IPv6-based NGNs with other IP-based networks.

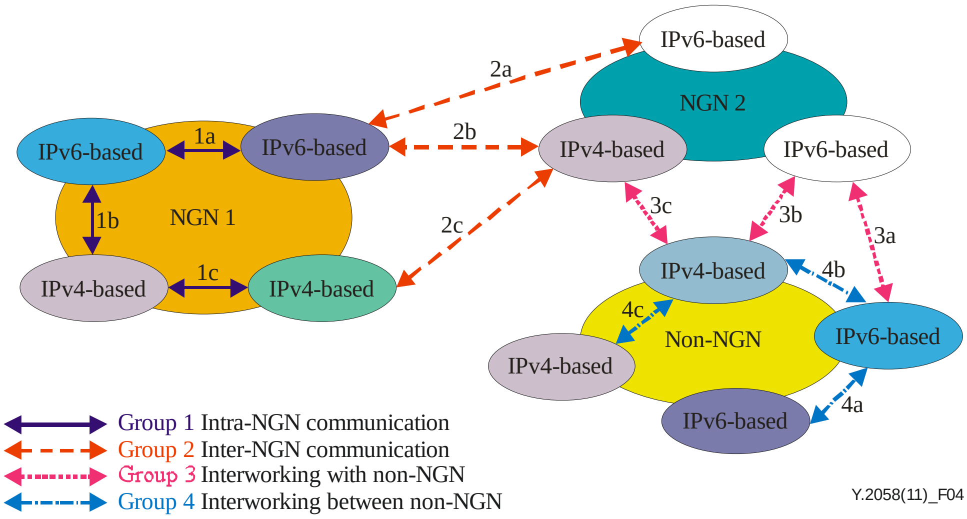

Figure 4 – Relationships of IPv6-based NGNs with other IP-based networks

As noted in [ITU-T Y.2051], IPv6-based NGNs will be gradually deployed. However, in the near future, NGNs will mainly continue to be based on IPv4. This implies that a similar study of IPv6 related issues is also required for NGNs that are in transition from an IPv4-based NGN to an IPv6-based NGN, and for the inter-communication between them, etc.

This Recommendation studies the inter-communication requirements between an IPv4-based NGN and an IPv6-based NGN during the IPv6 migration period. In different migration phases, in particular, NGN operators may have different IP-based NGNs in different locations within their overall network. This Recommendation does not consider the inter-communication between NGN and non-NGN.

In this clause, the IPv6 migration period is divided into five phases. In each phase, NGN operators would structure their networks differently, from an IPv4/IPv6 point of view.

7.1 Phase 0: NGN with IPv4

In this phase, NGNs are IPv4-based. IPv4 plays an essential role. No IPv6 networks have been deployed and, as shown in Figure 5, there are no IPv6 services. Correspondingly, operator networks have not adopted any IPv6 functions.

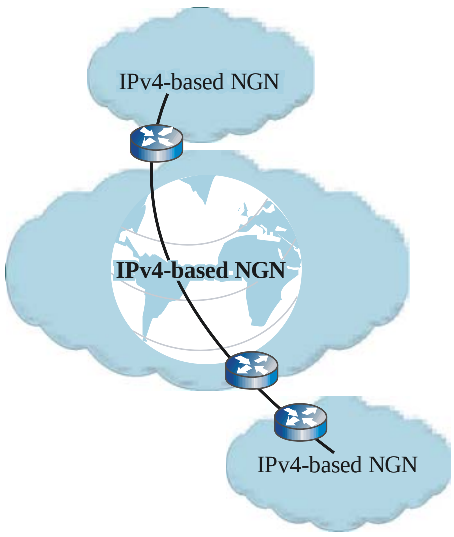

Figure 5 – Phase 0: Complete IPv4-based NGN

In this phase, IPv6 may be deployed in some customer networks locally. IPv6-based network islands may also be linked to each other through IPv6-over-IPv4 tunnelling or protocol translation technologies. However, since operators' networks do not provide IPv6 connectivity services, these IPv6 islands are totally isolated from the perspective of the NGN operators. The NGN itself is completely IPv4-based.

7.2 Phase 1: Connecting IPv6-based NGNs across an IPv4-based NGN

In the early stages where IPv6 co-exists with a native IPv4 environment, there would only be a few, isolated, IPv6-based NGNs, like islands, floating around an IPv4-based ocean, as shown in Figure 6. The initial focus of this phase is on the migration and transition techniques, rather than dealing with the volume of traffic.

In this phase, the most important IPv6 functional requirement for operators' networks is to support IPv6 tunnels in an IPv4 network. There may be a limited number of IPv6-only hosts, but they should be able to communicate with legacy IPv4-only hosts, and also with each other through IPv4-based NGNs, e.g., with IPv6 provider edge router (6PE) support across an IPv4-MPLS (multi-protocol label switching) backbone.

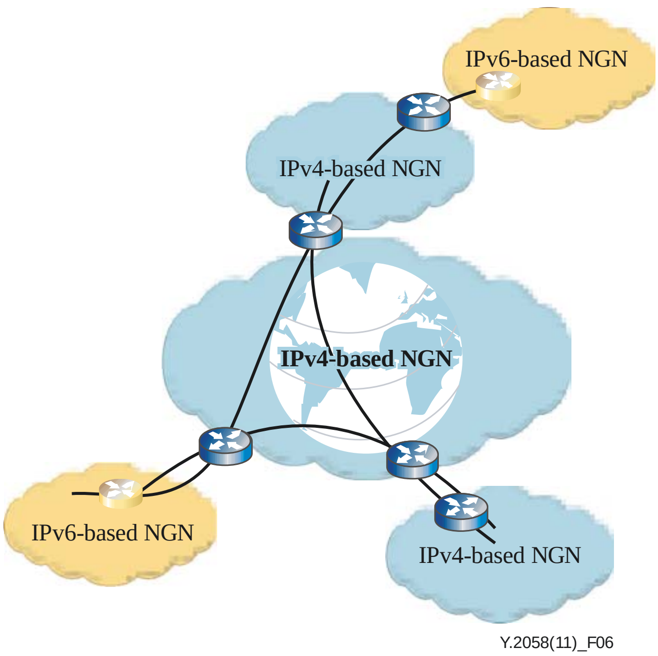

Figure 6 – Phase 1: Connecting IPv6-based NGNs across IPv4-based NGN

7.3 Phase 2: Connecting IPv6-based NGNs and IPv4-based NGNs across a dual-stack NGN

With increased IPv6 adoption, backbone routers would be upgraded to dual stack routers to form an IPv4 and IPv6 logical dual-plane, where IPv4 and IPv6 would be operated separately in the data, control and management planes, but would run on the same physical network.

In this phase, as shown in Figure 7, IPv4 and IPv6 logical planes are mutually isolated from each other. However, the same NGN devices may be used for both IPv4 and IPv6 logical planes. Resources may be dynamically adjusted between IPv4 and IPv6 logical planes according to the traffic status.

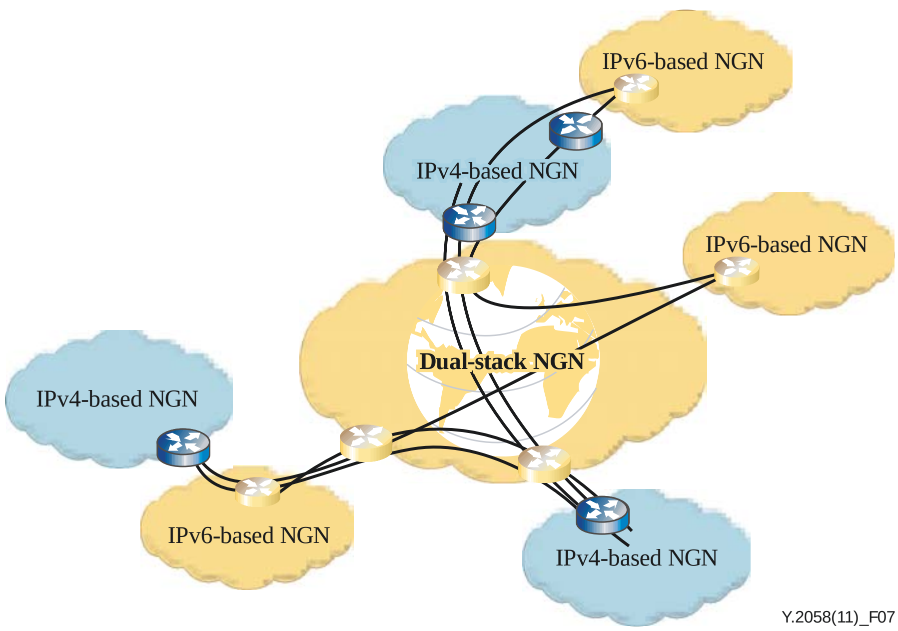

Figure 7 – Phase 2: Connecting IPv6-based NGNs and IPv4-based NGNs across a dual-stack NGN

7.4 Phase 3: Connecting IPv4-based NGNs through IPv6-based NGNs

The IPv4 address exhaustion will eventually result in large scale adoption of IPv6 and thus IPv6-only NGNs will emerge, as shown in Figure 8. In this phase, vast majority of business applications will have moved to IPv6 networks. The core backbone will only support IPv6. Sporadic small-sized IPv4-based NGNs may be distributed around the large IPv6-based NGN. IPv4-over-IPv6 tunnels are required to support IPv4-IPv4 communication through the IPv6-based NGN. Protocol translation would still be needed to allow IPv4 hosts to access IPv6 services.

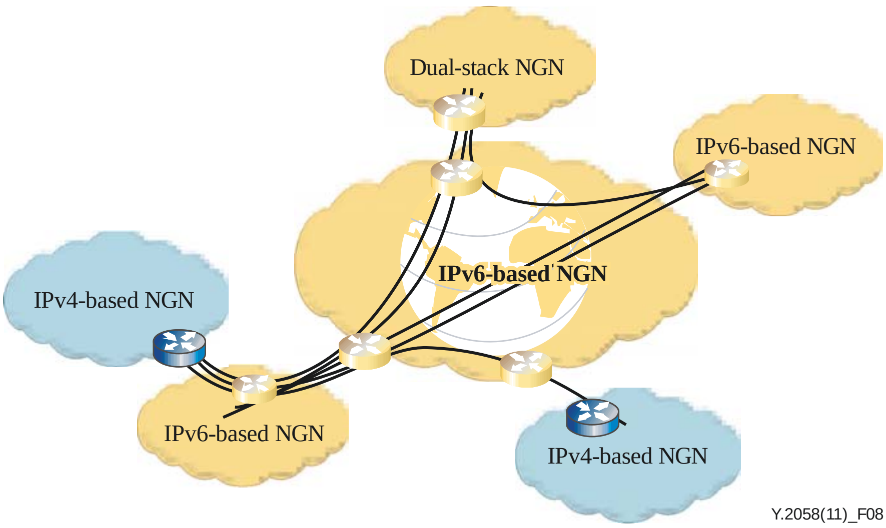

Figure 8 – Phase 3: IPv4 islands with an IPv6-based NGN

7.5 Phase 4: Fully migrated IPv6-based NGN

Finally, as shown in Figure 9, IPv6 will completely replace IPv4. The NGN will become purely IPv6-based. In this phase, there is no IPv4 connectivity service provided by NGN operators. Correspondingly, operator networks do not have any IPv4 functions remaining.

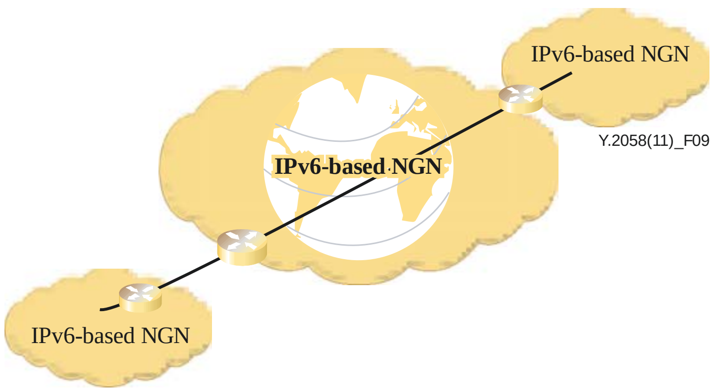

Figure 9 – Phase 4: Fully migrated IPv6-based NGN

In this phase, IPv4 may still exist locally in some customer networks. IPv4-based NGNs may also be linked to each other through IPv4-over-IPv6 tunnels or protocol translation mechanisms. However, since operators' networks will not provide an IPv4 connectivity service, these IPv4 islands are totally isolated from the NGN operators' perspective. The NGN is completely IPv6-based.

8 Functional requirements of IPv6 migration for NGN operators

This clause discusses the functional requirements of IPv6 migration for NGN operators, and lists available mechanisms that meet these functional requirements. Functional requirements are different in different migration phases.

NOTE – This Recommendation does not develop any new mechanisms, but only cites existing mechanisms.

8.1 General functional requirements to support IPv6 migration for NGN operators

Requirements of IPv6 migration for NGN operators include operational transparency, service continuity, smooth transition, no network or service degradation, etc. Figure 10 shows the functional architecture of an IPv6-based NGN.

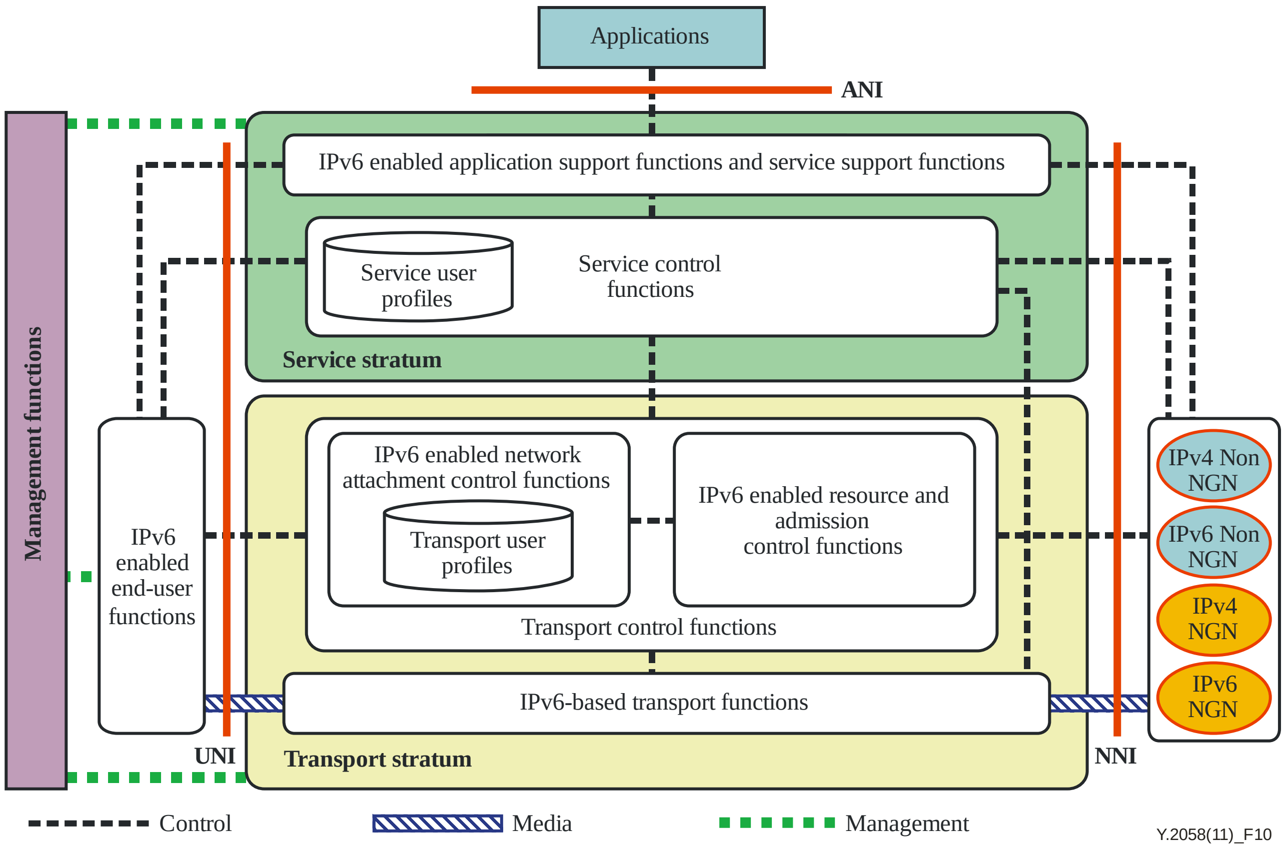

Figure 10 – Functional architecture of an IPv6-based NGN

IPv6 migration requires NGN operators to provide basic IPv6 network access while keeping the IPv4 services continuously available. The minimum that the network should provide is to allow IPv6 users access to IPv6 services. The maximum is to provide IPv4/IPv6 users access to any IPv4 or IPv6 service. Some initial IPv6 functional requirements include the following:

- IPv6 routing and forwarding: the fundamental function supports IPv6 packets delivered from their source hosts to destination hosts.
- IPv6 address assignment function: the fundamental function provides and manages IPv6 addresses and prefixes to networks and hosts.
- IPv6 domain name service (DNS) [b-IETF RFC 1035]: the function resolves services between domain names and correspondent IPv6 addresses.
- IPv6 network management: the functions are relevant to the operation, administration, maintenance, and provision of IPv6-based NGNs.

8.2 Functional requirements of each IPv6 migration phase for NGN operators

NGN operators are recommended to deploy IPv6 in their NGNs according to the sequential order of the four phases introduced in clause 6. They can also choose to skip one or more of the phases.

Following on from the above regarding the functional requirements of each IPv6 migration phase for NGN operators, this clause also gives recommendations on the strategies in each migration phase. Based on the different function requirements, NGN operators may choose to support the chosen combination of transition mechanisms that are listed in clause 6.1.

8.2.1 Functional requirements of IPv6 migration phase 1 for NGN operators

During IPv6 migration phase 1, the NGN operators may choose to support part of the aforementioned functional requirements with a chosen combination of transition mechanisms.

In this phase, the IPv4-based NGN could remain unchanged throughout. There is no extra function requirement for operators that maintain the IPv4-based NGN. However, the disadvantages are the IPv4-based NGN and its users are not aware of the existence of the IPv6 NGN and cannot launch a connection to it.

In the IPv6-based NGN, operators should provide basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management, within the scope of its own IPv6-based NGN. Depending on whether there are IPv4 users in the IPv6-based NGN and the availability of IPv4 public addresses, the combination of an IPv4-over-IPv6 tunnel, an IPv4-IPv4 CGN and IPv6/IPv4 translation, described in clause 6.2.2, may be deployed.

The routers located between the IPv6-based NGN and the IPv4-based NGN are recommended to provide two services: translation services, which translate IPv6 packets into IPv4 packets and vice versa; and the configuration of tunnels, which encapsulates IPv6 packets into IPv4 packets and forwards them to another IPv6-based NGN. If there are more than two IPv6-based NGNs connected together by the tunnels, IPv6 routing information should be provided in order to choose which tunnels IPv6 packets should be pushed into.

8.2.2 Functional requirements of IPv6 migration phase 2 for NGN operators

During IPv6 migration phase 2, the NGN operators may choose to support part of the aforementioned functional requirements with a chosen combination of transition mechanisms.

In this phase, the IPv4-based NGN could remain unchanged if there is no requirement to connect to an IPv6 NGN. If there are IPv6 connectivity requirements and there are not enough public IPv4 addresses, the combination of an IPv6-over-IPv4 tunnel, an IPv4-IPv4 CGN and IPv6/IPv4 translation, described in clause 6.2.2, may be deployed.

In the IPv6-based NGN, operators should provide basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management, within the scope of its own IPv6-based NGN. Depending on whether there are IPv4 users in the IPv6-based NGN and the availability of IPv4 addresses, the combination of an IPv4-over-IPv6 tunnel, an IPv4-IPv4 CGN and IPv6/IPv4 translation, described in clause 6.2.2, may be deployed.

The dual-stack NGN has both an IPv4 and an IPv6 plane. It provides both basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management; and basic IPv4 functions, including IPv4 routing and forwarding, IPv4 address assignment, IPv4 DNS and IPv4 network management. Translation services may be deployed in order to connect IPv6-only hosts and IPv4-only hosts.

The routers located between the IPv6-based NGN and the IPv4-based NGN are recommended to provide two services: translation services, which translate IPv6 packets into IPv4 packets and vice versa; and the configuring of tunnels, which encapsulates IPv6 packets into IPv4 packets and forwards them to another IPv6-based NGN. If there are more than two IPv6-based NGNs connected together by the tunnels, IPv6 routing information should be provided in order to choose which tunnels IPv6 packets should be pushed into.

The router located between the dual-stack NGN and the IPv6-based NGN may provide a translation service. The router located between the dual-stack NGN and the IPv4-based NGN may provide a translation service.

8.2.3 Functional requirements of IPv6 migration phase 3 for NGN operators

During IPv6 migration phase 3, the NGN operators may choose to support part of the aforementioned functional requirements with a chosen combination of transition mechanisms.

In this phase, the IPv4-based NGN could remain unchanged if there is no requirement to connect to an IPv6 NGN. If there are IPv6 connectivity requirements and there are not enough public IPv4 addresses, the combination of an IPv6-over-IPv4 tunnel, an IPv4-IPv4 CGN and IPv6/IPv4 translation, described in clause 6.2.2, may be deployed.

In the IPv6-based NGN, operators should provide basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management, within the scope of its own IPv6-based NGN. Depending on whether there are IPv4 users in the IPv6-based NGN and the availability of IPv4 addresses, the combination of an IPv4-over-IPv6 tunnel, an IPv4-IPv4 CGN and IPv6/IPv4 translation, described in clause 6.2.2, may be deployed.

The dual-stack NGN has both an IPv6 plane and an IPv4 plane. It provides both basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management; and basic IPv4 functions, including IPv4 routing and forwarding, IPv4 address assignment, IPv4 DNS and IPv4 network management. Translation services may be deployed in order to connect IPv6-only hosts and IPv4-only hosts.

The routers located between the IPv4-based NGN and the IPv6-based NGN are recommended to provide two services: translation services, which translate IPv4 packets into IPv6 packets and vice versa; and the configuring of tunnels, which encapsulates IPv4 packets into IPv6 packets and forwards them to another IPv4-based NGN. If there are more than two IPv4-based NGNs connected together by the tunnels, IPv4 routing information should be provided in order to choose which tunnels IPv4 packets should be pushed into.

The router located between the dual-stack NGN and the IPv6-based NGN may provide a translation service. The router located between the dual-stack NGN and the IPv4-based NGN may provide a translation service.

8.2.4 Functional requirements of IPv6 migration phase 4 for NGN operators

During IPv6 migration phase 4, the NGN operators only need to support IPv6 access and forwarding.

In the IPv6-based NGN, operators should provide basic IPv6 functions, including IPv6 routing and forwarding, IPv6 address assignment, IPv6 DNS and IPv6 network management, within the scope of its own IPv6-based NGN. Since there are no longer IPv4-based NGNs, translations services are not needed.

9 Security Considerations

This Recommendation complies with the security requirements in [ITU-T Y.2701], while some particular problems need to be considered as follows:

Inherited IPv4 security threats

Traditional IPv4 security threats may affect the dual-stack devices connected to IPv4 networks. Although IPv4 and IPv6 are logically processed separately in dual-stack devices, as they share the same hardware and software platforms, the IPv6-related functions are likely to be impacted if the device itself has a problem.

IPv6 specific security mechanisms to be supported during IPv6 migration

IPv6 introduced a new address architecture, and new protocols such as Neighbour Discovery. According to the results of early security analyses, mechanisms based on the introduced features, for example, cryptographically generated addresses (CGA) are very important and should be considered to be supported during IPv6 migration.

End-to-end security

Packets that pass across the network boundary may be re-encapsulated or even modified by tunnel or address/protocol translation devices. If the packets are processed by security mechanisms such as Internet protocol security (IPSec), the operation of boundary devices should not break the end-to-end security as far as possible.

Security policy interoperability and consistency

Some dual-stack devices may connect to both IPv4 and IPv6 networks. Interoperability and consistency of the security management policies of the IPv4 and IPv6 networks should be considered, especially for those networks where IPv4/IPv6 topologically overlap.

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