International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.3404
(08/2016)

SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN – Service and session control protocols

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Signalling requirements for NGN real-time multimedia services supporting IPv6 transition

Recommendation ITU-T Q.3404

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR THE NGN	Q.3000–Q.3709
General	Q.3000–Q.3029
Network signalling and control functional architecture	Q.3030–Q.3099
Network data organization within the NGN	Q.3100–Q.3129
Bearer control signalling	Q.3130–Q.3179
Signalling and control requirements and protocols to support attachment in NGN environments	Q.3200–Q.3249
Resource control protocols	Q.3300–Q.3369
Service and session control protocols	**Q.3400–Q.3499**
Service and session control protocols – supplementary services	Q.3600–Q.3616
Service and session control protocols – supplementary services based on SIP-IMS	Q.3617–Q.3639
NGN applications	Q.3700–Q.3709
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR SDN	Q.3710–Q.3899
TESTING SPECIFICATIONS	Q.3900–Q.4099

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Q.3404

Signalling requirements for NGN real-time multimedia services supporting IPv6 transition

Summary

Recommendation ITU-T Q.3404 describes the IPv6 transition technologies which could be applied in a next generation network (NGN) environment. The signalling requirements supporting NGN real-time multimedia services in Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) mixed network are specified. Three mechanisms for IPv6 transition are introduced in this Recommendation including dual stack, translation and tunnelling.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3404	2016-08-29	11	11.1002/1000/12987

Keywords

IPv6, multimedia services, NGN.

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* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Q.3404

Signalling requirements for NGN real-time multimedia services supporting IPv6 transition

1 Scope

This Recommendation describes the IPv6 transition technologies which could be applied in a next generation network (NGN) environment. The signalling requirements supporting NGN real-time multimedia services in Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) mixed network are specified. Three mechanisms for IPv6 transition are described in this Recommendation including dual stack, translation and tunnelling. The security issues introduced by IPv6 transition is out of scope of this Recommendation.

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.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 (2010), *Functional requirements and architecture of next generation networks*.

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

[IETF RFC 5565] IETF RFC 5565 (2009), *Softwire Mesh Framework*.

[IETF RFC 5747] IETF RFC 5747 (2010), *4over6 Transit Solution Using IP Encapsulation and MP-BGP Extensions*.

[IETF RFC 5969] IETF RFC 5969 (2010), *IPv6 Rapid Deployment on IPv4 Infrastructures (6rd) -- Protocol Specification*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 NGN service stratum [ITU-T Y.2011]: That part of the NGN which provides the user functions that transfer service-related data and the functions that control and manage service resources and network services to enable user services and applications.

3.1.2 NGN transport stratum [ITU-T Y.2011]: That part of the NGN which provides the user functions that transfer data and the functions that control and manage transport resources to carry such data between terminating entities.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ABG-FE	Access Border Gateway Functional Entity
ALG	Application Level Gateway
IBC-FE	Interconnection Border Gateway Control Functional Entity
IBG-FE	Interconnection Border Gateway Functional Entity
IP	Internet Protocol
ISDN	Integrated Services Digital Network
NACF	Network Attachment Control Functions
NAT	Network Address Translation
NAT-PT	Network Address Translation Protocol Translation
NNI	Network to Network Interface
NSIW-FE	Network Signalling Interworking Functional Entity
P-CSC-FE	Proxy Call Session Control Functional Entity
PSTN	Public Switched Telephone Network
RACF	Resource and Admission Control Functions
S-CSC-FE	Serving Call Session Control Functional Entity
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SIP	Session Initiation Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UE	User Equipment
UNI	User to Network Interface

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Architecture for NGN multimedia services supporting IPv6 transition

The architecture of NGN multimedia services supporting IPv6 transition is depicted in Figure 6-1.

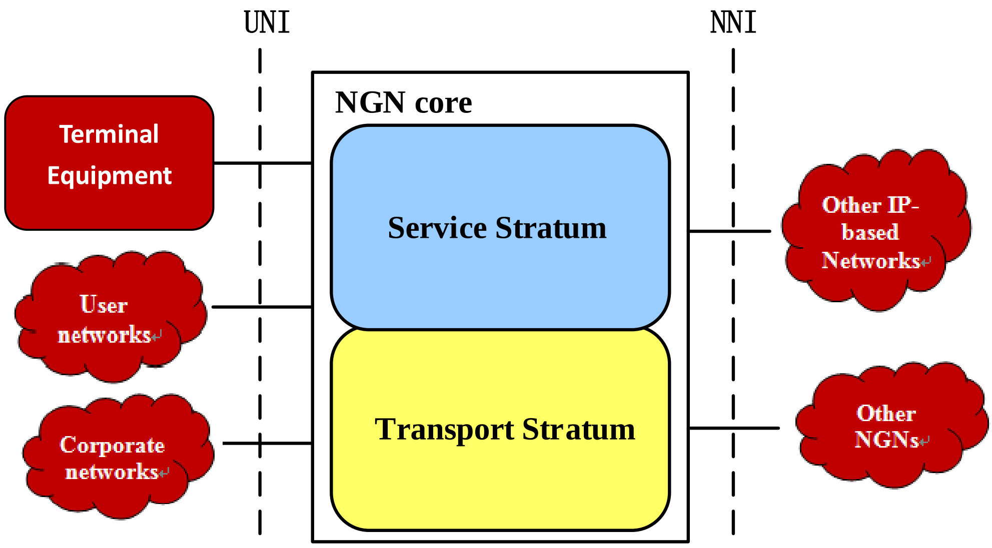

Figure 6-1 – Architecture for NGN multimedia services supporting IPv6 transition

In order to reduce the interworking complexity, all functional entities in the NGN core network (e.g., proxy call session control functional entity (P-CSC-FE), serving call session control functional entity (S-CSC-FE), access border gateway functional entity (ABG-FE)) should use the same version of internet protocol as far as possible. Accordingly, IP protocol transition is only required on user to network interface (UNI) and network to network interface (NNI) within both control plane and media plane in NGN service stratum and NGN transport stratum. Three IPv6 transition mechanisms are introduced in this Recommendation to support NGN real-time multimedia services, including dual stack, translation and tunnelling as specified in clause 7, clause 8 and clause 9 respectively.

7 Signalling requirements for dual stack

In order to support dual stack transition, all functional entities inside an NGN core network are required to support IPv4 and IPv6 simultaneously. At the edge of an NGN core network, the functional entities connected to user equipment (UEs) or other IP-based networks should have the capability to adapt the same IP version as that which is used by the connected entities (UEs and/or other IP-based networks) both at the signalling level and media level.

8 Signalling requirements for translation

8.1 General requirements

Network address translation (NAT)/network address translation protocol translation (NAT-PT) functions are required to be processed in the border of the IPv4 and IPv6 network for translation transition. The IPv4 address of the traffic from the IPv4 network to the IPv6 network shall be translated into IPv6 address in the border gateway, and vice versa. As an interconnecting node, the border gateway shall support dual stack.

The border gateway shall also implement application level gateway (ALG) function which provides the application level translation for specific protocols (e.g., session initiation protocol (SIP) and session description protocol (SDP)).

The border gateway shall be located in the border of networks using different protocols. Referring to NGN architecture defined in [ITU-T Y.2012], the functions of border gateway could be implemented in ABG-FE, interconnection border gateway functional entity (IBG-FE), P-CSC-FE and interconnection border gateway control functional entity (IBC-FE).

Considering IPv6 transition using translation mechanism, there are four specific scenarios:

1) Scenario 1: UE using IPv6 and NGN core using IPv4;
2) Scenario 2: UE using IPv4 and NGN core using IPv6;
3) Scenario 3: NGN core using IPv6 and other IP-based network using IPv4;
4) Scenario 4: NGN core using IPv4 and other IP-based network using IPv6.

8.2 Scenario 1: UE using IPv6 and NGN core using IPv4

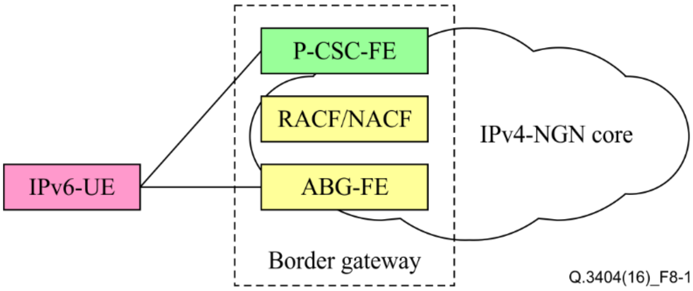

Figure 8-1 – Scenario 1: UE using IPv6 and NGN core using IPv4

In the scenario of "UE using IPv6 and NGN core using IPv4" shown in Figure 8-1, P-CSC-FE and ABG-FE act as a border gateway within the control plane and the user plane (media plane) respectively.

P-CSC-FE implements ALG function which provides the application level translation for SIP and SDP. It requests address mapping information based on the address binding information provided by the resource and admission control functions (RACF), and then modifies the addresses and/or ports contained in the SIP and SDP message bodies. The function and procedure of RACF refers to [ITU-T Y.2701].

ABG-FE implements NAT/NAT-PT function under the control of the network attachment control functions (NACF) and RACF. A globally unique IPv4 address, dynamically allocated from an IPv4 address pool, is associated to an IPv6 node and vice versa. ABG-FE, using NAT function to bind IPv6 addresses with IPv4 addresses, implements interworking function between the IPv4 and IPv6 domains without any additional requirements to UEs. ABG-FE shall carry out NAT-PT translation to provide transport identifier translation (e.g., transmission control protocol (TCP), user datagram protocol (UDP) and stream control transmission protocol (SCTP)) on basis of network address translation.

8.3 Scenario 2: UE using IPv4 and NGN core using IPv6

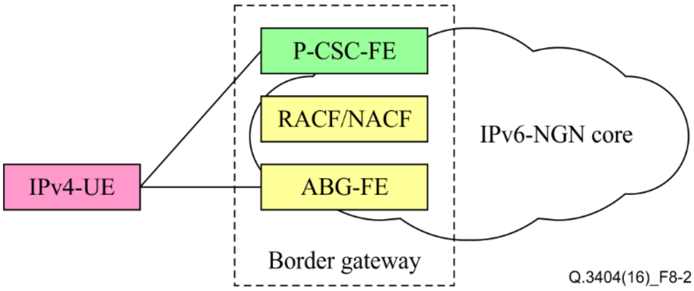

Figure 8-2 – Scenario 2: UE using IPv4 and NGN core using IPv6

In the scenario of "UE using IPv4 and NGN core using IPv6" shown in Figure 8-2, P-CSC-FE and ABG-FE act as a border gateway within the control plane and the user plane (media plane) respectively.

The difference between scenario 1 and scenario 2 is that UE and NGN core network are using different IP versions. In scenario 2, the P-CSC-FE and ABG-FE implement the same functions as described in clause 8.2.

8.4 Scenario 3: NGN core using IPv6 and other IP-based network using IPv4

The scenario of "NGN core using IPv6 and other IP-based network using IPv4" could be categorized by two sub-scenarios.

In the scenario of "Interconnection between NGN core using IPv6 and other IP-based network using IPv4 (which could be a PSTN/ISDN emulation subsystem or another NGN core) via IBC-FE" shown in Figure 8-3, the IBC-FE and IBG-FE act as a border gateway within the control plane and the user plane (media plane) respectively.

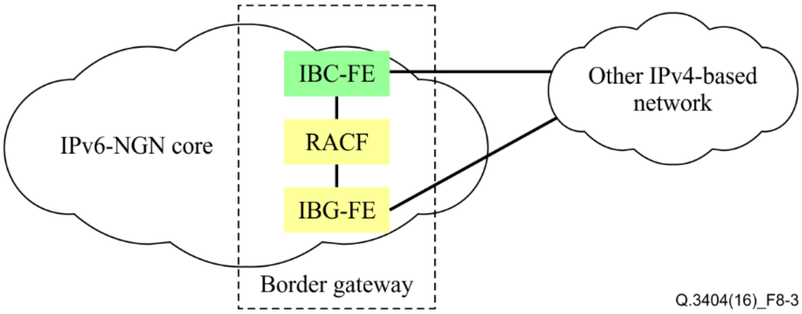

Figure 8-3 – Scenario 3-1: Interconnection between NGN core using IPv6 and other IP-based networks using IPv4 via IBC-FE

In the scenario of "Interconnection between NGN core using IPv6 and other IP-based network using IPv4 (which is using other SIP profiles or other IP-based protocols such as ITU-T H.323) via NSIW-FE" shown in Figure 8-4, the network signalling interworking functional entity (NSIW-FE) and IBG-FE act as a border gateway within the control plane and the user plane (media plane) respectively.

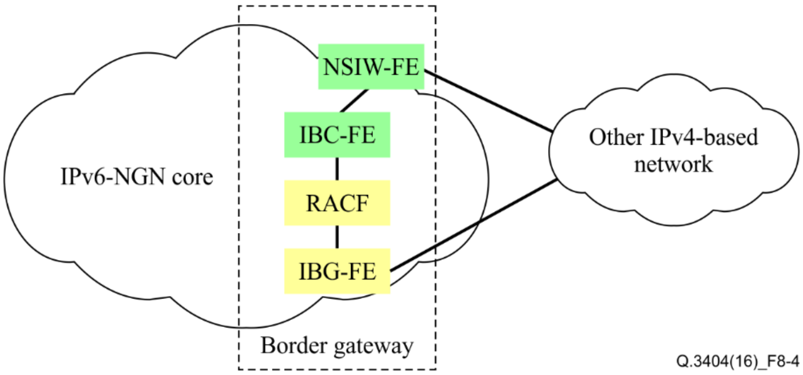

Figure 8-4 – Scenario 3-2: Interconnection between NGN core using IPv6 and other IP-based networks using IPv4 via NSIW-FE

In scenario 3-1, IBC-FE implements ALG function which provides the application level translation for SIP and SDP. It requests address mapping information based on the address binding information provided by the RACF, and then modifies the addresses and/or ports contained in the SIP and SDP message bodies.

In scenario 3-2, NSIW-FE implements ALG function which provides the application level translation for SIP and SDP. It implements the same address and port translation function as that of IBC-FE described in scenario 3-1.

In both scenarios, IBG-FE implements NAT/NAT-PT functions under the control of IBC-FE and RACF. A globally unique IPv4 address, dynamically allocated from an IPv4 address pool, is associated to an IPv6 node, and vice versa. IBG-FE, using NAT function to bind IPv6 addresses with IPv4 addresses, implements interworking function between IPv4 and IPv6 domains. IBG-FE shall carry out NAT-PT translation to provide transport identifier translation (e.g., TCP, UDP and SCTP) on basis of network address translation.

8.5 Scenario 4: NGN core using IPv4 and other IP-based networks using IPv6

The scenario of "NGN core using IPv4 interconnecting with other IP-based networks using IPv6" could be categorized by 2 sub-scenarios.

In the case of "NGN core using IPv4 and other IP-based network using IPv6 (which could be a PSTN/ISDN emulation subsystem or another NGN core) via IBC-FE" shown in Figure 8-5, the IBC-FE and IBG-FE act as border gateways within the control plane and the user plane (media plane) respectively.

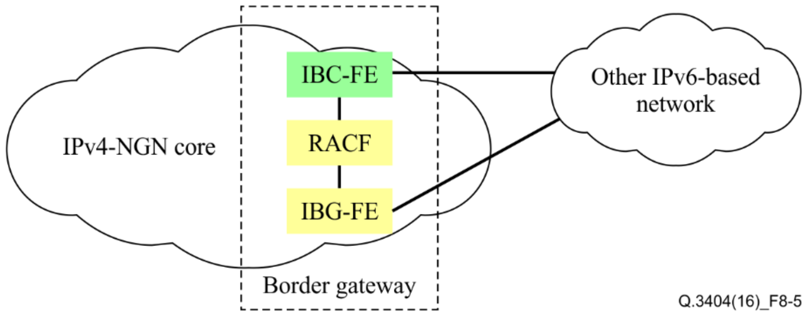

Figure 8-5 – Scenario 4-1: Interconnection between NGN core using IPv4 and other IP-based network using IPv6 via IBC-FE

In the scenario of "NGN core using IPv4 and other IP-based network using IPv6 (which is using other SIP profile or other IP-based protocols such as H.323) via NSIW-FE" shown in Figure 8-6, the NSIW-FE and IBG-FE act as border gateways within the control plane and the user plane (media plane) respectively.

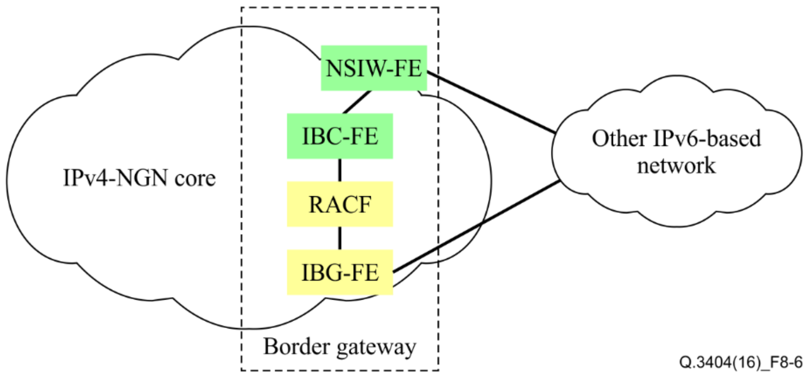

Figure 8-6 – Scenario 4-2: Interconnection between NGN core using IPv6 and other IP-based networks using IPv4 via NSIW-FE

In scenario 4-1, IBC-FE implements ALG function which provides the application level translation for SIP and SDP. It requests address mapping information based on the address binding information provided by the RACF, and then modifies the addresses and/or ports contained in the SIP and SDP message bodies.

In scenario 4-2, NSIW-FE implements ALG function which provides the application level translation for SIP and SDP. It implements the same address and port translation functions as that of IBC-FE described in scenario 4-1.

In both scenarios, IBG-FE implements NAT/NAT-PT functions under the control of IBC-FE and RACF. A globally unique IPv6 address, dynamically allocated from an IPv6 address pool, is associated to an IPv4 node, and vice versa. IBG-FE, using NAT function to bind IPv4 addresses with IPv6 addresses, implements interworking function between IPv4 and IPv6 domains. IBG-FE shall carry out NAT-PT translation to provide transport identifier translation (e.g., TCP, UDP and SCTP) on basis of network address translation.

9 Signalling requirements for tunnelling

9.1 Overviews

Tunnelling is a mechanism to transfer data by encapsulating an IP packet into another IP packet, where a point-to-point connection is established between two peers using different IP versions. For details of this tunneling mechanism refer to [IETF RFC 5565]. In the tunneling mechanism, packets are encapsulated at the start point of a tunnel and de-capsulated at the end point of a tunnel, while the intermediate nodes simply transfer the data without any modification. In an NGN environment, the tunnelling mechanism is applicable to connect two NGN core networks, each using the same IP version, via a carrier's network using a different IP version. The start point and the end point of the tunnel are located in the border of each NGN core network respectively. The tunneling mechanism is categorized by two scenarios:

1) Scenario 1: 4over6 tunnel connecting IPv4 NGN core networks;
2) Scenario 2: 6over4 tunnel connecting IPv6 NGN core networks.

9.2 Scenario1: 4over6 tunnel connecting IPv4 NGN core networks

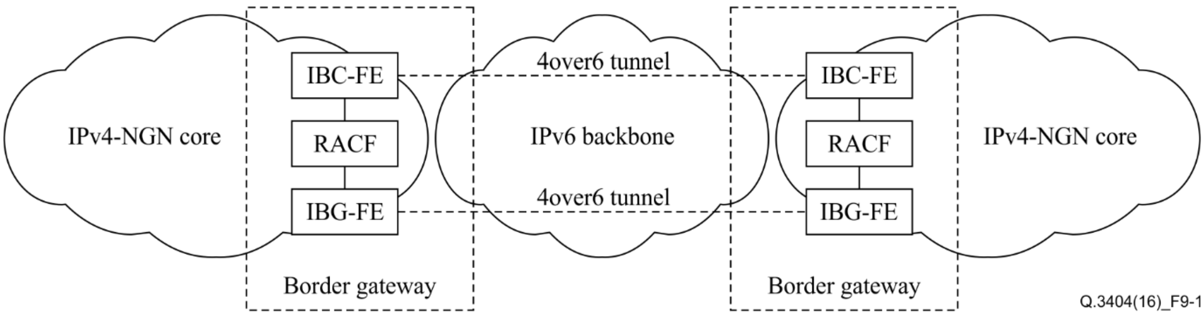

Figure 9-1 – Scenario 1: 4over6 tunnel connecting IPv4 NGN core networks

As shown in Figure 9-1, two IPv4 NGN core networks are connected via an IPv6 bearer network by establishing 4over6 tunnels. The border gateway acting as the start and the end point of the tunnel implements packet capsulation and de-capsulation. The border gateway is required to support IPv4 and IPv6 dual stack. As implemented, the signaling messages are transferred through the tunnel established between IBC-FEs located at the edge of two IPv4 NGN core networks, while media streams are transferred through the tunnel established between IBG-FEs at the edge of two IPv4 NGN core networks.

There are three steps to transfer an IPv4 packet through the IPv6 transit core network:

1) Encapsulate the incoming IPv4 packet with an IPv6 tunnel header at the start point of a tunnel;

2) Transmit the encapsulated packet over the IPv6 transit backbone;

3) De-capsulate the IPv6 header and forward the original IPv4 packet at the end point of a tunnel.

The 4over6 tunnel protocol refers to [IETF RFC 5747].

9.3 Scenario 2: 6over4 tunnel connection IPv6 NGN core networks

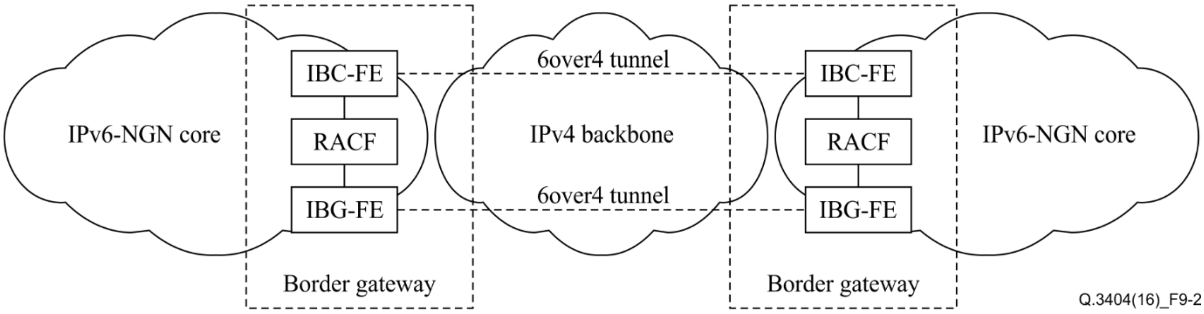

Figure 9-2 – Scenario 2: 6over4 tunnel connecting IPv6 NGN core networks

As shown in Figure 9-2, two IPv6 NGN core networks was connected via IPv4 bearer network by establishing 6over4 tunnel. The border gateway acting as the start and the end point of a tunnel implements packet capsulation and de-capsulation. The border gateway is required to support IPv4 and IPv6 dual stack. As implemented, the signal messages are transferred through the tunnel established between IBC-FEs located at the edge of two IPv6 NGN core networks, while media streams are transferred through the tunnel established between IBG-FEs located at the edge of two IPv6 NGN core networks.

There are three steps to transfer an IPv6 packet through the IPv4 transit core network:

1) Encapsulate the incoming IPv6 packet with an IPv4 tunnel header at the start point of a tunnel;

2) Transmit the encapsulated packet over the IPv4 transit backbone;

3) De-capsulate the IPv4 header and forward the original IPv6 packet at the end point of a tunnel.

The 6over4 tunnel protocol refers to [IETF RFC 5969].

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Series D	General tariff principles
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Printed in Switzerland
Geneva, 2016