

ETSI TS 129 573 V17.7.0 (2023-04)



**5G;
5G System;
Public Land Mobile Network (PLMN) Interconnection;
Stage 3
(3GPP TS 29.573 version 17.7.0 Release 17)**

<https://standards.iteh.ai/catalog/standards/sist/4e2d364e-6888-402f-aed5-a92846dc7122/etsi-ts-129-573-v17-7-0-2023-04>



ReferenceRTS/TSGC-0429573vh70

Keywords5G

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Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
Foreword.....	7
1 Scope	9
2 References	9
3 Definitions and abbreviations.....	10
3.1 Definitions	10
3.2 Abbreviations	10
4 General Description.....	10
4.1 Introduction	10
4.2 N32 Interface.....	11
4.2.1 General.....	11
4.2.2 N32-c Interface	11
4.2.3 N32-f Interface.....	11
4.3 Protocol Stack	12
4.3.1 General.....	12
4.3.2 HTTP/2 Protocol.....	13
4.3.2.1 General	13
4.3.2.2 HTTP standard headers	13
4.3.2.3 HTTP custom headers	13
4.3.2.4 HTTP/2 connection management	13
4.3.3 Transport Protocol	14
4.3.4 Serialization Protocol.....	14
5 N32 Procedures	14
5.1 Introduction	14
5.2 N32 Handshake Procedures (N32-c)	15
5.2.1 General.....	15
5.2.2 Security Capability Negotiation Procedure.....	15
5.2.3 Parameter Exchange Procedure	17
5.2.3.1 General	17
5.2.3.2 Parameter Exchange Procedure for Cipher Suite Negotiation	17
5.2.3.3 Parameter Exchange Procedure for Protection Policy Exchange	18
5.2.3.4 Parameter Exchange Procedure for Security Information list Exchange	20
5.2.4 N32-f Context Termination Procedure	21
5.2.5 N32-f Error Reporting Procedure	22
5.3 JOSE Protected Message Forwarding Procedure on N32 (N32-f)	23
5.3.1 Introduction.....	23
5.3.2 Use of Application Layer Security.....	23
5.3.2.1 General	23
5.3.2.2 Protection Policy Lookup.....	24
5.3.2.3 Message Reformatting	25
5.3.2.4 Message Forwarding to Peer SEPP	26
5.3.3 Message Forwarding to Peer SEPP when TLS is used	27
5.3.4 JOSE Protected Forwarding Options	27
5.4 Nsepp_Telescopic_FQDN_Mapping Service	28
5.4.1 General.....	28
5.4.2 Foreign FQDN to Telescopic FQDN Mapping Procedure.....	28
5.4.3 Telescopic FQDN to Foreign FQDN Mapping Procedure.....	28
6 API Definitions	29
6.1 N32 Handshake API.....	29
6.1.1 API URI	29

6.1.2	Usage of HTTP	29
6.1.2.1	General	29
6.1.2.2	HTTP standard headers	29
6.1.2.2.1	General	29
6.1.2.2.2	Content type	29
6.1.2.3	HTTP custom headers	30
6.1.2.3.1	General	30
6.1.3	Resources	30
6.1.3.1	Overview	30
6.1.4	Custom Operations without Associated Resources	30
6.1.4.1	Overview	30
6.1.4.2	Operation: Security Capability Negotiation	30
6.1.4.2.1	Description	30
6.1.4.2.2	Operation Definition	30
6.1.4.3	Operation: Parameter Exchange	31
6.1.4.3.1	Description	31
6.1.4.3.2	Operation Definition	31
6.1.4.4	Operation: N32-f Context Terminate	32
6.1.4.4.1	Description	32
6.1.4.4.2	Operation Definition	32
6.1.4.5	Operation: N32-f Error Reporting	33
6.1.4.5.1	Description	33
6.1.4.5.2	Operation Definition	33
6.1.5	Data Model	33
6.1.5.1	General	33
6.1.5.2	Structured data types	34
6.1.5.2.1	Introduction	34
6.1.5.2.2	Type: SecNegotiateReqData	35
6.1.5.2.3	Type: SecNegotiateRspData	36
6.1.5.2.4	Type: SecParamExchReqData	37
6.1.5.2.5	Type: SecParamExchRspData	38
6.1.5.2.6	Type: ProtectionPolicy	39
6.1.5.2.7	Type: ApiIeMapping	39
6.1.5.2.8	Type: IeInfo	40
6.1.5.2.9	Type: ApiSignature	42
6.1.5.2.10	Type: N32fContextInfo	42
6.1.5.2.11	Type: N32fErrorInfo	43
6.1.5.2.12	Type: FailedModificationInfo	43
6.1.5.2.13	Type: N32fErrorDetail	44
6.1.5.2.14	Type: CallbackName	44
6.1.5.2.15	Type: IpxProviderSecInfo	44
6.1.5.2.16	Type: IntendedN32Purpose	44
6.1.5.3	Simple data types and enumerations	45
6.1.5.3.1	Introduction	45
6.1.5.3.2	Simple data types	45
6.1.5.3.3	Enumeration: SecurityCapability	45
6.1.5.3.4	Enumeration: HttpMethod	45
6.1.5.3.5	Enumeration: IeType	46
6.1.5.3.6	Enumeration: IeLocation	46
6.1.5.3.7	Enumeration: N32fErrorType	47
6.1.5.3.8	Enumeration: FailureReason	47
6.1.5.3.9	Enumeration: N32Purpose	48
6.1.5.4	Binary data	48
6.1.6	Error Handling	48
6.1.6.1	General	48
6.1.6.2	Protocol Errors	48
6.1.6.3	Application Errors	48
6.1.7	Feature Negotiation	49
6.2	JOSE Protected Message Forwarding API on N32	49
6.2.1	API URI	49
6.2.2	Usage of HTTP	50
6.2.2.1	General	50

6.2.2.2	HTTP standard headers	50
6.2.2.2.1	General	50
6.2.2.2.2	Content type	50
6.2.2.2.3	Accept-Encoding	50
6.2.2.3	HTTP custom headers	50
6.2.2.3.1	General	50
6.2.3	Resources	50
6.2.3.1	Overview	50
6.2.4	Custom Operations without associated resources	51
6.2.4.1	Overview	51
6.2.4.2	Operation: JOSE Protected Forwarding	51
6.2.4.2.1	Description	51
6.2.4.2.2	Operation Definition	51
6.2.4.3	Operation: JOSE Protected Forwarding Options	52
6.2.4.3.1	Description	52
6.2.4.3.2	Operation Definition	53
6.2.5	Data Model	53
6.2.5.1	General	53
6.2.5.2	Structured data types	54
6.2.5.2.1	Introduction	54
6.2.5.2.2	Type: N32fReformattedReqMsg	55
6.2.5.2.3	Type: N32fReformattedRspMsg	56
6.2.5.2.4	Type: DataToIntegrityProtectAndCipherBlock	56
6.2.5.2.5	Type: DataToIntegrityProtectBlock	57
6.2.5.2.6	Type: RequestLine	57
6.2.5.2.7	Type: HttpHeaders	58
6.2.5.2.8	Type: HttpPayload	59
6.2.5.2.9	Type: Metadata	62
6.2.5.2.10	Type: Modifications	62
6.2.5.2.11	Type: FlatJweJson	63
6.2.5.2.12	Type: FlatJwsJson	64
6.2.5.2.13	Type: IndexToEncryptedValue	64
6.2.5.2.14	Type: EncodedHttpHeaderValue	64
6.2.5.3	Simple data types and enumerations	64
6.2.5.3.1	Introduction	64
6.2.5.3.2	Simple data types	64
6.2.5.3.3	Void	65
6.2.5.3.4	Void	65
6.2.6	Error Handling	65
6.2.6.1	General	65
6.2.6.2	Protocol Errors	65
6.2.6.3	Application Errors	65
6.3	Nsepp_Telescopic_FQDN_Mapping API	65
6.3.1	API URI	65
6.3.2	Usage of HTTP	65
6.3.2.1	General	65
6.3.2.2	HTTP standard headers	66
6.3.2.2.1	General	66
6.3.2.2.2	Content type	66
6.3.2.3	HTTP custom headers	66
6.3.2.3.1	General	66
6.3.3	Resources	66
6.3.3.1	Overview	66
6.3.3.2	Resource: Mapping	67
6.3.3.2.1	Description	67
6.3.3.2.2	Resource Definition	67
6.3.3.2.3	Resource Standard Methods	67
6.3.4	Data Model	68
6.3.4.1	General	68
6.3.4.2	Structured data types	68
6.3.4.2.1	Introduction	68
6.3.4.2.2	Type: TelescopicMapping	68

6.3.4.3	Simple data types and enumerations	69
6.3.4.3.1	Introduction	69
6.3.4.3.2	Simple data types.....	69
6.3.5	Error Handling.....	69
6.3.5.1	General.....	69
6.3.5.2	Protocol Errors.....	69
6.3.5.3	Application Errors.....	69
6.3.6	Feature Negotiation.....	69
6.3.7	Security.....	69
6.3.7.1	General.....	69
Annex A (normative):	OpenAPI Specification	70
A.1	General	70
A.2	N32 Handshake API.....	70
A.3	JOSE Protected Message Forwarding API on N32-f	77
A.4	SEPP Telescopic FQDN Mapping API.....	81
Annex B (informative):	Examples of N32-f Encoding.....	83
B.1	General	83
B.2	Input Message Containing No Binary Part.....	83
B.3	Input Message Containing Multipart Binary Part	84
Annex C (informative):	End to end call flows when SEPP is on path	87
C.1	General	87
C.2	TLS security between SEPPs	87
C.2.1	When http URI scheme is used	87
C.2.1.1	General.....	87
C.2.1.2	Without TLS protection between NF and SEPP and with TLS security without the 3gpp-Sbi-Target-apiRoot header used over N32f.....	87
C.2.1.3	Without TLS protection between NF and SEPP and with TLS security with the 3gpp-Sbi-Target-apiRoot header used over N32f.....	90
C.2.2	When https URI scheme is used	91
C.2.2.1	General.....	91
C.2.2.2	With TLS protection between NF and SEPP relying on telescopic FQDN, and TLS security without the 3gpp-Sbi-Target-apiRoot header used over N32f	91
C.2.2.3	With TLS protection between NF and SEPP relying on 3gpp-Sbi-Target-apiRoot header, and TLS security without the 3gpp-Sbi-Target-apiRoot header used over N32f	95
C.2.2.4	With TLS protection between NF and SEPP relying on telescopic FQDN, and TLS security with the 3gpp-Sbi-Target-apiRoot header used over N32f.....	98
C.2.2.5	With TLS protection between NF and SEPP relying on 3gpp-Sbi-Target-apiRoot header, and TLS security with the 3gpp-Sbi-Target-apiRoot header used over N32f.....	101
C.3	Application Layer Security between SEPPs.....	103
C.3.1	When http URI scheme is used	103
C.3.2	When https URI scheme is used	105
C.3.2.1	General.....	105
C.3.2.2	With TLS protection between NF and SEPP relying on telescopic FQDN	106
C.3.2.3	With TLS protection between NF and SEPP relying on 3gpp-Sbi-Target-apiRoot header	109
Annex D (informative):	Withdrawn API versions.....	112
D.1	General	112
D.2	N32 Handshake API.....	112
Annex E (informative):	Change history	113
History		116

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- might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

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1 Scope

The present document specifies the stage 3 protocol and data model for the PLMN and/or SNPN interconnection Interface. It provides stage 3 protocol definitions and message flows, and specifies the APIs for the procedures on the PLMN interconnection interface (i.e N32).

The 5G System stage 2 architecture and procedures are specified in 3GPP TS 23.501 [2] and 3GPP TS 23.502 [3].

The Technical Realization of the Service Based Architecture and the Principles and Guidelines for Services Definition are specified in 3GPP TS 29.500 [4] and 3GPP TS 29.501 [5].

The stage 2 level N32 procedures are specified in 3GPP TS 33.501 [6].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".
- [4] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".
- [5] 3GPP TS 29.501: "5G System; Principles and Guidelines for Services Definition; Stage 3".
- [6] 3GPP TS 33.501: "Security architecture and procedures for 5G system".
- [7] IETF RFC 7540: "Hypertext Transfer Protocol Version 2 (HTTP/2)".
- [8] IETF RFC 8259: "The JavaScript Object Notation (JSON) Data Interchange Format".
- [9] IETF RFC 7231: "Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content".
- [10] IETF RFC 7230: "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing".
- [11] IETF RFC 793: "Transmission Control Protocol".
- [12] 3GPP TS 29.571: "5G System; Common Data Types for Service Based Interfaces Stage 3".
- [13] IETF RFC 7518: "JSON Web Algorithms (JWA)".
- [14] IETF RFC 7516: "JSON Web Encryption (JWE)".
- [15] IETF RFC 4648: "The Base16, Base32, and Base64 Data Encodings".
- [16] IETF RFC 7515: "JSON Web Signature (JWS)".
- [17] IETF RFC 6901: "JavaScript Object Notation (JSON) Pointer".
- [18] 3GPP TS 29.510: "Network Function Repository Services; Stage 3".
- [19] 3GPP TS 23.003: "Numbering, addressing and identification".

- [20] 3GPP TR 21.900: "Technical Specification Group working methods".
- [21] IETF RFC 7468: "Textual Encodings of PKIX, PKCS, and CMS Structures".
- [22] IETF RFC 7807: "Problem Details for HTTP APIs".
- [23] IETF RFC 1952: "GZIP file format specification version 4.3".
- [24] IETF RFC 7694: "Hypertext Transfer Protocol (HTTP) Client-Initiated Content-Encoding".
- [25] 3GPP TS 29.518: "5G System; Access and Mobility Management Service; Stage 3".
- [26] 3GPP TS 29.503: "5G System; Unified Data Management Services; Stage 3".
- [27] OpenAPI: "OpenAPI Specification Version 3.0.0", <https://spec.openapis.org/oas/v3.0.0>.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

c-SEPP: The SEPP that is present on the NF service consumer side is called the c-SEPP.

p-SEPP: The SEPP that is present on the NF service producer side is called the p-SEPP.

NOTE: For the purpose of N32-c procedures, the two interacting SEPPs are called "initiating" SEPP and "responding" SEPP. The c-SEPP and p-SEPP terminology is not used in this specification though it is used in 3GPP TS 33.501 [6].

c-IPX: The IPX on the NF service consumer side.

p-IPX: The IPX of the NF service producer side.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

GZIP	GNU ZIP
IPX	IP Exchange Service
JOSE	Javascript Object Signing and Encryption
JWE	JSON Web Encryption
JWS	JSON Web Signature
PRINS	PRotocol for N32 INterconnect Security
SEPP	Security and Edge Protection Proxy
TLS	Transport Layer Security
UPU	UE Parameters Update

4 General Description

4.1 Introduction

This clause provides a general description of the interconnect interfaces used between the PLMNs and/or SNPNs for transporting the service based interface message exchanges.

4.2 N32 Interface

4.2.1 General

The N32 interface is used between SEPPs of different PLMNs for both roaming and PLMN interconnect scenarios.

The N32 interface may also be used between SEPPs from an SNPN and another SNPN or PLMN, for SNPN interconnect scenarios (e.g. for SNPN connectivity with a Credentials Holder network, see clause 5.30.2.9.3 of 3GPP TS 23.501 [2]). Unless specified otherwise, references to "PLMN" throughout this specification shall be substituted by "SNPN" for a SEPP that is deployed in an SNPN.

The SEPP that is on the NF service consumer side is called the c-SEPP and the SEPP that is on the NF service producer side is called the p-SEPP. The NF service consumer or SCP may be configured with the c-SEPP or discover the c-SEPP by querying the NRF. The NF service producer or SCP may be configured with the p-SEPP or discover the p-SEPP by querying the NRF.

The N32 interface can be logically considered as 2 separate interfaces as given below.

- N32-c, a control plane interface between the SEPPs for performing initial handshake and negotiating the parameters to be applied for the actual N32 message forwarding.
- N32-f, a forwarding interface between the SEPPs which is used for forwarding the communication between the NF service consumer and the NF service producer after applying application level security protection.

4.2.2 N32-c Interface

The following figure shows the scope of the N32-c interface.

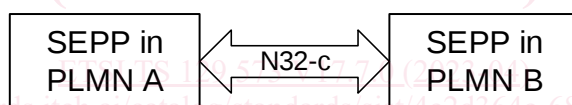


Figure 4.2.2-1: N32-c Interface

The N32-c interface provides the following functionalities:

- Initial handshake procedure between the SEPP in PLMN A (called the initiating SEPP) and the SEPP in PLMN B (called the responding SEPP), that involves capability negotiation and parameter exchange as specified in 3GPP TS 33.501 [6].

4.2.3 N32-f Interface

The following figure shows the scope of the N32-f interface.

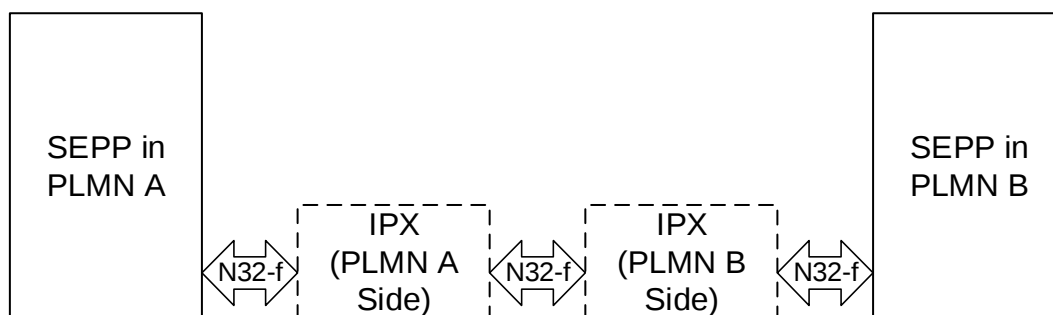


Figure 4.2.3-1: N32-f Interface

The N32-f interface shall be used to forward the HTTP/2 messages of the NF service producers and the NF service consumers in different PLMN, through the SEPPs of the respective PLMN. The application layer security protection functionality of the N32-f is used only if the PProtocol for N32 INTERconnect Security (PRINS) is negotiated between the SEPPs using N32-c.

The N32-f interface provides the following application layer security protection functionalities:

- Message protection of the information exchanged between the NF service consumer and the NF service producer across PLMNs by applying application layer security mechanisms as specified in 3GPP TS 33.501 [6].
- Forwarding of the application layer protected message from a SEPP in one PLMN to a SEPP in another PLMN. Such forwarding may involve IPX providers on path.
- If IPX providers are on the path from SEPP in PLMN A to SEPP in PLMN B, the forwarding on the N32-f interface may involve the insertion of content modification instructions which the receiving SEPP applies after verifying the integrity of such modification instructions.

If TLS is the negotiated security policy between the SEPP, then the N32-f shall involve only the forwarding of the HTTP/2 messages of the NF service producers and the NF service consumers without any reformatting at the SEPPs and/or the IPXs.

4.3 Protocol Stack

4.3.1 General

The protocol stack for the N32 interface is shown below in Figure 4.3.1-1.

Application (PRINS may be used for security)
HTTP/2
TLS (Conditional)
TCP
IP
L2
L1

Figure 4.3.1-1: N32 Protocol Stack

The N32 interfaces (N32-c and N32-f) use HTTP/2 protocol (see clause 4.2.2 and 4.2.3, respectively) with JSON (see clause 4.2.4) as the application layer serialization protocol. For the security protection at the transport layer, the SEPPs shall support TLS as specified in clause 13.1.2 of 3GPP TS 33.501 [6].

For the N32-f interface, the application layer (i.e the JSON payload) encapsulates the complete HTTP/2 message between the NF service consumer and the NF service producer, by transforming the HTTP/2 headers and the body into specific JSON attributes as specified in clause 6.2. For the scenarios when there are IPX entities between SEPPs, see clause 4.3.2 for TLS/PRINS usage.

4.3.2 HTTP/2 Protocol

4.3.2.1 General

HTTP/2 as described in IETF RFC 7540 [7] shall be used for N32 interface.

4.3.2.2 HTTP standard headers

The HTTP request standard headers and the HTTP response standard headers that shall be supported on the N32 interface are defined in Table 4.2.2.2-1 and in Table 4.2.2.2-2 respectively.

Table 4.3.2.2-1: Mandatory to support HTTP request standard headers

Name	Reference	Description
Accept	IETF RFC 7231 [9]	This header is used to specify response media types that are acceptable.
Accept-Encoding	IETF RFC 7231 [9]	This header may be used to indicate what response content-encodings (e.g gzip) are acceptable in the response.
Content-Length	IETF RFC 7230 [10]	This header is used to provide the anticipated size, as a decimal number of octets, for a potential payload body.
Content-Type	IETF RFC 7231 [9]	This header is used to indicate the media type of the associated representation.
Via	IETF RFC 7230 [10]	This header is used to indicate the intermediate proxies in the service request path. Please refer to clause 6.10.8 of 3GPP TS 29.500 [4] for encoding of the via header

Table 4.3.2.2-2: Mandatory to support HTTP response standard headers

Name	Reference	Description
Content-Length	IETF RFC 7230 [10]	This header may be used to provide the anticipated size, as a decimal number of octets, for a potential payload body.
Content-Type	IETF RFC 7231 [9]	This header shall be used to indicate the media type of the associated representation.
Content-Encoding	IETF RFC 7231 [9]	This header may be used in some responses to indicate to the HTTP/2 client the content encodings (e.g gzip) applied to the response body beyond those inherent in the media type.
Via	IETF RFC 7230 [10]	This header is used to indicate the intermediate proxies in the service response path. Please refer to clause 6.10.8 of 3GPP TS 29.500 [4] for encoding of the via header.
Server	IETF RFC 7231 [9]	This header is used to indicate the originator of an HTTP error response.

4.3.2.3 HTTP custom headers

The HTTP custom headers specified in clause 5.2.3 of 3GPP TS 29.500 [4] shall be supported on the N32 interface.

4.3.2.4 HTTP/2 connection management

Each SEPP initiates HTTP/2 connections towards its peer SEPP for the following purposes

- N32-c interface
- N32-f interface

The scope of the HTTP/2 connection used for the N32-c interface is short-lived. Once the initial handshake is completed the connection is torn down as specified in 3GPP TS 33.501 [6]. The HTTP/2 connection used for N32-c is end to end between the SEPPs and does not involve an IPX to intercept the HTTP/2 connection, though an IPX may be involved for IP level routing.

The scope of the HTTP/2 connection used for the N32-f interface is long-lived. The N32-f HTTP/2 connection at a SEPP can be:

- Case A: Towards a SEPP of another PLMN without involving any IPX intermediaries or involving IPX intermediaries where IPX does not require modification or observation of the information; or
- Case B: Towards a SEPP of another PLMN via IPX where IPX requires modification or observation of the information. In this case, the HTTP/2 connection from a SEPP terminates at the next hop IPX with the IPX acting as a HTTP proxy.

For the N32-f interface the HTTP/2 connection management requirements specified in clause 5.2.6 of 3GPP TS 29.500 [4] shall be applicable. The URI scheme used for the N32-f JOSE protected message forwarding API shall be "http". If confidentiality protection of all IEs for the N32-f JOSE protected message forwarding procedure is required, then:

- For case A, the security between the SEPPs shall be ensured by means of an IPSec or TLS connection;
- For case B, hop-by-hop security between the SEPP and the IPXs should be established on N32-f. This hop-by-hop security shall be established using an IPSec or TLS connection.

4.3.3 Transport Protocol

The Transmission Control Protocol as described in IETF RFC 793 [11] shall be used as transport protocol as required by HTTP/2 (see IETF RFC 7540 [7]).

When there is no IPX between the SEPPs or IPX(s) are offering only IP routing service without modification or observation of the content, TLS shall be used for security protection (see clause 13.1.2 of 3GPP TS 33.501 [6]). When there is IPX between the SEPPs and IPX requires modification or observation of the content, TLS or NDS/IP should be used for security protection as specified in clause 13.1.2 of 3GPP TS 33.501 [6].

NOTE: When using TCP as the transport protocol, an HTTP/2 connection is mapped to a TCP connection.

4.3.4 Serialization Protocol

The JavaScript Object Notation (JSON) format as described in IETF RFC 8259 [8] shall be used as the serialization protocol.

5 N32 Procedures

5.1 Introduction

The procedures on the N32 interface are split into two categories:

- Procedures that happen end to end between the SEPPs on the N32-c interface;
- Procedures that are used for the forwarding of messages on the service based interface between the NF service consumer and the NF service producer via the SEPP across the N32-f interface.

Table 5.1-1 summarizes the corresponding APIs defined for this specification.