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Recommendation

ITU-T Q.5006 (07/2023)

SERIES Q: Switching and signalling, and associated measurements and tests

Signalling requirements and protocols for IMT-2020 – Signalling requirements and architecture of IMT-2020

Signalling requirements for hierarchical network slicing service

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Recommendation ITU-T Q.5006

Signalling requirements for hierarchical network slicing service

Summary

Recommendation ITU-T Q.5006 specifies the signalling requirements for hierarchical network slicing services. This signalling is used for hierarchically and automatically slicing the network for the customers and their applications.

History [*]

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T Q.5006	2023-07-14	11	11.1002/1000/15586

Keywords

Hierarchical network slicing, signalling requirements.

[*] To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

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Recommendation ITU-T Q.5006

Signalling requirements for hierarchical network slicing service

1 Scope

The scope of this Recommendation consists of:

– Overview for hierarchical network slicing service;

– Framework for hierarchical network slicing service;

– Interfaces reference model for hierarchical network slicing service;

– Signalling procedures for hierarchical network slicing service;

– Signalling requirements for interfaces.

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.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 network slice [b-ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 hierarchical network slicing: A layering logical networking technology that hierarchically provides specific network capabilities and network characteristics.

3.2.2 slice controller: A component (virtual or physical) provides the capabilities of generating, allocating, and managing network slice and sub-network slice.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

SIG Slice ID Generation

SPG Slice Path Generation

SRC Slice Resource Calculation

SRDA Slice Resource Demand Acquisition

S-SIG Sub-Slice ID Generation

S-SPG Sub-Slice Path Generation

S-SRC Sub-Slice Resource Calculation

S-SRDA Sub-slice Resource Demand Acquisition

TC Topology Collection

5 Conventions

{A}: indicates that the parameter A is mandatory.

6 Overview for hierarchical network slicing service

Different from the IMT-2020 use cases described in [b-ITU-T Y.3103], Figure 6-1 depicts the hierarchical network slicing scenario in a broadband network.

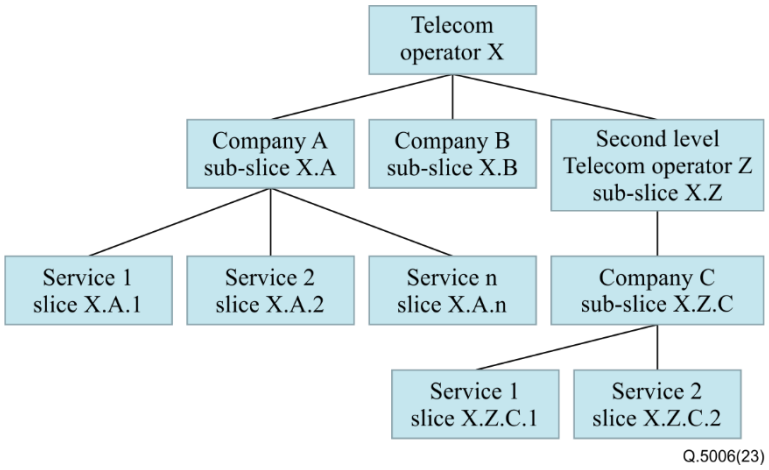

Figure 6-1 – A hierarchical network slicing scenario in a broadband network

The broadband network operator X is the first level broadband network operator. Customer A, customer B and the second level broadband network operator Z subscribe the sub-network slices X.A, X.B and X.Z from the broadband network operator X. Customer A further slices the X.A into sub-slices X.A.1, X.A.2 until X.A.n for multiple different services. Customer C subscribes network slice X.Z.C from network operator Z. Customer C further slices the X.Z.C.1 and X.Z.C.2 for two different services.

The depth of the hierarchical network slice is ranged from 1 to n. The framework and the interface reference model of any depth of the hierarchical network slicing services is similar to the network slicing service of depth 2.

7 Framework for a hierarchical network slicing service

7.1 General framework for a hierarchical network slicing service

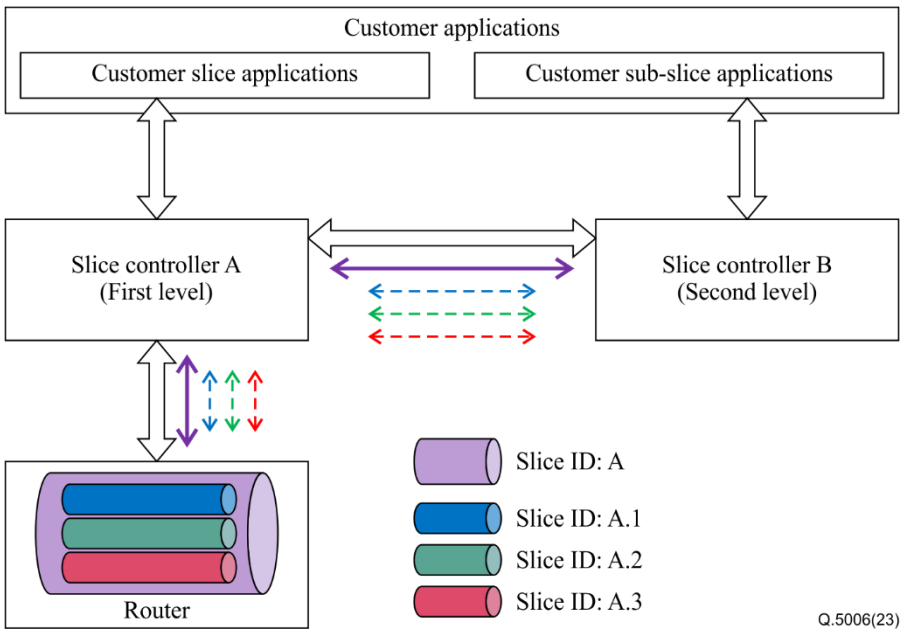

Figure 7-1 – General framework of a hierarchical network slicing service

As shown in Figure 7-1, the hierarchical network slicing service is fulfilled by the components, including customer slice applications component, customer sub-slice applications component, first level slice controller component, second level slice controller component, and router component cooperatively.

The hierarchical network slicing service is implemented in five phases as follows:

1) Phase 1: Network resource obtaining;
2) Phase 2: Customer slice application registration;
3) Phase 3: Customer slice application service deployment;
4) Phase 4: Customer sub-slice application registration;
5) Phase 5: Customer sub-slice application service deployment.

The customer slice applications component and the first level controller component are responsible for creating a specific network slice through phase 1, phase 2 and phase 3.

The customer sub-slice applications component, the first level controller component and the second level controller component are responsible for creating a specific sub-network slice through phase 1, phase 4 and phase 5.

The signalling procedure for these five phases is illustrated in clause 9.

The examples for creating network slice and sub-network slice are illustrated as follows:

Network slice creation example

A customer slice application registers itself to the first level slice controller component. The first level slice controller component creates the customer's ID (for example A). The customer rents a network slice (colour="purple") from the network operator by sending the service request, involving the resource demand to the first level slice controller component. The first level slice controller component calculates the network configuration parameters based on the slice resource demands and the current network resource, and then allocates the configurations to the routers.

Sub-network slice creation example

A customer sub-slice application registers itself to the second level slice controller component. The second level slice controller component creates the application's ID (for example A.1). The application rents a sub-network slice (colour="blue") from the customer by sending the service request, involving the sub-slice resource demand to the second level slice controller component. The first level slice controller component calculates the sub-network configuration parameters based on the sub-slice resource demand and the current network resourceand it then allocates the configurations to the slice A.1. The sub-slice A.2 (colour="green") and A.3 (colour="red") are created in the same way.

7.2 Components functions for hierarchical network slicing service

7.2.1 Functions for first level slice controller

The first level slice controller component includes the functions i.e., ID generation (IG), path generation (PG), topology collection (TC), T1-SDAC, SRDA, SPG, and SIG-relay as shown in Figure 7-2.

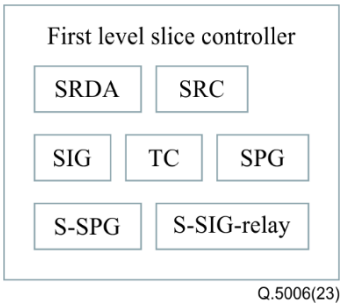

Figure 7-2 – Functions for the first level slice controller

The detailed description of each function for the first level slice controller component is as below.

1) Slice ID generation (SIG) is responsible for generating the slice ID for the purpose of customer slice application registration.
2) Slice path generation (SPG) is responsible for allocating the slice transmission path according to related slice resource demand.
3) Sub-slice path generation (S-SPG) is responsible for allocating the sub-slice transmission path according to related sub-slice resource demand.
4) Topology collection (TC) is responsible for collecting the network topology and network slice / sub-slice topology from the routers.
5) Slice resource demand acquisition (SRDA) is responsible for receiving slice resource demand from customers.
6) Slice resource calculation (SRC) is responsible for:
   – obtaining the network resource from the TC;
   – calculating the transmission paths and their related resources for the slice and sub-slice in order to satisfy their resource demand. In the calculating stage, SRC updates the transmission paths and its related resources for the dedicated slice by gathering several sub-slice resource demands of the related sub-slice received from S-SRC (described in clause 7.2.2);
   – sending the remaining slice resource, the calculated sub-slice resource, and the available transmission paths for the sub-slice to the S-SRC.
7) SIG-relay is responsible for relaying the S-SIG (described in clause 7.2.2) information.

7.2.2 Functions for second level slice controller

The second level slice controller includes the functions i.e., slice ID generation (S-SIG), sub-slice resource demand acquisition (S-SRDA) and sub-slice resource calculation (S-SRC).

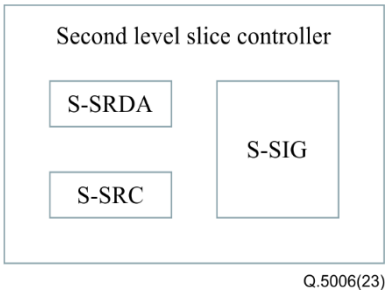

Figure 7-3 – Functions for the second level slice controller

The detailed description of each function of the second level slice controller is as below.

1) Sub-slice ID generation (S-SIG) is responsible for generating the sub-slice ID for the purpose of customer sub-slice application registration.

2) Sub-slice resource demand acquisition (S-SRDA) is responsible for acquiring sub-slice resource demand from the customer sub-slice applications component.

3) Sub-slice resource calculation (S-SRC) is responsible for:

   – Calculating the required sub-slice resource based on its demand and available transmission path for this sub-slice and sending the calculating results to the SRC.

   NOTE – How the SRC and S-SRC calculate the sub-slice resource according to the sub-slice resource demand is out of the scope of this Recommendation.

   – Receiving the sub-slice resource and available transmission path is calculated by SRC.

8 Interface reference model

8.1 Reference points description

The reference points for the hierarchical network slicing service are shown in Figure 8-1.

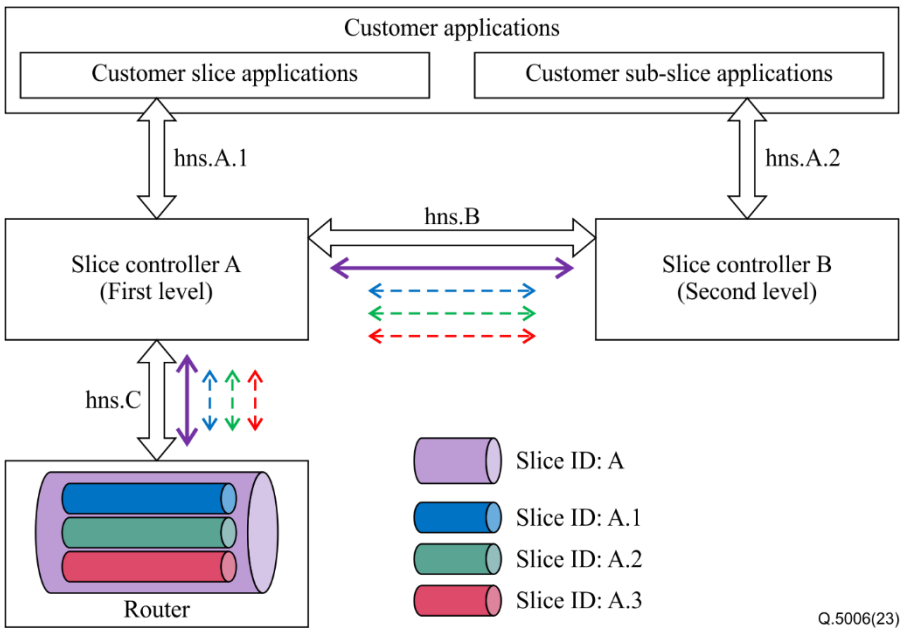

Figure 8-1 – The reference points model

The reference point hns.A.1 is responsible for exchanging messages between the first level slice controller A and the customer slice applications component to collect the customer slice applications' requests.

The reference point hns.A.2 is responsible for exchanging messages between the second level slice controller B and the customer sub-slice applications component to collect the customer sub-slice applications' requests.

The reference point hns.B is responsible for exchanging messages between the first level slice controller A and the second level slice controller B to collect the sub-slice resource demand, sub-slice ID, and send the calculation results of the resource allocated for the sub-slice.

The reference point hns.C is between the first level slice controller A and the routers to collect the forwarding resources and allocate the slice configuration information.

8.2 Interface description

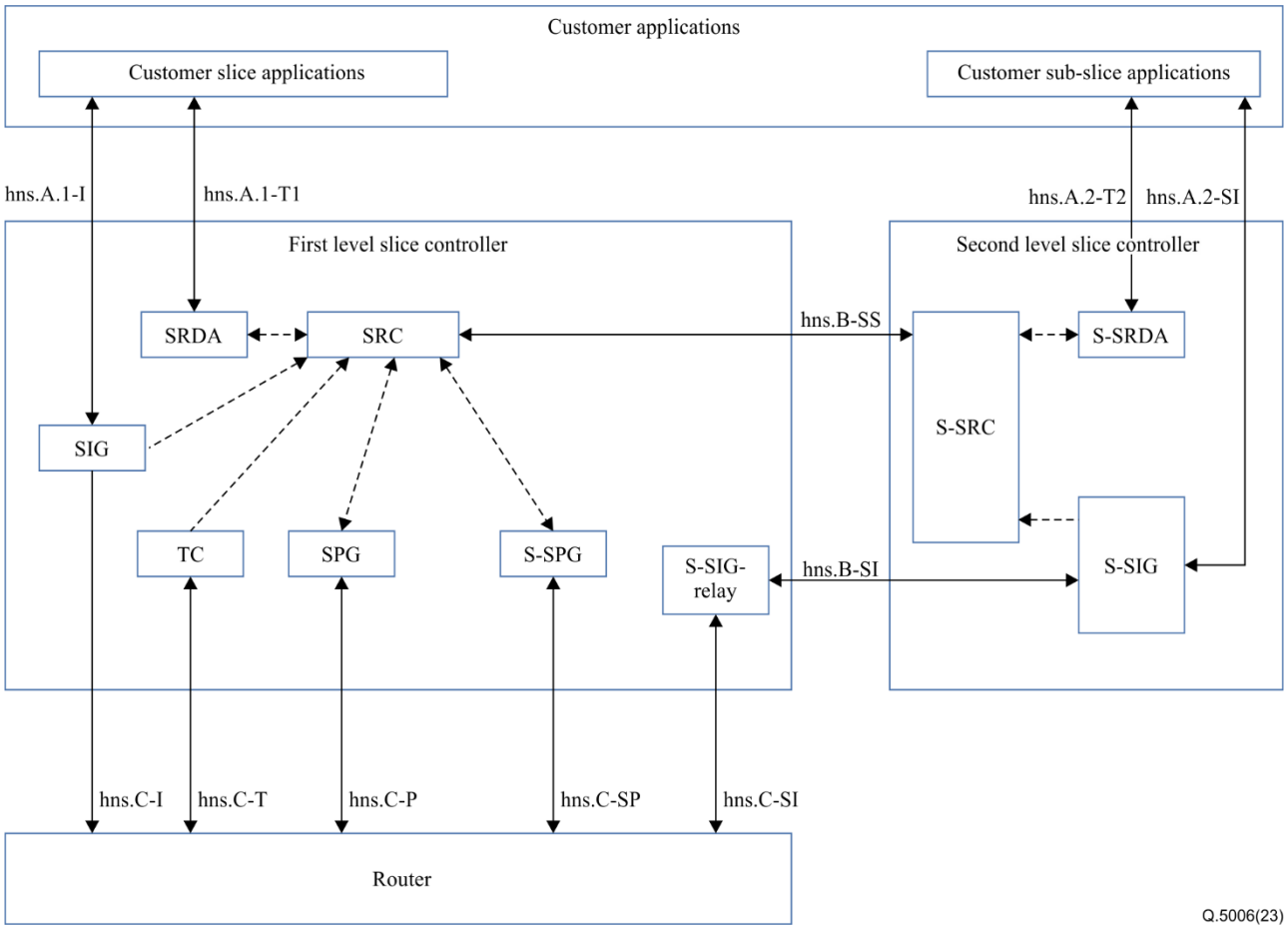

Figure 8-2 – The interfaces model

The interfaces model is shown in Figure 8-2.

The reference point hns.A.1 includes two interfaces:

1) The interface hns.A.1-I is responsible for exchanging messages between SIG and the customer slice applications component for the purpose of customer slice application registration.

2) The interface hns.A.1-T1 is responsible for exchanging messages between SRDA and the customer slice applications component for the purpose of customer slice service deployment.

The reference point hns.A.2 includes two interfaces:

1) The interface hns.A.2-SI is responsible for exchanging messages between S-SIG and the customer sub-slice applications component for the purpose of customer sub-slice application registration.

2) The interface hns.A.2-T2 is responsible for exchanging messages between S-SRDA and the customer sub-slice applications component for the purpose of customer sub-slice service deployment.

The reference point hns.B includes two interfaces:

1) The interface hns.B-SI is responsible for relaying customer sub-slice application registration information between S-SIG and S-SIG-relay.

2) The interface hns.B-SS is responsible for exchanging messages between SRC and S-SRC for the purpose of customer sub-slice service deployment.

The reference point hns.C includes the following five interfaces:

1) The interface hns.C-I is responsible for exchanging messages between SIG and the routers for the purpose of customer slice application registration.

2) The interface hns.C-T is responsible for exchanging messages between TC and the routers for the purpose of network resource obtaining.

3) The interface hns.C-P is responsible for exchanging messages between SPG and the routers for the purpose of customer slice service deployment.

4) The interface hns.C-SP is responsible for exchanging messages between S-SPG and the routers for the purpose of customer sub-slice service deployment.

5) The interface hns.C-SI is responsible for exchanging messages between S-SIG-relay and the routers for the purpose of customer sub-slice application registration.

9 Signalling procedures of hierarchical network slicing service

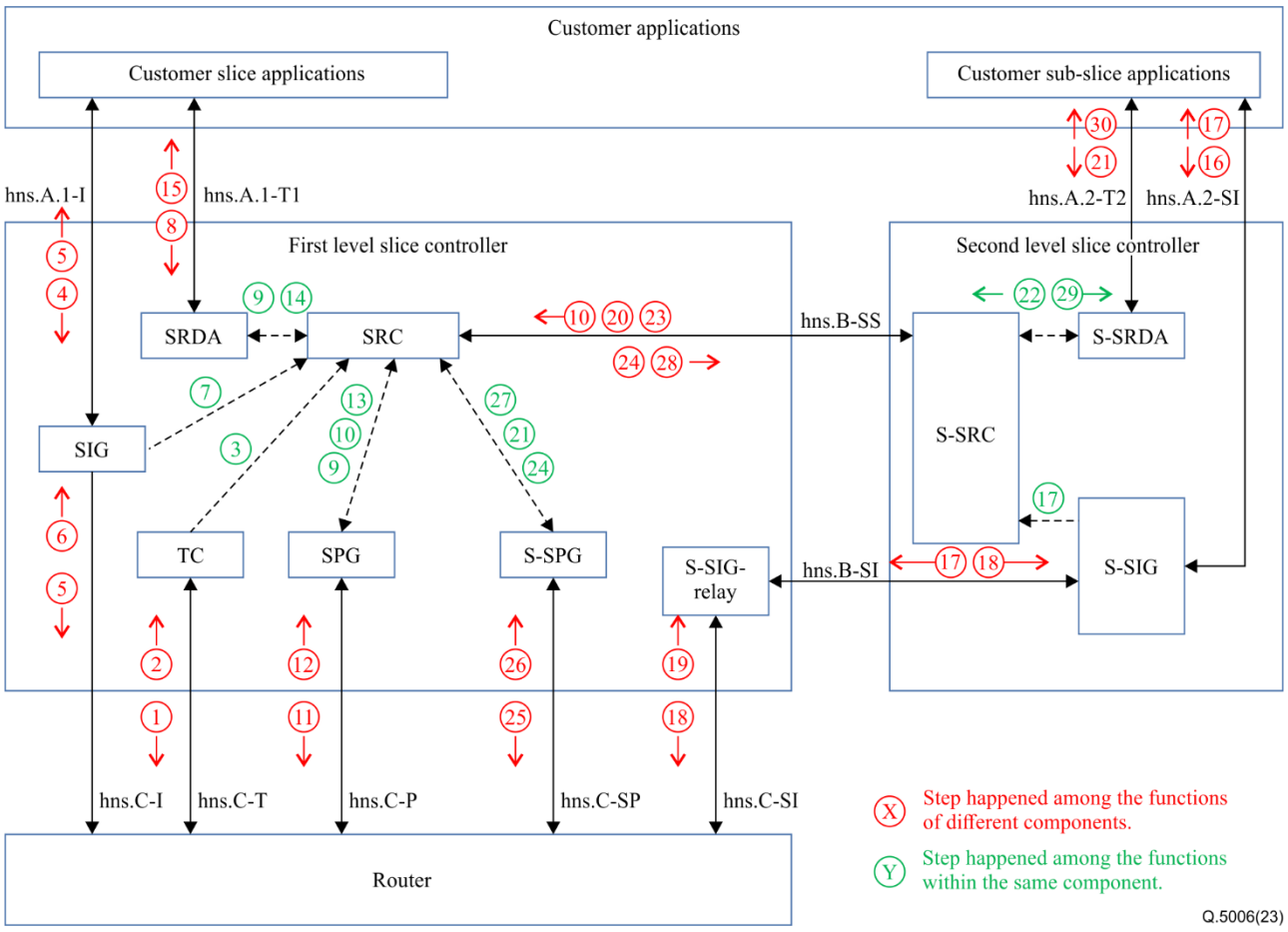

Figure 9-1 – Signalling procedures of hierarchical network slicing service

The signalling procedures of hierarchical network slicing service are shown in Figure 9-1.

9.1 Phase 1: Network resource obtaining

Step 1: TC requests the network resource information from the routers through interface hns.C-T;

Step 2: The routers respond their resource and topology information to the TC or actively uploads the information in a scheduled frequency to the TC through interface hns.C-T;

Step 3: The TC sends the resources and the topology information of the routers to the SRC.

9.2 Phase 2: Customer slice application registration

Step 4: Customer slice applications component sends a registration request to the SIG through interface hns.A.1-I;

Step 5: SIG generates the slice ID (for example slice ID=A) and sends it to the customer slice application component through interface hns.A.1-I and to the routers through interface hns.C-I;

Step 6: The routers acknowledge that the slice ID has been received through interface hns.C-I;

Step 7: SIG sends the slice ID to the SRC.

9.3 Phase 3: Customer slice application service deployment

Step 8: Customer slice applications component sends the slice service request to the SRDA in the form of the resource demand with slice ID through interface hns.A.1-T1;

Step 9: SRDA relays the resource demand to the SRC with slice ID;

Step 10: Based on the current forwarding resources, topology information, slice ID and slice resource demand, SRC figures out the available transmission path. SRC sends the available transmission path, slice resource demand with slice ID to the SPG and the S-SRC (through the interface hns.B-SS).

Step 11: SPG constructs the network configuration parameters based on the available transmission path and the related slice resource demand and then sends them to the routers with slice ID through interface hns.C-P;

Step 12: The routers acknowledge that the network configuration parameters are received and the related slice resources are deployed through interface hns.C-P;

Step 13: SPG informs the SRC slice service deployment is complete;

Step 14: SRC informs the SRDA the slice service deployment is complete;

Step 15: SRDA informs the customer slice applications component that the slice service deployment is complete through interface hns.A.1-T1.

9.4 Phase 4: Customer sub-slice application registration

Step 16: The customer sub-slice application component sends a registration request to the S-SIG through interface hns.A.2-SI;

Step 17: S-SIG generates the sub-slice ID (for example slice ID=A.1) and sends it to the customer sub-slice applications component through interface hns.A.2-SI, the S-SRC and the S-SIG-relay (through interface hns.B-SI);

Step 18: S-SIG-relay sends the sub-slice ID to the routers through interface hns.C-SI;

Step 19: The routers acknowledge that the sub-slice ID is received;

Step 20: S-SRC sends the sub-slice ID to the SRC through the interface hns.B-SS.

9.5 Phase 5: Customer sub-slice application service deployment

Step 21: Customer sub-slice application component sends the sub-slice service request to the S-SRDA in the form of the resource demand through interface hns.A.2-T2;

Step 22: S-SRDA sends sub-slice resource demand to the S-SRC;

Step 23: Based on the current available slice resource and sub-slice resource demand, S-SRC figures out the initially available transmission path and other related resource of the sub-slice and then sends them to the SRC with sub-slice ID through interface hns.B-SS;

Step 24: Based on the current available slice resource, the available transmission path of the dedicated slice and sub-slice's initial resource and the transmission path calculated by the S-SRC, SRC acts as below:

1) Calculating and confirming transmission path and another related resource of sub-slice and sends them to the S-SPG and S-SRC through interface hns.B-SS.

2) Sending the current available slice resource to the multiple S-SRC through interface hns.B-SS.

Step 25: S-SPG constructs the network configuration parameters based on the sub-slice transmission path with sub-slice ID, and then sends them to the routers through interface hns.C-SP;

Step 26: The routers acknowledge that the network configuration is complete;

Step 27: S-SPG informs the SRC that the sub-slice service deployment is complete;

Step 28: SRC sends the result of service deployment to S-SRC through the interface hns.B-SS;

Step 29: S-SRC sends the result of service deployment to the S-SRDA;

Step 30: S-SRDA informs the results of the service deployment to the customer sub-slice applications component through interface hns.A.2-T2.

10 Signalling requirements of interfaces

10.1 Overview

The signalling messages are exchanged over various interfaces for hierarchical network slicing services. The signalling messages may be extensible markup language (XML)-based messages over (or carried by) transmission control protocol (TCP), user datagram protocol (UDP), stream control transmission protocol (SCTP), transport layer security (TLS), etc. All of the messages consist of the message header and the message body.

The message format is described in Figure 10-1.

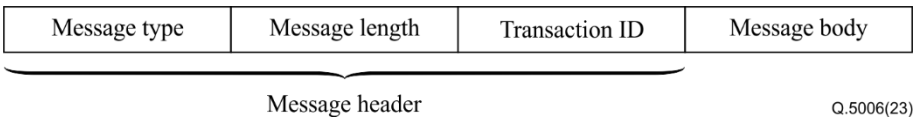

Figure 10-1 – Message composition

The message header field contains the following information:

– Message type: uniquely specifies the type of message;

– Message length: specifies the length of the message body;

– Message transaction ID: generated by the sender of the message. If there is a response message for the request message, the transaction IDs of the request and response messages are the same;

– The message body field contains the message contents which are described below based on the different types of interfaces.

Table 10-1 – Relationships among interfaces, messages and steps

Interface	Message	Step
hns.A.1-I	CR-Request	4
	CR-Response	5

Table 10-1 – Relationships among interfaces, messages and steps

Interface	Message	Step
hns.A.1-T1	T1S-Request	8
	T1S-Response	15
hns.A.2-T2	CA-Request	21
	CA-Response	30
hns.A.2-SI	T2S-Request	16
	T2S-Response	17
hns.B-SI	SID-relay	17
	SID-relay-ACK	18
hns.B-SS	SS-Request	10, 20, 23
	SS-Response	24, 28
hns.C-I	CI-Allocation	5
	CI-Allocation-ACK	6
hns.C-T	NR-Request	1
	NR-Response	2
hns.C-P	P-allocation	11
	P-allocation-ACK	12
hns.C-SI	SID-allocation	18
	SID-allocation- ACK	19
hns.C-SP	SP-allocation	25
	SP-allocation-ACK	26

Table 10-1 gives the relationships mapping among interfaces, messages and the related steps of the signalling procedures specified in clause 9.

10.2 Signalling requirements of interface hns.A.1-I

The customer slice application registration request message is defined as the CR-Request message.

The CR-Request message, indicated by the message type in the message header field, is sent by the customer slice applications component to the SIG in order to register the customer slice application and generates the slice ID for them.

Message format:

```
< CR-Request-Message > ::= < Message Header >
    { Customer-Slice-Application-Name }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1 `Customer-Slice-Application-Name` uniquely specifies the customer slice application's name.

The CR-Response message, indicated by the message type in the message header field, is sent by the SIG to the customer slice applications component in order to acknowledge the dedicated slice ID.

Message format:

```
< CR- Response-Message > ::= < Message Header >
    { Customer-Slice-Application-Name }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Customer-Slice-Application-Name` uniquely specifies the customer slice application's name.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.3 Signalling requirements for interface hns.A.1-T1

The customer's slice service request message is defined as the T1S-Request message.

The T1S-Request message, indicated by the message type in the message header field, is sent by the customer slice applications component to the SRDA in order to send the customer's slice application resource demand to the first level controller.

Message format:

```
< T1S-Request-Message > ::= < Message Header >
    {Resource-Demand }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Resource-Demand` uniquely specifies the resource demand of the customer slice applications.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application. The customer's slice service response message is defined as the T1S-Response message.

The T1S-Response message, indicated by the message type in the message header field, is sent by the SRDA to the customer slice applications component in order to acknowledge the service demand to the customer. Message format:

```
< T1S-Response -Message > ::= < Message Header >
    { Slice-Service-Deployment-Completion }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Slice-Service-Deployment-Completion` uniquely specifies that the service deployment is complete for the customer-slice-applications.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.4 Signalling requirements of interface hns.A.2-SI

The customer sub-slice application registration request message is defined as the CA-Request message.

The CA-Request message, indicated by the message type in the message header field, is sent by the customer sub-slice applications component to the S-SIG in order to register the customer sub-slice applications and generates a sub-slice ID for them.

Message format:

```
< CA-Request-Message > ::= < Message Header >
    { Customer-Sub-Slice-Application-Name }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Customer-Sub-Slice-Application-Name` uniquely specifies the customer sub-slice application's name.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application and is obtained from customer slice applications component.

The CA-Response message, indicated by the message type in the message header field, is sent by the S-SIG to the customer sub-slice applications component in order to acknowledge the dedicated sub-slice ID.

Message format:

```
< SID- Response -Message > ::= < Message Header >
    { Customer-Sub-Slice-Application-Name }
    {Sub-Slice-ID }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Customer-Sub-Slice-Application-Name` uniquely specifies the customer sub-slice application's name.
2. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.5 Signalling requirements of interface hns.A.2-T2

The customer sub-slice application service request message is defined as the T2S-Request message. The T2S-Request message, indicated by the message type in the message header field, is sent by the customer sub-slice applications component to the S-SRDA in order to send the sub-slice application's resource demand to the second level controller.

Message format:

```
< T2S-Request-Message > ::= < Message Header >
    { Resource-Demand }
    { Slice-ID }
    {Sub-Slice-ID }
```

1. `Resource-Demand` uniquely specifies the resource demand of customer sub-slice application.
2. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.

3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The customer sub-slice application service response message is defined as the T2S-Response message. The T2S-Response message, indicated by the message type in the message header field, is sent by the S-SRDA to the customer sub-slice applications component in order to acknowledge the sub-slice's resource demand.

Message format:

```
< T2S-Response-Message > ::= < Message Header >
    { Sub-Slice-Service-Deployment-Completion }
    { Slice-ID }
    { Sub-Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-Service-Deployment-Completion` uniquely specifies that the service deployment is complete for the customer sub-slice applications.
2. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.6 Signalling requirements of interface hns.B-SI

The sub-slice ID relay message is defined as the SID-relay message.

The SID-relay message, indicated by the message type in the message header field, is sent by the S-SIG to the S-SIG-relay in order to relay the sub-slice ID to the first level controller.

Message format:

```
< SID-relay-Message > ::= < Message Header >
    {Sub-Slice-ID }
    {Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The sub-slice ID relay acknowledgement message is defined as the SID-relay-ACK message.

The SID-relay-ACK message, indicated by the message type in the message header field, is sent by the S-SIG-relay to the S-SIG in order to acknowledge the relay of the sub-slice ID.

Message format:

```
< SID-relay-ACK-Message > ::= < Message Header >
    {Sub-Slice-ID }
    {Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.7 Signalling requirements of interface hns.B-SS

The resource interaction request from the sub-slice to the slice message is defined as the SS-Request message.

The SS-Request message, indicated by the message type in the message header field, is sent by the S-SRC to the SRC in order to send the sub-slice resource demand, the customer sub-slice application's transmission path to the first level controller.

Message format:

```
< SS-Request-Message > ::= < Message Header >
    { Initial-Sub-Slice-Resource }
    { Initial-Transmission-Path-Of-Sub-Slice }
    { Sub-Slice-ID }
    { Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Initial-Sub-Slice-Resource` uniquely specifies the initial sub-slice resource calculated by the S-SRC.
2. `Initial-Transmission-Path-Of-Sub-Slice` uniquely specifies the initial sub-slice transmission path.
3. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The response message for the resource interaction is defined as the SS-Response message.

The SS-Response message, indicated by the message type in the message header field, is sent by the SRC to the S-SRC in order to inform the calculated resource results of the customer sub-slice application to the second level controller.

Message format:

```
< SS-Response-Message > ::= < Message Header >
    {Remaining-Slice-Resource }
    {Calculated-Sub-Slice-Resource }
    {Calculated-Sub-Slice-transmission-path}
    {Sub-Slice-ID }
    {Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Remaining-Slice-resource` uniquely specifies the remaining resource of the slice.
2. `Calculated-Sub-Slice-Resource` uniquely specifies the sub-slice resource calculated and confirmed by the SRC.

3. `Calculated-Sub-Slice-transmission-path` uniquely specifies the sub-slice transmission path calculated and confirmed by the SRC.
4. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
5. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.8 Signalling requirements of interface hns.C-I

The customer ID allocation message is defined as the CI-Allocation message.

The CI-Allocation message, indicated by the message type in the message header field, is sent by the SIG to the routers in order to allocate the customer slice application ID to the routers.

Message format:

```
< CI-Allocation-Message > ::= < Message Header >
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Slice-ID` uniquely specifies the slice's ID for the dedicated customer slice application.

The customer ID allocation acknowledgement message is defined as the CI-Allocation-ACK message.

The CI-Allocation-ACK message, indicated by the message type in the message header field, is sent by the routers to the SIG in order to acknowledge the allocation of the customer slice application ID to the routers.

Message format:

```
< CI-Allocation-ACK-Message > ::= < Message Header >
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Slice-ID` uniquely specifies the slice's ID for the dedicated customer slice application.

10.9 Signalling requirements of interface hns.C-T

The network resource request message is defined as the NR-Request message.

The NR-Request message, indicated by the message type in the message header field, is sent by the TC to the routers in order to request the network resource.

Message format:

```
< NR-Request-Message > ::= < Message Header >
    { Network-Resource}
    { Slice-ID }
    {Sub-Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Network-Resource` uniquely specifies the available network resource of routers and topology.

2. `Sub-Slice-ID` uniquely specifies the sub-slice ID of the dedicated customer sub-slice application.

3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The network resource response message is defined as the NR-Response message.

The NR-Response message, indicated by the message type in the message header field, is sent by the routers to the TC in order to respond to the first level controller.

Message format:

```
< NR- Response-Message > ::= < Message Header >
    { Network-Resource-Information }
    { Slice-Network-Resource-Information }
    { Sub-Slice-Network-Resource-Information }
    { Slice-ID }
    {Sub-Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Network-Resource-Information` uniquely specifies the available network resource results of routers and topology.

2. `Slice-Network-Resource-Information` uniquely specifies the consumed network resource results of the slice.

3. `Sub-Slice-Network-Resource-Information` uniquely specifies the consumed network resource of the sub-slice.

4. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.

5. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.10 Signalling requirements of interface hns.C-P

The path allocation message is defined as the P-allocation message.

The P-allocation message, indicated by the message type in the message header field, is sent by the SPG to the routers in order to allocate the path in the form of network configuration parameters.

Message format:

```
< P-allocation-Message > ::= < Message Header >
    { Network-Configuration-Parameters }
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Network-Configuration-Parameters` uniquely specifies the network configuration parameters constructed by the SPG.

2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The path allocation acknowledgement message is defined as the P-allocation-ACK message.

The P-allocation-ACK message, indicated by the message type in the message header field, is sent by the routers to the SPG in order to acknowledge that the configuration for the slice is complete.

Message format:

```
< P-allocation-ACK-Message > ::= < Message Header >
    { Slice-ID }
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.11 Signalling requirements of interface hns.C-SP

The sub-slice path allocation message is defined as the SP-allocation message.

The SP-allocation message, indicated by the message type in the message header field, is sent by the S-SPG to the routers in order to allocate the sub-slice path in the form of network configuration parameters.

Message format:

```
< SP-allocation-Message > ::= < Message Header >
    {Network-Configuration-Parameters }
    {Sub-Slice-ID }
    {Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Network-Configuration-Parameters` uniquely specifies the network configuration parameters constructed by S-SPG.
2. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
3. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The sub-slice path allocation acknowledgement message is defined as the SP-allocation-ACK message.

The SP-allocation-ACK message, indicated by the message type in the message header field, is sent by the routers to the S-SPG in order to acknowledge that the configuration for the sub-slice is complete.

Message format:

```
< SP-allocation-ACK-Message > ::= < Message Header >
    {Sub-Slice-ID }
    {Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

10.12 Signalling requirements of interface hns.C-SI

The customer sub-slice application's ID allocation message is defined as the SID-allocation message.

The SID-allocation message, indicated by the message type in the message header field, is sent by the S-SIG-relay to the router in order to allocate the application ID to the router.

Message format:

```
< SID-allocation-Message > ::= < Message Header >
    {Sub-Slice-ID }
    {Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

The customer sub-slice application's ID allocation acknowledgement message is defined as the SID-allocation-ACK message.

The SID-allocation-ACK message, indicated by the message type in the message header field, is sent by the router to the S-SIG-relay in order to acknowledge the sub-slice ID for the dedicated customer sub-slice application is received.

Message format:

```
< SID-allocation-ACK-Message > ::= < Message Header >
    {Sub-Slice-ID }
    {Slice-ID}
```

Meanings and explanations:

The detailed information indicates but is not limited to:

1. `Sub-Slice-ID` uniquely specifies the sub-slice ID for the dedicated customer sub-slice application.
2. `Slice-ID` uniquely specifies the slice ID for the dedicated customer slice application.

Bibliography

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Published in Switzerland
Geneva, 2023