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SERIES Q: SWITCHING AND SIGNALLING, AND
ASSOCIATED MEASUREMENTS AND TESTS

Signalling requirements and protocols for the NGN –
Network signalling and control functional architecture

**Signalling architecture for virtualization of
control network entities**

Recommendation ITU-T Q.3054

ITU-T



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Recommendation ITU-T Q.3054

Signalling architecture for virtualization of control network entities

Summary

Recommendation ITU-T Q.3054 provides a functional architecture for virtualization of control network entities. Based on the functional architecture of virtualization of control network entities, it specifies the signalling requirements for interfaces supporting the reference points in the architecture. The Recommendation defines the protocols used for interfaces and also provides security considerations.

History

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Recommendation ITU-T Q.3054

Signalling architecture for virtualization of control network entities

1 Scope

This Recommendation provides a functional architecture for the virtualization of control network entities (VCN). In accordance with the functional architecture of VCN, it specifies the signalling requirements for interfaces supporting the reference points in the VCN architecture. It defines the protocols used for interfaces, and provides security considerations.

Appendices I and II provide message format and message examples, respectively, for interfaces supporting the reference point V(or-vim).

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.2320] Recommendation ITU-T Y.2320 (2015), *Requirements for Virtualization of control network entities in next generation network evolution.*
- [ITU-T Y.2321] Recommendation ITU-T Y.2321 (2016), *Functional architecture for supporting virtualization of control network entities in next generation network evolution.*
- [ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1.*
- [ETSI GS NFV-IFA 005] ETSI GS NFV-IFA 005 V3.1.1 (2018), *Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vi reference point – Interface and Information Model Specification.*
- [ETSI GS NFV-IFA 006] ETSI GS NFV-IFA 006 V3.1.1 (2018), *Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Vi-Vnfm reference point – Interface and Information Model Specification.*
- [ETSI GS NFV-IFA 007] ETSI GS NFV-IFA 007 V3.1.1 (2018), *Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vnfm reference point – Interface and Information Model Specification.*
- [ETSI GS NFV-IFA 008] ETSI GS NFV-IFA 008 V3.1.1 (2018), *Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Ve-Vnfm reference point – Interface and Information Model Specification.*
- [ETSI GS NFV-IFA 013] ETSI GS NFV-IFA 013 V3.1.1 (2018), *Network Functions Virtualisation (NFV) Release 3; Management and Orchestration;*

Os-Ma-Nfvo reference point – Interface and Information Model Specification.

- [ETSI GS NFV-SOL 002] ETSI GS NFV-SOL 002 V2.5.1 (2018), *Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point.*
- [ETSI GS NFV-SOL 003] ETSI GS NFV-SOL 003 V2.5.1 (2018), *Network Function Virtualisation (NFV) Release 2; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point.*
- [ETSI GS NFV-SOL 005] ETSI GS NFV-SOL 005 V2.5.1 (2018), *Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; RESTful protocols specification for the Os-Ma-Nfvo Reference Point.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 virtualized control network entity (VCNE) [ITU-T Y.2320]: A control network entity deployed on virtualized infrastructure (i.e., across one or multiple virtual machines (VMs)).

3.1.2 virtual machine (VM) [ITU-T Y.2320]: The virtualized computation environment that behaves like a physical server.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CRLF	Carriage Return Line Feed
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol over Secure Socket Layer
IP	Internet Protocol
JSON	JavaScript Object Notation
MF	Management Function
NS	Network Service
NSD	Network Service Descriptor
RESTful	Representational State Transfer
URI	Uniform Resource Identifier
VCN	Virtualization of Control Network Entities
VCNE	Virtualized Control Network Entity
VCNM	VCN Manager
VI	Virtual Infrastructure
VIM	Virtualized Infrastructure Manager

5 Conventions

In this Recommendation:

The phrase "is recommended" indicates a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be satisfied to claim conformance to this Recommendation.

In this Recommendation and its appendixes, the word "should" sometimes appears, in which case it is to be interpreted, respectively, as the phrase "is recommended".

6 VCN functional architecture

Figure 6-1 shows the VCN functional architecture in accordance with [ITU-T Y.2321].

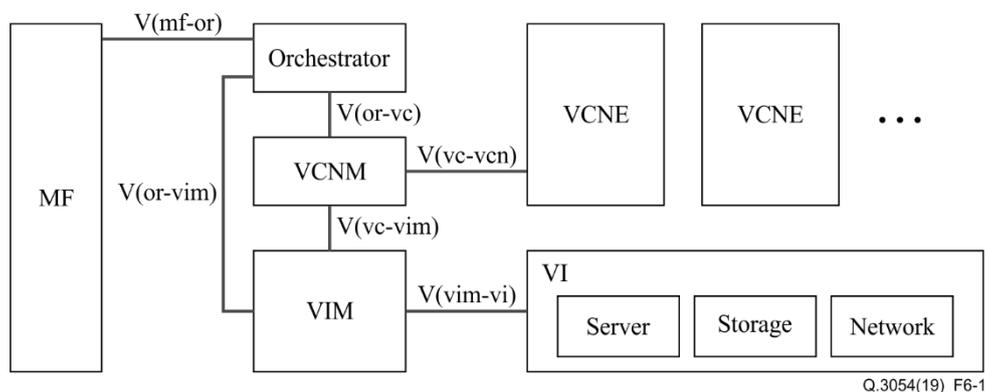


Figure 6-1 – VCN functional architecture

6.1 Functions

The functions identified in Figure 6-1 are described in detail in [ITU-T Y.2321].

6.2 Reference points

The reference points in Figure 6-1 are described in detail in [ITU-T Y.2321].

7 Signalling requirements and protocols for interfaces supporting the reference points in VCN architecture

7.1 Signalling requirements and protocols for interfaces supporting the reference point V(mf-or)

Reference point V(mf-or) allows communications of the management function (MF), and is the orchestrator for support of network service descriptor (NSD) management, network service (NS) lifecycle management and lifecycle change notification, NS performance management, NS fault management and virtualized control network entity (VCNE) package management, etc.

The signalling requirements for interfaces supporting reference point V(mf-or) refer to [ETSI GS NFV-IFA 013], which provides the procedures and information elements exchanged over these interfaces.

The protocols used for interfaces supporting V(mf-or) refer to [ETSI GS NFV-SOL 005], which specifies a set of representational state transfer (RESTful) protocol specifications and data models fulfilling the relevant signalling requirements for reference point V(mf-or).

7.2 Signalling requirements and protocols for interfaces supporting the reference point V(or-vc)

Reference point V(or-vc) allows communications between the orchestrator and VCN manager (VCNM) in support of the VCNE lifecycle management and the resource request coordinating involved in the VCNE lifecycle management, etc.

The signalling requirements for interfaces supporting reference point V(or-vc) refer to [ETSI GS NFV-IFA 007], which provides the procedures and information elements exchanged over these interfaces.

The protocols used for interfaces supporting reference point V(or-vc) refer to [ETSI GS NFV-SOL 003], which specifies a set of RESTful protocols and data models fulfilling the relevant signalling requirements for the reference point V(or-vc).

7.3 Signalling requirements and protocols for interfaces supporting the reference point V(or-vim)

The reference point V(or-vim) allows communications between the orchestrator and the virtualized infrastructure manager (VIM) in support of the VCNE package management, resources querying, resource monitoring, resource reservation management, resources performance management, virtualised network resource management, resources change notifications and resource alarm information management, etc.

The general signalling requirements for interfaces supporting reference point V(or-vim) refer to [ETSI GS NFV-IFA 005], which provides the procedures and information elements exchanged over these interfaces.

The additional signalling requirements for interfaces supporting reference point V(or-vim) for a specific operator may differ from other operators. Under this circumstance, the additional signalling requirements for interfaces supporting reference point V(or-vim) can be specified by operators in accordance with their specific requirements.

The protocols used for interfaces supporting reference point V(or-vim) can be developed by operators based on their specific signalling requirements. Appendix I provides an example of the message formats for interfaces supporting the reference point V(or-vim), and Appendix II provides message examples for interfaces supporting reference point V(or-vim), which can be referred to by operators in case of VCN deployment.

7.4 Signalling requirements and protocols for interfaces supporting the reference point V(vc-vim)

Reference point V(vc-vim) allows communications between the VCNM and VIM in support of VM management, VM network topology and routing mechanism configuration, resource status reporting, resource performance data reporting and resource configuration information reporting, etc.

The general signalling requirements for interfaces supporting reference point V(vc-vim) refer to [ETSI GS NFV-IFA 006], which provides the procedures and information elements exchanged over these interfaces.

The additional signalling requirements for interfaces supporting the reference point V(vc-vim) for a specific operator may differ from other operators. Under this circumstance, the additional signalling requirements for interfaces supporting the reference point V(vc-vim) can be specified by operators in accordance with their specific requirements.

The protocols used for interfaces supporting reference point V(vc-vim) can be developed by operators based on the specific signalling requirements. Messages can be developed according to similar formats described in Appendix I and the information flows described in [ITU-T Y.2321].

7.5 Signalling requirements and protocols for interfaces supporting the reference point V(vc-vcn)

Reference point V(vc-vcn) allows communications between VCNM and VCNE in support of VCNE lifecycle management, VCNE performance management, VCNE fault management, etc.

The signalling requirements for interfaces supporting the reference point V(vc-vcn) refer to [ETSI GS NFV-IFA 008], which provides the procedures and information elements exchanged over these interfaces.

The protocols used for interfaces supporting reference point V(vc-vcn) refer to [ETSI GS NFV-SOL 002], which specifies a set of Restful protocols fulfilling the relevant signalling requirements for the reference point V(vc-vcn).

7.6 Signalling requirements and protocols for interfaces supporting the reference point V(vim-vi)

Reference point V(vim-vi) allows communications between VIM and virtual infrastructure (VI) in support of virtual resource management, virtual machine migration, network resource configuration, physical server fault reporting and physical server resource performance reporting, etc.

The signalling requirements for interfaces supporting the reference point V(vim-vi) for a specific operator may differ from other operators. Under this circumstance, the signalling requirements for interfaces supporting reference point V(vim-vi) can be specified by operators in accordance with their specific requirements.

The protocols used for interfaces supporting the reference point V(vim-vi) can be developed by operators based on their specific signalling requirements. Messages can be developed according to similar formats described in Appendix I and the information flows described in [ITU-T Y.2321].

8 Security considerations

The security requirements for the VCN architecture should be aligned with the requirements defined in [ITU-T Y.2701]. No specific considerations for security mechanisms are required in this Recommendation.

Appendix I

Message format for interfaces supporting reference point V(or-vim)

(This appendix does not form an integral part of this Recommendation.)

I.1 General development requirements

The protocols used for interfaces supporting reference point V(or-vim) can be developed based on OpenStack with Liberty or higher versions. The messages should support RESTful, which should support username and password. The format of messages used for the interfaces can be based on JavaScript object notation (JSON), which can refer to [b-IETF RFC 8259]. The interfaces can use hypertext transfer protocol (HTTP) v1.1 as the transmission protocol, which can refer to [b-IETF RFC 7230], [b-IETF RFC 7231], [b-IETF RFC 7232], [b-IETF RFC 7233], [b-IETF RFC 7234] and [b-IETF RFC 7235]. The interfaces should be authorized by hypertext transfer protocol over secure socket layer (HTTPS).

I.2 Message formats

I.2.1 Request message

The Request message includes three parts, namely, request line, header and body. Part of the body is optional.

1) Request line

Request line consists of four parts, namely, method, request-URI, HTTP-version and carriage return line feed (CRLF).

- a) Method, which is the first part, indicates the method of request. It includes:
 - GET serves to fetch the resources indicated by request-URI.
 - POST adds data for resources indicated by request-URI.
 - PUT requests server to store a source, which is indicated by request-URI.
 - DELETE requests the server to delete a source, which is indicated by request-URI.
- b) Request-URI, which is the second part, is a uniform resource indicator.
- c) The third part, the HTTP-version refers to the version of HTTP used by request message.
- d) The last part the CRLF signifies the end of the request line.

2) Header

The request message can contain several headers, which are based on JSON and include name, colon and values.

The following are headers that can be included in the request message:

- a) Host indicates the Internet protocol (IP) and port of the machine that requests resources.
- b) Content-Type indicates the media type of the body, which should be JSON, and the character set of the response message should be UTF-8.
- c) X-Auth-Token indicates "Token_ID" fetched by the user from server when authorized.

3) Body

The body of request message is based on JSON and each line of the body includes name, colon and values.

I.2.2 Response message

The response message consists of three parts, namely, status line, header and body. Part of the body is optional.

1) Status line

The status line consists of four parts, namely, HTTP-Version, Status-Code, Reason-Phrase and CRLF.

- a) The first part is HTTP-Version, which indicates the version of the HTTP.
- b) The second part is Status-Code, which indicates the status code that server would like to response. Status code can be a number with three digits. The first digit of the status code indicates different types of response:
 - The first digit with "1" indicates that request has been accepted and handling continues.
 - The first digit with "2" indicates that request has been handled successfully.
 - The first digit with "3" indicates that request has been redirected and will be handled after more operations.
 - The first digit with "4" indicates that the request cannot be handled because of the fault which occurs in client.
 - The first digit with "5" indicates that the request cannot be handled because of the fault which occurs in server.
- c) The third part is Reason-Phrase, which indicates the description for Status-Code.

Table I.1 shows the Status-Code and Reason-Phrase, which can be used for HTTP.

Table I.1 – Status code and Reason-Phrase used for HTTP

Status-Code	Reason-Phrase
100	Continue
200	OK
201	Created
202	Accepted
204	No content
400	Bad request
401	Unauthorized
403	Forbidden
404	Not found
405	Method not allowed
406	Not acceptable
408	Time out
409	Conflict
410	Gone
412	Precondition failed
413	Over limit
500	Internal server error
501	Not implemented
503	Service unavailable

- d) The last part CRLF signifies the end of the status line.

2) Header

The headers can consist of the following:

- a) Date indicates the time for sending message [b-IETF RFC 5322].
- b) Server indicates the software information of the server that handles the request.
- c) Content-Length indicates the length of the body of the response message.
- d) Content-Type indicates the media type of the body, which should be JSON and character set of the response message should be UTF-8.

3) Body

The body of response message is based on JSON, and each line of the body includes name, colon and values.

Appendix II

Message examples for interfaces supporting the reference point V(or-vim)

(This appendix does not form an integral part of this Recommendation.)

II.1 Messages for on boarding VCNE package

Upload image(s) request and corresponding response are used for interfaces supporting the reference point V(or-vim) in the flow of on boarding VCNE package according to [ITU-T Y.2321].

Method of the Request line in Upload image(s) request can be PUT. And Request-URI of the Request line in Upload image(s) request can be "/v2/images/{image_id}/file". Table II.1 shows the parameters defined in Upload image(s) request.

Table II.1 – Parameters in upload image(s) message

Parameter	Part	Type	Description
image_id	Request-URI	string, mandatory	UUID of image
X-Auth-Token	Header	string, mandatory	Token fetched by user when login
Content-type	Header	string, mandatory	Application/octet-stream
file	Body	File, optional	Binary image file content

The following is an example of an upload image(s) message request:

```
PUT /v2/images/bc51fde1-4fdc-4c43-9ba5-c64551a6ca63/file HTTP/1.1
```

```
Content-Type: application/octet-stream
```

```
X-Auth-Token: a510524b39995c3533bf99505982e396
```

```
{
```

```
"File": "/home/app/packagemanager/uploads/cscf.iso"
```

```
}
```

The format of the corresponding response for upload image(s) request is similar to the format of the response message in clause I.2. Following is the example of a successful response for upload image(s) request:

```
x-application-context: csdp-vim-gateway:80
```

```
date: Tue, 08 May 2018 07:05:24 GMT
```

```
path: /v2/images/bc51fde1-4fdc-4c43-9ba5-c64551a6ca63/file
```

```
status: 204
```

```
status_line: "HTTP/1.1 204 \r\n"
```

II.2 Messages for deleting VCNE package

Delete image request and corresponding response are used for interfaces supporting the reference point V(or-vim) in the flow of delete VCNE package according to [ITU-T Y.2321].

Method of the request line in delete image request can be Delete. The Request-URI of the request line in delete image request can be "/v2/images/{image_id}". Table II.2 shows the parameters defined in delete image request.

Table II.2 – Parameters in delete image request

Parameter	Part	Type	Description
image_id	Request-URI	String, mandatory	UUID of image
X-Auth-Token	Header	String, mandatory	Token fetched by user when login

Following is the example of delete image request:

```
DELETE /v2/images/bc51fde1-4fdc-4c43-9ba5-c64551a6ca63 HTTP/1.1
Content-Type: application/json
X-Auth-Token: cb8552a61768c2222a6788633f80b51c\
```

The format of the corresponding response for delete image request is similar to the format of response message in clause I.2. Following is the example of a successful response for delete image request:

```
x-application-context: csdp-vim-gateway:80
date: Tue, 08 May 2018 07:59:30 GMT
path: "/v2/images/bc51fde1-4fdc-4c43-9ba5-c64551a6ca63"
status: 204
status_line: "HTTP/1.1 204 \r\n"
```

II.3 Messages for VCNE instantiation and scale out of VCNE

Resource reservation requests and corresponding response are used for interfaces supporting the reference point V(or-vim) in the flow of VCNE instantiation and scale out of VCNE according to [ITU-T Y.2321].

Method and Request-URI of the request line for resource reservation requests can be used for computing resource reservation, network resource reservation and storage resource reservation, which are shown in Table II.3. Parameters for the requests and corresponding responses can be developed based on OpenStack.

Table II.3 – Method and Request-URI for resource reservation requests

Method	Request-URI	Description
POST	/v2/{tenant_id}/servers	Creates a server
POST	/v2.0/networks	Creates a network
POST	/v2.0/subnets	Creates a subnet on a specified network
POST	/v2.0/ports	Creates a port on a specified network
POST	/v2/{tenant_id}/volumes	Creates a volume
POST	/v2/{tenant_id}/volumes/{volume_id}/action	Attaches a volume to a server Specify the os-attach action in the request body

II.4 Messages for scale in of VCNE

Requests to shut down some of the VMs and to recycle related network, storage and corresponding response are used for interfaces supporting the reference point V(or-vim) in the flow of scale of VCNE according to [ITU-T Y.2321].

Method and Request-URI of the request line for the requests to shut down some of the VMs and to recycle the related network and storage are shown in Table II.4. Parameters in the requests and corresponding responses can be developed based on OpenStack.

Table II.4 – Method and request-URI for the requests to shut down VMs and to recycle network and storage

Method	Request-URI	Description
POST	/v2/{tenant_id}/servers/{server_id}/action	Stops a running server and changes its status to STOPPED
PUT	/v2.0/networks/{network_id}	Updates a specified network
PUT	/v2.0/subnets/{subnet_id}	Updates a specified subnet
PUT	/v2.0/ports/{port_id}	Updates a specified port
PUT	/v2/{tenant_id}/volumes/{volume_id}	Updates a volume
POST	/v2/{tenant_id}/volumes/{volume_id}/action	Detaches a volume from a server Specify the os-detach action in the request body

II.5 Messages for termination of VCNE

Requests to release the resources of the terminated VCNE instance and corresponding response messages are used for interfaces supporting the reference point V(or-vim) in the flow of termination of VCNE according to [ITU-T Y.2321].

Method and Request-URI of the request line for the requests to release the resources of the terminated VCNE instance can be used to release computing, network and storage resources, which are shown in Table II.5. Parameters in the requests and corresponding responses can be developed based on OpenStack.

Table II.5 – Method and Request-URI for the requests to release the resources of the terminated VCNE instance

Method	Request-URI	Description
DELETE	/servers/{server_id}	Deletes a specified server
DELETE	/v2.0/networks/{network_id}	Deletes a specified network and its associated resources
DELETE	/v2.0/subnets/{subnet_id}	Deletes a specified subnet
DELETE	/v2.0/ports/{port_id}	Deletes a specified port
DELETE	/v2/{tenant_id}/volumes/{volume_id}	Deletes a specified volume
POST	/v2/{tenant_id}/volumes/{volume_id}/action	Detaches a volume from a server Specify the os-detach action in the request body

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