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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 of orchestration in next generation network evolution

Recommendation ITU-T Q.3058

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Recommendation ITU-T Q.3058

Signalling architecture of orchestration in next generation network evolution

Summary

The orchestration in next generation network evolution (NGNe) is of great significance, because it takes into consideration the coexistence and corporation of traditional networks, such as next generation networks (NGNs) and networks enabled by software-defined networking/network function virtualization (SDN/NFV). Recommendation ITU-T Q.3058 specifies the mapping of reference points to interfaces in the signalling architecture of orchestration in NGNe, provides the signalling requirements of the interfaces and establishes the protocols used for interfaces. The descriptions of the requirements, the functional architecture and the reference points of orchestration in NGNe are aligned with Recommendations ITU-T Y.2323 and ITU-T Y.2324.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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NFV, NGNe, orchestration, signalling architecture, SDN.

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FOREWORD

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Signalling architecture of orchestration in next generation network evolution

1 Scope

This Recommendation provides the signalling architecture for orchestration in next generation network evolution (NGNe). Based on the functional architecture of orchestration in NGNe, this Recommendation introduces the reference points and specifies the mapping of reference points to interfaces in the signalling architecture of orchestration in NGNe. This Recommendation also provides the signalling requirements of the interfaces and establishes the protocols used 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.

[ITU-T Y.2323] Recommendation ITU-T Y.2323 (2018), *Requirements and capabilities of orchestration in next generation network evolution.*

[ITU-T Y.2324] Recommendation ITU-T Y.2324 (2019), *Functional architecture of orchestration in next generation network evolution (NGNe).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 next generation network (NGN) [b-ITU-T Y.2001]: A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AFE Adaptor Functional Entity

BSS Business Support System

CMS Cloud Management System

CMS-AFE Cloud Management System-Adaptor Functional Entity

COFE Capability Openness Functional Entity

CPE	Customer Premises Equipment
CRLF	Carriage Return Line Feed
DAFE	Data Awareness Functional Entity
ESN	Electronic Serial Number
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ID	Identifier
IP	Internet Protocol
JSON	JavaScript Object Notation
NFV	Network Function Virtualization
NFV-AFE	Network Function Virtualization – Adaptor Functional Entity
NFVO	Network Function Virtualization Orchestration
NGN	Next Generation Network
NGNe	Next Generation Network evolution
NGNe-AFE	NGNe-Adaptor Functional Entity
NGNe-NMS	NGNe-Network Management System
OFE	Orchestration Functional Entity
ROFE	Resource Orchestration Functional Entity
SDN	Software-Defined Networking
SDN-AFE	SDN-Adaptor Functional Entity
SDNO	Software-Defined Networking Orchestration
SOFE	Service Orchestration Functional Entity
TCFE	Template Catalogue Functional Entity
URI	Uniform Resource Identifier
UTF-8	Unicode Transformation Format-8 bit
VCPE	Virtual Customer Premises Equipment
VFW	Virtual Firewall
VLAN	Virtual Local Area Network
VM	Virtual Manufacturing

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.

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

In the body of this document, the word "shall" sometimes appears, in which case it is to be interpreted, respectively, as the phrase "is required to".

6 Functional architecture of orchestration in NGNe

This clause describes the functional architecture for orchestration in NGNe. Figure 6.1 shows orchestration in NGNe functional architecture specified in [ITU-T Y.2324] and the general requirements for orchestration in NGNe specified in [ITU-T Y.2323], respectively.

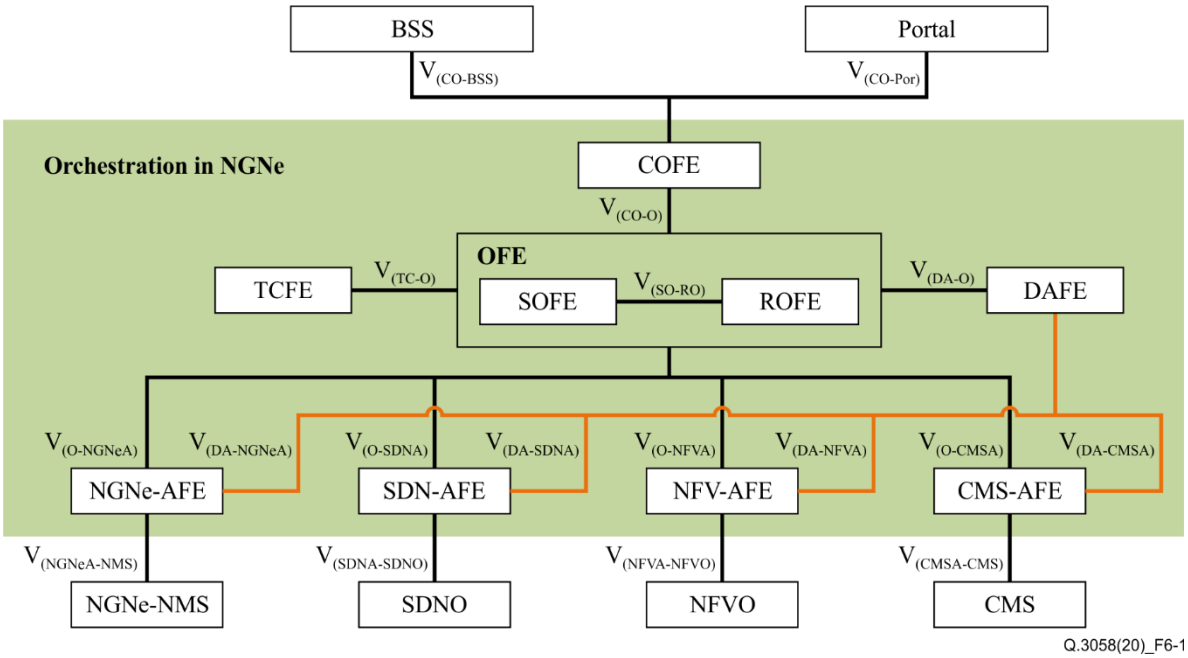

Figure 6-1 – Functional architecture of orchestration in NGNe ([ITU-T Y.2324])

ROFE: resource orchestration functional entity; SOFE: service orchestration functional entity

6.1 Functions and functional entities

Functions and functional entities identified in Figure 6-1 are described in detail in [ITU-T Y.2324].

6.2 Reference points

The reference points shown in Figure 6-1 are described in detail in [ITU-T Y.2324].

6.3 Signalling architecture of orchestration in NGNe

This clause describes the signalling requirements and protocols for interfaces of orchestration in NGNe, the signalling architecture of orchestration in NGNe is shown in Figure 6-2.

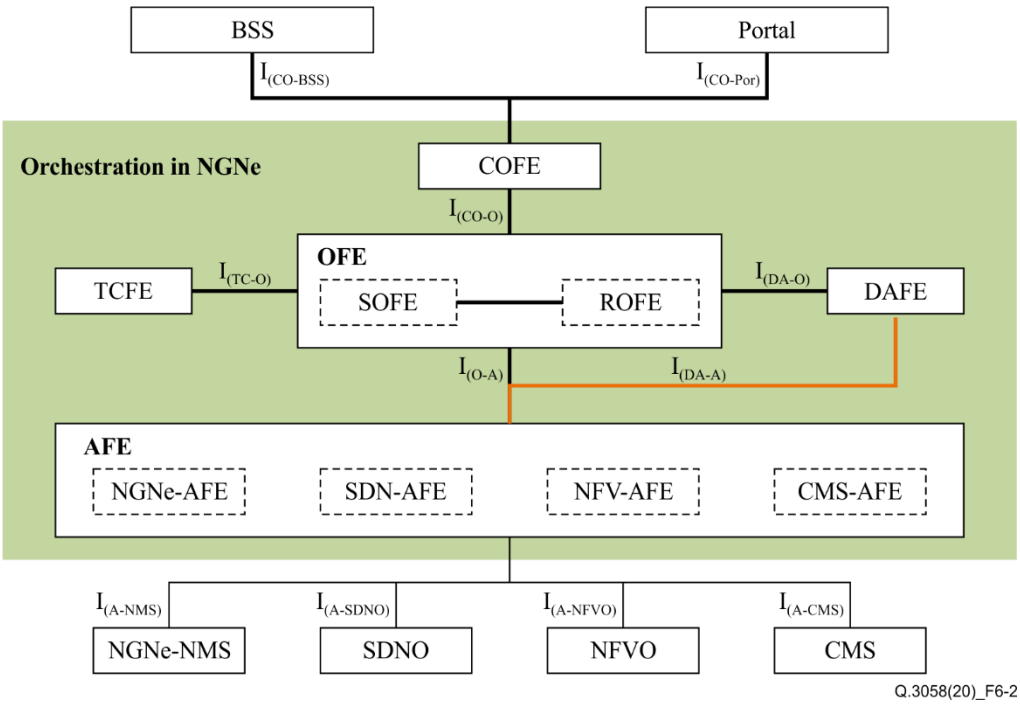

Figure 6-2 – Signalling architecture of orchestration in NGNe

7 Signalling requirements and protocols for interfaces of orchestration in NGNe

7.1 Signalling requirements and protocols for interface $I_{CO\text{-}BSS}$

The $I_{CO\text{-}BSS}$ is the interface between the capability openness functional entity (COFE) and the business support system (BSS). When the BSS produces a dispatching order, it is transmitted to the COFE through this interface.

The COFE and the BSS shall exchange signalling messages about account-related services (e.g., billing generation and billing write back) and synchronization of tenant account information through this interface.

The protocols used for interface $I_{CO\text{-}BSS}$ can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface $I_{CO\text{-}BSS}$ and Appendix II provides an example of message descriptions for interface $I_{CO\text{-}BSS}$, which can be referred to by operators in case of NGNe deployment.

7.2 Signalling requirements and protocols for interface $I_{CO\text{-}Por}$

The $I_{CO\text{-}Por}$ is the interface between the COFE and the portal. When the client initiates a request, the portal shall send a signalling message about a basic service purchase and configuration information (e.g., network connection rental, cloud hosting rental or cloud lines rental) to COFE through this interface.

The COFE shall report performance data and warning messages to the portal through this interface according to client requirements.

The protocols used for interface $I_{CO\text{-}Por}$ can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface $I_{CO\text{-}Por}$.

7.3 Signalling requirements and protocols for interface $I_{CO\text{-}O}$

The $I_{CO\text{-}O}$ is the interface between the COFE and the orchestration functional entity (OFE). The COFE shall gather and parse service messages generated by the upper layer (e.g., portal, BSS) and then they are transmitted to the OFE through this interface.

The OFE shall report performance data and warning messages to COFE through this interface.

The protocols used for interface I_{CO-O} can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{CO-O}.

7.4 Signalling requirements and protocols for interface I_{TC-O}

The I_{TC-O} is the interface between the template catalogue functional entity (TCFE) and the OFE. The OFE shall send sub-service requirements though this interface. The TCFE shall match sub-service requirements with the encapsulated templates and return the matched service and resource template to the OFE though this interface.

The protocols used for interface I_{TO-O} can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{TO-O}.

7.5 Signalling requirements and protocols for interface I_{DA-O}

The I_{DA-O} is the interface between the data awareness functional entity (DAFE) and the OFE. When the OFE collects customer requirements, it shall send requirements to the DAFE to set warning principles for multiple systems (e.g., NGNe-adaptor functional entity (NGNe-AFE), SDN-adaptor functional entity (SDN-AFE), network function virtualization-adaptor functional entity (NFV-AFE), cloud management system-adaptor functional entity (CMS-AFE)) through this interface.

When monitoring data meets an alarm condition, the DAFE sends a warning message to the OFE through this interface.

The protocols used for interface I_{DA-O} can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{DA-O}.

7.6 Signalling requirements and protocols for interface I_{O-A}

The I_{O-A} is the interface between the OFE and the adaptor functional entity (AFE). The OFE shall connect to the AFE and transmit decomposed service and resource requirements to the AFE through this interface.

The AFE shall process messages related to network and cloud resource allocation to OFE through this interface.

The protocols used for interface I_{O-A} can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{O-A}.

7.7 Signalling requirements and protocols for interface I_{DA-A}

The I_{DA-A} is the interface between the DAFE and the AFE. The AFE shall report network performance data, resource utilization and warning information to DAFE through this interface.

The protocols used for interface I_{DA-A} can be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{DA-A}.

7.8 Signalling requirements and protocols for interface I_{A-NMS}

The I_{A-NMS} is the interface between the AFE and the NGNe-network management system (NGNe-NMS). The AFE shall connect to multiple NGNe-NMSs and exchange traditional device configuration and topology management with them through this interface.

The protocols used for interface I_{A-NMS} could also be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface I_{A-NMS}. Appendix III provides an example of a message description for interface I_{A-NMS}.

7.9 Signalling requirements and protocols for interface $I_{A\text{-}SDNO}$

The $I_{A\text{-}SDNO}$ is the interface between the AFE and software-defined networking orchestration (SDNO). The SDN-AFE shall connect to multiple SDNO agents and exchange software-defined networking (SDN) device configuration and topology management messages with them through this interface.

The protocols used for interface $I_{A\text{-}SDNO}$ could also be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface $I_{A\text{-}SDNO}$.

7.10 Signalling requirements and protocols for interface $I_{A\text{-}NFVO}$

The $I_{A\text{-}NFVO}$ is the interface between the AFE and network function virtualization orchestration (NFVO). The NFV-AFE shall connect to multiple NFVO agents, dispatch or hand out service requirements to them and exchange mapping messages between the associating network services and network function virtualization (NFV) resources through this interface.

The protocols used for interface $I_{A\text{-}NFVO}$ could also be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface $I_{A\text{-}NFVO}$.

7.11 Signalling requirements and protocols for interface $I_{A\text{-}CMS}$

The $I_{A\text{-}CMS}$ is the interface between the AFE and the cloud management system (CMS). The AFE shall connect to multiple CMSs, and hand out decomposed service requirements. Then, it exchanges messages about cloud resources (cloud host, cloud storage etc.) and virtual manufacturing (VM) lifecycle management through this interface.

The protocols used for interface $I_{A\text{-}CMS}$ could also be developed by operators according to their specific signalling requirements. Appendix I provides an example of the message formats for interface $I_{A\text{-}CMS}$.

Appendix I

Message format for interfaces

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

I.1 General development requirement

The protocol used for interfaces can be developed based on OpenStack with Liberty or higher version. 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 the hypertext transfer protocol (HTTP) v1.1 as 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 the hypertext transfer protocol secure (HTTPS).

I.2 Message format

1 Request message

The request message includes three parts: Request line; Header; and Body. Part of the Body is optional.

1) Request line

   The Request line includes four parts: Method, Request-URI, HTTP-Version and carriage return line feed (CRLF).

   a) The first part is Method, which indicates the method of request. The Method part includes:
      - GET means to fetch resources indicated by the Request-URI;
      - POST means to add data for resources indicated by the Request-URI;
      - PUT means to request the server to store a source, which is indicated by the Request-URI;
      - DELETE means to request the server to delete a source, which is indicated by the Request-URI.

   b) The second part is Request-URI, which means a uniform resource indicator.

   c) The third part is HTTP-Version, which means the version of HTTP used by the request message.

   d) The last part is CRLF, which means the end of the Request line.

2) Header

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

   The following headers can be contained:

   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, which should be unicode transformation format-8 bit (UTF-8).

   c) X-Auth-Token indicates "`Token_ID`" fetched by the user from the server when authorized.

3) Body

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

2 Response message

The response message includes three parts: Status line; Header; and Body. Part of the Body is optional.

1) Status line

The Status line includes four parts: HTTP-Version; Status-Code; Reason-Phrase; and CRLF.

a) The first part is HTTP-Version, which indicates the version of HTTP.

b) The second part is the Status-Code, which indicates the Status-Code that the server would like to use as a response. The Status-Code can be a number with three digits. The first digit of the status code indicates different types of response:

- "1" – a request has been accepted and handling continues;
- "2" – a request has been handled successfully;
- "3" – a request has been redirected and will be handled after more operations;
- "4" – a request cannot be handled because of a fault that occurs on the client side;
- "5" – a request cannot be handled because of a fault that occurs on the server side.

c) The third part is Reason-Phrase, which indicates the description of the 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
200	OK
201	Created successfully (commonly used for POST operation)
202	Accepted
401	Unauthorized
404	Not Found
409	Conflict
500	Internal Server Error
599	Failed

d) The last part CRLF means the end of the Status line.

2) Header

Following headers can be contained:

a) Date indicates the time for message sending, which can refer to [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 the character set of the response message should be UTF-8.

3) Body

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

Appendix II

Message description for interface $I_{CO\text{-}BSS}$

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

II.1 Messages for registering customer premises equipment

A customer premises equipment (CPE) register request is used to add a tenant who has successfully opened an account through interface $I_{CO\text{-}BSS}$.

The Method of the Request line in the CPE register request can be POST. The Request-URI of the Request line in the CPE register request can be "`/v1/cpe`". Table II.1 lists the parameters specified in a CPE register request. Table II.2 lists the status code in a CPE register respond message.

Table II.1 – Parameters in a CPE register massage

Parameter	Type	Length	Mandatory/ optional	Description
`tenant_id`	string	1~30	M	Tenant identifier (ID)
`cpe_esn`	string	1~48	M	The CPE electronic serial number (ESN)
`cpe_model`	string	1~30	M	CPE model with following values: CPE: 4096 Virtual customer premises equipment (VCPE): 4097 Virtual firewall (VFW): 4100
`cpe_vendor`	string	1~30	M	CPE vendor: "`HUAWEI`", "`ZTE`", "`H3C`", "`VERSA`", "`FIBERHOME`" etc.
`cpe_certficate`	string		O	CPE certificate, Base64 coding
`cpe_authusr`	string		O	CPE boot authentication username
`cpe_authpw`	string		O	CPE boot authentication password
`ctrler_id`	string	1~30	O	The controller ID
`access_type`	int		O	0x10 – 163 Public network 0x11 – 163 Private network 0x20 – CN2 Public network 0x21 – CN2 Private network

Table II.2 – Status code in CPE register respond message

Status code	Description
201	Created successfully
404	Tenant not found
409	The CPE already exists

An example of a register CPE message request follows.

```
POST /v1/cpe

{
    "cpe_vendor": "H3C",
    "cpe_model": "",
    "tenant_id": "zgc",
    "ctrler_id": "ecloud_ctrler",
    "access_type": 16,
```

```
    "dev_type": 4097,
    "cpe_esn": "2837236433",
    "cpe_authpwd": "h3c!",
    "cpe_authusr": "admin"
}
```

II.2 Messages for deleting CPE

Deleting CPE request is used to delete the CPE though interface $I_{CO\text{-}BSS}$. The Method of the Request line in deleting CPE request can be DELETE. The Request-URI of the Request line in deleting CPE request can be "`/v1/cpe`". Table II.3 shows the parameter specified to delete a CPE request. Table II.4 shows the status code used to delete a CPE respond message.

Table II.3 – Parameter to delete a CPE massage

Parameter	Type	Length	Mandatory/optional	Description
cpe_esn	string	1~30	M	The CPE ESN

Table II.4 – Status code used to delete a CPE respond message

Status code	Description
200	Deleted successfully
404	Tenant not found

II.3 Messages for enquiring about a CPE

An enquiring CPE request is used to query CPE information though interface $I_{CO\text{-}BSS}$. The Method of the Request line in an enquiring CPE request can be GET. The Request-URI of the Request line in a CPE enquiry request can be "`/v1/cpe`". Table II.5 shows the parameters specified in an enquiring CPE request.

Table II.5 – Parameters in an enquiring CPE message

Parameter	Type	Length	Mandatory/optional	Description
`tenant_id`	string	1~30	M	Tenant ID
`tenant_name`	string	1~64	M	The name of the tenant
`cpe_esn`	string	1~48	M	The CPE ESN
`cpe_model`	string	1~30	M	CPE model
`cpe_vendor`	string	1~30	O	CPE vendor
`cpe_addr`	string		O	The address of the CPE
`cpe_status`	int		M	CPE status: 0 – offline 1 – online –1 – illegal
`cpe_ipv4`	string	7~15	O	IPV4 public network address
`if_name`	string	1~30	M	The name of the interface

II.4 Messages for monitoring CPE

A monitoring CPE request is used to monitor the status of CPE though interface $I_{CO\text{-}BSS}$. The Method of the Request line in a monitoring CPE request can be GET. The Request-URI of the Request line

in a monitoring CPE request can be "`/v1/cpe/mon`". Table II.6 shows the parameters specified in a monitoring CPE request.

Table II.6 – Parameters in a monitoring CPE message

Parameter	Type	Length	Mandatory/ optional	Description
`cpe_esn`	string	1~48	M	The CPE ESN
`network_in`	ts-val array			Downlink traffic data, bps
`network_out`	ts-val array			Uplink traffic data, bps
`cpu`	ts-val array			Percentage of CPU utilization, such as 20%, value 20

Appendix III

Message description for interface $I_{A\text{-}NMS}$

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

III.1 Messages for querying a virtual local area network port

A querying virtual local area network (VLAN) port request is used to support interface $I_{A\text{-}NMS}$ for querying a VLAN port.

The Method of the Request line in a querying VLAN port request can be POST. The Request-URI of the Request line in querying a VLAN port can be "`/v1/InterVlans?IP=X.X.X.X&PORT=X`". Table III.1 shows the parameters specified in a querying VLAN port request. Table III.2 shows the status code in querying VLAN port respond message.

Table III.1 – Parameter in a querying VLAN port message

Parameter	Type	Length	Mandatory/optional	Description
IP	string	1~48	M	IP address
PORT	string		M	Port, such as gigaethernet1/2/3 GigabitEthernet0/1/4

Table III.2 – Parameters in a querying VLAN port respond message

Parameter	Description
ServiceFlag	0 – enquired successfully 1 – request resource not found 2 – request resource not found 3 – query failure 4 – other reasons
VLAN	1000,1001,1003 return to used VLAN

III.2 Messages for service provisioning

A service provisioning request is used to support interface $I_{A\text{-}NMS}$ for sending work orders.

The Method of the Request line in a service provisioning request can be POST. The Request-URI of the Request line in service provisioning can be "`/interface/order/`". Table III.3 shows the parameters specified in a service provisioning request.

Table III.3 – Parameter in service provisioning message

Parameter	Type	Length	Mandatory / optional	Description
`serial_no`	varchar		M	The serial number of the work order, global unique
`order_no`	varchar		M	The number of the purchase order
`service_type`	varchar		M	2 – type 1 4 – type 2

Table III.3 – Parameter in service provisioning message

Parameter	Type	Length	Mandatory / optional	Description
order_type	varchar		M	2 – open 4 – disassembly 5 – change 7 – stop 8 – reset
line_no	varchar		M	The serial number of the line
line_name	varchar		M	The name of the line
custom_no	varchar		O	The serial number of the customer
custom_name	varchar		O	The name of the customer
custom_level	varchar		O	The level of the customer

Bibliography

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