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Abstract: This document is the output of draft Recommendation ITU-T Q.3742 (ex. Q.SD-DCI) "Signalling requirements and data models for SD-DCI service" for consent. It includes the discussion results in the Q4/11 meeting held on 1-10 May 2024.

This document is the output document of draft Recommendation ITU-T Q.3742 (ex.Q.SD-DCI) "Signalling requirements and data models for SD-DCI service" for consent based on the previous output document SG11-TD912/GEN (e-meeting, 20 March - 22 March 2024), the following input document, and the meeting discussion (Geneva, 1-10 May 2024, Q4/11 meeting).

The following table shows discussion results for input documents.

DOC	Source	Title	Meeting results
C434	China Unicom	ITU-T Q.SD-DCI "Signalling requirements and data models for SD-DCI service" - Proposal to advance the baseline text and consent	Agreed with modifications

Draft new Recommendation ITU-T Q.3742

Signalling requirements and data models for SD-DCI service

Summary

As the enterprises use more and more geographically distributed cloud services, the demand for interconnection among different data centers is increasing. Network operators develop Software-Defined Data Center Interconnection (SD-DCI) services to meet customized demands for interconnection among multiple data centers. This draft Recommendation specifies the signalling requirements and data models for SD-DCI service.

Keywords

SDN, DCI, data center interconnection

Introduction

Table of Contents

Draft new Recommendation ITU-T Q.3742

Signalling requirements and data models for SD-DCI service

1 Scope

This Recommendation provides the signalling requirements for Software-Defined Data Center Interconnecting (SD-DCI) service in one single network operator. The signalling is to support the dynamical setup and management of the multiple data centers' interconnections. This Recommendation focuses on the signalling requirements among the SD-DCI controller, orchestrator and application.

The scope of this Recommendation includes:

– general description for SD-DCI service;

– functional architecture for SD-DCI service;

– data models for SD-DCI service deployment;

– signalling procedures for SD-DCI service deployment;

– signalling requirements for SD-DCI service deployment.

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.3300] Recommendation ITU-T Y.3300 (2014), *Framework of software-defined networking.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 software-defined networking [ITU-T Y.3300]: A set of techniques that enables to directly program, orchestrate, control and manage network resources, which facilitates the design, delivery and operation of network services in a dynamic and scalable manner.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

VPN Virtual Private Network

CE Customer Edge

CLI Command Line Interface

CSP	Cloud Service Provider
DCI	Data Center Interconnection
Netconf	Network Configuration Protocol
PE	Provider Edge
P router	Provider router
SD-DCI	Software-Defined Data Center Interconnection

5 Conventions

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

In the body of this document and its appendixes, the words shall, shall not, should, and may sometimes appear, in which case they are to be interpreted, respectively, as is required to, is prohibited from, is recommended, and can optionally. The appearance of such phrases or keywords in an appendix or in material explicitly marked as informative are to be interpreted as having no normative intent.

6 General description for SD-DCI service

The construction of data centers for various organizations and enterprises is becoming increasingly common. There is a need for multiple data centers to be interconnected since a single data center may not be always suitable for the digital business needs. Some of these difficulties are listed below:

– extended response time for remote data center interconnection network configuration;

– difficulty in meeting a large number of services with varying demands;

– inefficient utilization of network resources.

SD-DCI service should satisfy the following key capabilities with software-defined networking (SDN) technologies:

- automatic establishment and flexible configuration of services;
- smart traffic engineering and QoS differentiation;
- instant service alternation.

7 Functional architecture of SD-DCI service

7.1 Functional components

As shown in Figure 7-1, the functional architecture for SD-DCI service includes the self-service application for customers, the service orchestrator, the SD-DCI controller and the routers, where the routers consist of CE routers, PE routers and P routers. The CE routers in data centers are connected with PE routers of the IP network. The SD-DCI controller is required to control all the appropriate routers of the dedicated carrier network, which realizes the automatic establishment and flexible configuration of services, as well as provides the functions of smart traffic engineering and QoS differentiation. Based on the service parameters from the service orchestrator, the DC controller is used to manage the configuration of the data center network in order to achieve the interconnectivity and interoperability of the services.

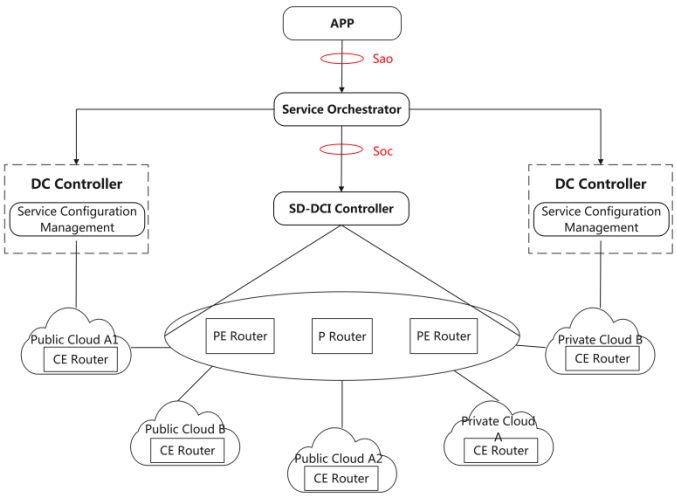

Figure 7-1 The functional architecture for SD-DCI

(1) The APP functional component

The APP functional component provides the GUI for customers. Through the App functional component, a user requests one new DC interconnection service or modifies the existing DC interconnection service by inputting the service parameters based on their demands, which include but not limited to the targeted DC, bandwidth, delay, QoS. After confirming and approving the customer's request, the App functional component transmits the request information to the service orchestrator functional component.

In addition, the App functional component informs customers if the service configuration is deployed successfully, and shows customers the established connections and topology of the deployed service.

(2) The service orchestrator functional component

The service orchestrator functional component analyzes the received service request information from customers and converts the analysis results into the service configuration based on the unified data model.

The service orchestrator functional component sends the service configuration information to the SD-DCI controller functional component to realize the automatic service deployment in the IP network. The communication between the service orchestration functional component and the SDN controller functional component may be based on the standard Restful interface.

The service orchestration functional component can also coordinate with the DC controller, which can realize the automatic service deployment within the data center to satisfy the SLA requirements for customers. However, the interaction process is out of the scope of this Recommendation.

(3) The SD-DCI controller functional component

The SD-DCI controller functional component manages the relevant resources of the carrier network, including but not limited to routers, topology, links. It treats the underlying carrier network as one virtualized network resource pool. The network resource can be allocated flexibly and virtually according to the service requirements of different customers and the network conditions.

The SD-DCI controller functional component communicates with the service orchestrator functional component through its northbound API. It processes service request and provides specific functions including but not limited to L3 VPN for DCI, TE Tunnel for traffic engineering or low latency based on DCI service requirement, and PCE server, and translates or adapts the service configuration into the detailed configuration. The SD-DCI controller communicates with the underlying network routers through the southbound API which realizes the issue of network control instructions and feedback of network status.

When the SD-DCI controller functional component receives the service configuration from the orchestrator functional component, it will map the service configuration to the command-line-based configuration for the corresponding routers. After that, the command-line-based configuration will be sent to the corresponding routers for instance based on NetConf protocol or CLI.

(4) The routers' functional component

The routers' functional component provides the data forwarding function. The PE routers need to support SDN function, which means the PE routers can be controlled by the SD-DCI controller functional component. The P routers need to support the VPN tunnels between the PE routers.

(5) The CE devices of data centers

The CE devices of data centers are connected with the PE routers of the IP network. The connection can be based on IP access network, L2 transport network, or direct fibre connection. The DC controller can manage the CE devices of the data centers, and the SD-DCI controller functional component can configure the interfaces of the PE routers connected to the CE devices.

7.2 Interfaces

The interfaces among SD-DCI controller, orchestrator and application needs to support the information exchange and authentication. It needs to support Restconf protocol, and the authentication is based on the token mode.

7.2.1 Sao interface

This interface permits the interaction between APP functional component and the service orchestrator functional components. The service orchestrator functional component receives the service creation/deletion/alternation request from the APP functional component and allocates the basic network resources for the service request including but not limited to the PE device loopback, the interface ID, the VLAN ID.

7.2.2 Soc interface

The interface permits the interaction between the service orchestrator functional component and the SD-DCI controller functional component. The SD-DCI controller functional component receives the service creation/deletion/alternation request from the service orchestrator functional component and

maps the service configuration to the command-line-based configuration for the corresponding routers.

8 Data model for SD-DCI service deployment

8.1 Customer

The data model description for a customer is specified in Table 8-1.

Table 8-1 – Data model of a customer

Element	Description
CustID	CustID uniquely specifies the customer.
EnterpriseName	The enterprise name.

8.2 VPN

The data model description for a VPN is specified in Table 8-2.

Table 8-2 – Data model of a VPN

Element	Description
VPNID	VPN ID uniquely specifies an MPLS VPN of one customer.
VRFID	The customer's VRF ID.
Topology	The structural relationship of the nodes in the VPN.
QoSStrategy	The customer's QoS policy.

8.3 Node

The data model description for the node is specified in Table 8-3.

Table 8-3 – Data model of a node

Element	Description
NodeID	NodeID uniquely specifies a node of one MPLS VPN.
PELoopback	PE loopback uniquely specifies the PE router.
InterfaceID	The ID of the PE router port.
VLANID	The identification of the customer's VLAN.
RouteType	The type of the customer's network, e.g., BGP, Static.
RD	The customer's route distinguisher.
RT	Tte customer's route target.
Bandwidth	The maximum bandwidth of this node available to the customer.

9 Signalling procedures for SD-DCI service deployment

The deployment SD-DCI service consists of three procedures:

1) service creation,

2) service deletion,

3) service alternation.

9.1 Signalling procedure for SD-DCI service creation

Figure 9-1 describes the creation procedure for SD-DCI service. The information exchange for service creation is based on push mode.

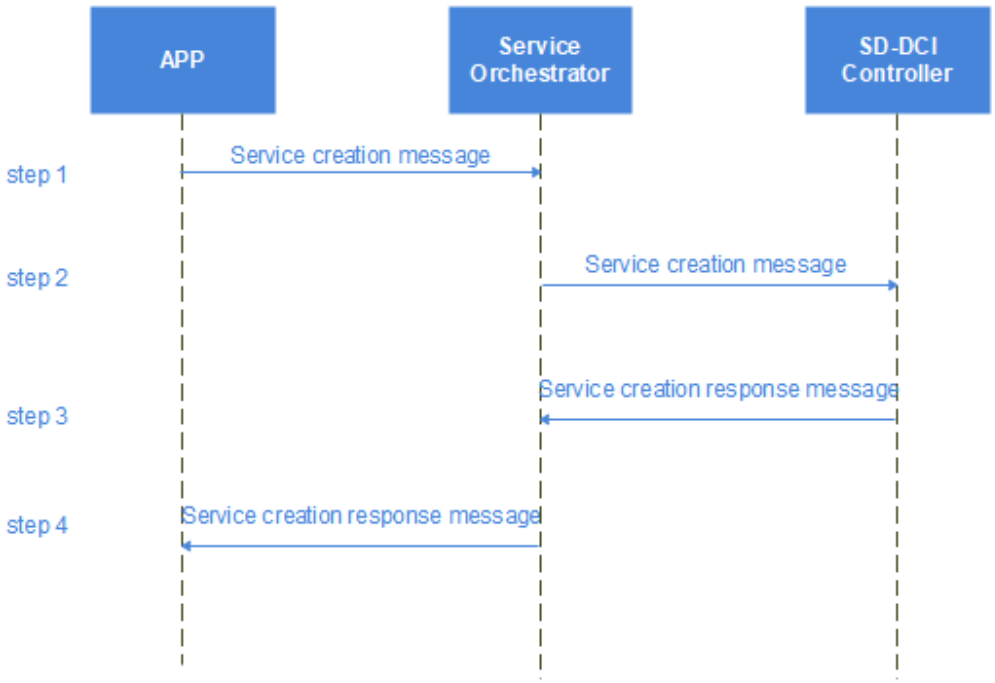

Figure 9-1 – Service creation procedure

Step 1: The APP functional component transfers the service parameters filled in by customers into attribute values, and then sends them to the service orchestrator functional component by service creation message through the Sao interface.

Step 2: The service orchestrator functional component allocates network resources for the customer's service, then sends the service creation message through the Soc interface to the SD-DCI controller functional component to create the customer’s service.

Step 3: The SD-DCI controller functional component responds to the service orchestrator functional component with the result of customer’s service creation through the Soc interface.

Step 4: The service orchestrator functional component responds to the APP functional component with the result of customer’s service creation through the Sao interface.

9.2 Signalling procedure for SD-DCI service deletion

Figure 9-2 describes the deletion procedure for the SD-DCI service. The information exchange for service deletion request is based on push mode.

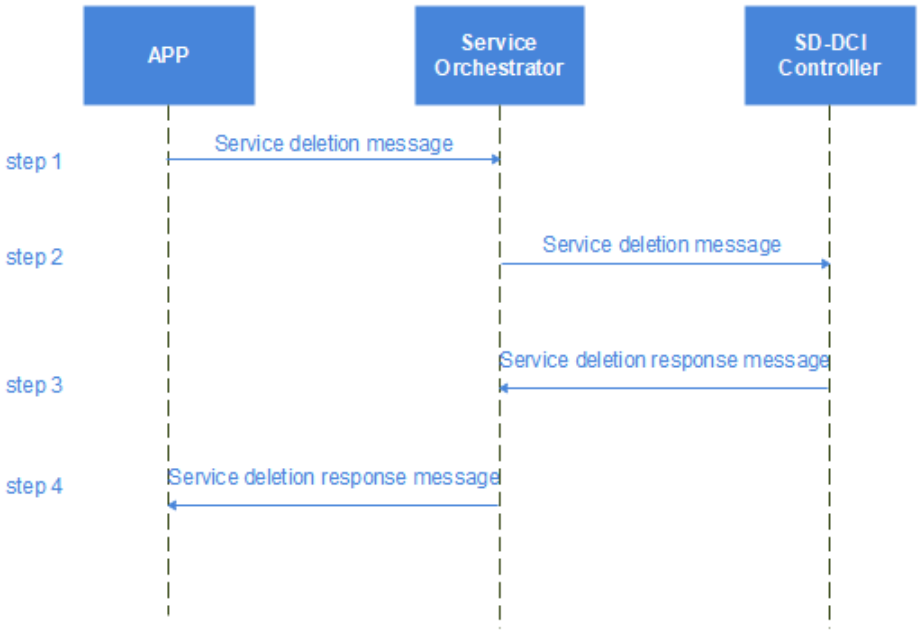

Figure 9-2 – Service deletion procedure

Step 1: The App functional component sends service deletion message to the service orchestrator functional component through the Sao interface.

Step 2: The service orchestrator functional component sends the service deletion message to the SD-DCI controller functional component through the Soc interface.

Step 3: The SD-DCI controller functional component responds to the service orchestrator functional component with the result of customer's service deletion through the Soc interface, then the service orchestrator releases related network resources of the customer's network service.

Step 4: The service orchestrator functional component responds to the App functional component with the result of customer's service deletion through the sao interface, then the App functional component releases the service data of the customer's service.

9.3 Signalling procedure for service alternation

Figure 9-3 describes the alternation procedure for SD-DCI service. The information exchange for service alternation request is based on push mode.

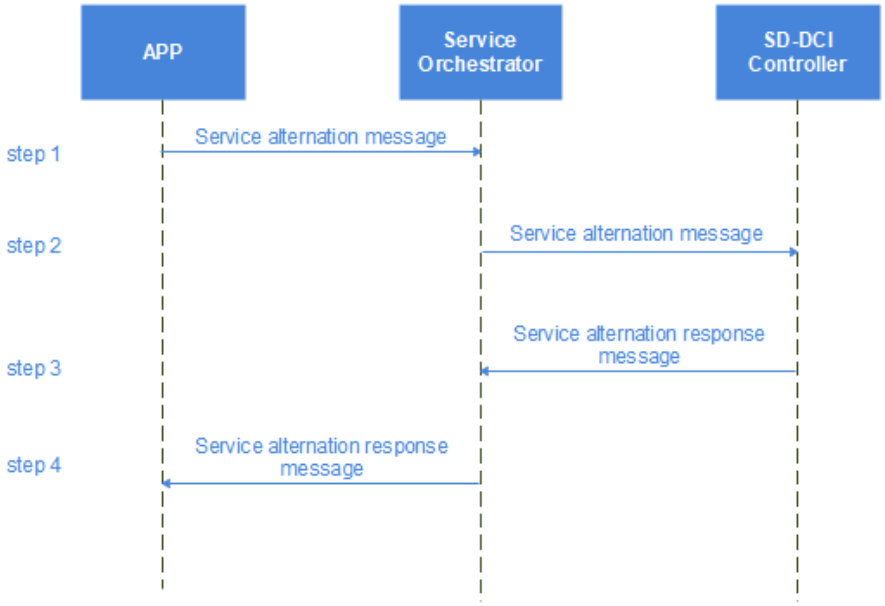

Figure 9-3 – Service alternation procedure

Step 1: The App functional component converts the alternation parameters into attribute values, and sends the service alternation message to the service orchestrator functional component through the Sao interface. The parameters that can be alternated include but not limited to bandwidth, QoS, interconnection IP addresses.

Step 2: The service orchestrator functional component allocates or records related network resources of the alternation request before sending the attribute alternation message to the SD-DCI controller functional component.

Step 3: The SD-DCI controller functional component responds to the service orchestrator functional component with the result of customer's service alternation through the Soc interface, then the service orchestrator functional component updates the usage of related network resources, such as the interface bandwidth.

Step 4: The service orchestrator functional component responds to the APP functional component with the result of customer's service alternation through the sao interface, then the App functional component updates the service parameters, including but not limited to the bandwidth, QoS ratio, interconnection IP addresses.

10 Signalling requirement for SD-DCI service deployment

10.1 Overview

The message interactions are based on request and response mode. The request messages are used for service creation/deletion/alternation and query of the result, while the response message contains the handing results of the corresponding requests.

NOTE – No transport protocol or message content format for the signalling messages is specified here. The signalling messages may be extensible markup language (XML) -based messages over (or carried by) transmission control protocol (TCP) [b-IETF RFC793], user datagram protocol (UDP) [b-IETF RFC768], stream control transmission protocol (SCTP) [b-IETF RFC2960], transport layer

security (TLS) [b-IETF RFC5246], QUIC [b-IETF RFC9000], etc. All of the messages consist of the message header and the message body. The message format is described in Figure 10-1.

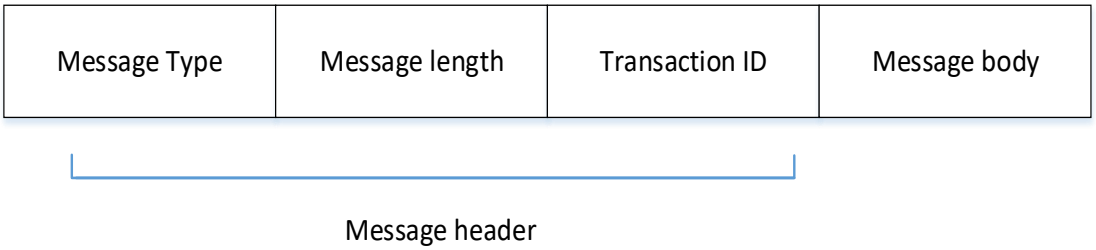

Figure 10-1 Message composition

The message header field contains the following information:

– Message type: uniquely specifies the type of message, including service creation, service creation response; service deletion, service deletion response; service alternation, service alternaiton response;

– 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.

10.2 Signalling requirement for service creation

The service creation message is defined as a ServiceCreation message.

The ServiceCreation message, indicated by the message type in the message header field, is sent by the App functional component to the SD-DCI controller functional component through the service orchestrator functional component.

Message format:

```
< ServiceCreation-Message > ::=< Message Header >
                        {CUST-ID}
                        {VPN-ID}
                        {Node-List}
```

Meanings and explanations:

The detailed information is as follows:

(1) `CUST-ID` uniquely specifies the customer, which is specified based on the data model described in 8.1.

(2) `VPN-ID` uniquely specifies the specific SD-DCI service which is related to the specific customer, which is specified based on the data model described in 8.2, and is allocated by the App functional component.

(3) `Node-List` uniquely specifies the node information of the VPN service of the customer, which is specified based on the data model described in 8.3.

The service creation response message is defined as a ServiceCreation-R message.

The ServiceCreation-R message, indicated by the message type in the message header field, is sent by the SD-DCI controller functional component to the App functional component through SD-DCI orchestrator functional component.

Message format:

```
< ServiceCreation-R-Message > ::=< Message Header >
                        {Configuration-result}
                        {Node-List}
```

The detailed information is as follows:

(1) `Configuration-result` specifies the result of the network configuration distribution. If the network configuration distribution is successful, `Configuration-result` is TRUE; if not, `Configuration-result` is FALSE.

(2) `Node-List` uniquely specifies the node information of the VPN service of the customer, which is specified based on the data model described in 8.3.

10.3 Signalling requirement for service deletion

The service deletion message is defined as a ServiceDeletion message.

The ServiceDeletion message, indicated by the message type in the message header field, is sent by the app to the SD-DCI controller through the service orchestrator.

Message format:

```
< ServiceDeletion-Message > ::=< Message Header >
                             {CUST-ID}
                        {VPN-ID}
                        {Node-ID}
```

Meanings and explanations:

The detailed information is as follows:

(1) `CUST-ID` uniquely specifies the customer, which is specified based on the data model described in 8.1.

(2) `VPN-ID` uniquely specifies the specific SD-DCI service which is related to the specific customer, , which is specified based on the data model described in 8.2.

(3) `Node-ID` uniquely specifies the node to be deleted, which is specified based on the data model described in 8.3.

The network service deletion response message is defined as a ServiceDeletion-R message.

The Servicedeletion-R message, indicated by the message type in the message header field, is sent by the SD-DCI controller functional component to the App functional component through the service orchestrator functional component.

Message format:

```
< Servicedeletion-R-Message > ::=< Message Header >
                        {Deletion-result}
```

The detailed information is as follows:

(1) `Deletion-result` specifies the result of the network deletion. If the network deletion is successful, `Deletion-result` is TRUE; if not, `Deletion-result` is FALSE.

10.4 Signalling requirement for service alternation

The service alternation message is defined as a ServiceAlternation message.

The ServiceAlternation message, indicated by the message type in the message header field, is sent by the App functional component to the SD-DCI controller functional component through the service orchestrator functional component.

Message format:

```
< Servicealternation-Message > ::=< Message Header >
                        {CUST-ID}
                        {VPN-ID}
                        {Node-List}
```

Meanings and explanations:

The detailed information is as follows:

(1) `CUST-ID` uniquely specifies the customer, which is specified based on the data model described in 8.1.

(2) `VPN-ID` uniquely specifies the specific SD-DCI service which is related to the specific customer, which is specified based on the data model described in 8.2.

(3) `Node-List` uniquely specifies the node information of the VPN service of the customer, which is specified based on the data model described in 8.3.

The service alternation response message is defined as a ServiceAlternation-R message.

The ServiceAlternation-R message, indicated by the message type in the message header field, is sent by the SD-DCI controller functional component to the App functional component through the service orchestrator functional component.

Message format:

```
< ServiceAlternation-R-Message > ::=< Message Header >
                        {Configuration-result}
                        {Node-List}
```

The detailed information is as follows:

(1) `Configuration-result` specifies the result of the service alternation configuration. If the service alternation configuration is successful, `Configuration-result` is TRUE; if not, `Configuration-result` is FALSE.

(2) `Node-List` uniquely specifies the altered node information of the VPN service of the customer, which is specified based on the data model described in 8.3.

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