Requirements for Interfaces of Network Digital Twin

Abstract

   The interfaces of Digital Twin Network can be divided as twin
   network southbound interface, internal interface and northbound
   interface. In order to build a digital twin network and realize its
   many advantages, different interfaces should be able to meet
   different requirements. And this memo introduces the requirements
   for the interfaces of the Digital Twin Network.

Requirements Language

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in RFC 2119 [RFC2119].

Status of This Memo

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1. Introduction

As defined in the[I-D.irtf-nmrg-network-digital-twin-arch] , the
digital twin network is defined as "a network system with a physical
network entity and a virtual twin, and the two can interact with
each other in real time". It should have four core elements: data,
model, mapping and interaction. Accordingly, a "three-layer, three-
domain and double-closed loop" architecture is adopted.) and the
network telemetry technology

Based on the above architecture definition of three-layer, three-
domain and double-closed-loop, the interfaces of each layer and
their positions of the digital twin network are shown in Figure 1.
The network elements in the physical entity network exchange network
data and network control information with the twin network layer
through the twin southbound interface. The twin network layer
contains three key subsystems, which are data sharing warehouse,
service mapping model and digital twin management. Through the
corresponding interface protocol, the construction and interaction
requirements of the three key subsystems should be met. And through
the internal interface of the twin layer, the interaction between
the three key subsystems and the physical network layer and network
application layer is realized. Network applications input
requirements to the twin network layer through the twin northbound
interface, and deploy services in the twin network layer through the
model example. To sum up, there are differences in interface
protocol requirements between different layers of DTN and within
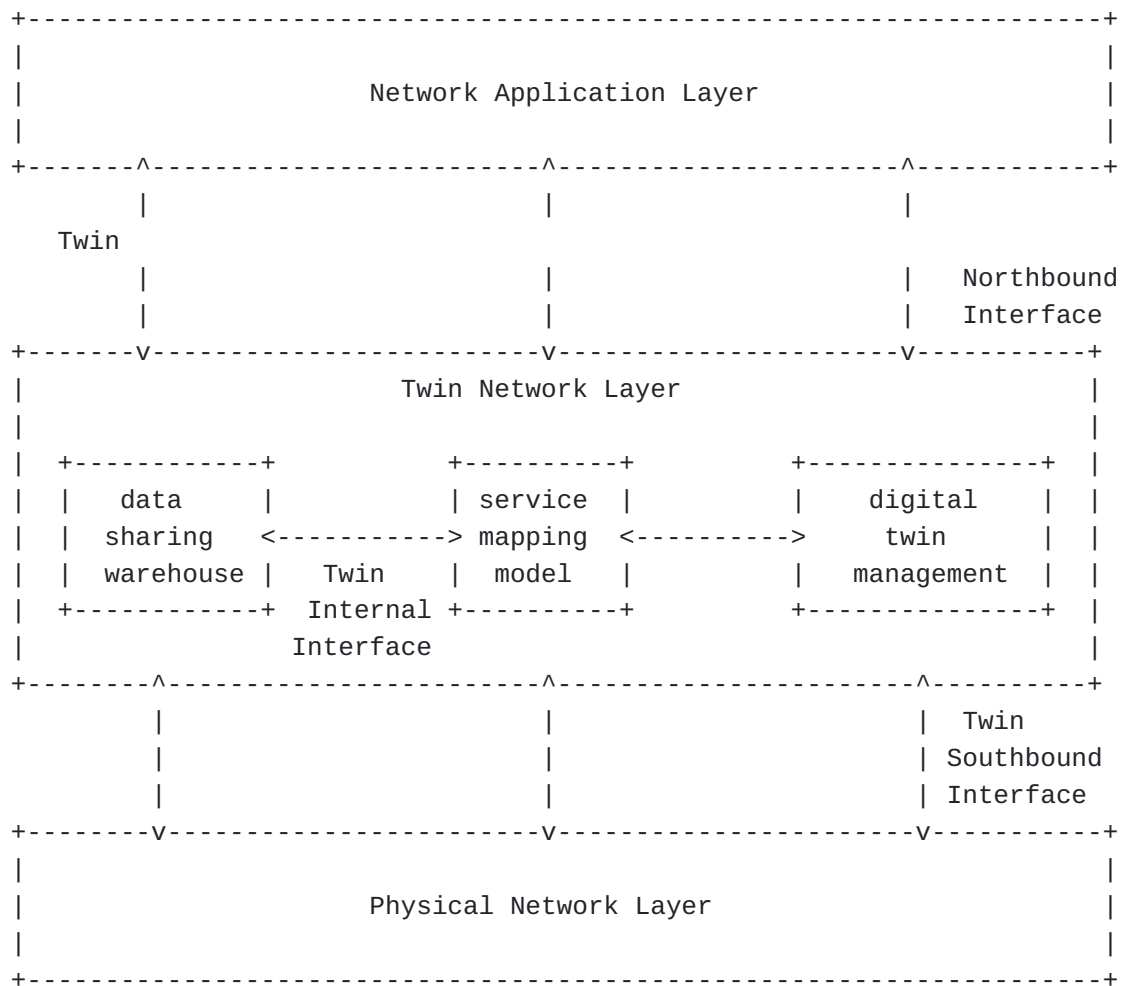twin layers.

```
+------------------------------------------------------------------------+
|                                                                        |
|                    Network Application Layer                           |
|                                                                        |
+-------^--------------------------^----------------------^--------------+
        |                          |                      |
   Twin                                                     
        |                          |                      |  Northbound
        |                          |                      |  Interface
+-------v--------------------------v----------------------v-----------+
|                       Twin Network Layer                           |
|                                                                    |
|   +------------+         +----------+         +---------------+   |
|   |   data     |         | service  |         |    digital    |   |
|   | sharing    <----------> mapping  <---------->    twin      |   |
|   | warehouse  |   Twin   | model    |         |  management   |   |
|   +------------+  Internal +----------+         +---------------+   |
|              Interface                                             |
+--------^------------------------^----------------------^----------+
         |                        |                      |  Twin
         |                        |                      |  Southbound
         |                        |                      |  Interface
+--------v------------------------v----------------------v-----------+
|                                                                    |
|                    Physical Network Layer                          |
|                                                                    |
+------------------------------------------------------------------------+
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Figure 1: Schematic Representation of DTN Interface

2. Requirements for Different Interfaces

   *Twin northbound interface

      -The twin northbound interface is the interface between the
       network application layer and the twin network layer. The
       network application requirements are input from the twin
       northbound interface to the twin network layer. The twin
       northbound interface can support the rapid deployment of
       network applications such as network operation and
       optimization, network visualization, intent verification, and
       network automatic driving with lower cost, higher efficiency,
       and less impact on live network services. Therefore, the twin
       northbound interface should have the characteristics of the
       following 4 aspects.

         oOpenness: The twin northbound interface must meet the
          business requirements of different network applications and

can be input to the twin network layer, so it needs to have good openness and compatibility;

  oScalability: There are a variety of network applications in the network application layer, which will inevitably lead to the generation of network applications. At the same time, the continuous development of the network is bound to introduce new network applications. With the upgrade of network applications and the generation of new applications, the twin northbound interface should be able to expand in time to meet the needs of new network applications;

  oPortability: There are twins with different sizes and functions in the twin network layer. The same or similar requirements of various applications in the network application layer may be deployed on different twins. Therefore, the twin northbound interface should be easily transplanted and deployed on different twins;

  oFlexible deployment: To reduce deployment time and cost, twin northbound interfaces must be flexibly deployed.

*Twin Internal interface

  -As shown in the "three-layer, three-domain, double-closed loop" of DTN architecture, the twin network layer contains three key subsystems, namely, data sharing warehouse, service mapping model and digital twin management, which is the most critical part of the digital twin network. The internal interface of the twin layer refers to the interface within and between the three subsystems: data sharing warehouse, service mapping model and digital Twin management. In order to support the functions of the three subsystems in the twin network layer and the interaction between the three subsystems, the internal interface of the twin layer should have the following four functions.

    oUnity: Each subsystem in the twin network layer should be able to provide the same data format and data service for other subsystems through the internal interface of the twin layer, that is, the interface should have unity.

    oAdaptability: The twin network layer must interact with the network application layer and the physical network layer, and should be well adapted to various network devices and interfaces. Therefore, the internal interfaces of the twin layer also need to be adaptive.

oPortability: The data model instances provided by the service mapping model subsystem for different applications may have a high degree of similarity. In order to improve efficiency, the data model instances must be able to be provided and deployed through different internal interfaces of twin layers.

oFlexible and extensible: The twin network layer must be able to verify different new network services. In order to shorten the implementation time of functions, the implementation of functions inside the twin layer should be simplified as far as possible. Therefore, the internal interface of the twin network layer must be flexible and extensible.

*Twin southbound interface

-The twin southbound interface is the interface between the twin network layer and the physical entity network. Control updates are delivered from the twin southbound interface to the physical entity network, and various nes in the physical entity network exchange network data and network control information with the twin network layer through the twin southbound interface. Therefore, the southbound twin interface should have three functions.

oInformation interaction capability: the twin southbound interface should be able to collect the information of different physical nes or network devices, and send the configuration information of the twin network to the physical network for execution, that is, it can realize the information interaction between the twin network layer and the physical entity network.

oReal-time: The realization of twin network configuration verification and other functions must have certain real-time, so the information collected and uploaded from the physical entity network and the configuration information sent from the twin network to the physical network must have certain real-time, in order to meet the real-time requirements of the digital twin network.

oCompatibility: Network devices and nes from different manufacturers use different interfaces and protocols. The southbound interfaces must be compatible to ensure the reliability of information collection and configuration delivery.

3. Suggestions on the applicability of common protocols

With the development of communication networks, many North-South and intra-network communication protocols have been formed in the network, such as RESTCONFRFC 8527 [RFC8527], NETCONFRFC 8526 [RFC8526], OpenFlow, XMPPRFC 7622 [RFC7622], East-West Bridge, etc.. Because different communication protocols have different characteristics, the existing protocols are suitable for different twin network interfaces. In this draft, we attempt to give some suggestions about the applicability of some existing general protocols suitable for DTN construction.

RESTCONF uses the Hypertext Transfer Protocol (HTTP) as the transport protocol and XML/JSON as the message exchange format, allowing WEB applications to access configuration and operation data of network devices in a modular and extensible manner. It applies to twin northbound interfaces.

NETCONF uses remote procedure call (RPC) based mechanism to provide a set of framework mechanism to add, modify, delete network device configuration, query configuration, status and statistics between the client and the server, and can be used as a network administrator or network configuration application and network device logical connection. NETCONF can transmit configuration data and status data. So it can be used for twin northbound interfaces and twin southbound interfaces.

OpenFlow are used for information exchange between OpenFlow switches and controllers, so it appllies to twin southbound interfaces.

Extensible Message Processing Thread Protocol (XMPP) is an open technology for instant messaging, multi-party chat, voice and video calling, collaboration, content syndication, and generic XML data routing, so it is suitable for twin southbound interfaces and twin internal interfaces.

Routing system interface protocols (I2RS) dynamically deliver routing status and policies based on topology changes and traffic statistics, enabling external applications or controlling entities to read router information and it can also be used for twin southbound interfaces and twin internal interfaces.

East-West Bridge is an application-layer protocol based on Transmission Control Protocol/Secure Socket Protocol (TCP/SSL), which has good portability and scalability. NEs can be abstracted into concepts such as nodes, links, ports, and flows. The extended link layer discovery protocol is used to obtain the ID,

capacity, and status of each NE in the domain. So it applies for twin internal interfaces.

Simple Network Management Protocol (SNMP) is a standard protocol specifically designed to manage network nodes over IP networks. Network administrators can use SNMP to manage network performance, identify and resolve network problems, and plan network growth. It can be used for twin northbound interfaces and twin internal interfaces.

4. Security Considerations

TBD

5. IANA Considerations

This document has no requests to IANA.

6. References

6.1. Informative References

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