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Abstract: This is the output document of draft Recommendation ITU-T Q.SDTN "Signalling and protocol for Digital Twin Network supported for IMT-2020 network and beyond", developed at ITU-T Q6/11 session during the SG11 meeting (Geneva 1-10 May 2024).

<Summary of discussion>

One contribution was submitted to the Q6/11 meeting (Geneva, 1-10 May 2024) for ITU-T Q.SDTN. It was discussed and agreed at the meeting as follow:

No.	Title	Source	Discussion
SG11-C425	ITU-T Q.SDTN - Proposal to add signalling flow and message format of data collection	China Mobile	Accepted with modifications

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Draft Recommendation ITU-T Q.SDTN

Signalling and protocol for Digital Twin Network supported for IMT-2020 network and beyond

1. Scope

This draft new Recommendation is aiming to specify the interface for data exchange among digital twin network, 3rd party application and physical network, procedure of data interaction among physical network, IMT 2020 network management and digital twin network, procedure of network simplification, automatic, resilient, and full life-cycle operation and maintenance with assistance of digital twin network.

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.

[ITU-T Y.3102] Recommendation ITU-T Y.3102 (2018), *Framework of the IMT-2020 network*

[ITU-T Y.3104] Recommendation ITU-T Y.3104 (2018), *Architecture of the IMT-2020 network*

[ITU-T Y.3090] Recommendation ITU-T Y.3090 (2022), *Digital twin network – Requirements and architecture*

3. Definitions

3.1. Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 IMT-2020 [b-ITU-T Y.3100]: Systems, system components, and related technologies that provide far more enhanced capabilities than those described in [b-ITU-R M.1645].

NOTE – [b-ITU-R M.1645] defines the framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000 for the radio access network.

3.1.2 management [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at fulfilment, assurance, and billing of services, network functions, and resources in both physical and virtual infrastructure including compute, storage, and network resources.

3.1.3 digital twin network: A virtual representation of a physical network. It is useful for analysing, diagnosing, emulating and controlling the physical network based on data, model and interface, to achieve the real-time interactive mapping between the physical network and virtual twin network.

3.1.4 network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

3.2. Terms defined in this Recommendation

This Recommendation defines the following terms:

4. Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AF	Application Function
AI	Artificial Intelligence
DTN	Digital Twin Network
UE	User Equipment

5. Conventions

In this Recommendation:

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

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6. Overview

Digital Twin Network (DTN) is a virtual representation of the physical network, analyzing, diagnosing, emulating and controlling the physical network based on data, model and interface, so as to achieve the real-time interactive mapping between physical network and virtual twin network. The Y.3090 specified the functional requirements, service requirements and the architecture of DTN.

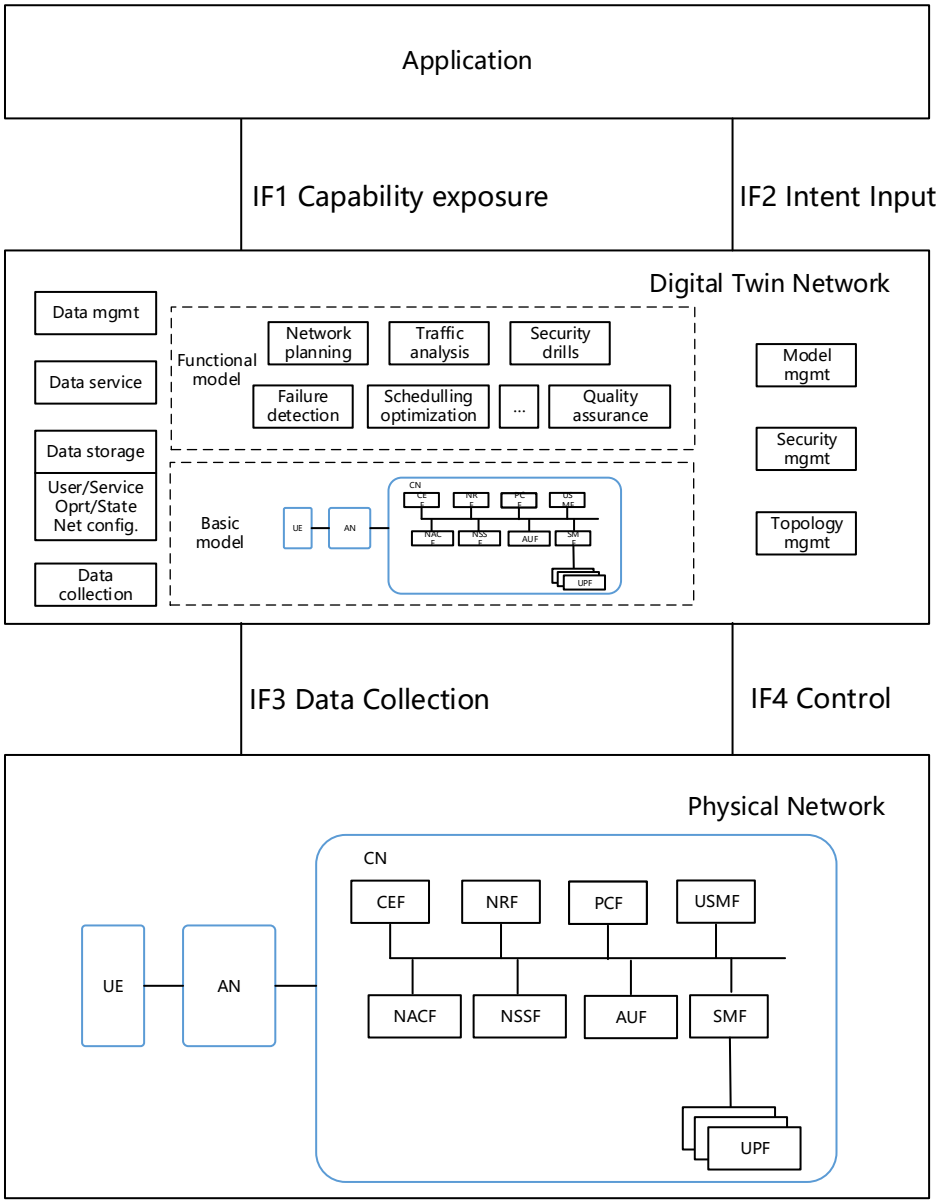

Figure 6-1 Signaling architecture of Digital Twin Network

IF1: This reference point exists between the application and digital twin network. It supports:

- Provide a digital copy of network digital twin, or common data models to third-party applications;
- Report execution results from data models in the network digital twin.

IF2: This reference point exists between the application and digital twin network. It supports:

- Application input the requirements to the network digital twin layer. Requirements can be regular network management, innovation network protocol validation, network optimization, etc.

IF3: This reference point exists between digital twin network and physical network. It supports:

- Collect various network data, including provisional data, operational data, and data from the control-plane and user-plane;
- Various collecting methods, including passive collection, active collection, subscription collection, on-demand collection, etc.;
- High speed information exchange.

IF4: This reference point exists between digital twin network and physical network. It supports:

- Twin network layer sends the control updates to the physical entity network;
- Configure management, including data collection protocol, frequency or period, etc;
- Delivering control signalling and configuration changes to network elements in the physical network.

7. Interface and Protocol enhancement

[Editor's Note] This clause specifies the interface for data exchange among digital twin network, 3rd party application and physical network.

8. Signalling flow

8.1. Data collection and data distribution

The data collection and data distribution flow for digital twin network defines the whole process of data collection for digital twin real-time and big data requirements, including the steps of data collection configuration, data collection, data transfer and data distribution, which is shown in figure 8-1.

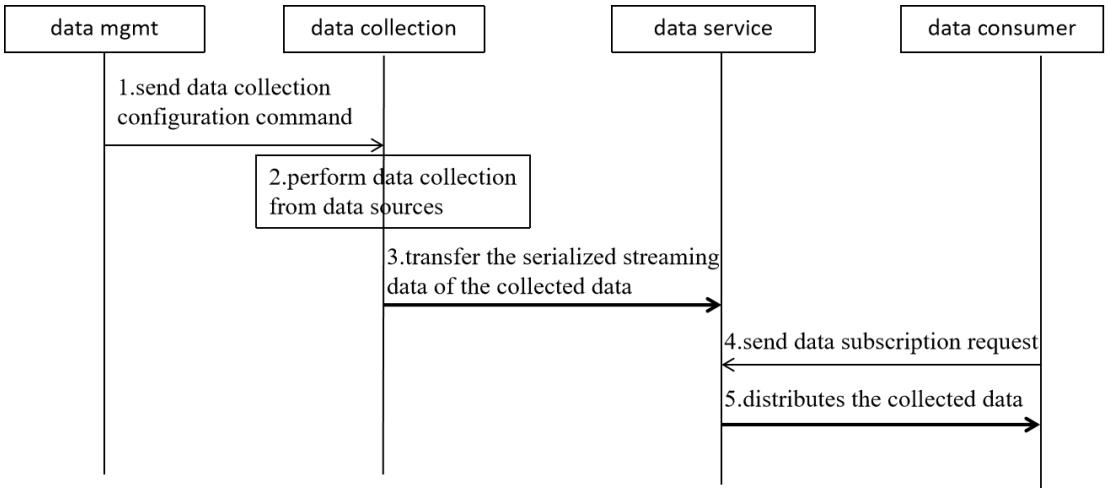

Figure 8-1: The data collection and data distribution flow for digital twin network

1. The data management sends data collection configuration command to the data collection with the parameters including collection objects, collection frequency and collection time, etc. The data collection configuration command can be encapsulated in a programmable framework, which can be used to customize data collection information.

NOTE 1 - Data collection management is a part of function of data management.

2. After receiving data collection configuration command from the data management, the data collection performs data collection from data sources according to the data collection configuration command, generates serialized streaming data from the collected data.

3. The data collection transfers the serialized streaming data of the collected data to the intermediary platform for data processing.

NOTE 2 - The intermediary platform for data processing is tasked with receiving, storing, and distributing streaming data efficiently to cater to the demands of handling large volumes of data and ensuring real-time processing.The data processed by the The intermediary platform can be distributed directly to the data consumer or stored in the data storage.

NOTE 3 - The intermediary platform for data processing can be integrated into data service.

4. The data consumer sends data subscription request to the intermediary platform for data processing.

5. After receiving data subscription request, the intermediary platform for data processing distributes the corresponding collected data to the data consumers on demand.

8.2. Data collection from data source

Network digital twin is able to collect data from 3rd party application, IMT-2020 network functions, IMT-2020 network management. Figure 8-2 depicts that data collection entity of network digital twin collects data from IMT-2020 network functions.

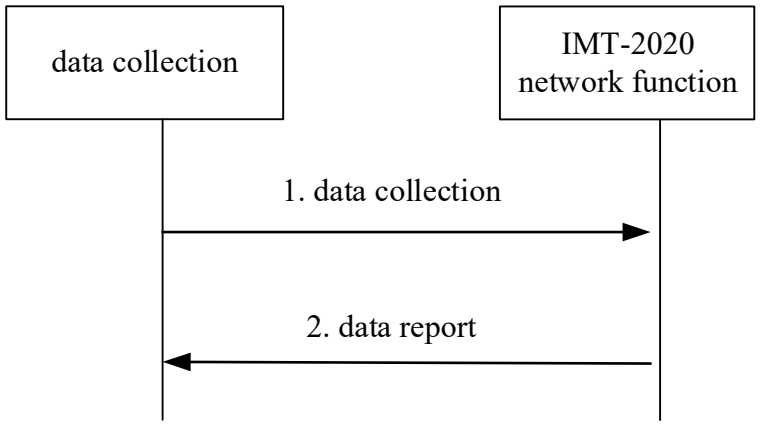

Figure 8-2: data collection from IMT-2020 network functions

1. IMT-2020 network functions receives data collection command from data management, data collection send data collection message to IMT-2020 network functions.

2. IMT-2020 network functions report data as required from data collection, e.g. collection elements, collection frequency, collection time.

9. Message Format

9.1. Data collection from data source

Table 9-1 describes the detailed information of data collection from IMT-2020 network functions.

Table 9-1 data collection request

Information element	Status	Data type	Cardinality	Description
network function ID	M	string	1..N	Indicate identifier list of network function.
Traffic information	O	string	1..N	Indicate traffic information of IMT-2020 network funtions, e.g. traffic packet volume, data bit rate, data packet size.
Network KPI	O	string	1..N	Indicate KPI information of IMT-2020 network function, e.g. latency, throughput, packet loss, jitter.
Fault warning information	O	string	1..N	Indicate network funtion warning information, e.g, fault type, warning level, warning time.

Table 9-2 describes the detailed information of data collection response:

Table 9-2 data collection response

Information element	Status	Data type	Cardinality	Code value	Description
result	M	num	1	201 400 500	Indicates the success or failure of the date collection. 201 Created 400 Input Parameter Error 500 Server Internal Error
Traffic information	O	string	1..N	N/A	Indicate traffic information of IMT-2020 network funtions, e.g. traffic packet volume, data bit rate, data packet size.
Network KPI	O	string	1..N	N/A	Indicate KPI information of IMT-2020 network function, e.g. latency, throughput, packet loss, jitter.
Fault warning information	O	string	1..N	N/A	Indicate network funtion warning information, e,g, fault type, warning level, warning time.