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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Future networks

Functional architecture for supporting fixed mobile convergence in IMT-2020 networks

Recommendation ITU-T Y.3131

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Recommendation ITU-T Y.3131

Functional architecture for supporting fixed mobile convergence in IMT-2020 networks

Summary

Recommendation ITU-T Y.3131 describes the functional architecture of fixed mobile convergence in IMT-2020 networks, which supports the requirements of network evolution and accommodates convergent services in fixed and mobile networks. This Recommendation presents the overview, framework and functional architecture for supporting fixed mobile convergence in IMT-2020 networks.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3131	2019-08-13	13	11.1002/1000/13987

Keywords

Fixed mobile convergence, FMC, IMT-2020.

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FOREWORD

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1 Scope

This Recommendation presents the functional architecture of fixed mobile convergence (FMC) in IMT-2020 networks, which supports the requirements of network evolution and accommodates convergent services in fixed and mobile networks. This Recommendation addresses the following issues:

– Framework of FMC in IMT-2020 networks;

– Functional entities and functions in FMC;

– Detailed capabilities of functions in FMC;

– Reference points between functional entities in FMC;

– General security considerations.

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.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

[ITU-T Y.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 control plane [b-ITU-T Y.2011]: The set of functions that controls the operation of entities in the stratum or layer under consideration, plus the functions required to support this control.

3.1.2 data plane [b-ITU-T Y.2011]: The set of functions used to transfer data in the stratum or layer under consideration.

3.1.3 fixed mobile convergence [b-ITU-T Y.3100]: In the context of IMT-2020, the capabilities that provide services and applications to end users regardless of the fixed or mobile access technologies being used and independently of the users' location.

3.1.4 fixed network [b-ITU-T Q.1762]: A network that provides wire-based (e.g., copper, fibre) or wireless access to its services. The fixed network may support nomadism, but does not support mobility.

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

3.1.6 mobile network b-ITU-T Q.1762]: A network that provides wireless access to its services and supports mobility.

3.1.7 user plane [b-ITU-T Y.2011]: A synonym for data plane.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA Authentication, Authorization, Accounting

ASF Authentication Server Function

BB Broadband

CAPEX Capital Expenditure

CN Core Network

CP Control Plane

FMC Fixed Mobile Convergence

HSS Home Subscriber Server

NACF Network Access Control Function

NFV Network Function Virtualization

OPEX Operational Expenditure

PDU Protocol Data Unit

RAN Radio Access Network

SDN Software Defined Network

SMF Session Management Function

TIC Telecom Integrated Cloud

UE User Equipment

UNIC Unified Network Integrated Cloud

UP User Plane

UPF User Plane Function

USM Unified Subscription Management function

WLAN Wireless Local Area Network

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.

6 Introduction to functional architecture for supporting fixed mobile convergence in IMT-2020 networks

6.1 Overview of FMC architecture in IMT-2020 networks

This Recommendation provides a cloud based FMC architecture for next generation network, called unified network integrated cloud (UNIC), in which different kinds of access technologies are aggregated to constitute a converged network.

UNIC is facilitated by technologies such as control and user plane separation, service based architecture, service chain, network function virtualization (NFV), software defined network (SDN), cloud and other key technologies. Since UNIC is a unified FMC architecture across different access technologies, it has the following advantages:

– Similar functionalities can be merged and reused, which saves the capital expenditure (CAPEX);

– Single and isolated network can be provided and maintained, which saves the operational expenditure (OPEX);

– Unique user identity, unified billing, service consistency and continuity across different access technologies can be provided, which improves the user experience.

The architecture reference model of UNIC is shown in Figure 1.

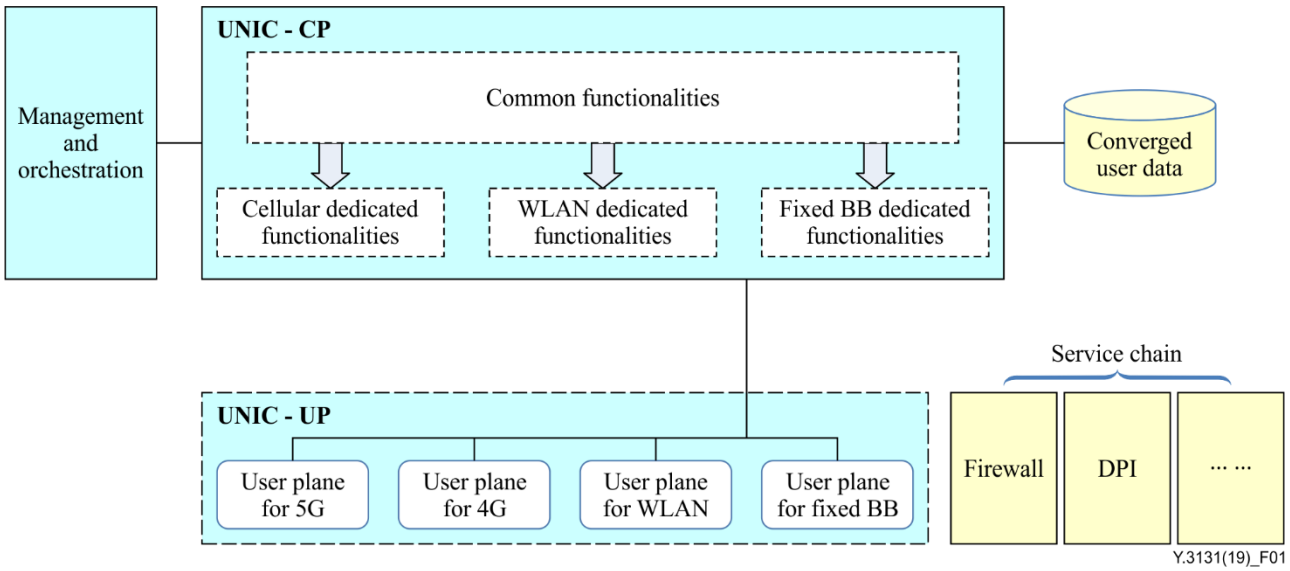

Figure 1 – Architecture reference model of UNIC

UNIC is composed of five main components:

– UNIC-CP

– UNIC-UP

– Converged user data

– Service chain

– Management and orchestration

The core functions of UNIC are divided into control plane functions and user plane functions, which are UNIC-CP and UNIC-UP in this architecture. UNIC-CP takes most of the control logics, while UNIC-UP mainly provides packets switching under instruction of UNIC-CP. The converged user data is the central data repository in this architecture, in which most of the permanent and temporary data is stored. The service chain is supplementary to the UNIC-UP and provides user plane

enhancement features. The management and orchestration provides the functions of network management, service management, user management and resource orchestration.

6.2 Design considerations of FMC architecture in IMT-2020 networks

1) Support of control and user plane separation

Control and user plane separation is to decouple the control plane functions and the user plane functions in the network entity; and each type of function is implemented in separate equipment. With control and user plane separation, the control plane functions can be deployed in a more centralized way while the user plane functions can be deployed in a more distributed way according to the service requirements. The upgrading, scaling can be applied separately on control plane and user plane functions. Control and user plane separation can bring advantages such as more flexibility of network upgrading, faster new service deployment, etc.

Control and user plane separation makes it possible to integrate different access technologies under single network architecture due to the following reasons:

– The composed network entities are too complicated to be converged;

– The different user plane functions need to be deployed in centralized or distributed ways depending on the access technology it serves.

With control and user plane separation, different user plane functions can be deployed in centralized or distributed ways on demand, under the control of the unified control plane function.

2) Support of control plane reconstruction

Network slicing is a concept introduced in 5G, by which operators can deploy different network slices to serve different service requirements. A network slice is an end-to-end network, including radio access network (RAN) and core network (CN). The functions in network slice can be virtualized or dedicated. Network slicing, together with NFV/SDN, can enable flexible, programmable and extendable network architecture.

Function modularization, customization and composition are the basis of network slicing with NFV/SDN. When redesigning the functions of control plane functions, the following issues should be taken into account:

a) Control plane functions of fixed network should be included;

b) Control plane functions of mobile network should be included;

c) Control plane functions of wireless local area network (WLAN) should be included;

d) Which functions can be common?

e) Which functions should be specific?

f) Which functions should support unified control to these different networks?

In addition, orchestration of control plane is also important for network slicing. This enables creating a network slice which includes corresponding control functions required by service requirements.

3) Support of service chain

In order to adapt to the rapid development of data communications services, fixed broadband and mobile operators are developing a variety of value-added services such as video optimization, Web cache, HTTP header enhancement and network acceleration based on different user groups and market demand. With the development of value-added services, the value-added service network is gradually evolving into the status of serial connection or hairpin connection, which leads to data traffic roundabout, management and maintenance difficulties, low business deployment flexibility and time consuming problems.

Service chain can be introduced in the mobile or fixed broadband communication network to break the traditional serial or hairpin mode of value-added services. It can provide customized value-added services for different users and applications based on time, location, network status and other dimensions. Moreover, the capability exposure interfaces can be designed for third parties to achieve lower business access thresholds, rapid on-line and off-line business, unified management and reduced maintenance costs.

At the same time, with the development of mobile Internet and home broadband, access modes for fixed broadband and mobile accesses are constantly converging, as are the needs of value-added services. Service chain architecture facilitates the implementation of a unified traffic management strategy of fixed mobile convergence, improves resource utilization and further reduces deployment costs and expenses.

4) Support of user data convergence

In 4G networks, user data is stored and managed by a home subscriber server (HSS), while in fixed networks, the user data equipment is an authentication, authorization, accounting (AAA) server. Data separation results in key drawbacks, such as data redundancy and service development difficulties. In user data management respect of 5G networks, it is important to focus on user data convergence.

User data convergence means that not only can user data in the HSS and AAA be merged together that belongs to the same user, but unified user data management can also be provided. In addition it is expected to store the status data of a large number of users, e.g., registered, unregistered, in the form of group user data. With the help of NFV, a large scale data-base could provide this bulk storage service. Due to data convergence of one user and convergence of lots of users' data, it brings advantages in the aspects of maintenance and facilities such as service development and big data analysis.

From the view of the service layer and control plane, user data convergence shall provide multiple kinds of access protocols. At the same time, to improve the efficiency of a large scale data-base, it is important to define unified access protocols.

5) Support of network function virtualization and software defined network

Network function virtualization (NFV) and software defined network (SDN) are the foundation of future network.

Network function virtualization transforms the network from dedicated hardware to common hardware. Network functions can be implemented by software. Management and orchestration are introduced to realize unified resource management and allocation, to support auto-scaling, flexible function deployment and quick business on-line.

SDN realizes the separation of control plane and user plane, supports unified management of network connection and realizes intelligent and optimized traffic scheduling.

7 Framework for supporting fixed mobile convergence in IMT-2020 networks

7.1 Framework of FMC architecture

Fixed mobile convergence in IMT-2020 networks is expected to be based on UNIC functional architecture, which can be deployed on the telecom integrated cloud (TIC), NFV/SDN based common infrastructure with management and orchestration. The framework of the FMC in IMT-2020 networks including high-level description of functionalities is provided in this clause.

Figure 2 presents the framework of FMC in IMT-2020 networks from a functional point of view. The framework of FMC is composed of five main components and each main component consists of several functions:

– UNIC-CP, which takes most of the control logics.

– UNIC-UP, which provides packets switching under instruction of UNIC-CP.

– Converged user data, which is the central data repository, in which most of the permanent and temporary data is stored.

– Service chain, which is a supplementary to the UNIC-UP and provides user plane enhancement features.

– Management and orchestration, which provides the functions of network management, service management, user management and resource orchestration.

The framework of FMC architecture is recommended to support flexible extensibility to be compatible with future technologies such as machine learning, block chain and satellite communications.

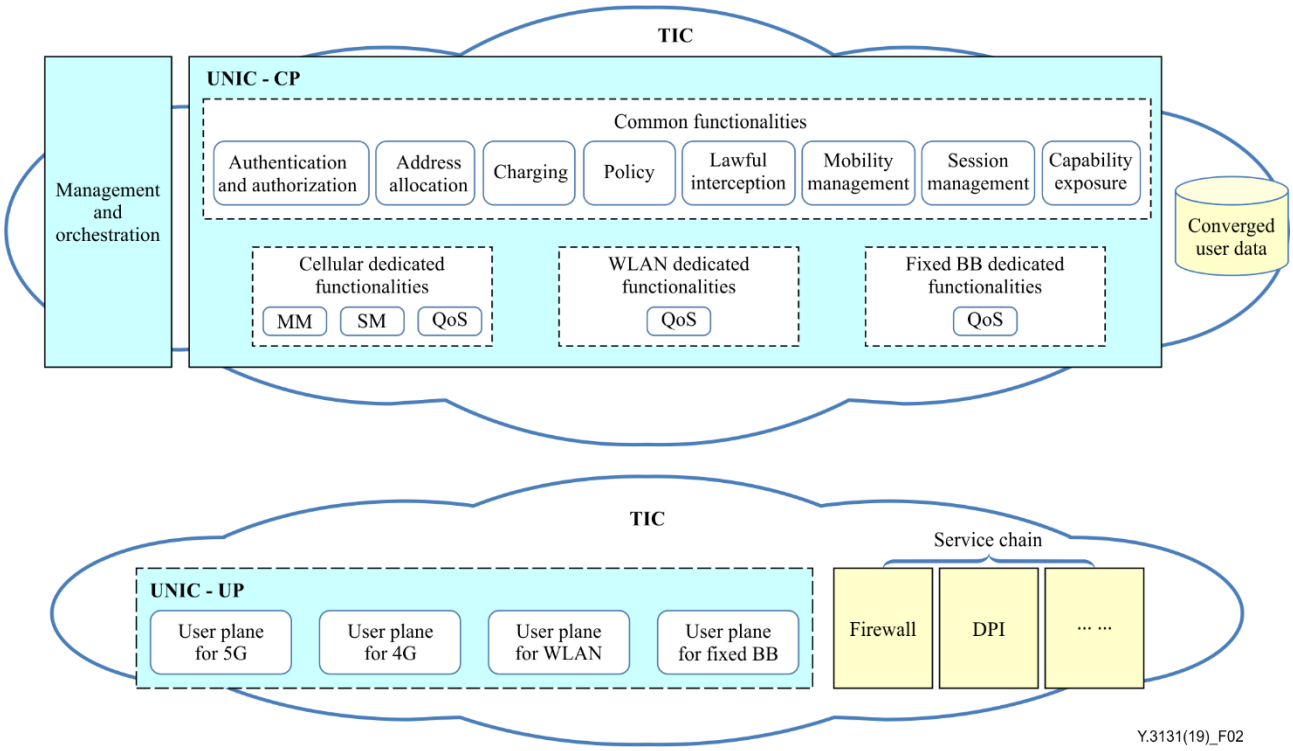

Figure 2 – Framework of FMC in IMT-2020 networks

7.2 High-level description of functionalities

The following functions are specifically addressed in the framework of FMC in IMT-2020 networks. Cellular dedicated functions, WLAN dedicated functions and fixed broadband (BB) dedicated functions follow general standards of ITU-T and other SDOs.

7.2.1 Mobility management

Mobility management function is designed to support service continuity and IP address reachability in mobility scenarios of FMC in IMT-2020 networks. To provide unified management for intra-AN and inter-AN mobility, mobility management is required to work as one of the common functionalities in the UNIC-CP. The main functions of mobility management include but are not limited to location management, connection management, handover control and coordination management. The network functionalities of IMT-2020 network, such as network access control function (NACF), unified subscription management (USM) function, session management function (SMF), user plane function (UPF) and authentication server function (ASF) are required to cooperate together to support mobility management.

Mobility management is required to cooperate with the address allocation functionality of UNIC-CP to maintain IP address information of UE. For other functionalities of UNIC-CP, such as authentication and authorization, charging and policy, the interfaces are required to follow general standards of ITU-T and other SDOs.

7.2.2 Session management

Session management function provides functions to setup the IP or non-IP protocol data unit (PDU) connectivity (i.e., PDU session) for a UE, as well as to control the user plane to support connectivity.

In the IMT-2020 network, FMC is required to support session continuity for active fixed or mobile connections. Session management is the key technology to enable session continuity in FMC. The session management functions include but are not limited to: PDU session management, selection and control of user plane (UP) function, and configurations of traffic steering at user plane function (UPF), which routes traffic to its proper destination.

7.2.3 Capability exposure

Capability exposure function enables the UNIC-CP to provide network capabilities and desensitized user data to applications through capability exposure interfaces.

The network capabilities are recommended to include but not be limited to:

– Converged voice and video capabilities;
– Converged message capabilities;
– Converged QoS control capabilities;
– FMC network slice control capabilities;
– Multi-access edge computing capabilities;
– Service continuity capabilities;
– Network status capabilities;
– Network authorization capabilities.

The desensitized user data is recommended to include but not be limited to:

– Converged desensitized user location;
– Converged desensitized user trajectory;
– Converged desensitized user behaviours.

7.2.4 Authentication and authorization

Authentication and authorization function is designed to support fixed mobile convergence, in the way that existing functions of authentication and authorization for fixed network and mobile network are reconstructed and merged as one function, providing unified authentication and authorization for end users.

7.2.5 Address allocation

Address allocation function is designed to support fixed mobile convergence, in the way that existing functions of address allocation for fixed network and mobile network are reconstructed and merged as one function, providing unified address allocation for end users.

7.2.6 Charging

Charging function is designed to support fixed mobile convergence, in the way that existing functions of online charging and offline charging for fixed network and mobile network are reconstructed and merged as one function, providing unified charging for end users.

7.2.7 Policy

Policy is designed to support fixed mobile convergence, in the way that existing functions of policy control and policy management for fixed network and mobile network are reconstructed and merged as one function, providing unified policy for end users.

7.2.8 Lawful interception

Lawful interception is designed to support fixed mobile convergence, in the way that existing functions of lawful interception for fixed network and mobile network are reconstructed and merged as one function, providing the operators with the capability of unified lawful interception.

8 Functional architecture for supporting fixed mobile convergence in IMT-2020 networks

8.1 Architecture of FMC in IMT-2020 networks

Figure 3 presents the architecture of FMC in IMT-2020 networks, which consists of UNIC-CP, UNIC-UP, converged user data, service chain, management and orchestration, and with reference points Uc, Ud, Umo.

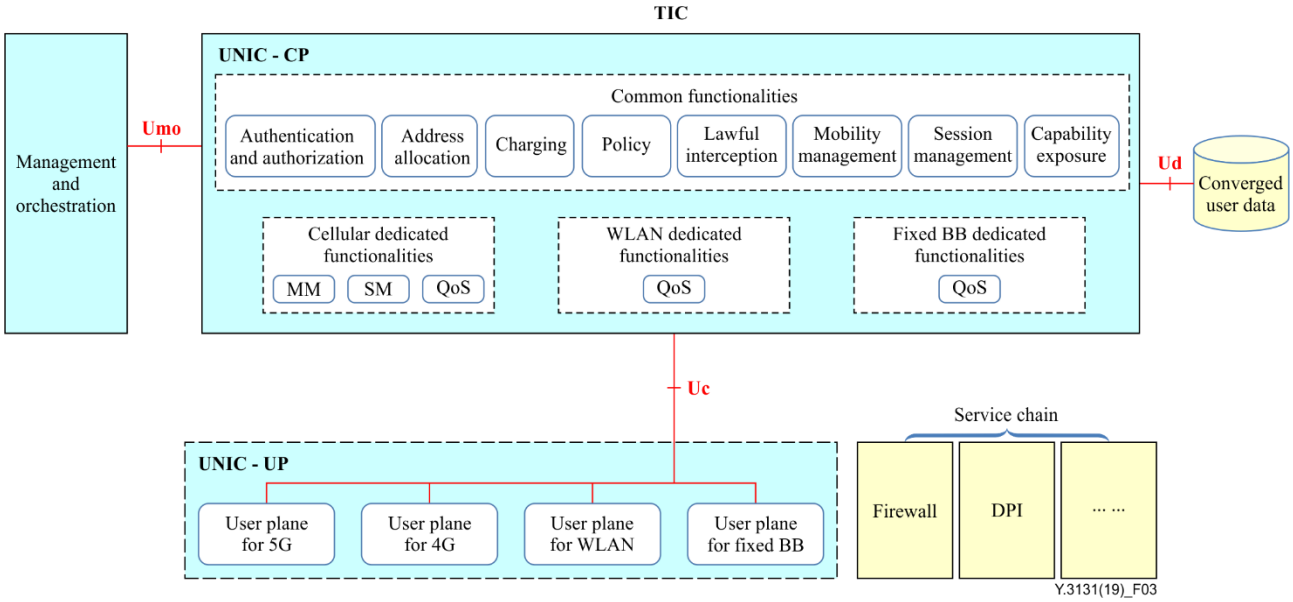

Figure 3 – Architecture of FMC in IMT-2020 networks

8.2 Architecture of FMC in IMT-2020 networks functional description of network functions

The functional description of architecture of FMC in IMT-2020 networks is as follows. The high-level description of functionalities is presented in clause 7.2.

1) UNIC-CP, which takes most of the control logics. The UNIC-CP component consists of common functionalities, cellular dedicated functionalities, WLAN dedicated functionalities and fixed BB dedicated functionalities, in which common functionalities consist of authentication and authorization, address allocation, charging, policy, lawful interception, mobility management, session management and capability exposure functions. UNIC-CP addresses the issues of fixed mobile convergence, in the way that existing functions of the fixed side and mobile side are reconstructed and merged to provide the unified control logics. UNIC-CP is cloud based, supporting auto-scaling, flexible function deployment and quick business on-line with the support of management and orchestration.

2) UNIC-UP, which provides packets switching under instruction of UNIC-CP. The UNIC-UP component consists of user plane for 5G, user plane for 4G, user plane for WLAN and user plane for fixed broadband functions. UNIC-UP is cloud based, supporting flexible function deployment.

3) Converged user data, which is the central data repository, in which most of the permanent and temporary data is stored. The converged user data component consists of converged user data, group user data and unified user data management functions. Converged user data is cloud based, supporting flexible function deployment.

4) Service chain, which is a supplementary to the UNIC-UP and provides user plane enhancement features. The service chain component consists of firewall, load balance and DPI functions. Service chain is cloud based, supporting flexible function deployment.

5) Management and orchestration, which provides the functions of network management, service management, user management and resource orchestration. The management and orchestration component includes the following aspects: Resource aspect, Service aspect and User aspect. Management and orchestration is cloud based, supporting flexible function deployment. The functional description of the management and orchestration component follows general management and orchestration related standards of ITU-T and other SDOs.

8.3 Architecture of FMC in IMT-2020 networks reference points

This clause describes the FMC related reference points as shown in Figure 3.

Reference point Uc

Reference point Uc exists between UNIC-CP and UNIC-UP. It allows UNIC-CP and UNIC-UP to interact for user access, traffic steering rules delivering, policy installation and event reporting (e.g., reporting user traffic volume, reporting user access status).

Reference point Ud

Reference point Ud exists between UNIC-CP and converged user data. It allows UNIC-CP to interact with converged user data repository for user authentication and authorization, user data downloading and updating, user information query, user data restoration, desensitized user data exposure, etc.

Reference point Umo

Reference point Umo exists between UNIC-CP and management and orchestration. It allows UNIC-CP to interact with management and orchestration for network management, service management, user management and resource orchestration. This reference point is addressed in general management and orchestration related standards of ITU-T and other SDOs.

9 General security considerations

The FMC in IMT-2020 should take into account the issues of security and privacy. Each component of the FMC network should adopt the measures of network information protection and user information protection, to avoid unauthorized access and information leaking.

Security and privacy concerns should be aligned with the requirements specified in [ITU-T Y.3101] and [ITU-T Y.2701].

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

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