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NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Future networks

Fixed, mobile and satellite convergence – Requirements for IMT-2020 networks and beyond

Recommendation ITU-T Y.3200

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Recommendation ITU-T Y.3200

Fixed, mobile and satellite convergence – Requirements for IMT-2020 networks and beyond

Summary

Recommendation ITU-T Y.3200 specifies the service requirements, network capability requirements, and use cases of fixed, mobile and satellite convergence in the context of the IMT-2020 networks and beyond. Fixed, mobile and satellite convergence (FMSC) are the capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used and independently of the users' location.

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FOREWORD

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Fixed, mobile and satellite convergence – Requirements for IMT-2020 networks and beyond

1 Scope

This Recommendation specifies the service requirements, network capability requirements, and use cases of fixed, mobile and satellite convergence (FMSC) in the IMT-2020 network and beyond. Fixed, mobile and satellite convergence are the capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used and independently of the users' location. This Recommendation specifies the following aspects of fixed, mobile and satellite convergence in the context of the IMT-2020 network and beyond:

- Service requirements, which include general requirements of converged service and requirements of supported converged services.

- Network capability requirements, which include general requirements of converged network, requirements of converged network functions, and requirements of applying enabling technologies.

- Use cases of fixed, mobile and satellite convergence.

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

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

[ITU-T Y.3130]   Recommendation ITU-T Y.3130 (2018), *Requirements of IMT-2020 fixed mobile convergence*.

[ITU-T Y.3172]   Recommendation ITU-T Y.3172 (2019), *Architectural framework for machine learning in future networks including IMT-2020*.

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 and 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 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].

3.1.5 machine learning (ML) [ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

3.1.6 machine learning overlay [ITU-T Y.3172]: A loosely coupled deployment model of machine learning functionalities whose integration and management with network functions are standardized.

NOTE – A machine learning overlay aims to minimise interdependencies between machine learning functionalities and network functions using standard interfaces, allowing for parallel evolution of functionalities of the two.

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

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

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 fixed, mobile and satellite convergence: The capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used independently of the users' location.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AF	Application Function
AI	Artificial Intelligence
ASF	Authentication Server Function
CEF	Capability Exposure Function
CPE	Customer Premise Equipment
DLT	Distributed Ledger Technology
FMC	Fixed Mobile Convergence
FMSC	Fixed, Mobile and Satellite Convergence
FQDN	Fully Qualified Domain Name
GBR	Guaranteed Bit Rate
GEO	Geostationary Earth Orbit
HEO	Highly Elliptical Orbit
IMSI	International Mobile Subscriber Identity
IoT	Internet of Things
ISDN	Integrated Services Digital Network
LEO	Low Earth Orbit

MEO   Medium Earth Orbit

ML   Machine Learning

MSISDN   Mobile Station ISDN Number

NACF   Network Access Control Function

NFR   Network Function Registry function

NFV   Network Function Virtualization

NGSO   Non-Geostationary Satellite Orbit

NSSF   Network Slice Selection Function

PCF   Policy Control Function

PDU   Protocol Data Unit

QIT   Quantum Information Technology

QoS   Quality of Service

RAN   Radio Access Network

RCS   Rich Communication Suite

SDN   Software-Defined Networking

SMF   Session Management Function

UE   User Equipment

UPF   User Plane Function

URL   Uniform Resource Locator

USM   Unified Subscription Management function

5   Conventions

In this Recommendation:

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

6   Overview

With the development of satellite communications technologies especially low earth orbit (LEO) satellite communications technologies, the technical capabilities of satellite communications are enhanced and the use cases and services of satellite communications are also enriched. It is technically possible that a satellite-based network could complement and interact with IMT-2020 land-based network. Fixed, mobile and satellite convergence are the capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used independently of the users' location. The main purpose of fixed, mobile and satellite convergence for a multi-access network is to federate all means of access technologies including fixed, mobile and satellite accesses, providing users with the capability to access the network ubiquitously and enjoy the best service experience under the circumstance. Users and operators benefit from network convergence of fixed, mobile and satellite, in the aspects of seamless service, connection reliability, service continuity, network efficiency, load balancing, disaster recovery, etc.
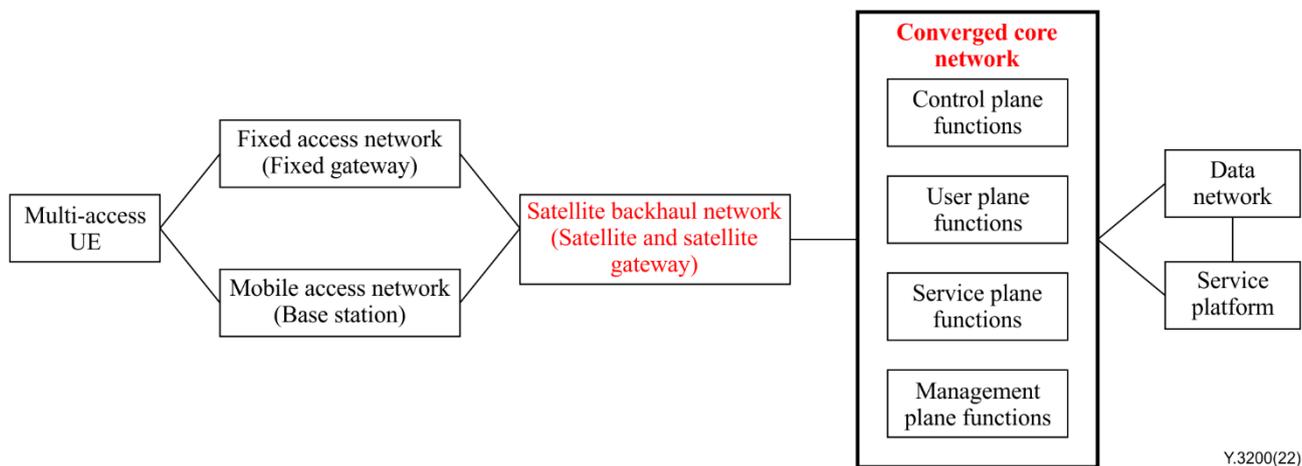
Figure 6-1 depicts the high-level framework of fixed, mobile and satellite convergence in the IMT-2020 network and beyond. In the high-level framework, the multi-access user equipment (UE) has all the fixed access, mobile access and satellite access. Apart from fixed access networks and mobile access networks, satellite access networks including satellites and satellite gateways are introduced. The converged core network has connections to all the access networks, including fixed access networks, mobile access networks, and satellite access networks; it also connects to the service platform and data network. The control plane functions, user plane functions, service plane functions, and management plane functions are included in the converged core network, in which the control plane functions include network access control function (NACF), session management function (SMF), policy control function (PCF), capability exposure function (CEF), network function registry function (NFR), unified subscription management function (USM), network slice selection function (NSSF), authentication server function (ASF), an application function (AF), the user plane functions include user plane function (UPF) for mobile access, UPF for fixed access and UPF for satellite access [ITU-T Y.3102].

A satellite link is used as the backhaul between the converged core network and fixed/mobile access networks as shown in Figure 6-2. The satellite backhaul network consists of one satellite and two satellite gateways. The satellite gateways connecting to the access network and the core network are used for transporting data via the satellite.

Considering the new features such as low bandwidth, high latency, limited capacity, wide coverage, and dynamic topology of satellite communications, some enabling technologies are required to be introduced in fixed, mobile and satellite converged networks, which may include, but are not limited to, mobility management, session management, connection management, subscription management, service continuity, traffic scheduling, network slicing, multi-access edge computing, and network self-organizing. It is also recommended to apply enabling technologies including artificial intelligence (AI)/ML, distributed ledger technology (DLT), and quantum information technology (QIT) in fixed, mobile and satellite converged networks.
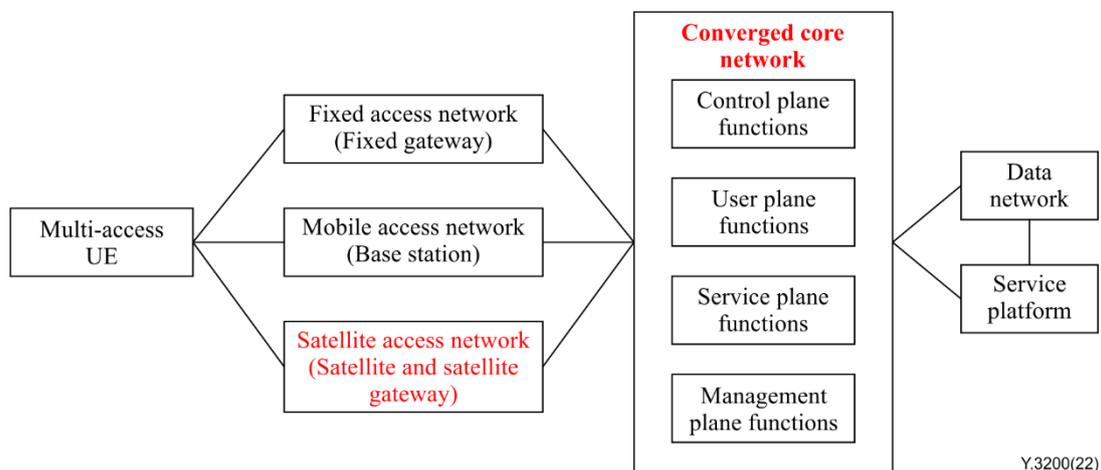
Figure 6-1 – High-level framework of fixed, mobile and satellite convergence from the viewpoint of satellite access

Figure 6-2 – High-level framework of fixed, mobile and satellite convergence from the viewpoint of satellite backhaul

7 Service requirements of fixed, mobile and satellite converged network

7.1 General requirements

The general requirements of fixed, mobile and satellite converged services provided by the IMT-2020 network and beyond are as follows.

In the converged network, the user identity used in the fixed access network, mobile access network, satellite access network, and converged core network is unified, in which the user identity is the identification of the user, including but not limited to mobile station integrated services digital network number (MSISDN) and international mobile subscriber identity (IMSI). The processes of mobility management, session management, subscription management, authentication and authorization, policy control, charging, etc. are based on the unified user identity. It is an enhanced requirement on the basis of [ITU-T Y.3130].

•   It is required for fixed, mobile and satellite converged networks to support a unified user identity.

In the converged network, the seamless service experience is supported, when there is a handover between fixed access and mobile access, or between fixed access and satellite access, or between mobile access and satellite access, or between satellite accesses, no matter if the handover is initiated by the network side or user side. It is an enhanced requirement on the basis of [ITU-T Y.3130].

•   It is required for fixed, mobile and satellite converged network to support service continuity during handover between different access networks.

In the converged network, the best-effort quality of service (QoS) handling and guaranteed bit rate (GBR) QoS handling for fixed access, mobile access, and satellite access are supported. It is an enhanced requirement on the basis of [ITU-T Y.3130].

•   It is required for fixed, mobile and satellite converged networks to support best-effort QoS for supported services and applications.

•   It is recommended for fixed, mobile and satellite converged networks to support GBR QoS for supported services and applications, if network capabilities and network resources allow.

•   It is required for fixed, mobile and satellite converged networks to provide QoS for the services and applications that are better than the corresponding non-converged networks.

In the converged network, the service provision method, service charging method, and user account for fixed access, mobile access, and satellite access are unified. It is an enhanced requirement on the basis of [ITU-T Y.3130].

• It is required for fixed, mobile and satellite converged networks to support unified service provision and unified charging.

In the converged network, various types of user equipment, including but not limited to mobile phones, wearable devices, vehicular devices, customer premise equipment (CPE), satellite terminals are to be supported. It is a new requirement compared to [ITU-T Y.3130].

• It is required for fixed, mobile and satellite converged networks to support various types of user equipment.

Service scheduling is the capability to collect information from the application layer, network layer, and user layer to make service scheduling policies such as traffic scheduling and access selection. In the converged network, service scheduling is supported in a fixed access network, mobile access network, satellite access network, and converged core network to achieve efficient use of network capabilities and better QoS. It is a new requirement compared to [ITU-T Y.3130].

• It is recommended for fixed, mobile and satellite converged networks to support service scheduling among different access networks.

7.2 Service requirements

The service requirements of fixed, mobile and satellite converged services provided by the IMT-2020 network and beyond are as follows.

In the converged network, converged voice services, video services, message services, data services, broadcast services, multicast services are to be supported.

• It is required for fixed, mobile and satellite converged networks to support converged voice services and converged video services.

• It is required for fixed, mobile and satellite converged networks to support converged message services, including short message service, multimedia message service, and rich communication suite (RCS) services.

• It is required for fixed, mobile and satellite converged networks to support converged data services.

• It is required for fixed, mobile and satellite converged networks to support converged broadcast services and converged multicast services.

In the converged network, multi-access edge computing services, vertical industry services, and international services are to be supported.

• It is recommended for fixed, mobile and satellite converged networks to support multi-access edge computing services.

• It is recommended for fixed, mobile and satellite converged networks to support vertical industry services.

• It is recommended for fixed, mobile and satellite converged networks to support international roaming services and international communications services.

8 Network capability requirements of fixed, mobile and satellite converged networks

8.1 General requirements

The general requirements of fixed, mobile and satellite converged networks of IMT-2020 and beyond are as follows.

In the converged network, the control plane for fixed access, mobile access, and satellite access is unified, providing the functions of mobility management, session management, connection management, subscription management, authentication and authorization, policy control, and capability exposure. It is an enhanced requirement on the basis of [ITU-T Y.3130].

• It is required to support fixed, mobile and satellite converged control planes.

In the converged network, the user planes for fixed access, mobile access, and satellite access are separate, they collaborate with each other to provide the functions of traffic routing and forwarding, traffic filtering, traffic off-load, protocol data unit (PDU) session tunnel management, QoS enforcement, service identification, and fully qualified domain name (FQDN)/uniform resource locator (URL) resolution. It is an enhanced requirement on the basis of [ITU-T Y.3130].

• It is required to support fixed, mobile and satellite collaborative user planes.

In the converged network, the service plane for fixed access, mobile access, and satellite access is unified, providing the services and applications specified in clause 7.2 of this Recommendation with the service plane functions inside of the converged core network and the service platform outside of the converged core network. It is a new requirement compared to [ITU-T Y.3130].

• It is required to support fixed, mobile and satellite converged service planes.

In the converged network, the management plane for fixed access, mobile access, and satellite access is unified, providing the functions of network function management, network connection management, service and application management, user management, and resource management and orchestration. It is an enhanced requirement on the basis of [ITU-T Y.3130].

• It is required to support fixed, mobile and satellite converged management planes.

In the converged network, cloud-based infrastructure and corresponding enabling technologies, which include but are not limited to network function virtualization (NFV) and software-defined networking (SDN), are to be supported. It is an enhanced requirement on the basis of [ITU-T Y.3130].

• It is required to support cloud-based infrastructure enabled by NFV and SDN technologies.

In the converged network, enabling technologies include but are not limited to AI/ML, DLT, and QIT. In some use cases, these enabling technologies are expected to be applied in the converged network. Considering the high mobility of non-geostationary satellite orbit (NGSO) satellite, to predict the NGSO satellite connected to the multi-access UE and core network at a specific time, AI/ML could be applied. Considering the satellite network is decentralized, to realize efficient authentication, authorization, information exchange, and information processing between satellites of the same constellation and different constellations, DLT could be applied. Considering the heterogeneity and security issues of the converged network, to realize authentication and authorization with extremely high reliability, QIT could be applied. It is a new requirement compared to [ITU-T Y.3130].

• It is recommended to apply AI/ML related enabling technologies in fixed, mobile and satellite converged networks.

• It is recommended to apply DLT related enabling technologies in fixed, mobile and satellite converged networks.

• It is recommended to apply QIT related enabling technologies in fixed, mobile and satellite converged networks.

8.2 Requirements of converged network functions

8.2.1 Requirements of mobility management

The converged network is required to support unified mobility management for fixed access, mobile access and satellite access. The speed of the satellite is different from that of the earth so the satellite connecting to the UE may be changed to another. The UE on the earth handovers to a new

satellite if possible. If a UE fails to connect to an access network, then different access networks may be connected to the UE. The detailed requirements of mobility management are as follows.

- It is required to support unified UE access control and satellite access control.

NOTE – Satellite access control is the access control of geostationary earth orbit (GEO) satellite (with no mobility) and NGSO satellite (with high mobility) connected to a satellite gateway and a converged core network.

- It is required to support a unified UE registration management and satellite registration management.

- It is required to support a unified UE location management and satellite location management.

- It is required to support a unified UE handover management and satellite handover management.

- It is required to support a unified UE selection and satellite selection of network functions.

- It is recommended to support inter-satellite handover between different satellites.

- It is recommended to support inter-access handover between different accesses.

8.2.2 Requirements of session management

The converged network is required to support unified session management for fixed access, mobile access, and satellite access. The detailed requirements of session management are as follows.

- It is required to support a unified session life cycle management, including control of PDU session tunnel establishment, modification and release.

- It is required to support a unified address allocation.

NOTE 1 – In the fixed access network, mobile access network, satellite access network, and converged core network, the address is allocated by using the same method.

- It is required to support a unified routing selection, including traffic steering, traffic splitting, and traffic switching on both the network side and the user equipment side.

NOTE 2 – Traffic steering refers to selecting access network(s) to transport traffic; traffic splitting refers to dividing traffic into multiple pieces which are transported through access networks; traffic switching refers to moving traffic from one access network to another access network.

- It is required to support a unified session continuity, including the ability of the user to maintain continuity of ongoing sessions while changing between terminal devices and across various accesses and core networks.

NOTE 3 – For example, the user of a terminal may wish to switch from a mobile access network to a satellite access network. This should be supported without any session discontinuity.

8.2.3 Requirements of connection management

The converged network is required to support a unified connection management for fixed access, mobile access and satellite access. The detailed requirements of connection management are as follows.

- It is required to support connection status management, including marking the connection status and efficient utilization of network resources.

- It is required to provide session continuity and service continuity for rapid movement of NGSO satellites.

- It is required to support unified signalling connection management, including establishing, migrating, and releasing a signalling connection between a UE and the control plane functions including NACF.

- It is required to support a unified user plane connection management, including activation, reactivation and deactivation of user plane connections.

- It is required to support dual connectivity, either for transparent or regenerative satellite access and in combination with or without fixed access and mobile access.

NOTE – Dual connectivity includes the addition, modification, and release of secondary user plane connection, transfer of connection information flows between different access networks and different satellites.

8.2.4 Requirements of subscription management

The converged network is required to support a unified subscription management for fixed access, mobile access and satellite access. The detailed requirements of subscription management are as follows.

- It is required to support a unified user data structure, of which the data segments are specific for different types of multi-access users.
- It is required to support a unified user data management.
- It is required to support a user data synchronization between land-based networks and satellite-based networks.

8.2.5 Requirements of authentication and authorization

The converged network is required to support a unified authentication and authorization for fixed access, mobile access and satellite access. The detailed requirements of authentication and authorization are as follows.

- It is required to support a unified authentication and authorization for multi-access UE and corresponding users.
- It is required to support a unified authentication and authorization for converged services and applications.
- It is required to support authentication information synchronization and authorization information synchronization between land-based networks and satellite-based networks.

8.2.6 Requirements of policy control

The converged network is required to support a unified policy control for fixed access, mobile access and satellite access. The detailed requirements of policy control are as follows.

- It is required to support unified policies unrelated to a session, including UE access policy and UE mobility policy.
- It is required to support unified policies related to session, including traffic control policy, QoS control policy, event monitoring policy, usage amount monitoring policy and charging policy.
- It is required to support QoS mechanisms (including best-effort QoS and GBR QoS) for multi-access UE.

8.2.7 Requirements of capability exposure

The converged network is required to support a unified capability exposure for fixed access, mobile access and satellite access. The exposed capabilities include common capabilities of the IMT-2020 network and specific capabilities of fixed, mobile and satellite convergence. The detailed requirements of capability exposure are as follows.

- It is required to support unified exposure of control plane capabilities.
- It is required to support unified exposure of user plane capabilities.
- It is required to support unified exposure of end-to-end QoS capabilities.
- It is required to support unified exposure of network slicing capabilities.
- It is required to support unified exposure of multi-access edge computing capabilities.

- It is required to support unified exposure of network management and orchestration capabilities.
- It is required to support unified exposure of network data analytics capabilities.
- It is required to support unified exposure of multi-access convergence capabilities, including fixed mobile convergence (FMC) capabilities and FMSC capabilities.

8.2.8 Requirements of user planes

The converged network is required to support collaborative user planes for fixed access, mobile access and satellite access. The detailed requirements of the user plane are as follows.

- It is required to support unified traffic routing and forwarding.
- It is required to support unified traffic filtering.
- It is required to support unified traffic off-load.
- It is required to support unified PDU session tunnel management.
- It is required to support unified QoS enforcement.
- It is required to support unified service identification.
- It is required to support unified FQDN/URL resolution.

8.2.9 Requirements of service planes

The converged network is required to support a converged service plane for fixed access, mobile access and satellite access. The detailed requirements of a service plane are as follows.

- It is required to support the service plane functions (inside of the converged core network).
- It is required to support the service platform (outside of the converged core network).

NOTE – The service plane functions, and the service platform work together to provide the services and applications specified in clause 7.2.

8.2.10 Requirements of management plane

The converged network is required to support a converged management plane for fixed access, mobile access and satellite access. The detailed requirements of a management plane are as follows.

- It is required to support unified network function management and network connection management.
- It is required to support unified service and application management.
- It is required to support unified user management.
- It is required to support unified resource management and orchestration.

8.2.11 Requirements of satellite classes

A couple of satellite classes are identified [b-3GPP TR 22.822]. The class is fundamentally defined based on the altitude of the satellite position. The following describes several classes.

– GEO satellites: It is located precisely in the plane of the Equator at an altitude of 35 786 km and these satellites rotate at the same rate as the Earth's rotation.

– NGSO satellites: NGSO satellites do not stand still with respect to Earth. In order to support service continuity over time, several satellites (a constellation) are required to meet this requirement.

Different classes of NGSO satellites are listed below.

– LEO satellites with altitudes ranging from 500 km to 2 000 km.

– Medium earth orbit (MEO) satellites with altitude ranging from 8 000 km to 20 000 km.

– Highly elliptical orbit (HEO) satellites with a range of operational altitudes between 7 000 km and more than 45 000 km.

As described above each satellite class can have different QoS requirements (e.g., latency) since the QoS is closely related to the altitude of the satellite position.

The general requirements of fixed, mobile and satellite converged networks of IMT-2020 and beyond are as follows.

• IMT-2020 is recommended to support all of the satellite classes, as many as possible.

• IMT-2020 is required to support at least one satellite class.

• IMT-2020 is required to select a proper satellite class for meeting QoS requirements (e.g., latency).

8.2.12 Requirements of satellite link

A satellite link [b-3GPP TR 22.822] is applied to a satellite access and a satellite backhaul. The satellite access is used for connecting to a UE and a satellite gateway inside the access network. The capabilities of UE support satellite access as well as fixed / mobile accesses. On the other hand, the satellite backhaul is used for transporting data between the access network and the core network. In this case, the UE would be capable of fixed / mobile accesses only.

The requirements of satellite links for fixed, mobile and satellite converged networks of IMT-2020 and beyond are as follows.

• IMT-2020 is required to support at least one satellite link, either satellite access or satellite backhaul.

• IMT-2020 is recommended to support all of the satellite links as many as possible.

8.2.13 Requirements of multi-connectivity

A UE has different access interfaces such as terrestrial and satellite. The satellite access interfaces are LEO, MEO, and GEO. The UE may support multiple satellite access interfaces. In this condition, the UE can appropriately select a single access interface that matches the feature of the requesting service. Furthermore, the UE can use multiple access interfaces at the same time and transmit more data by aggregating the accesses. In other words, it is considered as multi-connectivity.

Multi-connectivity may be applied to backhaul between radio access network (RAN) node and a core network.

The requirements of multi-connectivity for fixed, mobile and satellite converged networks of IMT-2020 and beyond are as follows.

• IMT-2020 is required to select a single access interface that matches the feature of a requesting service.

• IMT-2020 is recommended to support multi-connectivity.

8.3 Requirements of applying enabling technologies

8.3.1 Requirements of applying AI/ML

The converged network is recommended to support AI/ML in the aspects of mobility management, connection management, subscription management, policy control, capability exposure, network self-organizing, and management and orchestration.

The converged network is recommended to support the high-level architectural requirements of the AI/ML overlay.

NOTE 1 – The use case of applying AI/ML in the FMSC network includes predicting the NGSO satellite connected to the multi-access UE and the core network at a specific time, in which AI/ML could accelerate the process of prediction and increase the accuracy of prediction.

NOTE 2 – AI/ML overlay is specified in [ITU-T Y.3172].

8.3.2 Requirements of applying DLT

The converged network is recommended to support DLT in the aspects of mobility management, session management, connection management, authentication and authorization, and network self-organizing.

NOTE – The use case of applying DLT in the FMSC network includes realizing efficient authentication, authorization, information exchange and information processing between satellites of the same constellation and of different constellations, in which DLT could help to build the FMSC network in a decentralized, trustworthy and efficient way.

8.3.3 Requirements of applying QIT

The converged network is recommended to support QIT in the aspect of authentication and authorization, including the authentication and authorization of land to satellite, satellite to land and inter-satellite.

NOTE – The use case of applying QIT in the FMSC network includes realizing the authentication and authorization between satellites with extremely high reliability, in which QIT could guarantee the security of information being transmitted between network entities.

9 Security considerations

The security and privacy considerations of fixed, mobile and satellite convergence in the IMT-2020 network and beyond include the following aspects.

• Control plane security, which includes the security considerations on NACF, SMF, PCF, CEF, NFR, USM, NSSF, ASF, and AF, which have been enhanced to support fixed, mobile and satellite convergence.

• User plane security, which includes the security considerations on UPF for mobile access, UPF for fixed access, and UPF for satellite access, which have been enhanced to support collaboration in fixed access, mobile access and satellite access.

• Service plane security, which includes the security considerations on converged voice services, video services, message services, data services, broadcast services, multicast services, multi-access edge computing services, vertical industry services, international services, and converged capability exposure and corresponding applications.

• Management plane security, which includes the security considerations on the converged management and orchestration functions of network, capability, service and application, user and resource.

• User privacy, which includes the privacy considerations on converged core network, fixed access network, mobile access network, and satellite access network, which could store, cache and process user data related to privacy.

In addition, the security and privacy considerations of fixed, mobile and satellite convergence should be aligned with the requirements specified in [ITU-T Y.3101] and [b-ITU-T Y.2701].

Appendix I

Use cases of fixed, mobile and satellite convergence

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

The use cases of fixed, mobile and satellite convergence are as follows.

Use case 1: Land-based network with low speed

The use cases of land-based networks with low speed include a remote village, remote settlement, ecoregion, small isle, etc., in which there are land-based networks with low speed, that could not meet the requirements of users and the communications services. Fixed, mobile and satellite convergence facilitates the provision of services specified in clause 7.2 and enhances the QoS in the above use cases.

Use case 2: Land-based network with low capacity

The use cases of land-based networks with low capacity include remote Internet of things (IoT), remote industrial networks, remote vehicular networks, etc., in which there are land-based networks with low capacity, that could not meet the requirements of users and the communications services. Fixed, mobile and satellite convergence facilitates the provision of services specified in clause 7.2 and enhances the QoS in the above use cases.

Use case 3: No land-based network of a specific operator

The use cases of no land-based networks of specific operators include domestic roaming between operators, international roaming between operators and international communications service provision, in which there are no land-based networks of specific operators. The precondition is, the above use cases should conform to the local communications regulations. Given this precondition, the above use cases could be supported with fixed, mobile and satellite convergence. Fixed, mobile and satellite convergence facilitates the provision of services specified in clause 7.2 and enhances the QoS in the above use cases.

Use case 4: Disaster recovery

The use cases of disaster recovery include large-scale disaster recovery and local disaster recovery, where land-based networks cannot work properly, or the capacity of a land-based network cannot meet the requirements of users and the communications services. Fixed, mobile and satellite convergence facilitates the provision of services specified in clause 7.2 and enhances the QoS in the above use cases.

Bibliography

[b-ITU-T Y.2011]   Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks*.

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

[b-ITU-T Y.3100]   Recommendation ITU-T Y.3100 (2017), *Terms and definitions for IMT-2020 network*.

[b-ITU-R M.1645]   Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000*.

[b-3GPP TR 22.822]   3GPP TR 22.822 (2018), Study on using satellite access in 5G, Stage 1 (Release 16).
<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3372>

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