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

Future networks

Requirements of the IMT-2020 network

Corrigendum 1

Recommendation ITU-T Y.3101 (2018) – Corrigendum 1

ITU-T

ITU-T Y-SERIES RECOMMENDATIONS

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

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	**Y.3000–Y.3499**
CLOUD COMPUTING	Y.3500–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	Y.4100–Y.4249
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899
Evaluation and assessment	Y.4900–Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.3101

Requirements of the IMT-2020 network

Corrigendum 1

Summary

Recommendation ITU-T Y.3101 describes requirements of the international mobile telecommunications 2020 (IMT-2020) network.

Recommendation ITU-T Y.3101 first provides general principles of the IMT-2020 network, then specifies requirements for overall non-radio aspects of the IMT-2020 network from both the service and network operation points of view.

Corrigendum 1 adds a clarification, and adapts the Recommendation accordingly.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3101	2018-01-13	13	11.1002/1000/13466
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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

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Table of Contents

Recommendation ITU-T Y.3101

Requirements of the IMT-2020 network

Corrigendum 1

Editorial note: This is a complete-text publication. The modifications introduced by this corrigendum are shown in revision marks relative to Recommendation ITU-T Y.3101 (2018).

1 Scope

This Recommendation describes requirements of the international mobile telecommunications 2020 (IMT-2020) network.

The Recommendation first provides general principles of the IMT-2020 network, then specifies requirements for overall non-radio aspects of the IMT-2020 network from both the service and network operation points of view.

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.3110] Recommendation ITU-T Y.3110 (2017), *IMT-2020 network management and orchestration requirements*.

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

[ITU-R M.2083-0] Recommendation ITU-R M.2083-0 (2015), *IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 backhaul [b-ITU-T Y.3100]: A network path between base station systems and a core network.

3.1.2 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.

3.1.3 evolved IMT-advanced RAT [b-ITU-T Y.3100]: The enhanced version of IMT-advanced radio access technologies (RATs).

NOTE – IMT-advanced is the ITU's official terminology for so-called LTE-advanced.

3.1.4 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.

3.1.5 fronthaul [b-ITU-T Y.3100]: A network path between centralized radio controllers and remote radio units of a base station function.

3.~~2~~1.~~1~~6 IMT-2020 [b-ITU-T Y.3100]): Systems, system components, and related aspects 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.~~6~~7 logical resource [b-ITU-T Y.3011]: An independently manageable partition of a physical resource, which inherits the same characteristics as the physical resource and whose capability is bound to the capability of the physical resource.

NOTE – "independently" means mutual exclusiveness among multiple partitions at the same level.

3.1.~~7~~8 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.~~8~~9 network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

NOTE 1 – Network functions include but are not limited to network node functionalities, e.g., session management, mobility management and transport functions, whose functional behaviour and interfaces are defined.

NOTE 2 – Network functions can be implemented on a dedicated hardware or as virtualized software functions.

NOTE 3 – Network functions are not regarded as resources, but rather any network functions can be instantiated using the resources.

3.1.~~9~~10 network functions virtualization (NFV) [b-ETSI GS NFV 003]: Principle of separating network functions from the hardware they run on by using virtual hardware abstraction.

3.1.11~~0~~ network slice [b-ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.1.12~~1~~ network slice instance [b-ITU-T Y.3100]: An instance of network slice, which is created based on a network slice blueprint.

NOTE 1 – A network slice instance is composed of a set of managed run-time network functions, and physical/logical/virtual resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the service instance(s).

NOTE 2 – A network slice instance may also be shared across multiple service instances provided by the network operator. A network slice instance may be composed of none, one or more sub-network slice instances which may be shared with another network slice instance.

3.1.13~~2~~ network softwarization [b-ITU-T Y.3100]: An overall approach for designing, implementing, deploying, managing and maintaining network equipment and/or network components by software programming.

NOTE – Network softwarization exploits the nature of software such as flexibility and rapidity all along the lifecycle of network equipment and/or components, for the sake of creating conditions that enable the re-design of network and services architectures, the optimization of costs and processes, self-management and bring added values in network infrastructures.

3.1.14~~3~~ network virtualization [b-ITU-T Y.3011]: A technology that enables the creation of logically isolated network partitions over shared physical networks so that heterogeneous collection of multiple virtual networks can simultaneously coexist over the shared networks. This includes the aggregation of multiple resources in a provider and appearing as a single resource.

3.1.15~~4~~ nomadism [b-ITU-T Q.1761]: Ability of the user to change his network access point after moving; when changing the network access point, the user's service session is completely stopped and then started again, i.e., there is no handover possible. It is assumed that the normal usage pattern is that users shutdown their service session before moving to another access point or changing terminal. This is the mobility alluded to in the case of fixed mobile convergence.

3.1.16~~5~~ orchestration [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at the automated arrangement, coordination, instantiation and use of network functions and resources for both physical and virtual infrastructures by optimization criteria.

3.1.17~~6~~ physical resource [b-ITU-T Y.3100]: A physical asset for computation, storage and/or networking.

NOTE – Components, systems and equipment can be regarded as physical resources.

3.1.18~~7~~ software-defined networking [b-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.

3.1.19~~8~~ third party (3rd party) [ITU-T Y.3100]: In the context of IMT-2020, with respect to a given network operator and network end-users, an entity which consumes network capabilities and/or provides applications and/or services.

NOTE 1 – An example of 3rd party, a virtual network operator (VNO) may use capabilities exposed by a network operator, e.g., to manage specific network slices. Another example of 3rd party, a service and/or application provider (e.g., an over the top (OTT) player) may provide applications and/or services to enhance the network capabilities.

NOTE 2 – Network end-users are not regarded as 3rd parties.

3.1.~~19~~20 user plane [b-ITU-T Y.1714]: This refers to the set of traffic forwarding components through which traffic flows.

NOTE – "User plane" is referred to as "data plane" or "transport plane" in other ITU-T Recommendations.

3.1.21~~0~~ virtual resource [b-ITU-T Y.3011]: An abstraction of physical or logical resource, which may have different characteristics from the physical or logical resource and whose capability may be not bound to the capability of the physical or logical resource.

3.2 Terms defined in this Recommendation

~~This Recommendation defines the following term:~~

~~**3.2.1 IMT-2020** (Based on [ITU-R M.2083-0]): Systems, system components, and related aspects 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.~~

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3D Three Dimensional

4G fourth Generation

API Application Programming Interface

AR Augmented Reality

DSCP	Differentiated Service Code Point
E2E	End-to-End
ICN	Information Centric Networking
IMT	International Mobile Telecommunications
IP	Internet Protocol
IoT	Internet of Things
LTE	Long-Term Evolution
MBH	Mobile Backhaul
MFH	Mobile Fronthaul
MTC	Machine Type Communication
MVNO	Mobile Virtual Network Operator
NFV	Network Functions Virtualization
NGN	Next Generation Network
OAM	Operation, Administration and Maintenance
QCI	QoS Class Indicator
QoS	Quality of Service
RAN	Radio Access Network
RAT	Radio Access Technology
SDN	Software-Defined Networking
UE	User Equipment
UHD	Ultra-High Definition
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.

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 or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Introduction to the IMT-2020 network

According to [ITU-R M.2083-0], IMT-2020 can be seen as "systems, system components, and related aspects that provide far more enhanced capabilities than those described in [b-ITU-R M.1645]". Note that [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.

The IMT-2020 network will differentiate itself from fourth generation (4G) networks [b-ITU-R M.2012] for not only further evolution in terms of radio performance, but also greatly increased end-to-end (E2E) flexibility. This E2E flexibility will come in large part from the introduction of the network softwarization approach [b-ITU-T Y.3150] in IMT-2020 network components. Technologies such as software-defined networking (SDN) [b-ITU-T Y.3300], network functions virtualization (NFV) [b-ETSI NFV-WP1] [b-ETSI NFV-WP5G] and cloud computing [b-ITU-T Y.3501] will together allow unprecedented flexibility in the IMT-2020 network. Such flexibility will enable a lot of new capabilities in the IMT-2020 network, including network slicing [b-ITU-T Y-Sup.44].

IMT-2020 is essentially not about an increase in bandwidth with respect to legacy IMT networks [b-ITU-R M.1457] [b-ITU-R M.2012], but rather about various fundamental strategic objectives in terms of deployment efficiency and flexibility, including:

– minimized dependency on access network technologies; coping with traffic explosion in urban areas;
– easy incorporation of future emerging services;
– provision of a cost-efficient infrastructure;
– expansion of the geographic reach of the network.

The services expected to be supported by the IMT-2020 network can be classified into three categories [ITU-R M.2083-0]: enhanced mobile broadband services; ultra-reliable and low-latency communication-based services; and massive machine type communication- (MTC-) based services.

Enhanced mobile broadband services allow users to experience high-speed and high-quality multimedia services, e.g., virtual reality, augmented reality (AR), 4K or 8K ultra-high-definition (UHD) videos and even hologram services, at any time and place.

Ultra-reliable and low-latency communications enable delay-sensitive and mission-critical services that require very low E2E delay, e.g., tactile Internet, remote control of medical or industrial robots, driverless cars and real-time traffic control.

Massive MTCs enable services involving massive numbers of MTC devices.

NOTE – A number of design principles and requirements specified in clauses 7 to 9 are based on relevant studies of different expert groups, including, but not limited to, [b-FG IMT2020-Gap], [b-ITU-T Y.4100], [b-ITU-T Y.4113], [b-NGMN-WP5G] and [b-3GPP TS 22.261].

7 General principles of the IMT-2020 network

7.1 Service diversity

The IMT-2020 network should support diversified services accommodating a wide variety of traffic characteristics and behaviours.

NOTE – This includes the support of a huge number and wide variety of communication objects, such as user devices, peripheral devices, and MTC devices.

7.1.1 Diversity of quality of service requirements

The IMT-2020 network should support services with diversified E2E quality of service (QoS) requirements including, but not limited to, data rate, reliability and latency.

7.1.2 Diversity of mobility levels

The IMT-2020 network should support a wide range of mobility levels.

NOTE – It is expected that the mobility requirements will vary depending on the device or service type. Therefore, the IMT-2020 network should not assume the same mobility support for all devices and services, but rather provide the appropriate mobility level according to requirements. In general terms, the IMT-2020 network should enable the appropriate mobility in high-speed and large-scale networks, where a huge number of pieces of user equipment (UE) can dynamically move across heterogeneous access networks.

7.1.3 Diversity of user data types

The IMT-2020 network should be capable of handling both Internet protocol (IP) and non-IP user data, which may vary from service to service.

7.1.4 Diversity of traffic patterns

The IMT-2020 network should support diverse traffic patterns efficiently.

NOTE – The IMT-2020 network should cope with diverse traffic patterns, e.g., short lived burst traffic, long lived burst traffic, high throughput traffic, delay sensitive traffic and non-real-time traffic.

7.2 Common core network with minimized access network technology dependency

In legacy IMT networks, the introduction of a new technology in the access segment of the network has been accompanied by a new type of core network, and the consequent need for interworking between the new core and legacy core networks has always been a technical challenge.

The IMT-2020 network architecture is envisioned to be access network-agnostic, and with a core network common to radio access technologies (RATs) for IMT-2020, as well as existing fixed and wireless networks. The IMT-2020 core network should be accompanied by common control mechanisms that are decoupled from the access network technologies.

NOTE – The IMT-2020 network should support new RATs for IMT-2020, evolved IMT-advanced RATs, wireless LAN (WLAN) access networks, fixed broadband network access, and satellite networks. The use of satellite technologies can provide advantages in sparsely populated, unserved or underserved areas.

7.3 Flexibility and programmability

The IMT-2020 network should be flexible and extensible to cope with various, and sometimes even conflicting, service requirements in an adaptive way, instead of requiring the deployment of a separate dedicated network for each specific service.

The IMT-2020 network should support a clear separation between control plane and user plane functions to make the IMT-2020 network flexible and extensible.

NOTE 1 – Standardized interfaces for the separation between control plane and user plane should be provided.

The IMT-2020 network should support programmable allocation and configuration of functions, services and applications, as well as dynamic scale-in and scale-out.

The IMT-2020 network should support the virtualization of resources associated with network functions.

The IMT-2020 network should support on-demand composition of multiple network slices with diverse characteristics.

The IMT-2020 network should support isolation between network slice instances, with different isolation levels depending on the requirements of each network slice.

NOTE 2 – As an example, in specific network situations, this would allow the pre-emption of the resources of a network slice instance with a given isolation level by other network slice instances with higher isolation levels.

7.4 Distributed network architecture

The IMT-2020 network should be flexible enough to handle the explosive increase of traffic from emerging bandwidth-hungry services such as UHD television (TV), AR, video conferencing and remote medical surgery.

A heavily centralized architecture on to an anchor node of legacy IMT networks is expected not to satisfy the requirements associated with the explosion in mobile data traffic. This implies that the gateways to the core network are expected to be located closer to the network edges, resulting in a distributed network architecture.

NOTE – The distributed network architecture is expected to bring a significant reduction of backhaul and core network traffic by enabling the placement of content servers closer to the end user devices and also to be beneficial in terms of service latency.

7.5 In-network data processing

The IMT-2020 network should be designed and implemented to handle huge amounts of data efficiently. Therefore, the IMT-2020 network should have mechanisms that allow users to retrieve data promptly regardless of their location. In-network data processing can provide the means for network-wide data processing and application services in network nodes.

NOTE – The support of data processing and application services, as well as storage capabilities, by IMT-2020 network nodes, may allow, where and when required, reductions ine network congestion and improvements in service response time. Technologies enabling in-network data processing capabilities include information centric networking (ICN), on-path data processing and edge computing [b-ETSI MEC-WP].

7.6 Network management

Management and orchestration for the IMT-2020 network should support both legacy networks as well as evolving networks in an integrated manner [ITU-T Y.3110].

In line with the introduction of the network softwarization approach in IMT-2020 network components, the network management functions should be able to manage both physical and virtual resources.

The IMT-2020 network should be designed to keep the operations and management of the network simple, despite its increased complexity due to network softwarization.

The operation and management procedures should be automated as much as possible, with well-defined open interfaces to mitigate multi-vendor interworking problems, as well as interoperability issues.

The IMT-2020 network should support standardized common operation and management protocols.

NOTE – The application of artificial intelligence technologies to the IMT-2020 network is expected to provide promising supporting tools for - but not limited to - advanced network management and operations, including self-healing, self-organization, self-adaptation and self-optimization mechanisms.

7.7 Dynamic and intelligent control of user data transport

The IMT-2020 network should provide dynamic control of user data transport, adapting to the change of service requirements related to user data transport performance.

The IMT-202 network should provide dynamic and intelligent data routing and forwarding mechanisms in order to adapt to changing network conditions.

7.8 Reliability and resiliency

The IMT-2020 network should be designed and operated with reliability and resiliency.

NOTE – Reliable and resilient operations are particularly critical if network congestion and disaster situations occur.

The reliability and resiliency of the IMT-2020 network should not be compromised by software or hardware network upgrades.

7.9 Security and personal data protection

The IMT-2020 network should support security and personal data protection, including consideration of confidentiality, integrity and availability.

7.10 Energy efficiency

The IMT-2020 network should be designed with a goal of achieving energy efficiency in overall network operations, including minimization of UE power consumption.

NOTE –The future availability of standardized methods and metrics to evaluate energy efficiency in the IMT-2020 network [b-ITU-T L.Sup. 36] is for consideration.

8 Requirements from the service point of view

8.1 Enhanced mobile broadband services

8.1.1 Description

More and more user devices are being equipped with enhanced media consumption capabilities, such as UHD display, multi-view high-definition display, mobile three dimensional (3D) projections, immersive video conferencing, AR and mixed reality display and interface. This will lead to a demand for significantly higher data rates in the IMT-2020 network.

In addition, the demand for mobile high-definition multimedia keeps increasing in many areas beyond entertainment, as reflected in the performance targets for connection density and area traffic capacity contained in [ITU-R M.2083-0].

8.1.2 Requirements

[REQ] The IMT-2020 network is required to support capabilities to cope with the explosion in mobile data traffic.

NOTE 1 – Distribution of network functions at the network edge can be considered.

[REQ] The IMT-2020 network is recommended to be flexible and resilient to support ultra-high bandwidth services.

NOTE 2 – Enhanced capabilities for consideration include simplified session or bearer management mechanisms, efficient multicast methods, distribution of network functions at the network edge, network slicing and efficient codecs.

[REQ] The IMT-2020 network is recommended to support local offloading in an efficient manner.

[REQ] The IMT-2020 network is required to support diverse mobile fronthaul (MFH) and mobile backhaul (MBH) technologies in order to cope with extreme traffic or connection density.

8.2 Massive machine type communication-based services

8.2.1 Description

In the IMT-2020 network, almost every object that can benefit from being connected is expected to be connected, leading to a huge number of connected devices. These connected devices can range from low-complexity to highly complex and advanced devices. As more and more devices get connected, many new services that benefit from the devices connected will appear (e.g., services for smart grid, agriculture, healthcare, vehicle-to-vehicle and vehicle-to-road infrastructure).

The IMT-2020 network needs to provide mechanisms to support consistent E2E QoS and minimize traffic congestion situations for a massive number of MTC devices.

8.2.2 Requirements

[REQ] The IMT-2020 network is required to support a massive number of MTC devices in an efficient way.

NOTE 1 – Example traffic patterns include short and massive burst traffic, delay sensitive and non-sensitive traffic.

NOTE 2 – Example communication types include unicast, multicast and broadcast communications.

[REQ] The IMT-2020 network is required to minimize traffic congestion that can be caused by a massive number of MTC devices.

[REQ] The IMT-2020 network is required to support consistent E2E QoS even in the presence of a large number of concurrent connections.

8.3 Ultra-reliable and low latency communication-based services

8.3.1 Description

Services with high-reliability and real-time constraints are essential if they are to be supported on the IMT-2020 network.

8.3.2 Requirements

[REQ] The IMT-2020 network is required to support increased service reliability according to service requirements.

NOTE 1 – Considerations for increased service reliability include the ability to replicate and cache contents in network nodes.

[REQ] The IMT-2020 network is required to provide enhanced service performance by reducing E2E latency according to service requirements.

NOTE 2 – In addition to reducing transport delay, enhanced signalling may be used to lower E2E latency.

9 Requirements from the network operation point of view

9.1 Network flexibility and programmability

9.1.1 Description

The IMT-2020 network is required to be flexible enough to support diverse requirements of devices, users and applications.

The IMT-2020 network is envisioned as one where multiple logical network instances tailored to various requirements can be created. Network slicing allows the IMT-2020 network operator to provide dedicated logical networks (i.e., network slices) with customer-specific functionalities. A network slice, spanning all network segments including radio access network, transport network and core network, can be dedicated to specific types of service. Different network slices can be composed not only of standardized network functions, but also of proprietary network functions.

The separation between control plane and user plane is another basic feature for realization of network flexibility: this separation allows both planes to evolve independently of each other.

NFV is expected to play a significant role in making the IMT-2020 network more flexible and programmable by realizing network components as software components. The separation between control plane and user plane can also make the network programmable by controlling or steering of traffic depending on user-specific requirements and service requirements.

NOTE – Not all required network functions are expected to be softwarized, mainly for performance reasons.

9.1.2 Requirements

[REQ] The IMT-2020 network is required to support programmability of network functions for easier service provision.

NOTE 1 – The programmability requirements of the IMT-2020 network depend on the characteristics of different services. In-network data processing and NFV may be supporting capabilities to cope with diverse requirements on the user plane.

[REQ] The IMT-2020 network is required to support the separation of control and user plane functions.

[REQ] The IMT-2020 network is required to have the ability to manage the lifecycle of network slices.

NOTE 2 – The lifecycle management of network slices includes their creation, update and deletion.

NOTE 3 – A network slice can be created dynamically to form a complete and fully operational network customized to cater for different diverse service scenarios. The ability to compose multiple network slices by the IMT-2020 network operator is expected, e.g., for hosting in the IMT-2020 network multiple enterprises or mobile virtual network operators (MVNOs).

NOTE 4 – This includes the management of the lifecycle of network slices according to the requirements of third parties.

[REQ] The IMT-2020 network is required to enable the isolation between different network slice instances.

NOTE 5 – The isolation levels can vary depending on the requirements of each network slice.

[REQ] The IMT-2020 network is required to have the ability to assign priorities to network slices.

NOTE 6 – The priorities can be used to resolve conflicts in provisioning resources among competing network slice instances.

[REQ] The IMT-2020 network is required to support dynamic scale-in and scale-out of resources in a network slice with minimum service impact.

[REQ] The IMT-2020 network is required to provide application programming interfaces (APIs) to manage the network slice lifecycle.

NOTE 7 – Depending on the IMT-2020 network operator's policy, third parties can be allowed to manage the lifecycle of specific network slices using APIs.

[REQ] The IMT-2020 network is required to identify the association of UEs with a network slice.

NOTE 8 – Users can obtain services from one or more specific network slices based on user subscription, context, service provider's policy, etc. A UE may access multiple slices simultaneously, e.g., via a single radio access network (RAN), and may provide information to the network to assist the network slice selection process.

[REQ] The IMT-2020 network is required to have the capability to meet service-specific security assurance requirements in each network slice.

[REQ] The IMT-2020 network is required to support network slice selection capability when multiple network slices are available.

[REQ] The IMT-2020 network is required to consider QoS requirements and types of network slice when selecting a proper network slice.

[REQ] The IMT-2020 network is recommended to consider context information such as UE location when selecting a proper network slice.

[REQ] The IMT-2020 network is recommended to support dynamic scale-in and scale-out of virtualized network functions according to the IMT-2020 network operator's policy.

9.2 Fixed mobile convergence

9.2.1 Description

Interworking among multiple heterogeneous access networks including WLANs is becoming prevalent in legacy networks. The trend is expected to continue also in the IMT-2020 network, but with more advanced and efficient ways to realize interworking. Multi-connectivity through multiple access networks can improve the robustness of the network as well as the throughput performance. In particular, dual connectivity through the legacy IMT access network and IMT-2020 access network can facilitate a smooth introduction of the IMT-2020 network.

The IMT-2020 network is envisioned to have an access network technology-agnostic architecture, with a core network common to the diverse access networks. The access network technology-agnostic common core network is expected to be accompanied by common control mechanisms that are decoupled from the access network technologies (such as the mechanisms for network attachment and authentication).

Details about fixed-mobile convergence requirements can be found in [ITU-T Y.3130].

9.2.2 Requirements

[REQ] The IMT-2020 network is required to support new IMT-2020 RATs, evolved IMT-advanced RATs, WLAN access networks, and fixed broadband access networks.

[REQ] The IMT-2020 network is required to minimize access network technology dependency in order to allow independent evolution of core network and access networks.

[REQ] The IMT-2020 network is required to support the simultaneous use of multi-access network connections.

[REQ] The IMT-2020 network is required to support multi-access network coordination for traffic steering and selection of appropriate access network technology.

9.3 Enhanced mobility management

9.3.1 Description

The IMT-2020 network should support a wide range of mobility options. While mobility is not required for some stationary devices, such as smart meters and customer premises equipment (CPE) devices, there are many application scenarios that require high mobility, such as high-speed trains. Another mobility scenario to take into account is when the RAN itself (UEs and base stations) is moving, such as on a ship or aeroplane. The service continuity levels may also vary, including seamless mobility and nomadism [b-ITU-T Q.1761].

9.3.2 Requirements

[REQ] The IMT-2020 network is required to support enhanced mobility management considering context information, such as device types and application characteristics.

NOTE 1 – It is expected that mobility requirements for user devices will be variable depending on the device or application types.

[REQ] The IMT-2020 network is required to have the ability to assist mobile devices to choose the most suitable access network(s) among those available.

[REQ] The IMT-2020 network is recommended to support distributed mobility management.

NOTE 2 – Mobility management is expected to build on the distributed IMT-2020 network architecture.

[REQ] The IMT-2020 network is recommended to support consistent user experience in compliance with service level agreements while moving across different access networks.

9.4 Network capability exposure

9.4.1 Description

In order to allow third parties to access information regarding capabilities provided by the IMT-2020 network (e.g., information for connectivity, QoS and mobility) and to dynamically customize the network capabilities for diverse use cases within the limits set by the IMT-2020 network operator, the IMT-2020 network should provide suitable ways (e.g., via APIs) to expose network capabilities and relevant information to third parties.

Example scenarios enabled by network capability exposure include third party access to network slice management and installation of third party applications on network edges.

NOTE – The effective exposure of a given set of network capabilities, as well as third party authorization, are subject to the IMT-2020 network operator's policy.

9.4.2 Requirements

[REQ] The IMT-2020 network is required to support the exposure of network capabilities accessible by third parties.

NOTE 1 – The IMT-2020 network should be able to expose network capabilities to third party applications located inside or outside the IMT-2020 network operator's domain.

NOTE 2 – Example scenarios enabled by the exposure of network capabilities include QoS enforcement, charging control, congestion management, service chaining, network slicing and application hosting close to the network edge.

9.5 Identification and authentication

9.5.1 Description

Efficient and effective user and device identification mechanisms are needed in order to cope with the diversity of service and device types to be supported by the IMT-2020 network. Different identification schemes and mechanisms are expected to co-exist in a single IMT-2020 network deployment.

A unified authentication framework across heterogeneous access networks is desirable in the IMT-2020 network.

In particular, a massive number of MTC devices may access the IMT-2020 network and they are in general characterized by low cost, low power consumption, low complexity and low data rate. MTC devices are also restricted by their own limited computing capabilities to handle complex security algorithms. Therefore, efficient authentication mechanisms should be considered to overcome these limitations.

9.5.2 Requirements

[REQ] The IMT-2020 network is required to support efficient and effective user and device identification mechanisms according to service and device types.

NOTE 1 – In particular, efficient and effective identification mechanisms are necessary for the massive number of MTC devices.

[REQ] The IMT-2020 network is required to provide a unified authentication framework for heterogeneous access networks.

NOTE 2 – Backward compatibility with existing authentication mechanisms may not be required in order to support an efficient unified authentication framework.

[REQ] The IMT-2020 network is required to support efficient authentication mechanisms for MTC devices.

9.6 Security and personal data protection

9.6.1 Description

The IMT-2020 network needs to consider ways to preserve security and personal data protection for different types of devices, users and services, including rapid adaptation to dynamic network changes. The security mechanisms need to be able to support security challenges emerging from the proliferation of technologies like the Internet of things (IoT) and virtualization.

Besides methods for ensuring confidentiality, integrity and availability, the IMT-2020 network should support security mechanisms for power or processing constrained devices.

Customized and differentiated security services for devices, users and applications are needed. For example, lightweight security mechanisms are expected for MTC devices.

9.6.2 Requirements

[REQ] The IMT-2020 network is required to support security mechanisms addressing confidentiality, integrity and availability for diverse devices, users and applications.

[REQ] The IMT-2020 network is required to support security mechanisms to provide personal data protection for diverse devices, users and applications.

[REQ] The IMT-2020 network is required to support customized and differentiated security services for different devices, users and applications.

NOTE – Lightweight security mechanisms are expected to be supported for MTC devices that are characterized by low cost, low complexity, low power consumption, low data rate and limited computing capabilities.

9.7 Efficient signalling

9.7.1 Description

In legacy networks, a monolithic signalling mechanism is used for all types of traffic in a uniform way. Traffic characteristics are expected to vary significantly from device to device and from application to application in the IMT-2020 network.

Efficient signalling mechanisms are needed to mitigate risks of control and data traffic bottlenecks, e.g., due to the intermittent short burst traffic of a massive number of MTC devices. Also, lightweight signalling mechanisms should be provided in order to minimize power consumption of MTC devices.

NOTE – There are many other types of device that need fully fledged signalling, e.g., to support stringent mobility requirements.

9.7.2 Requirements

[REQ] The IMT-2020 network is required to provide signalling mechanisms coping with diverse traffic patterns and communication types.

[REQ] The IMT-2020 network is required to provide efficient signalling mechanisms to mitigate risks of control and data traffic bottlenecks.

[REQ] The IMT-2020 network is recommended to provide lightweight signalling to minimize power consumption of MTC devices.

9.8 Quality of service control

9.8.1 Description

The IMT-2020 network is expected to be able to provide the required QoS for a variety of different services with different characteristics. Different services may have different performance requirements in terms of latency, data rate, mobility, etc. Furthermore, some UEs may access more than one service with diverse characteristics simultaneously. In order to satisfy these requirements in a resource efficient manner, the QoS control mechanisms need to differentiate their handling according to service types.

As the IMT-2020 network is expected to support multiple access network technologies, the QoS control mechanisms of the core network need to work independently of access network technologies.

E2E QoS control is needed to support proper QoS interworking (e.g., mapping QoS class indicator (QCI) [b-3GPP TS 23.203] to differentiated service code point (DSCP) [b-RFC 2474]) between the different network segments of the IMT-2020 network.

The IMT-2020 network needs finer QoS granularity than bearer-based granularity of legacy networks, such as flow-based QoS, in order to support diverse performance requirements of services (e.g., ultra-low latency and ultra-high bandwidth).

The IMT-2020 network needs user-initiated QoS control (in addition to network-initiated QoS control) to enable provisioning of user-specified QoS parameters (e.g., maximum bit rate and guaranteed bit rate) in order to support diverse service performance requirements.

9.8.2 Requirements

[REQ] The IMT-2020 network is required to support unified QoS control mechanisms independently of network access technologies.

[REQ] The IMT-2020 network is required to support E2E QoS mechanisms.

[REQ] The IMT-2020 network is required to support implicit and explicit QoS policy enforcement mechanisms.

[REQ] The IMT-2020 network is recommended to support finer granularity of QoS control mechanisms than those supported by legacy networks.

[REQ] The IMT-2020 network is recommended to support user-initiated QoS control mechanisms in order to support diverse service performance requirements.

9.9 Network management

9.9.1 Description

Distinct network management protocols in different network domains make it difficult to support unified network operations over multiple network domains. A unified E2E network management framework needs to be considered to ensure compatibility and flexibility in IMT-2020 network operations and management.

Some advanced features of the IMT-2020 network are network slicing and orchestration. Single or multiple network slices need to be managed independently along their lifecycle, including network slice creation, update and deletion.

The IMT-2020 network needs to provide interfaces to support management and orchestration for legacy networks in an integrated manner.

Details about network management requirements can be found in [ITU-T Y.3110].

9.9.2 Requirements

[REQ] The IMT-2020 network is required to enable a unified E2E network management framework in order to ensure compatibility and flexibility in IMT-2020 network operations and management.

[REQ] The IMT-2020 network is required to support management capabilities for the lifecycle management of single or multiple network slices.

[REQ] The IMT-2020 network is required to manage and orchestrate all resources of each network slice instance.

[REQ] The IMT-2020 network is required to provide management capabilities that are dedicated to each network slice.

NOTE – The instance management for a network slice works independently of the instance management for another network slice.

[REQ] The IMT-2020 network is required to provide interfaces to support management and orchestration for legacy networks in an integrated manner.

9.10 Charging

9.10.1 Description

The IMT-2020 network needs to support different charging policies and requirements of network operators and service providers including third parties that may be involved in a given IMT-2020 network deployment. The charging models to be supported include, but are not limited to, charging based on volume, time, session and application. Combined charging models, composed of multiple individual charging models, may also be required.

To meet the requirements of third parties, such as MVNOs, the charging capability needs to enable the provision of charging data to them. The charging capability needs to support open APIs for third parties.

The IMT-2020 network should also be able to provide a charging capability that enables independent charging for each network slice. Different charging models may be applied to each network slice at the cost of complexity.

9.10.2 Requirements

[REQ] The IMT-2020 network is required to provide a charging capability that supports online or offline charging.

[REQ] The IMT-2020 network is required to support various charging models based on the charging policies and requirements of network operators and service providers.

[REQ] The IMT-2020 network is recommended to provide a charging capability that enables the provisioning of charging data to third parties.

[REQ] The IMT-2020 network is recommended to provide a charging capability that supports per-network slice charging.

9.11 Interworking with non-IMT-2020 networks

9.11.1 Description

As the deployments of the IMT-2020 network are expected to be incremental, legacy networks will co-exist with IMT-2020 network deployments. Interworking between the IMT-2020 network and non-IMT-2020 networks needs to be supported when a UE moves from the IMT-2020 network to a non-IMT-2020 network, or vice versa.

9.11.2 Requirements

[REQ] The IMT-2020 network is required to support interworking with non-IMT-2020 networks, including legacy IMT networks and the next generation network (NGN).

NOTE – The interworking support includes, but is not limited to, mobility management with service continuity, E2E QoS support, session management and charging control.

9.12 IMT-2020 network deployment and migration

9.12.1 Description

In its early stage of deployment, the IMT-2020 network is expected to be deployed only in specific geographical areas. Incremental deployments of the IMT-2020 network are expected to be based on the strategic policy and the business benefits of the involved stakeholders, such as network operators and service providers.

The gradual migration of services and related users from legacy networks to the IMT-2020 network requires enablement.

9.12.2 Requirements

[REQ] The IMT-2020 network is recommended to support incremental deployment methods.

[REQ] The IMT-2020 network is required to support migration processes of services and related users from legacy networks.

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