International Telecommunication Union

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# Y.3135

(02/2021)

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

Future networks

## Service scheduling to support fixed-mobile convergence in the IMT-2020 network

Recommendation ITU-T Y.3135

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# Recommendation ITU-T Y.3135

## Service scheduling to support fixed-mobile convergence in the IMT-2020 network


### Summary

Recommendation ITU-T Y.3135 specifies requirements for service scheduling (e.g., traffic scheduling and access selection) to support fixed-mobile convergence (FMC) in the international mobile telecommunication-2020 (IMT-2020) network. Based on the requirements of fixed-mobile convergence-service scheduling (FMC-SS), Recommendation ITU-T Y.3135 specifies a functional framework and corresponding reference points. Recommendation ITU-T Y.3135 also provides service-scheduling procedures and security considerations.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
|---|---|---|---|---|
| 1.0 | ITU-T Y.3135 | 2021-02-13 | 13 | 11.1002/1000/14596 |

### Keywords

Multi-access, policy, service awareness, service scheduling.


* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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## Service scheduling to support fixed-mobile convergence in the IMT-2020 network

### 1 Scope

This Recommendation specifies the requirements and functional framework for service scheduling (e.g., traffic scheduling and access selection) to support fixed-mobile convergence (FMC) in the international mobile telecommunication-2020 (IMT-2020) network. This Recommendation also specifies a service-scheduling procedure for user equipment (UE) initiating registration, a fixed-mobile convergence-service scheduling (FMC-SS) policy update procedure and 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*.

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

[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*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 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.

**3.1.2 fixed network** [b-ITU-T Y.2802]: 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.

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

**3.1.4 mobile network** [b-ITU-T Y.2802]: A network that provides wireless access to its services and supports mobility.

## 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

**3.2.1 fixed-mobile convergence-service scheduling (FMC-SS)**: A network capability that determines service-scheduling policies based on information from the application, network and user device layers, to select appropriate accesses for user equipment or a service, in an FMC network that supports multiple accesses.

# 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|---|---|
| AI | Artificial Intelligence |
| AM | Access Management |
| AN | Access Network |
| APP | Application |
| AS | Application Server |
| BDAS | Big Data Analysis System |
| BSS | Business Support System |
| CN | Core Network |
| CPE | Customer Premises Equipment |
| E-UTRA | Evolved-UMTS Terrestrial Radio Access |
| FMC | Fixed-Mobile Convergence |
| FMC-SS | Fixed-Mobile Convergence-Service Scheduling |
| FTP | File Transfer Protocol |
| IMT-2020 | International Mobile Telecommunication-2020 |
| ML | Machine Learning |
| MM | Mobility Management |
| OSS | Operation Support System |
| P2P | Peer to Peer |
| PC | Personal Computer |
| QoS | Quality of Service |
| RAT | Radio Access Technology |
| SM | Session Management |
| SSMP | Service-Scheduling Management Platform |
| UE | User Equipment |
| UMTS | Universal Mobile Telecommunications System |
| VR | Virtual Reality |
| Wi-Fi | Wireless Fidelity |
| WLAN | Wireless Local Area Network |

## 5 Conventions

In this Recommendation:

The phrase "is required to" indicates a requirement that must be strictly followed and from which no deviation is permitted, if conformity to this Recommendation is to be claimed.

The phrase "is recommended" indicates a requirement that is recommended, but which is not absolutely required. Thus, this requirement need not be present to claim conformity.

In the body of this Recommendation, the word "shall" sometimes appears, in which case it is to be interpreted as the phrase "is required".

## 6 Requirements of fixed-mobile convergence-service scheduling

### 6.1 General overview

The IMT-2020 network can support multiple accesses, including IMT-2020 radio access technology (RAT), evolved IMT-advanced RAT, wireless local area network (WLAN) access and fixed broadband access; this capability is described in [ITU-T Y.3101] and [ITU-T Y.3130]. Service scheduling is the network capability to collect information from the application (APP), network and user device layers to determine service-scheduling policies, then steer, split and switch service flow or hand over UE among these accesses based on policies. FMC-SS also supports legacy IMT network accesses (e.g., evolved-universal mobile telecommunications system (UMTS) terrestrial radio access (E-UTRA)), as IMT-2020 network and legacy IMT networks will coexist for a long time.

### 6.2 Requirements of multi-access

The network supporting FMC-SS can support multi-access and schedule service flows among these accesses. The detailed requirements are described as follows.

[REQ 6.2-1] It is required to support IMT-2020 accesses and non-IMT-2020 accesses.

NOTE 1 – IMT-2020 accesses include IMT-2020 RAT, evolved IMT RAT and evolved IMT-advanced RAT, while non-IMT-2020 accesses include legacy IMT RAT, legacy IMT-advanced RAT, WLAN access and fixed broadband access.

[REQ 6.2-2] It is required to steer, split and switch different APPs or different service flows for each APP among IMT-2020 accesses and non-IMT-2020 accesses based on service-scheduling policies.

NOTE 2 – Steering, splitting and switching may occur between IMT-2020 RAT and evolved/legacy IMT-advanced RAT, between IMT-2020 RAT and WLAN access, between evolved/legacy IMT-advanced RAT and WLAN access, between IMT-2020 RAT and fixed broadband access, between evolved/legacy IMT-advanced RAT and fixed broadband access, and between WLAN access and fixed broadband access.

[REQ 6.2-3] It is required to hand over UE for all service flows from one access to another based on service-scheduling policies.

NOTE 3 – Handover may occur between IMT-2020 RAT and evolved/legacy IMT-advanced RAT, between IMT-2020 RAT and WLAN access, between evolved/legacy IMT-advanced RAT and WLAN access, between IMT-2020 RAT and fixed broadband access, between evolved/legacy IMT-advanced RAT and fixed broadband access, and between WLAN access and fixed broadband access.

[REQ 6.2-4] It is required to formulate service-scheduling policies for different accesses based on information from the APP layer, network layer and user device layer.

[REQ 6.2-5] It is required to communicate policies to base stations or other access equipment to execute service scheduling.

[REQ 6.2-6] It is required to execute service-scheduling policies in real time mode or non-real time mode, which is decided by implementation of base stations or other access equipment.

NOTE 4 – The base stations or other access equipment should feed scheduling results (e.g., successful or unsuccessful handover result) back to the network to decide the next policies to be executed.

### 6.3 Requirements for information collection for service scheduling

Detailed information is as follows.

[REQ 6.3-1] It is required to store and analyse all information for service scheduling on a service-scheduling management platform (SSMP).

[REQ 6.3-2] It is required to collect information about service identity or description based on service awareness using encrypted or unencrypted traffic detection, policy of network management, etc. from mobile core networks (CNs) and fixed networks.

[REQ 6.3-3] It is required to collect information about bandwidth, access load, user movement track, user speed, etc. from a base station or other access equipment.

[REQ 6.3-4] It is required to collect information about RAT mode capability, current state, user behaviour or choice, device power margin, etc. from the user device.

[REQ 6.3-5] It is required to collect information about detailed service data (e.g., APP identity, quality of service (QoS) parameter or restriction area) and service status from the third party APP platform or server.

### 6.4 Requirements for service experience for service scheduling

The network supporting FMC-SS can ensure service experience during service scheduling. Detailed requirements are as follows.

[REQ 6.4-1] It is required to guarantee service continuity during service flows switching or UE handover from one access to another based on service-scheduling policies, which includes two specific issues:

– the network supporting service scheduling is required to support seamless service experience when there is a handover between fixed and mobile access technologies, no matter whether the handover is initiated by the network side or user side;

– the network supporting service scheduling is required to support seamless service experience when there is migration from a single access network (AN) to multiple ANs with different access technologies.

[REQ 6.4-2] It is required to guarantee low latency for real time services during service flow switching or UE handover, such as voice or video, from one access to another.

[REQ 6.4-3] It is required to guarantee that the target network can support the same service capabilities and service qualities when service flows should be steered, split and switched or UE should be handed over from one access to another.

## 7 Framework of fixed-mobile convergence-service scheduling

### 7.1 Overview of framework

Figure 7-1 shows the framework of FMC-SS. It is composed of the APP layer, CN layer, AN layer, user device layer, as well as the SSMP, operation support system/business support system (OSS/BSS) and big data analysis system (BDAS). The SSMP interacts with the APP layer, CN layer, OSS/BSS and BDAS to formulate service-scheduling policies.

NOTE 1 – The detailed network functions and corresponding interfaces within CN, between the APP and CN, between CN and AN, between AN and user device, between network and OSS/BSS, between network and BDAS lie outside the scope of this Recommendation.

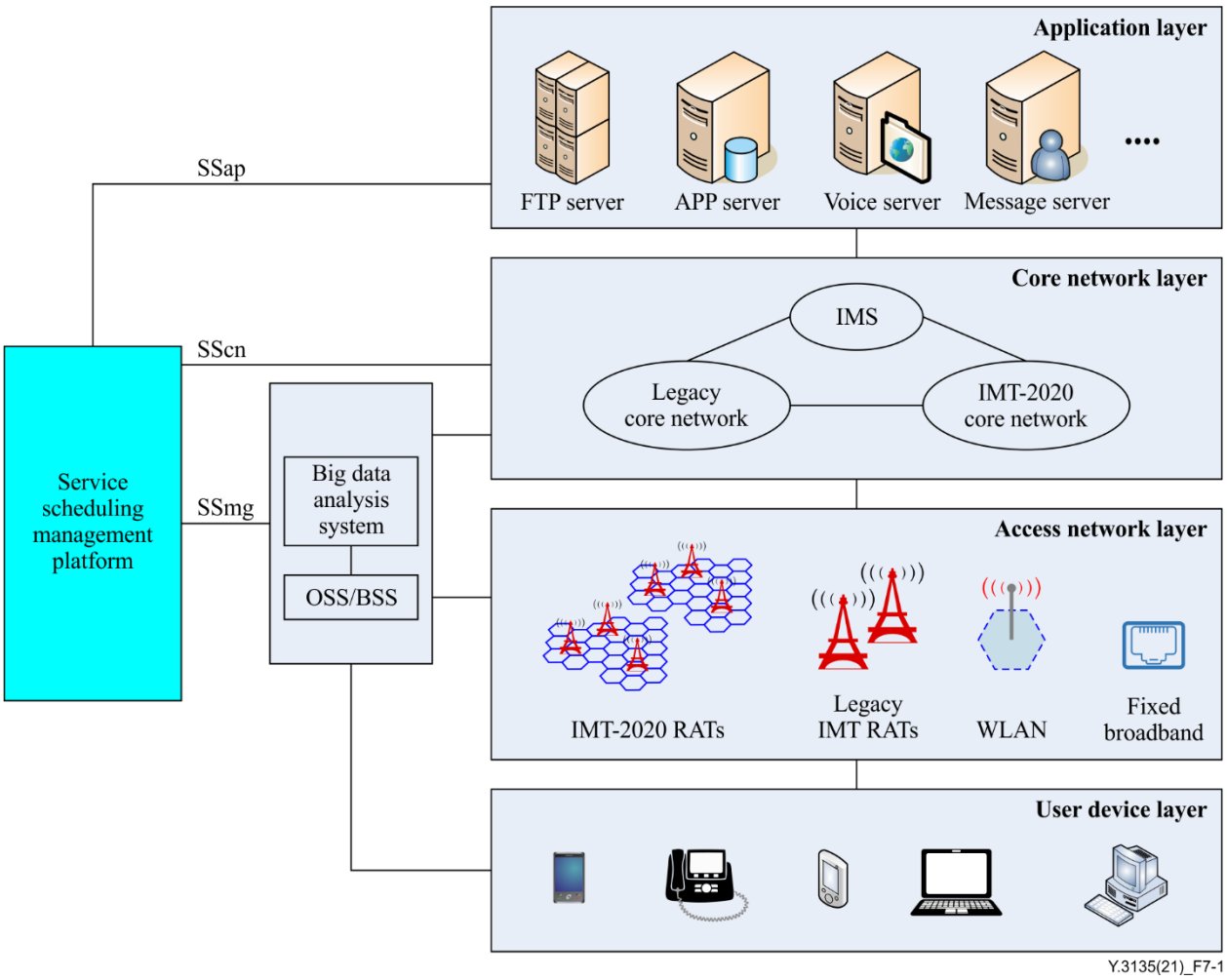


**Figure 7-1 – Framework of fixed-mobile convergence-service scheduling**

The SSMP is the unified core node to support service scheduling for FMC in IMT-2020 network. It collects information from different layers, stores and analyses them, and makes service-scheduling policy to schedule different service flows on to appropriate access. The platform collects information from four layers as follows.

– The APP layer includes diverse application servers (ASs), e.g., file transfer protocol (FTP) server, AS, voice server, video server, message server and third party server. These servers may be deployed by the operator or third-party.

– The CN layer includes CNs of the IMT-2020 network and legacy network. Based on interworking interfaces, it is a converged CN that supports multi-access and various types of services.

– The AN layer includes multi-access described in clause 6.

– The user device layer includes all kinds of end user devices, e.g., phone, wearable, personal computer (PC), customer premises equipment (CPE) and fixed device.

The platform collects information directly or indirectly from the related nodes of the listed layers. Service identity, UE contexts and UE identifier are collected directly from the CN layer and APP layer, while network load and user device type are collected indirectly from the AN layer and user device layer via the OSS/BSS and BDAS. As the information collected from different layers is comprehensive, for the SSMP, it is recommended that artificial intelligence/machine learning (AI/ML) technologies be applied to assist in the processes of service scheduling, including information analyses and formulating policies.

NOTE 2 – The framework of AI/ML for service scheduling aligns with [b-ITU-T Y.3172].

## 7.2 Reference points

The FMC-SS framework contains the following new reference points in addition to current reference points in the IMT-2020 network:

SSap: Reference point between the SSMP and APP layer. This reference point is used by SSMP to collect information (e.g., service requirements and service status) from various types of ASs. Depending on operator deployment, the SSap may be connected to different ASs directly or to an APP gateway that aggregates all ASs.

SScn: Reference point between the SSMP and CN layer. This reference point is used to collect information directly from the IMT-2020 CN, legacy CN and IMS (e.g., UE contexts, UE identifiers, service identity based on service awareness and subscription profile) by SSMP, which is not in the OSS/BSS and BDAS, and provide service-scheduling policies from the SSMP to CN.

SSmg: Reference point between the SSMP and OSS/BSS, and between the SSMP and BDAS. This reference point is used by the SSMP to indirectly collect information about the networks (e.g., AN load, CN congestion status, and supporting RAT type and frequencies), and user devices (e.g., user device type, user location, user data rate and user behaviours) from the CN layer, AN layer and user device layer via the OSS/BSS and BDAS.

# 8 Procedures for fixed-mobile convergence-service scheduling

## 8.1 Service-scheduling procedure for user equipment initiation of registration

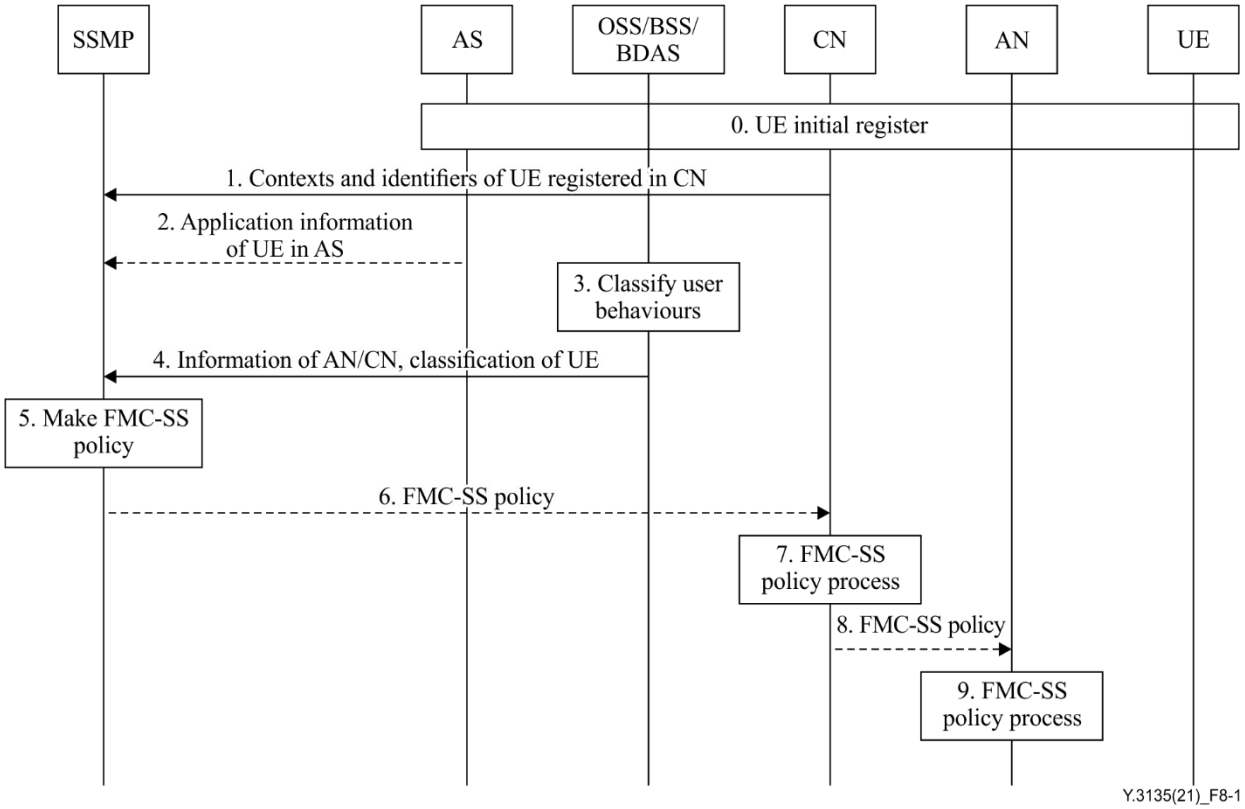


**Figure 8-1 – Service-scheduling procedure for user equipment initiation of registration**

Figure 8-1 shows when UE initiates a registration procedure using the initial registration type, after which the SSMP shall collect related information, and formulate UE service-scheduling policy.

0. UE registers on the network. If this UE supports FMC-SS, the network begins the FMC-SS procedure for the UE after responding with a "Register Accept" message to the UE.

1. After UE registration, CN nodes send UE contexts (including access management (AM), session management (SM) and mobility management (MM)) and UE identifiers to the SSMP. Then the SSMP subscribes to the CN for this UE to notify when UE information is changed later.

2. If UE subscribes to an IMS service such as voice or message, there is a corresponding AS (e.g., IMS voice server or message server), which shall be registered by UE. Then the AS may send APP information of the UE to SSMP. Then the SSMP subscribes to AS for this UE to notify when UE information is changed later.

3. The OSS/BSS and BDAS classify user behaviours based on information about networks (e.g., AN load in the OSS/BSS) and user devices (e.g., UE registration location or UE device type in the OSS/BSS, user behaviours during last registration in the BDAS, if available). User behaviours may indicate the user in a specific location or using specific devices, e.g., a user on a campus who usually downloads video streams or an augmented reality user in a museum.

4. The OSS/BSS and BDAS send AN/CN information and classification of user behaviours to the SSMP. Then the SSMP subscribes to the OSS/BSS and BDAS for this UE to notify when UE information is changed later.

5. The SSMP collects all information received in steps 1, 2 and 4, analyses it, and formulates FMC-SS policy for this UE. AI/ML technologies are recommended for application in this step.

6. If UE does not use an appropriate network access, the SSMP sends the selected FMC-SS policy for this UE to the CN.

7. The CN processes the FMC-SS policy.

8. If the CN decides the FMC-SS policy to be processed by the AN, then sends it to the AN.

9. The AN processes the FMC-SS policy.

### 8.2 Fixed-mobile convergence-service scheduling policy update procedure

Figure 8-2 shows the FMC-SS policy update procedure when UE information is changed.

1-3. Due to a new UE service, UE moving to specific area or updated network load, etc., if any subscribed information of the UE is changed, including updating contexts and identifiers of UE, updating APP information, and updating information of AN/CN and classification of user behaviours, the SSMP will be notified via the CN, AS and OSS/BSS/BDAS.

4. The SSMP analyses the information, and if FMC-SS policy should be changed, it triggers a FMC-SS policy change for this UE. AI/ML technologies are recommended for applicationin this step.

5. The SSMP sends the new FMC-SS policy for this UE to the CN.

6. The CN processes the new FMC-SS policy.

7. If the CN decides the new FMC-SS policy is to be processed by the AN, then sends it there.

8. The AN processes the new FMC-SS policy.

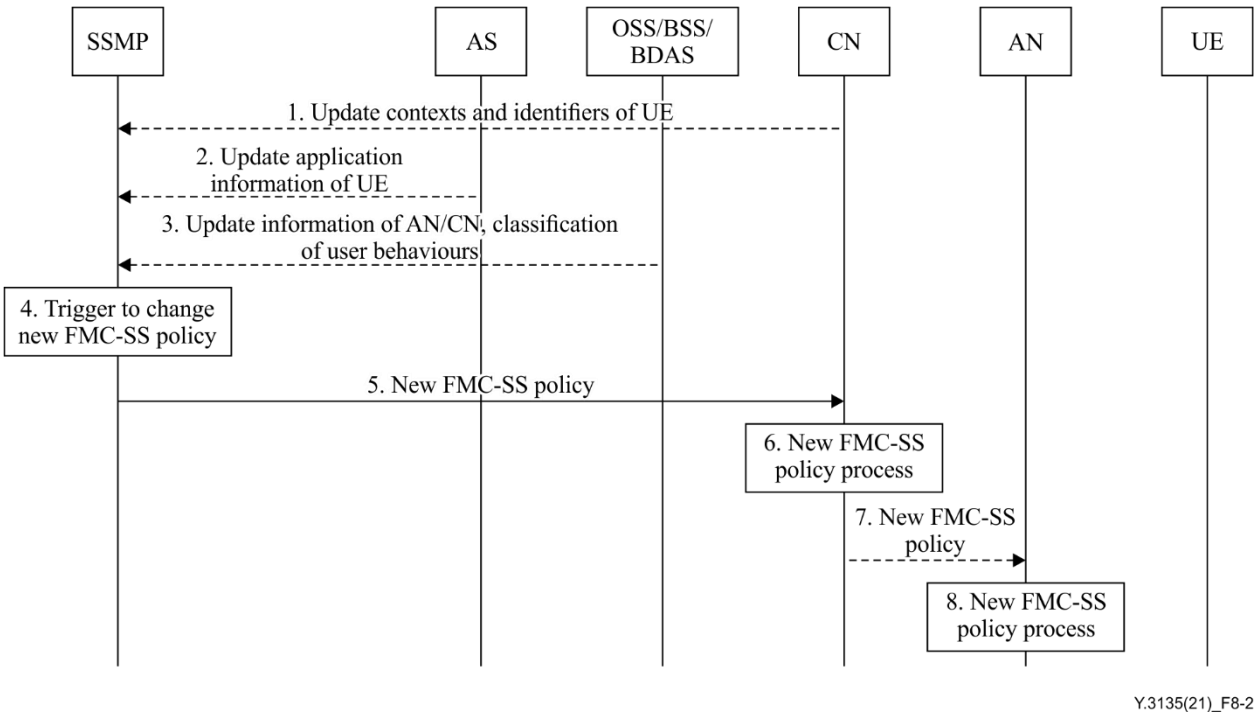


**Figure 8-2 – Fixed-mobile convergence-service scheduling policy update procedure**

## 9 Security considerations

FMC-SS is required to take into account the issues of security and privacy. The SSMP, which is the unified core node to support service scheduling for FMC in the IMT-2020 network, is required to provide the mechanisms of network information protection, policy information protection and user information protection, to avoid unauthorized access and information leakage.

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

# Appendix I

## Scenarios and use cases supported by fixed-mobile convergence-service scheduling

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

This appendix lists several service-scheduling scenarios and related cases supported by FMC-SS in the network, for readers to understand related requirements of FMC-SS in IMT-2020.

Two main service-scheduling scenarios supported by FMC-SS in IMT-2020 are provided, but the service scenarios supported are not limited to those ones described.

### Scenario-A – Service scheduling between IMT-2020 RAT and evolved/legacy IMT-advanced RAT

#### Use case 1

A dual-mode mobile terminal supporting single radio can access IMT-2020 RAT or evolved/legacy IMT-advanced RAT at one time, so it can only keep one type of access and shall trigger handover procedures between IMT-2020 RAT and evolved/legacy IMT-advanced RAT based on the service awareness and policies.

Figure I.1 illustrates operator policy when services requiring a high throughput (e.g., virtual reality (VR) or video) are carried on IMT-2020 RAT, and the services requiring continuous coverage (e.g., voice or cruise) are carried on evolved/legacy IMT-advanced RAT.

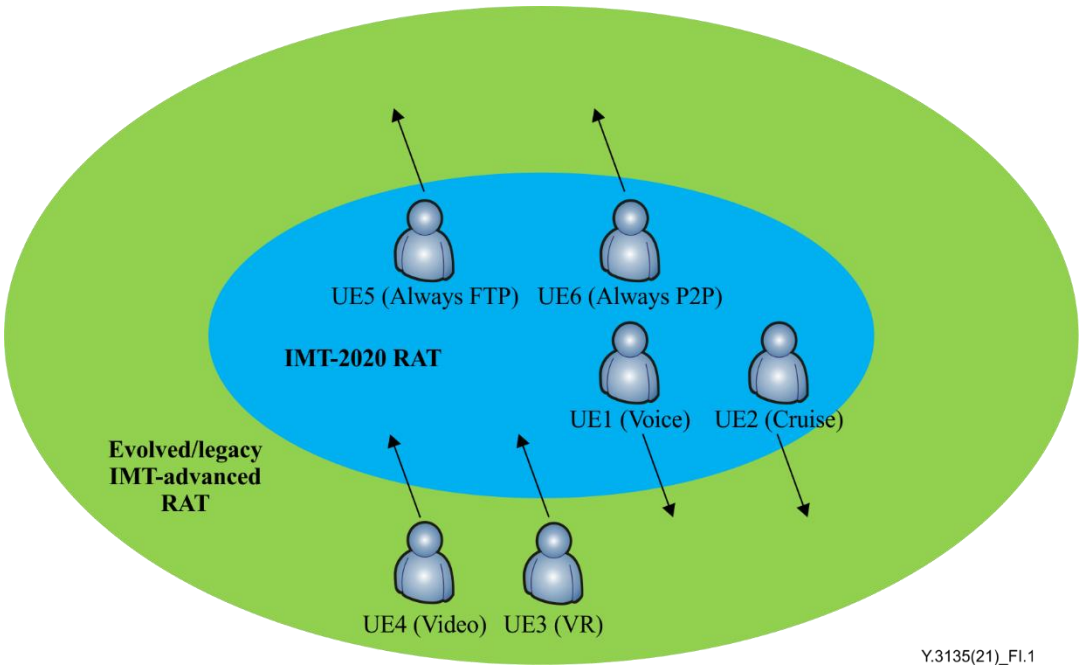


**Figure I.1 – Service scheduling between IMT-2020 RAT and evolved/legacy IMT-advanced RAT (single radio)**

For example, on a campus, there are a large number of unlimited-flow packet users. They perform FTP or peer to peer (P2P) download operations by using mobile devices from time to time, taking up a large amount of valuable network access resources and causing other users to fail to operate normally, just like UE 5 and UE 6 in Figure I.1. To guarantee that the network in this area work better and to protect fair access for all users, when the FMC-SS network detects that one user carries out

these services in busy time, it hands over the users to the evolved/legacy IMT-advanced RAT from the IMT-2020 RAT and reasonably limits its maximum access speed.

**Use case 2**

A dual-mode mobile terminal supporting dual radio can access IMT-2020 RAT and evolved/legacy IMT-advanced RAT simultaneously, so it can keep two types of access and shall steer, split or switch some special service flows between IMT-2020 RAT and evolved/legacy IMT-advanced RAT, based on service awareness and policies.

Figure I.2 illustrates operator policy when service flows requiring continuous signal coverage are steered to the evolved/legacy IMT-advanced RAT, and service flows requiring a high throughput are steered to IMT-2020 RAT.

For example, a self-driving car is moving at a high speed automatically, while passengers in the car are watching high-definition live TV. The auto cruise service requires high network continuity, and the video download service has high requirements on throughput. The network steers the video download service flow to IMT-2020 RAT and the auto cruise service to evolved/legacy IMT-advanced RAT. When the car moves out of IMT-2020 RAT coverage, the video service flow will be switched from IMT-2020 RAT to evolved/legacy IMT-advanced RAT.

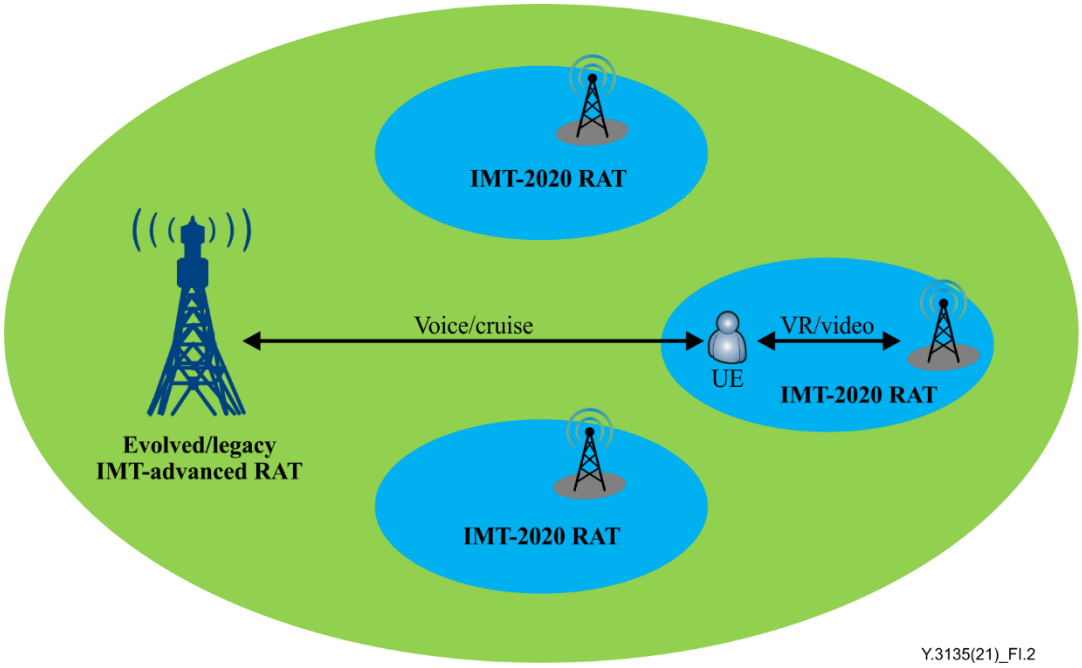


**Figure I.2 – Service scheduling between IMT-2020 RAT and evolved/legacy IMT-advanced RAT (Dual Radio)**

**Scenario-B – Service scheduling between IMT-2020 RAT and WLAN access**

A mobile terminal can access the IMT-2020 network and WLAN simultaneously. Therefore, it can keep two types of access and shall steer, split or switch some special service flows between IMT-2020 RAT and WLAN access based on service awareness and policies.

**Use case**

Figure I.3 illustrates the use case of service scheduling between IMT-2020 RAT and WLAN access.

For example, when an unmanned aerial vehicle patrols the city, it needs continuous IMT-2020 AN for auto cruise. However, when it reaches the monitoring point, a large amount of videos need to be sent back to the data base. If there is an accessible wireless fidelity (Wi-Fi) connection, the network steers the video service flow to it.

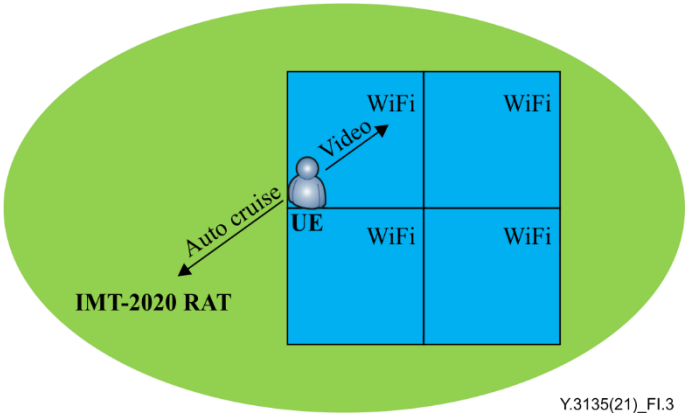


**Figure I.3 – Service scheduling between IMT-2020 RAT and WLAN access**

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[b-ITU-T Q.1762/Y.2802] Recommendation ITU-T Q.1762/Y.2802 (2007), *Fixed-mobile convergence general requirements*.

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

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

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Printed in Switzerland
Geneva, 2021