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International Telecommunication Union
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Recommendation

# ITU-T F.743.18 (12/2022)

SERIES F: Non-telephone telecommunication services

Multimedia services

# Requirements for IMT-2020 ultra-high definition surveillance cameras

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# Recommendation ITU-T F.743.18

## Requirements for IMT-2020 ultra-high definition surveillance camera


**Summary**

Recommendation ITU-T F.743.18 specifies functional, performance and security requirements of IMT-2020 ultra-high definition (UHD) surveillance cameras, in order to ensure reliable UHD video transmission in IMT-2020. This Recommendation also specifies services for classification of IMT-2020 UHD surveillance, service level agreement ranking of IMT-2020 UHD surveillance and network requirements for IMT-2020 UHD video surveillance, which are very relevant to IMT-2020 surveillance scenarios, to meet the actual user's UHD video capture and transmission requirements. Recommendation ITU-T F.743.18 also describes typical use cases.



**History**

| Edition | Recommendation | Approval | Study Group | Unique ID* |
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| 1.0 | ITU-T F.743.18 | 2022-12-14 | 16 | 11.1002/1000/15185 |

**Keywords**

IMT-2020, surveillance, UHD.


* 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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## Requirements for IMT-2020 ultra-high definition surveillance camera

### 1 Scope

This Recommendation specifies the functional, performance and security requirements of IMT-2020 ultra-high definition (UHD) cameras. The requirements include those for service level agreement (SLA) monitoring, video coder-decoder (codec), application layer transport protocols and video transmission performance. This Recommendation also specifies the classification of IMT-2020 UHD surveillance services, SLA ranking of IMT-2020 UHD surveillance business and network requirements for IMT-2020 UHD video surveillance business, which are very relevant to IMT-2020 surveillance scenarios.

This Recommendation includes:

– classification and SLA ranking of IMT-2020 UHD surveillance business;

– network requirements for IMT-2020 UHD video surveillance business;

– use cases of IMT-2020 UHD surveillance cameras;

– functional requirements for IMT-2020 UHD surveillance cameras;

– performance requirements for IMT-2020 UHD surveillance cameras;

– security requirements for IMT-2020 UHD surveillance cameras.

### 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 H.222.0] Recommendation ITU-T H.222.0 (2021), *Information technology – Generic coding of moving pictures and associated audio information: systems*.

[ITU-T H.264] Recommendation ITU-T H.264V14 (2021), *Advanced video coding for generic audiovisual services*.

[ITU-T H.265] Recommendation ITU-T H.265V8 (2021), *High efficiency video coding*.

[ITU-T H.626] Recommendation ITU-T H.626V2 (2019), *Architecture requirements for video surveillance system*.

[ITU-T H.627] Recommendation ITU-T H.627V2 (2020), *Signalling and protocols for a video surveillance system*.

[ITU-T T.81] Recommendation ITU-T T.81 (1992), *Information technology – Digital compression and coding of continuous-tone still images – requirements and guidelines*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

**3.1.1 premises unit** [ITU-T H.626]: A device located at the remote part of a video surveillance system and used to capture multimedia information (such as audio, video, image, alarm signal, etc.) from a surveilled object.

### 3.2 Terms defined in this Recommendation

None.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|---|---|
| 3G | third Generation |
| 4G | fourth Generation |
| codec | coder-decoder |
| E2E | End to End |
| HD | High Definition |
| IMT-2020 | International Mobile Telecommunications-2020 |
| IP | Internet Protocol |
| O&M | Operation and Maintenance |
| PU | Premises Unit |
| SLA | Service Level Agreement |
| TCP | Transmission Control Protocol |
| UHD | Ultra-High Definition |
| WAN | Wide-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 conformance to this document 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 to be present to claim conformance.

– The phrases "**can optionally**" and "**may**" indicate an optional requirement that is permissible, without implying any sense of being recommended. These terms are 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 the specification.

## 6 Overview of IMT-2020 UHD video business

This clause specifies the classification, SLA rank and network performance requirements for IMT-2020 UHD surveillance business, which are the prerequisites for defining the functional and performance requirements for IMT-2020 UHD camera.

### 6.1 Classification of IMT-2020 UHD surveillance business

IMT-2020 UHD surveillance business can be divided into the following video business categories:

a) type A: Real-time control level, the receiving buffer does not exceed 150 ms;

b) type B: Interactive real-time broadcast level, the receiving buffer is not more than 500 ms;

c) type C: Security monitoring level, the receiving buffer is not greater than 1 000 ms.

## 6.2 SLA rank of IMT-2020 UHD surveillance business

This clause specifies the SLA grade for IMT-2020 UHD surveillance business, Table 6-1 shows the different SLA grades that suit type A, type B and type C surveillance business.

**Table 6-1 – SLA rank of IMT-2020 UHD surveillance business**

| SLA grade | Frame receiving rate (%) | Frame loss rate | Average frame loss time (s) | Acceptability |
|---|---|---|---|---|
| 1 | 99.9 | 1/1 000 | 40 | Unacceptable |
| 2 | 99.99 | 1/10 000 | 400 | |
| 3 | 99.999 | 1/100 000 | 4 000 | Acceptable for type B |
| 4 | 99.999 9 | 1/1 000 000 | 40 000 | Acceptable for type A and type C |
| 5 | 99.999 99 | 1/10 000 000 | 400 000 | Acceptable for type A, B and C |
| 6 | 99.999 999 | 1/100 000 000 | 4 000 000 | Acceptable for type A, B and C |
| NOTE – Video frame is the objective metric for IMT-2020 surveillance business, this table is based on a rate of 25 frame/s. | | | | |

## 6.3 Network construction requirements for IMT-2020 UHD video surveillance business

In the IMT-2020 surveillance scenario, the UHD video is transmitted in the wireless situation, due to the different coverage and capacity of the user's location, the IMT-2020 network provides different carrying capacity. The classifications and requirements of the network for specific video businesses are shown in Table 6-2.

**Table 6-2 – Classification and requirement for the IMT-2020 UHD video business**

| No. | Network | Description | Network performance | | | Supportable business type |
|---|---|---|---|---|---|---|
| | | | Uplink/downlink bandwidth (single user) [Mbit/s] | E2E delay (ms) | Network package loss rate (%) | |
| 1 | I | Supports carriage of high bit rate and low latency video business, e.g., near the point of a wide-area network (WAN) or IMT-2020 dedicated network | 70/500 | ≤ 30 | ≤ 1 | A, B and C |

**Table 6-2 – Classification and requirement for the IMT-2020 UHD video business**

| No. | Network | Description | Network performance | | | Supportable business type |
|---|---|---|---|---|---|---|
| | | | Uplink/downlink bandwidth (single user) [Mbit/s] | E2E delay (ms) | Network package loss rate (%) | |
| 2 | II | Supports carriage of medium bit rate and delay insensitive video business, e.g., the mid-point of a WAN | 40/300 | ≤ 50 | ≤ 3 | B (SLA ≥ 4) and C |
| 3 | III | Supports carriage of low bit rate and delay-insensitive video services, e.g., remote locations on a WAN | 15/100 | ≤ 80 | ≤ 10 | B (SLA ≥ 3) and C |
| NOTE 1 – Mobile handover can exist for all the above network scenarios, which is manifested in that the bit rate is damaged within 100 ms, the time delay becomes larger, the packet loss rate increases, and the bandwidth decreases.<br>NOTE 2 – Uplink refers to the uplink channel in which message data is carried from the cellular communication terminal to the server, while downlink refers to the channel in which data is carried from the server to the cellular communication terminal. | | | | | | |

## 7 Use cases of IMT-2020 UHD surveillance cameras

### 7.1 Remote control of gantry cranes with an IMT-2020 UHD surveillance camera in a smart port

Traditional ports mainly deploy optical fibre and industrial wireless fidelity for key services and communication systems, covering gantry cranes, container trucks and video surveillance systems. However, these methods often cause high construction and operation and maintenance (O&M) costs, inflexible deployment, and low stability and reliability.

IMT-2020 UHD surveillance cameras installed on each gantry crane can solve these issues by sending surveillance video feedback to the central control room over the network. IMT-2020 wireless networks can also enable multiple gantry cranes to be operated together and solve the problem of optical fibre winding, effectively reducing device purchase costs (such as those for cable) and costs of cable replacement. The ultra-high bandwidth ensures that the uplink rate meets the requirements of concurrent high definition (HD) video services, and the ultra-low latency ensures the precision of remote control effectively.

### 7.2 Smart environmental protection

Traditional environmental detection faces problems with high labour resources cost, fast response, and lack of sampling points. In addition, detection personnel may miss certain alarms, or alarms may fail to be reported.

To combat this, an IMT-2020 multi-dimensional environmental surveillance system installed with 4K/8K HD IMT-2020 UHD surveillance cameras and environmental detection sensors at key points, such as drainage ports, river courses and forests, can efficiently detect the environmental issue and solve these traditional problems. Using IMT-2020 edge computing, the system can: analyse and process real-time video data; automatically identify and warn against unauthorized emissions and abnormal objects; summarize and generate visualized analysis results; and coordinate with

environmental protection management departments at all levels to implement all-round, efficient, and multi-dimensional environmental surveillance.

### 7.3 Smart inspection for power system

**Case 1: Power distribution room inspection**

A power distribution room contributes to the last phase for power supply, with clear correlations between its management level and the power supply capability and quality. Currently, most power distribution rooms are unattended and lack intelligent surveillance and analysis methods. Because these distribution rooms are usually located in remote regions, personnel cannot conduct onsite predictive maintenance and periodic manual inspection costs are high. In the event of a fault, a large number of sites will be affected, and the fault recovery is not immediate and time-consuming.

To resolve this issue, an IMT-2020 UHD surveillance camera with power distribution room inspection applications can be easily deployed to replace manual inspection. An IMT-2020 UHD surveillance camera can realize real-time video feedback to the analysis central platform to identify abnormalities. Alternatively, this IMT-2020 UHD surveillance camera can execute an intelligent inspection algorithm by itself and immediately identify any abnormal devices or issues. This intelligent modernization solution can reduce manual inspection time by half, significantly decreasing the frequency of emergency handling, and improve power supply quality.

**Case 2: Power line inspection**

Traditional power line inspection is required to successfully detect abnormal situations, such as a bird's nest or honeycomb in the tower and power pole, absence of a suspension clamp pin, a broken end of a shockproof hammer and insulator self-explosion. The pictures and videos are required to be in UHD for an analysis centre platform to detect a fault. It is vital to report these issues to the control centre as soon as possible to prevent power accidents. Usually, workers need to climb on to the tower and check them one by one, which is time-consuming and dangerous. Even with third generation (3G) and fourth generation (4G) networks, high-resolution images and videos cannot be transmitted to the terminal in real time due to the limitation of bandwidth of the transmission channel. It cannot meet the requirement for immediate feedback.

IMT-2020 network and IMT-2020 UHD surveillance cameras can be deployed on a drone. which can be used for ultra-long range remote control as long as there is IMT-2020 network coverage in the region. Drones in the connected region may communicate with each other. The inspector can control the drone to take UHD pictures or videos of the electric power line and the electricity tower, and then transmit them to the analysis centre platform. The analysis centre platform with computation resources can determine abnormal situations and alarms. Therefore, the worker can fix the problem immediately without economic losses occurring.

### 7.4 Smart travel

Nowadays, more and more shuttle buses, tour buses, and dangerous goods vehicles are required to deploy real-time surveillance cameras to report fatigued drivers and help prevent social public safety incidents. Currently, vehicle-mounted video surveillance cameras mainly use 3G or 4G networks for real-time data transmission. Due to limited uplink bandwidth, limited coverage, and high latency, surveillance video feeds and images are of poor quality. All of these issues can be solved by IMT-2020 UHD surveillance cameras; with HD image quality, more intelligent algorithms can be executed accurately to prevent fatigued driving, and identify the driver or abnormal driving behaviours, etc.

### 7.5 HD broadcast

IMT-2020 UHD cameras can be used for webcasting of remote regions (such as Mount Everest), providing users with a UHD video experience at convenient times or places. Due to the harsh

environmental and climatic conditions of such areas, traditional camera deployment cost is high, while the deployment of IMT-2020 UHD surveillance cameras will be more flexible, using high bandwidth and low latency features to achieve real-time and efficient live broadcast of beautiful scenery.

### 7.6 Security for temporary event

Sometimes, a large-scale exhibition or concert is temporarily held in a certain area where the existing monitoring system is incomplete, and lacks coverage and intelligent functions. To achieve full monitoring coverage and intelligent surveillance in the short term, the traditional wired monitoring deployment method is expensive and needs a long construction time. In contrast, IMT-2020 network coverage with IMT-2020 UHD surveillance cameras deployed is more simple and efficient, flexible to achieve multi-directional, no dead-angle surveillance deployment and can deliver intelligent monitoring transformation in a short time. IMT-2020 UHD surveillance cameras can also be dismantled afterwards, without causing waste of resource investment.

### 7.7 Smart farm

With the development of urbanization, animal cultivation is becoming be more and more specialized. Usually, farmers have a large number of animals such as cows and sheep in a wide region. An IMT-2020 UHD surveillance camera can be used in intelligent functions such as animal quantity detection and location tracking, and action recognition.

Traditionally, a farmer needs to check the number of animals when they depart and enter within a fence. With the deployment of an IMT-2020 UHD surveillance camera and IMT-2020 network, the animal count data can be easily transmitted to the cloud platform. By installing an IMT-2020 UHD surveillance camera mounted on an electronic fence and grassland, the animals can be identified in real time with high accuracy. 3G and 4G networks could not achieve the requirement for low latency and high accuracy. In addition, if the animals cross a prescribed area, there may be a security issue. With an IMT-2020 UHD surveillance camera, farmers can take measures to protect animals if they are stolen. Furthermore, animal growth monitoring, animal environment and grass degradation detection can be implemented with the deployment of an IMT-2020 UHD surveillance camera.

### 7.8 Smart fishery

With the deployment of an IMT-2020 UHD camera, IMT-2020 network and underwater camera system, fishery management of can be more efficient in breeding and save labour. It can improve underwater management by preventing cultured fish from escaping and pest diseases infecting them.

For example, a marine fish farming enterprise can use IMT-2020 UHD surveillance cameras to assist in feeding the fish, detect aquatic product growth and achieve panoramic detection due to the low latency and high bandwidth of the IMT-2020 network. Fishery managers can monitor aquatic growth at home or office. Furthermore, the images and videos captured by an IMT-2020 UHD surveillance camera are uploaded to an intelligent fishery management cloud platform, the algorithm working on the platform can detect pests and diseases, e.g., those affecting carp, and analyse them to prevent massive fish deaths.

## 8 Requirements for IMT-2020 UHD surveillance camera

### 8.1 Functional requirements

#### 8.1.1 Video codec requirements

FUN-001: The IMT-2020 UHD surveillance camera is required to support video codecs such as those in [ITU-T H.264], [ITU-T H.265] or [ITU-T H.222.0], and the common image file format such as that in [ITU-T T.81].

FUN-002: The IMT-2020 UHD surveillance camera is recommended to support intelligent video codecs such as region of interest.

### 8.1.2 SLA monitoring requirements

FUN-003: The IMT-2020 UHD surveillance camera is required to support the SLA monitoring function that supports the receiver in obtaining business SLA data and network real-time performance data, including frame loss rate, packet success rate, network packet loss rate and network end-to-end (E2E) delay.

FUN-004: The IMT-2020 UHD surveillance camera is recommended to support sending SLA data to other analysis platforms for O&M, statistics, and analyses.

### 8.1.3 Transmission protocol requirements

FUN-005: The IMT-2020 UHD surveillance camera is recommended to support transmission protocols with anti-packet loss, retransmission mechanism, data encryption, forward error correction, congestion control capability and network traffic shaping control.

NOTE – Traffic shaping is a bandwidth management technique used on computer networks to delay some or all datagrams to prevent datagram burst, thus ensuring that datagrams are sent out at a relatively uniform rate.

FUN-006: The IMT-2020 UHD surveillance camera in network I (see Table 6-2) is recommended to support a real-time streaming protocol over a transmission control protocol (TCP) or a real-time transport protocol over TCP.

FUN-007: The IMT-2020 UHD surveillance camera in network II or III (see Table 6-2) is recommended to support user datagram protocol.

### 8.1.4 Bandwidth adaptive requirements

FUN-008: The IMT-2020 UHD surveillance camera is recommended to support adaptively reducing video bit rates based on the reduction of networks (such as the reduction of uplink bandwidth, the increase of E2E delay and the packet loss rate).

### 8.1.5 Key frame timing adjustment requirements

FUN-009: The IMT-2020 UHD surveillance camera is recommended to support dynamically adjusting the key frame sequence, in order to reduce the peak video bit rate and maintain the smooth transmission of the video bit rate.

### 8.1.6 UHD video and image capture function requirements

FUN-010: The IMT-2020 UHD surveillance camera is recommended to support the environment adaptive function to ensure high-quality videos and images are captured in any environmental situation such as low illumination, dust, fog, harsh backlighting or large change in illumination.

FUN-011: The IMT-2020 UHD surveillance camera is recommended to support structured information extraction of interested targets (including persons, vehicles, objects and events).

### 8.1.7 Remote maintenance and upgrade requirements

FUN-012: The IMT-2020 UHD surveillance camera is required to support remote maintenance operations including camera status query and initial setting restoration.

FUN-013: The IMT-2020 UHD surveillance camera is required to support system upgrade remotely. If an abnormal situation such as power failure or disconnection occurs, the camera is required to be able to restore the state before the upgrade.

### 8.1.8 Video and audio access and control requirements

FUN-014: The IMT-2020 UHD surveillance camera is required to comply with the functional requirements of a premises unit (PU), which are specified in [ITU-T H.626].

FUN-015: The IMT-2020 UHD surveillance camera is required to comply with the signalling and protocols specified in [ITU-T H.627] related to a PU (specified in [ITU-T H.626]).

## 8.2 Performance requirements

### 8.2.1 Basic performance requirements

PER-001: The highest resolution of IMT-2020 UHD surveillance camera is required not to be lower than 3 840 × 2 160 pixels.

PER-002: The minimum illumination of IMT-2020 UHD surveillance camera is required not to be lower than 0.01 lx (in colour mode) and 0.001 lx (in monochrome mode).

NOTE – A colourful camera may work in both colour and monochrome mode; only black and white photographs are generated in monochrome mode.

PER-003: The maximum frame rate of an IMT-2020 UHD surveillance camera is required not to be lower than 25 frames/s.

PER-004: The IMT-2020 UHD surveillance camera is required to support the standard bit rate of 10 Mbit/s, maximum bit rate not lower than 16 Mbit/s.

PER-005: The IMT-2020 UHD surveillance camera is required to support not less than three videos streams.

PER-006: The maximum out-of-synchronization time between audio and video is required not to be larger than 1 s.

### 8.2.2 Video transmission performance requirements

PER-007: The video transmission performance of an IMT-2020 UHD surveillance camera is required to meet SLA rank not lower than grade 3 (specified in Table 6-1).

PER-008: The IMT-2020 UHD surveillance camera is required to support the peak to average power ratio of a single stream not larger than 6.

## 8.3 Security requirements

### 8.3.1 Authentication requirements

SEC-001: The IMT-2020 UHD surveillance camera's authentication control capability is required to meet all the following requirements:

a) the IMT-2020 UHD surveillance camera is required to support user authorization and authentication;

b) the administrator ID is required not to be easily used fraudulently, and the password is required to be complex and changed regularly;

c) the login failure handling function is required to be enabled, including session ending, number of illegal logins limited and automatic logout;

d) authentication control is required to be performed for important operations of the administrator, such as restoring configuration and modifying the administrator's information, when the IMT-2020 UHD surveillance camera is remotely managed.

### 8.3.2 Access control requirements

SEC-002: The IMT-2020 UHD surveillance camera's access control capability is required to meet all the following requirements:

a) the Internet protocol (IP) address or media access control address range of the access device is required to be restricted according to the security policy or management needs;

b) the number of users with remote access authority is required to be limited;

c) user rights are required to be separated, and the rights of administrator users and ordinary users are required to be separated.

### 8.3.3 Data integration and encryption requirements

SEC-003: The IMT-2020 UHD surveillance camera is required to support cryptographic technology or other mechanisms to ensure the integrity of data in the communication process according to business needs, e.g., by supporting encrypted transmission.

SEC-004: The IMT-2020 UHD surveillance camera is required to support important data encrypted, including the session process, entire message body and important authentication data during the transmission process.

### 8.3.4 Hacker intrusion detection requirements

SEC-005: The IMT-2020 UHD surveillance camera is required to be able to detect and deal with hacker intrusions, including but not limited to, sensitive system files tampering, abnormal super accounts, camera hijacking and process privilege escalation.

### 8.3.5 Personally identifiable information protection requirement

SEC-006: The IMT-2020 UHD surveillance camera is required to support video and image privacy mask transmission according to the user configuration.

NOTE – Privacy mask is a feature used in IP cameras to protect personally identifiable information by concealing parts of the image from viewing a masked area, usually according to the user's configuration.

### 8.3.6 Operation log query requirement

SEC-007: The IMT-2020 UHD surveillance camera is required to support the operation of log queries and uploading to the log server or monitoring management platform.

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