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Recommendation

# ITU-T F.760.1 (12/2022)

SERIES F: Non-telephone telecommunication services

Multimedia services

# Requirements and reference framework for emergency rescue systems

ITU-T F-SERIES RECOMMENDATIONS

**NON-TELEPHONE TELECOMMUNICATION SERVICES**



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

# Recommendation ITU-T F.760.1

## Requirements and reference framework for emergency rescue systems


### Summary

Recommendation ITU-T F.760.1 describes the application scenarios, functional requirements and reference architecture of pre-hospital emergency rescue and applies these to the planning and designing of emergency rescue systems in emergency centres, hospitals and other medical institutions. The appendix to this Recommendation includes some use cases of the proposed reference system.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
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### Keywords

Emergency rescue system, reference framework, requirements, use case.


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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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## Recommendation ITU-T F.760.1

# Requirements and reference framework for emergency rescue systems

## 1 Scope

The Recommendation specifies the requirements and reference framework for emergency rescue systems.

The scope of this Recommendation includes:

– requirements for an emergency rescue system;
– reference framework for an emergency rescue system;
– use cases for an emergency rescue system.

## 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 K.116] Recommendation ITU-T K.116 (2019), *Electromagnetic compatibility requirements and test methods for radio telecommunication terminal equipment.*

[ITU-T M.3050.x] Recommendation ITU-T M.3050.x-series (2007), *Enhanced Telecom Operations Map (eTOM).*

[ITU-T Q.3741] Recommendation ITU-T Q.3741 (2019), *Signalling requirements for SD-WAN service.*

[ITU-T Y.3500] Recommendation ITU-T Y.3500 (2014), *Information technology – Cloud computing – Overview and vocabulary*.

[ITU-T Y.3502] Recommendation ITU-T Y.3502 (2014), *Information technology – Cloud computing – Reference architecture.*

[ITU-R M.1787] Recommendation ITU-R M.1787-4 (2022), *Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz.*

[Bluetooth CS 5.3] Bluetooth CS 5.3 (2021), *Bluetooth Core Specification, v5.3.*

[ETSI GS MEC 003] ETSI GS MEC 003 V3.1.1 (2022-03), *Multi-access Edge Computing (MEC): Framework and Reference Architecture.*

[ETSI TS 123 501] ETSI TS 123 501 V17.6.0 (2022-09), *5G; System Architecture for the 5G System (5GS) (3GPP TS 23.501 version 17.6.0 Release 17).*

[ETSI TS 123 503] ETSI TS 123 503 V17.6.0 (2022-09), *5G; Policy and charging control framework for the 5G System (5GS); Stage 2 (3GPP TS 23.503 version 17.6.0 Release 17).*

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[IEC 62680-2-1] IEC 62680-2-1 (2015), *Universal Serial Bus interfaces for data and power – Part 2-1: Universal Serial Bus Specification, Revision 2.0.*

[IEC 62680-3-1] IEC 62680-3-1 (2017), *Universal Serial Bus interfaces for data and power – Part 3-1: Universal Serial Bus 3.1 Specification.*

[IEEE 802.11] IEEE 802.11-2020, *IEEE Standard for Information Technology – Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.*

[ISO 12052] ISO 12052 (2017), *Health informatics – Digital imaging and communication in medicine (DICOM) including workflow and data management.*

[ISO/HL7 21731] ISO/HL7 21731 (2014), *Health informatics – HL7 version 3 – Reference information model – Release 4.*

[ISO/IEC 7816-1] ISO/IEC 7816-1 (2011), *Identification cards – Integrated circuit cards – Part 1: Cards with contacts – Physical characteristics.*

[ISO/IEC 14443-1] ISO/IEC 14443-1 (2018), *Cards and security devices for personal identification – Contactless proximity objects – Part 1: Physical characteristics.*

## 3 Definitions

### 3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

**3.1.1 service level agreement (SLA)** [ITU-T Y.3500]: Documented agreement between the service provider and customer that identifies services and service targets.

NOTE 1 – A service level agreement can also be established between the service provider and a supplier, an internal group or a customer acting as a supplier.

NOTE 2 – A service level agreement can be included in a contract or another type of documented agreement.

### 3.2 Terms defined in this Recommendation

None.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

5G 5th Generation of Mobile Networks

AF Application Function

| | |
|---|---|
| AI | Artificial Intelligence |
| APN | Access Point Name |
| AR | Augmented Reality |
| ATSSS | Access Traffic Steering, Switching and Splitting |
| BSS | Business Support Systems |
| COVID-19 | Corona Virus Disease 2019 |
| CPR | Cardiopulmonary Resuscitation |
| CSP | Communication Service Provider |
| DICOM | Digital Imaging and Communications in Medicine |
| DNN | Data Network Name |
| ECG | Electrocardiogram |
| eMBB | enhanced Mobile Broadband |
| EMC | essential Electromagnetic Compatibility |
| GIS | Geography Information System |
| GNSS | Global Navigation Satellite System |
| HDMI | High Definition Multimedia Interface |
| HL7 | Health Level Seven |
| ICU | Intensive Care Unit |
| IEEE | Institute of Electrical and Electronics Engineers |
| iGW | industry Gateway |
| iMEP | industry MEC Platform |
| IMT | International Mobile Telecommunications |
| IoT | Internet of Things |
| IPv4 | Internet Protocol Version 4 |
| IPv6 | Internet Protocol Version 6 |
| KPI | Key Performance Indicator |
| LAN | Local Area Network |
| MEC | Multi-access Edge Computing |
| MEO | Mobile Edge Orchestrator |
| MEP | MEC Platform |
| MEPM | MEC Platform Manager |
| MPDS | Medical Priority Dispatch System |
| NAPT | Network Address Port Translation |
| NAT | Network Address Translation |
| NLP | Natural Language Processing |
| OSS | Operation Support Systems |
| PCI-E | Peripheral Component Interconnect Express |

| | |
|---|---|
| PGW-U | PDN Gateway User plane function |
| QoS | Quality of Service |
| RAN | Radio Access Network |
| RNSS | Radio Navigation Satellite System |
| SD-WAN | Software-Defined Wide Area Networking |
| SGW-U | Serving Gateway User plane function |
| SLA | Service Level Agreement |
| SMS | Short Message Service |
| UPF | User Plane Function |
| uRLLC | ultra-Reliable Low Latency Communications |
| URSP | UE Route Selection Policy |
| VGA | Video Graphics Array |
| VPN | Virtual Private Network |
| VR | Virtual Reality |
| Wi-Fi | Wireless Fidelity |

## 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 document is to be claimed.

The keywords "**is recommended**" and "**should**" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement needs not be present to claim conformance.

The keywords "**can optionally**" and "**may**" indicate an optional requirement which 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/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

## 6 Background

As advanced technologies such as 5G/IMT-2020, cloud computing, big data, artificial intelligence, and IoT accelerate, emergency rescue services have the potential to further save precious rescue time and save more lives. Especially with the continuous evolution of mobile communication technology, many emergency rescue services that rely on the characteristics of communication technology can be supported. 5G/IMT-2020 technology can eliminate the network delay within 10 ms, making it possible to remotely control drones and other equipment for emergency material distribution, emergency observation on the scene. 5G/IMT-2020 technology will allow emergency services to use Internet of Things (IoT) devices. For instance, emergency services can use it for sensor networks to help remotely monitor critically ill patients and epidemic control.

At present, there are already some successful cases of combining 5G/IMT-2020 technology and emergency rescue services around the world. However, there are still many problems in the existing emergency rescue system. The emergency rescue resources of multilevel medical institutions have not been effectively integrated, and there is a lack of generalized platform requirements, and standardized and shared intelligent emergency rescue service systems. The application of advanced technologies such as 5G/IMT-2020, cloud computing, big data, Internet of Things, artificial intelligence, etc. is still being explored and only applied in a limited range. The emergency rescue system is not systematic and intelligent enough. It is also necessary to study what use cases can effectively combine cutting-edge technologies with the emergency rescue system. Most of the current emergency rescue service scenarios empowered by 5G/IMT-2020 remain on the transmission of ultra-high-definition data based on eMBB. interoperability emergency services scenarios based on uRLLC need to be further studied, such as how to carry out remote surgery in emergency rescue scenarios.

Researching how advanced technologies enable an emergency rescue system can gradually realize the goal of patients getting effective treatment as soon as the onset of the illness arises, and patients can get equivalent intra-hospital medical services on the ambulance. It can further optimize the emergency service procedure and realize the smooth flow of information in the procedure, increase the utilization rate of medical resources, and comprehensively guarantee the efficient development of all emergency rescue services.

## 7 Requirements for emergency rescue systems

### 7.1 System functional requirements

This clause will provide a detailed description of the requirements of emergency rescue systems.

a) Multiple category medical devices should be connected via a cellular network and other communication technologies, including 2G, Wi-Fi [IEEE 802.11], Bluetooth [Bluetooth CS 5.3], etc. But it is optional for IMT-2000, IMT-Advanced, 5G/IMT-2020 networks since their deployment is not available everywhere.

b) Emergency rescue dedicated networks should be supported, providing private communication resources for guaranteed SLA performance under high-speed mobility scenarios and security by separating medical data from public communications.

c) Cloud-network management convergence should be supported, providing unified management on different access networks, emergency rescue applications and services management, computing resources virtualization, etc.

d) It should support various services and applications under different emergency rescue scenarios, which provide functionalities that include patient information synchronization, remote medical consultation and emergency resources scheduling (e.g., ambulance, doctors, etc.).

### 7.2 Requirements for emergency rescue applications

The requirements of emergency rescue applications are listed as follows:

a) They should support the scenario that the patient can make an alarm call in an emergency, and also support the scenario that the patient cannot make an alarm call, such as a sudden heart attack, where the patient cannot speak and there is no cellular network coverage.

b) They should support interactive text, voice, image and video data between emergency rescue terminals and servers, such as HL7 [ISO/HL7 21731] messages and DICOM [ISO 12052] images.

c) They should support medical information systems, including structured medical record information, vital sign data, prognosis data, medical knowledge graphs, etc.

d) They should support emergency dispatching functions, which carry out the overall dispatching of medical resources, such as the medical priority dispatch system (MPDS).

e) They should support real-time monitoring services of patients inside the ambulance, which include the performance requirements [b-3GPP TR 22.826] in Table 7-1.

f) They should support smart triage systems and early alert systems on the ambulance to facilitate in-hospital preparation in advance.

g) They can optionally support remote intervention for patients inside the ambulance, which includes the performance requirements [b-3GPP TR 22.826] in Table 7-2.

h) They can optionally support the location and tracking of patients and ambulances through cellular base station positioning or radio navigation satellite system (RNSS) positioning [ITU-R M.1787].

i) They can optionally support real-time tracking of the ambulances through the SMS message received from the emergency command centre.

j) They can optionally support a wireless emergency intercom system in non-regular scenarios so that medical staff can carry a lightweight two-way radio or use a base station intercom.

k) They can optionally support various emergency rescue applications based on AI technologies, including computer-aided diagnosis systems such as medical image recognition, medical information extraction and content structuring, voice recognition and transcription technology, etc.

**Table 7-1 – Performance requirements of patient monitoring inside the ambulance**

| Types | Communication service availability: target value in % | End-to-end latency: maximum (ms) | Bit rate | Direction |
|---|---|---|---|---|
| Compressed 4K (3 840 × 2 160 pixels) 12 bits per pixel (e.g., YUV4:1:1) 60 fps real time video stream | 99.99 | < 100 | 25 Mbits/s | UE towards network |
| Uncompressed 2 048 × 2 048 pixels 16 bits per pixel 10 fps real-time video scan stream | 99.999 | < 100 | 670 Mbits/s | UE towards network |
| Physical vital signs monitoring data stream | 99.999 | < 100 | 1 Mbits/s | UE towards network |
| High-quality audio stream | 99.99 | < 100 | 128 kbits/s | UE towards network; network towards UE |

**Table 7-2 – Performance requirements of intervention for patients inside the ambulance**

| Types | Communication service availability: target value in % | End-to-end latency: maximum (ms) | Bit rate (Mbits/s) | Direction |
|---|---|---|---|---|
| Compressed 4K (3 840 × 2 160 pixels) 60 fps 12 bits per pixel color coded (e.g., YUV 4:1:1) real-time video stream | 99.99 | < 20 | 25 | UE towards network |

**Table 7-2 – Performance requirements of intervention for patients inside the ambulance**

| Types | Communication service availability: target value in % | End-to-end latency: maximum (ms) | Bit rate (Mbits/s) | Direction |
|---|---|---|---|---|
| Uncompressed<br>512 × 512 pixels 32 bits<br>20 fps video stream<br>from ultra-sound probe | 99.999 | < 20 | 160 | UE towards network |

## 7.3 Requirements for emergency rescue terminals

An emergency rescue terminal is used for information collection and transmission, two types of emergency rescue terminals are referred to in the system, the emergency cellular terminals and access gateway. For emergency cellular terminals, which can access the cellular networks directly, and for the access gateway, which can support those traditional medical devices access to the wireless network, convert a non-3GPP network (Wi-Fi, optical fibre, Bluetooth, etc.) to a cellular network.

### 7.3.1 General requirements

Emergency rescue terminals are required to meet the following requirements, both for the emergency cellular terminals and access gateway equipment. The general requirements towards terminals are listed as follows:

a) They should support at least 2G and be optional for IMT-2000, IMT-Advanced, 5G/IMT-2020.

b) They should support APN configuration under IMT-Advanced networks and also support DNN configuration if a 5G/IMT-2020 network is available.

c) They should support network slicing, URSP [ETSI TS 123 503], and ATSSS [ETSI TS 123 501] if a 5G/IMT-2020 network is available.

d) They should support equipped with RNSS [ITU-R M.1787] receivers.

e) They should support electrical safety standards [IEC 60950-1].

f) They should support the basic safety and essential performance of medical electrical equipment [IEC 60601-1-2].

g) They should support EMC requirements for radiocommunication terminal equipment and ancillary accessories [ITU-T K.116].

h) They can optionally have a contact card reader [ISO/IEC 7816-1] and contactless card reader [ISO/IEC 14443-1].

### 7.3.2 Access gateway requirements

Specific requirements for the access gateway are as follows:

a) It should support IPv4 and IPv6 dual-stack protocols.

b) It should support NAT and NAPT functions.

c) It should support the SLA guarantee for those non-3GPP network connections to the access gateway.

d) It should support at least USB2.0 [IEC 62680-2-1] and be optional for USB3.x [IEC 62680-3-1], VGA, HDMI, PCI-E, Ethernet interface.

e) It can optionally support the fan-less cooling design and work at −30 to 70 degrees Celsius for the operating temperature.

f) It can optionally support a backup battery for power supply.

g) It can optionally support a built-in offline storage function and retransmit data when network connectivity is restored.

### 7.4 Requirements for emergency rescue networks

The requirements of emergency rescue networks are as follows.

a) They should support continuous cellular network coverage in urban and rural scenarios.

b) They should support temporary cellular network coverage in non-regular scenarios, including sea, desert, virgin forest, earthquakes, etc. Here, multiple types of backhaul modules (drones, satellite communications, relay, etc.) should be provided for network connection establishment, and they also can optionally support lightweight and portable wireless base stations which can be powered by batteries and connected to backhaul modules.

c) They should support providing dedicated physical or virtualized network resources for SLA guarantee and data security, and the performance requirements are listed in Table 7-3.

d) They should support the emergency rescue terminal to access the cellular network through a non-3GPP network.

e) They should support IoT, which includes the performance requirements [b-3GPP TR 22.826] in Table 7-4.

f) They should support unified management and access authority management over different networks, including cellular networks, Wi-Fi, IoT, Bluetooth, etc.

g) They should provide APIs for a hospital's self-management on the aforementioned networks in points a) and b) of clause 7.4.

h) They should provide different network exposure to medical applications, including positioning and QoS, etc., and also network slicing if a 5G/IMT-2020 network is available.

**Table 7-3 – Performance requirements of dedicated network**

| Bandwidth | Latency | Jitter | Packet loss rate |
|---|---|---|---|
| > 100 Mbit/s | < 50 ms | < 20 ms | $< 10^{-3}$ |

**Table 7-4 – Performance requirements of IoT**

| Communication service availability: target value | End-to-end latency: maximum | Service bit rate: user experienced data rate |
|---|---|---|
| 99.9999 % | < 100 ms | 0.5 Mbit/s |

### 7.5 Requirements for emergency rescue cloud platform

The requirements of the emergency rescue cloud platform are as follows:

a) It should support cloud computing management [ITU-T Y.3500], [ITU-T Y.3502], which provides the essential requirement for virtualization infrastructure, including compute, storage and network resources.

b) It should support MEC [ETSI GS MEC 003] functions and local management if a 5G/IMT-2020 network is available, which can enable mobile edge applications to run efficiently and seamlessly in a cellular network.

c) It should support the hospital's self-management on an emergency rescue network based on the APIs provided by the network, including unified network management over different network types, network slicing management, location management, and QoS management, access authority management, etc.

d) It should support onboard emergency application management, including application lifecycle management and package management, etc.

e) It should support emergency rescue-specific cloud capabilities, including high-reliability and high-definition video services, AI functions (data preprocessing, model training, model evaluation, and model prediction), big data compute functions (batch and streaming data processing), and object storage functions (database and file storage), etc.

f) It should support situational awareness capabilities to accurately perceive and actively acquire emergency events, including measurements of network quality (e.g., network packet loss, latency and jitter), cloud resources, applications, securities, etc.

g) It should support the management and maintenance functions of terminals mentioned in clause 7.3, such as terminal upgrade, software installation, work log reading and analysis.

## 7.6 Requirements for patients with specific needs

This clause provides a detailed description of the requirements for patients with specific needs (e.g., hearing and speech impairment, heavy dialect, unclear description of the condition due to emotional tension, etc.). They cannot raise the alarm in the usual manner. There should be support for some functions for those patients with specific requirements, as shown below.

a) **Disease condition function**: Personal information such as mobile phone number, residential address, emergency contact person, and medical conditions will be filled in advance.

b) **Positioning function**: The precise position of the patient can be located in real time.

c) **One-touch alarm function**: The condition of a patient's disease and positioning information will be sent to the emergency command centre with one click.

d) **NLP function**: The patient can keep in touch with the emergency command centre and receive self-rescue guidance.

There should be support for some functions for the emergency command centre, as shown below.

a) **SMS confirmation function**: This module interacts with the aforementioned one-touch alarm module so that the emergency command centre can promptly inform the patient that the alarm information has been received and a nearby ambulance has been dispatched.

b) **Self-rescue guidance function**: This module interacts with the aforementioned NLP module so that the emergency command centre can give preliminary self-rescue measures through proactive digital guidance (e.g., text, images, voice, etc.).

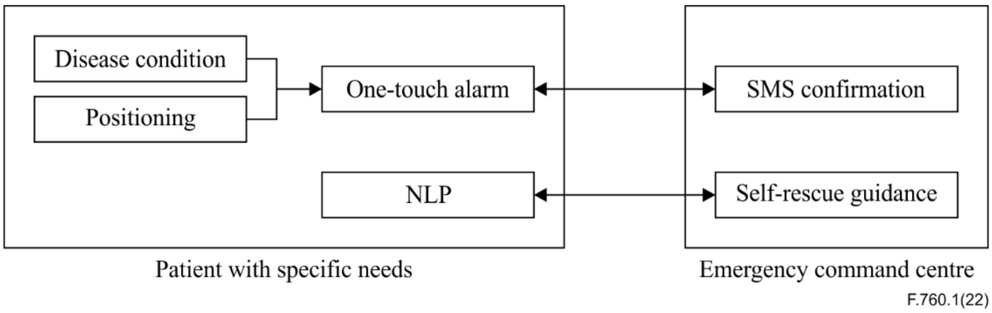


**Figure 7-1 – Requirements of patients with specific needs**

## 7.7 Compatibility requirements

There should be support for emergency rescue applications to run seamlessly on different cloud platforms.

## 8 Reference framework for the emergency rescue system

### 8.1 Reference architecture of the overall system design

Figure 8-1 illustrates the proposed overall emergency rescue system design. Four layers are defined here, including terminal, network, cloud and application layers. Moreover, to make the heterogeneous emergency rescue system manageable, flexible and suitable for various emergency applications, the cloud layer can orchestrate and manage the other three layers.

a) The terminal layer is used for information collection as the carrier of medical tools and applications and also for information transmission. It can be classified into integrated terminals, information collection and display terminals and auxiliary terminals. The integrated terminals are taken as a 5G/IMT-2020 access gateway, which connects multiple medical terminals and transfers the data to a 5G/IMT-2020 signal. The information collection and display terminals are used to gather and display emergency data; these are represented as wearable equipment, first aid kits, smart boxes, video terminals, imaging equipment, etc. The auxiliary terminals are used to improve the flexibility and efficiency of emergency rescue, including ambulances, robots, drones, etc.

b) The network layer plays a crucial role in emergency data transmission, providing SLA guaranteed, date isolated, global-area mobility and a private link between the terminal layer and the cloud layer. To support different scenarios, including for a smart first aid on the scene, emergency transportation, etc. Here different network topologies and KPIs should be provided to satisfy various requirements. The dedicated communication link can be carried as 5G/IMT-2020 network slicing, 5G/IMT-2020 LAN [ETSI TS 123 501], IoT, and dedicated lines (etc., VPN, fibre line).

c) The cloud layer cooperating with the network layer for the emergency data breakout from the dedicated network, also provides the virtualization infrastructure, including compute, storage and network resources, to run emergency-specific applications. Moreover, it provides emergency-specific services, including AI, big data, video, object storage, network ability (positioning, QoS management, etc.), as well as supporting various emergency-specific applications. The cloud layer could be implemented based on 5G/IMT-2020 MEC [ETSI GS MEC 003], private cloud, or other security-guaranteed public cloud, etc.

d) To support different emergency services and scenarios, various applications should be provided in the application layer, such as a high-definition audio and video interactive system, remote emergency consultation system, emergency auxiliary support system, positioning and search and rescue system (including GNSS and GIS system), emergency command system, big data analysis system, situational awareness system and emergency medical information system.

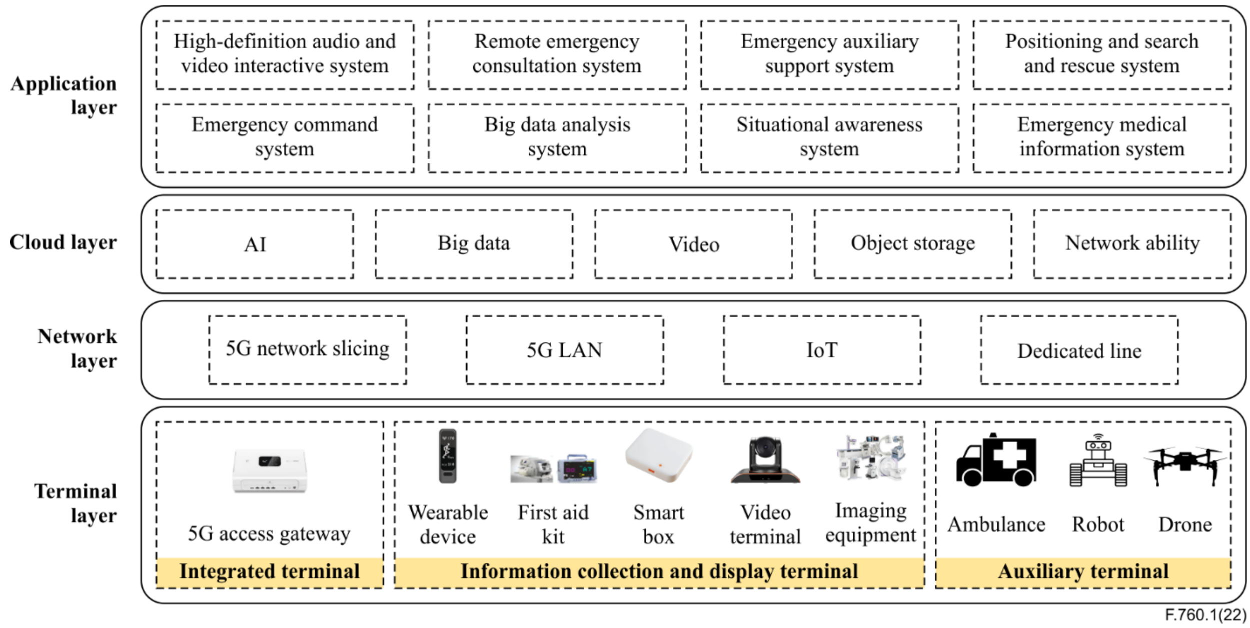


**Figure 8-1 – Reference architecture of the overall system design**

## 8.2 Reference architecture of the network layer

Under a typical emergency scenario, various facilities are required, such as ambulances, emergency command centres and hospitals. The network layer is used to build a connection between the aforementioned facilities and support a wide-connected, low-latency and highly-reliable data transmission path under emergency rescue scenarios. Here, the emergency control link and emergency data link shall be included, as shown below.

a) Emergency control link is used for the ambulance and hospital scheduling, and the transmitted information includes the patient location, illness, electronic medical record, etc.

b) After the control link is created, a dedicated data link is established between the hospital and the ambulance for transmitting emergency data. In general, the ambulance is equipped with networking access, such as a 5G/IMT-2020 connection.

c) The control link and data link could be 5G/IMT-2020 LAN, 5G/IMT-2020 network slicing, and the control link can also use the dedicated line (VPN, fibre line, etc.) for information transmission.

To make these defined communication links available, the emergency rescue network's infrastructure should include access network, transport network and local data breakout. The local data breakouts are performed as UPF [ETSI TS 123 501] in 5G/IMT-2020 systems and PGW-U/SGW-U [ETSI TS 129 244] in IMT-Advanced systems. Benefiting from network slicing, multiple virtualized and independent logical emergency networks can be created simultaneously on the same physical network infrastructure. Each logical emergency network is an isolated end-to-end network tailored to fulfil diverse requirements requested by a particular emergency application.

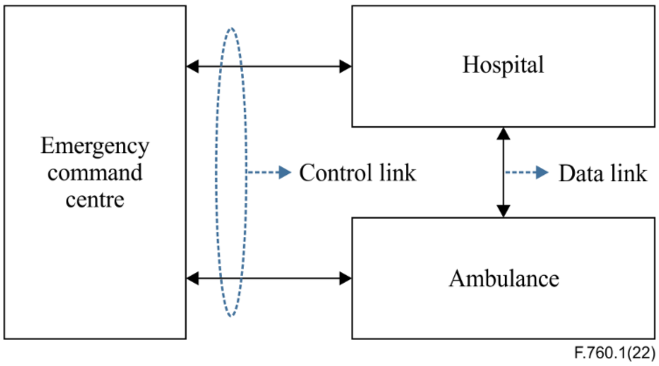


**Figure 8-2 – Reference network architecture of the network layer**

## 8.3 Reference architecture of the cloud layer

Concerning the 5G/IMT-2020 architecture definition in 3GPP, the MEC is fully integrated with the 5G/IMT-2020 network through the UPF and AF to play a good effect in the emergency scenarios, such as lower end-to-end latency, lighter load on backhaul link, less energy consumption for battery-operated devices, smaller network bandwidth and more secure data transmission. In addition to these key network elements, the BSS/OSS [ITU-T M.3050] is essential for the telecommunication service provider; functionalities such as billing, service management, assurance, element management, provisioning and network management are provided for network operation.

One emergency-specific MEC architecture is proposed here, as illustrated in Figure 8-3. A new network element named iGW is introduced between the UPF and MEP, and it is managed by a dedicated orchestrator system. The iGW will play a crucial role in network management, wide-area connection, user access control, and the network capabilities exposure. Meanwhile, the dedicated MEP, named iMEP here, had also been enhanced to coordinate with iGW to make these iGW's features feasible in emergency applications. The emergency-specific MEC consists of iGW and iMEP, which provide universal networks and computational resources and emergency rescue applications for end users.

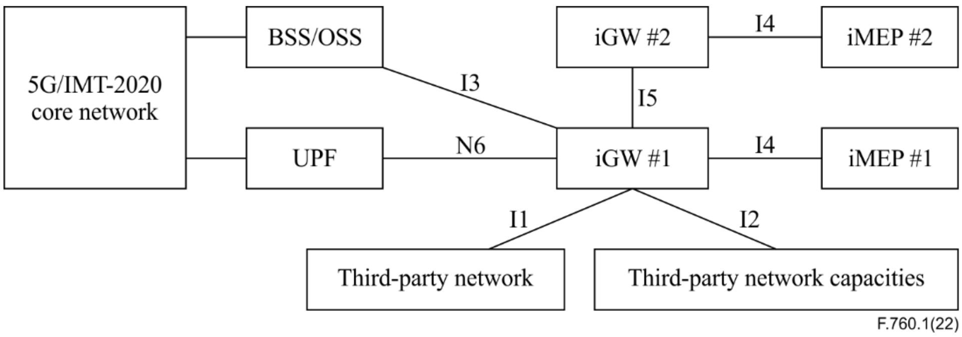


**Figure 8-3 – Reference architecture of emergency-specific MEC**

### 8.3.1 Network gateway functionalities

The iGW is the essential network element to achieve cloud-network integration. It's a manageable, controllable and perceptible integrated network service portal created exclusively for emergency rescue customers, responsible for all network-related processing and controlled by a CSP. It opens the supported five functionalities to applications with friendly APIs at the iGW, whose functions are described as follows.

a) **Hospital multi-standard network unified access management capabilities**. These support the unified access management of the hospital's multi-standard network, including 3GPP network, non-3GPP network (e.g., Wi-Fi, Bluetooth, etc.), network capabilities (e.g., position, QoS, network slicing, etc.), and emergency dedicated network access services.

b) **The wide-area interconnection between hospitals**. The wide-area mesh network is created by multiple iGWs, which can support SLA-guaranteed, confidential communications between hospitals to allow emergency business collaboration for those hospitals in different regions.

c) **Unified access and exposure of multiple types of network capabilities**. The iGW will be taken as an agent for 5G/IMT-2020 core network, RAN and other networks (e.g., Wi-Fi, Bluetooth, etc.), and exposing the different types of network capacities to iMEPs.

d) **Access authority management**: This provides user access authority management and service access authority management.

e) **Self-service resource management**: This realizes network partition authority management, performance management, routing strategy, network slicing template, etc. Based on standard APIs provided by the iGW, the user can use these network functionalities (position, QoS, network slicing, etc.) for fast emergency applications creation, self-service network management and operation on the 5G/IMT-2020 network.

### 8.3.2 Reference architecture of dedicated MEP

The MEP's resource assignment, applications boarding, and lifecycle are managed by the MEO and MEPM [ETSI GS MEC 003]. For data transmission security, the hospital manages the iMEP and authorizes all exchanged signalling and data between MEP and MEPM or MEO. Furthermore, the iMEP is an application empowerment platform built for emergency services. The more complex functions of iMEPs are divided into four functional layers, as described below.

a) A unified platform management layer provides application management, service management, resource management, configuration management, alarm monitoring and system management.

b) The platform capability opening layer provides unified protocol and conversion, flow restriction, authentication, routing forwarding, rule verification, statistics, etc.

c) The platform capability access layer provides a unified capability access framework for the emergency rescue applications.

d) The infrastructure layer provides compute, storage, network and security resources.

### 8.3.3 Reference architecture of dedicated cloud integrating with network

The aforementioned iGW needs to interact with many network devices or elements to realize those functions (e.g., multi-standard network unified access management capabilities, wide-area interconnection between hospitals, unified access and exposure of multiple types of network capabilities, etc.) agreed upon by the iGW. The newly increased interfaces I1~I5 are shown in Figure 8-3.

a) **I1 interface**. This is mainly used for access authentication, network control and data transmission of third-party networks. It can also transmit data between iGW and third-party networks through dedicated tunnels.

b) **I2 interface**. This is mainly used to access and control network capabilities acquisition and provide third-party network capability lists (bandwidth, bandwidth control granularity, position, QoS, number of access users, etc.) to the MEC platform based on standard APIs.

c) **I3 interface**. This is mainly used for the iGW's policy configuration and operation status monitoring, including the iGW registration, operation authority, method and range for network capabilities exposure, status monitoring, etc.

d) **I4 interface**. This is mainly used to realize network partition authority management, performance management, routing strategy, network slicing template, etc. Based on standard APIs provided by the iGW, the user can use those network functionalities (positioning, QoS, network slicing, etc.) for fast emergency applications creation, self-service network management, and operation on the 5G/IMT-2020 network.

e) **I5 interface**. This realizes wide-area interconnection between iGWs, allowing interconnection between hospitals anytime and anywhere. The wide-area interconnection can be implemented by SD-WAN [ITU-T Q.3741] or 5G/IMT-2020 LAN.

# Appendix I

## Use cases

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

This clause describes various scenarios for emergency rescue systems.

### I.1 Introduction

Use cases generated as part of this Recommendation are categorized as follows:

Use cases covering the emergency treatment of general scenarios for individuals: These use cases are captured in the "Smart first aid on the scene", "Emergency transportation", "Remote emergency service dispatch management", and "Emergency rescue equipment integration" clauses of this Recommendation.

Use cases covering the emergency treatment of public safety incidents for the community or society: These use cases are captured in the "Emergency rescue for natural disasters and accident disasters" and "Emergency rescue for public health emergencies" sections of this document.

### I.2 Smart first aid on the scene

#### I.2.1 Description

The typical methods of on-site first aid include extra-cardiac defibrillation, CPR and basic techniques such as haemostasis, bandaging, fixation and transportation. Smart first aid can maintain and rescue the wounded and sick's lives, alleviate their suffering and prevent complications and sequelae as much as possible.

#### I.2.2 Pre-conditions

A person has suddenly fainted on the road and the entourage called the police. The medical staff arrive at the scene in an ambulance. Each piece of required equipment (5G/IMT-2020 remote B-ultrasound, remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and
– the emergency control link and data link have been established.

#### I.2.3 Service flows

1) When the medical staff arrive at the scene, they immediately perform a physical examination of the patient, check the patient's vital signs and obtain vital signs data such as heart rate, pulse, blood pressure, blood sugar and ultrasound images.
2) The medical staff judge whether the patient's vital signs are stable and whether external defibrillation and CPR is needed.
3) 5G/IMT-2020 network slicing will transmit all medical data to the emergency room in the hospital.
4) Suppose the level and experience of the medical staff on board are insufficient. The medical staff transmits the first aid treatment situation in real time through portable high-definition cameras and AR glasses. The emergency doctors in the hospital can communicate with the on-site medical staff in real time and guide the medical staff to check and rescue.

#### I.2.4 Post-conditions

The medical staff have delivered emergency treatment and detailed examinations on the patient, collected the patient's vital signs data and initially controlled the condition. The patient is then transferred to an ambulance.

### I.3 Emergency transportation

#### I.3.1 Description

Emergency transportation generally refers to pre-hospital emergency transportation. It focuses on rescuing patients who are wounded in an accident. The service mainly includes emergency transport of injured and critically ill patients, and medical services' logistical support for major events. The ambulance is equipped with IoT bracelets, high-definition imaging equipment, remote ECG monitoring devices, medical AR glasses and other equipment. The patient's various data information will be immediately transmitted to the rescue centre of the hospital through the 5G/IMT-2020 network slicing, and the doctor can check the patient's physical signs data in advance. During the emergency transportation, doctors in the hospital can also remotely guide the paramedics in the ambulance to complete the pre-operation preparations for the patient, achieving the practices for the operation in the hospital in advance.

#### I.3.2 Pre-conditions

A person suddenly fainted on the road and the entourage called the police. The medical staff arrive at the scene in an ambulance. Each piece of required equipment (5G/IMT-2020 remote B-ultrasound, remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and

– the emergency control link and data link have been established.

#### I.3.3 Service flows

1) The medical staff send the patient to the ambulance, give the patient immediate emergency treatment such as oxygen inhalation, CPR, open venous access under the standard operating procedures.

2) On the way to the hospital the medical staff confirm the identity of the patient.

   – Suppose the patient is conscious, they can provide basic personal information.

   – Suppose the patient is no longer able to cooperate with the examination. The medical staff can connect an extensive database to determine the patient's identity quickly through intelligent devices such as facial recognition.

3) On the way to the hospital, the emergency doctors of the hospital make maximum use of the transportation time to prepare for the operation.

   – Suppose the patient has mild symptoms. The medical staff connect to the patient's electronic medical record system through a 5G/IMT-2020 network, which transmits the patient's past medical history, medical records and primary diseases to the emergency medical information system. Medical staff in pre-hospital emergency and in-hospital emergency can simultaneously obtain relevant information.

   – Suppose the patient is severely ill. The hospital's emergency experts observe the patient's condition in real time through the 5G/IMT-2020 network slicing, guide the onboard medical staff, and do the essential vital signs detection and basic medical examination before admission.

#### I.3.4 Post-conditions

When the ambulance arrived at the hospital, the hospital's medical staff had already prepared for the operation. If the patient is in a critical condition, the hospital will immediately open a green channel.

## I.4 Remote emergency service dispatch management

### I.4.1 Description

Remote emergency service dispatch management is to dispatch medical resources in a particular area. It gathers all emergency information within a specific range and effectively coordinates an ambulance, ICU, operating room and other related parties during the emergency rescue process. After receiving the alarm call there are two scenarios:

– **Scenario 1**: There is no ambulance in the emergency centre, and the selected hospital sends an ambulance.

– **Scenario 2**: The emergency centre owns many ambulances and dispatches an ambulance.

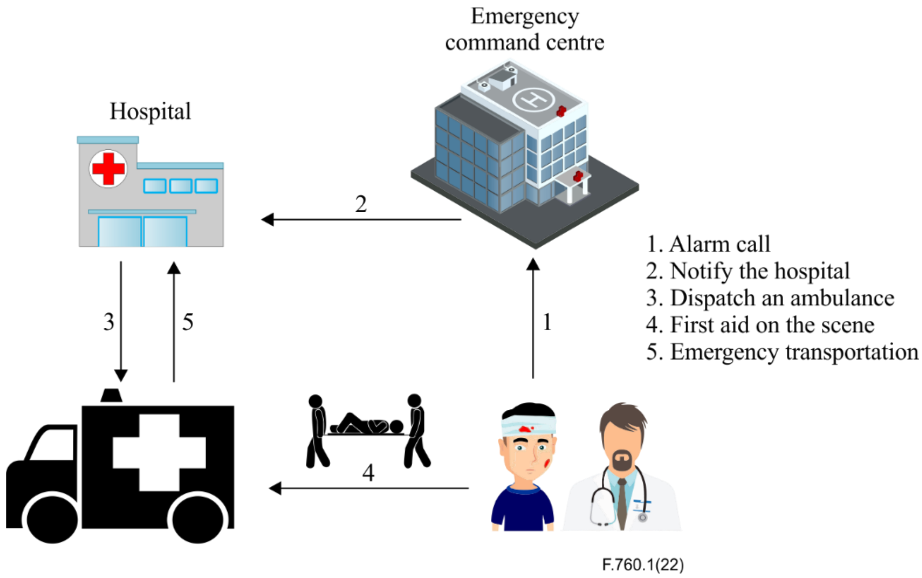


**Figure I.1 – Scenario 1: Ambulance dispatch from hospital**

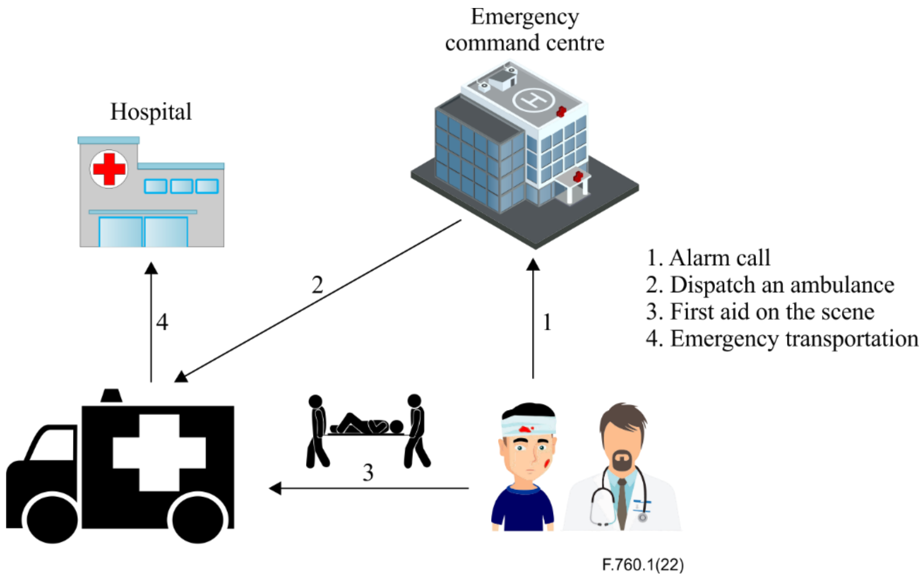


**Figure I.2 – Scenario 2: Ambulance dispatch from emergency command centre**

### I.4.2 Pre-conditions

A person suddenly fainted on the road. The entourage called the emergency command centre. The medical staff had arrived at the scene in an ambulance. Each piece of required equipment (5G/IMT-2020 remote B-ultrasound, remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and
– the emergency control link and data link have been established.

### I.4.3 Service flows

1) After receiving the alarm, the emergency command centre will conduct standardized inquiries on the patient.
2) The emergency command centre will quickly dispatch an ambulance.

   **Scenario 1**: The emergency command centre can view the in-hospital emergency data of the hospitals in the area where the alarm occurs, such as the number of patients receiving emergencies and the number of remaining emergency beds. It grasps the real-time reception capabilities of each hospital and notifies the hospital to dispatch an ambulance and medical staff.

   **Scenario 2**: The emergency command centre generates the best and fastest driving route for the ambulance based on the positioning and search and rescue system and grasps the driving situation of the ambulance in real time. After receiving the dispatch order, the ambulance will set off within the specified time according to the location provided by the positioning and search and rescue system.
3) Before the ambulance arrives, the medical staff in the ambulance will give patients first aid guidance through the 5G/IMT-2020 network slicing.
4) The onboard emergency system can produce patient handover orders in advance so that the hospital can triage according to the received patient information in advance and quickly hand over patients after the ambulance enters the hospital.

### I.4.4 Post-conditions

The emergency command centre records ambulances, drivers, patients and medical staff onboard to ensure that the whole process can be analysed and traced.

## I.5 Emergency rescue equipment integration

### I.5.1 Description

Emergency rescue equipment integration should meet the system requirements of miniaturization, intelligence and integration, which includes the integration of new technologies and the integration of medical applications. New technologies refer to 5G/IMT-2020, IoT, big data, artificial intelligence, etc. Medical applications refer to 5G/IMT-2020 remote B-ultrasound, 5G/IMT-2020 ICU, VR diagnosis and treatment, remote video interaction, remote emergency command platform, etc. It can provide high-quality life support for critically ill patients by performing cardiopulmonary resuscitation, mechanical ventilation, cardiac defibrillation, vital signs detection, etc.

### I.5.2 Pre-conditions

The ambulance is equipped with first aid equipment and a 5G/IMT-2020 access gateway. The first-aid kit includes monitors, ventilators, infusion pumps, blood gas analysers, high-definition audio and video monitoring, 5G/IMT-2020 mobile smart devices, etc. The 5G/IMT-2020 access gateway is responsible for communicating with first-aid equipment to seamlessly integrate the first-aid kit and the 5G/IMT-2020 emergency cloud platform.

Each piece of required equipment (5G/IMT-2020 remote B-ultrasound, remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and
– the emergency control link and data link have been established.

### I.5.3 Service flows

1) Medical staff use real-time high-definition audio and video interactive systems, under the guidance of remote diagnosis and treatment of hospital medical staff, use a vehicle-mounted defibrillator for other rescues or use a non-invasive ventilator for assisted ventilation.

2) The 5G/IMT-2020 access gateway collects the patient's vital signs data in real time, extracts or translates the data, and uploads it to the emergency cloud platform through the 5G/IMT-2020 network slicing.

### I.5.4 Post-conditions

The ambulance successfully sent the patient to the hospital and transmitted vital signs data to the emergency cloud platform.

## I.6 Emergency rescue for natural disasters and accident disasters

### I.6.1 Description

Natural disasters include meteorological disasters, earthquake disasters, geological disasters, forest and grassland fires, etc. Accident disasters include major traffic accidents, major environmental pollution, nuclear radiation accidents, ecological damage accidents, etc.

### I.6.2 Pre-conditions

A vicious traffic accident occurred on a particular highway, and dozens of people were injured. They have called the police and medical staff have rushed to the scene in an ambulance and drones.

Each piece of required equipment (5G/IMT-2020 remote B-ultrasound, remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and

– the emergency control link and data link have been established.

### I.6.3 Service flows

1) Deal with the alarm. The emergency command centre quickly analyses and accurately handles major traffic accidents' alarm locations and handles alarm affairs promptly.

2) Search and locate the wounded. Before the ambulance arrives at the location, if there are traffic jams, the medical staff on the ambulance will have used drones to search and locate all those injured in the traffic accident.

3) Collect data of injured persons. The on-site medical staff collected the injury information of all personnel at the traffic accident scene through the medical information collection terminal. It classified them into critical, severe, moderate and mild conditions according to the injured location, cause of injury and type of injury. The injury information is transmitted to the emergency medical information system through the 5G/IMT-2020 network.

4) Connect remote consultation. Medical experts provide real-time video consultation and technical guidance for on-site diagnosis and treatment based on the information of the wounded through the remote emergency consultation system.

5) Real-time monitoring of the wounded. Each wounded person will be equipped with IoT bracelets and GNSS positioning equipment. The on-site medical staff will continuously monitor the critically wounded's condition and transmit the data to the remote medical centre. Based on the positioning and search and rescue system, the wounded are located and tracked in real time.

### I.6.4 Post-conditions

All the wounded and sick have been treated in a timely and effective manner, and the hospital has allocated medical emergency resources.

## I.7 Emergency rescue for public health emergencies

### I.7.1 Description

Public health emergencies include major epidemics, mass diseases of unknown origin, major food and occupational poisoning, etc.

### I.7.2 Pre-conditions

A cluster of COVID-19 infections occurred in a particular place, and many alarms were issued. The medical staff have rushed to the scene in an ambulance.

Each piece of required equipment (remote ECG monitoring equipment, IoT bracelet, etc.) is:

– powered up, and

– the emergency control link and data link have been established.

### I.7.3 Service flows

1) Deal with the alarm. The emergency command centre handles alarm affairs promptly.

2) Dispatch an ambulance. The ambulance needs to carry COVID-19 antigen rapid test cassettes and medical oxygen cylinders, and the medical staff needs to wear protective clothing that meets the requirements for epidemic protection. According to the information provided by the positioning and search and rescue system, the ambulance quickly arrives at the emergency scene.

3) After the ambulance arrives at the scene, medical staff initially confirm that patients have contracted COVID-19 in about twenty minutes, enter patient data through voice, and obtain historical medical record information through the emergency medical information system.

4) The medical staff diagnose whether the patient was with mild or severe symptoms. Patients with mild symptoms are sent to a rapid deployment hospital, and patients with severe symptoms are sent to the hospital ICU. The experts in the hospital can carry out remote guidance.

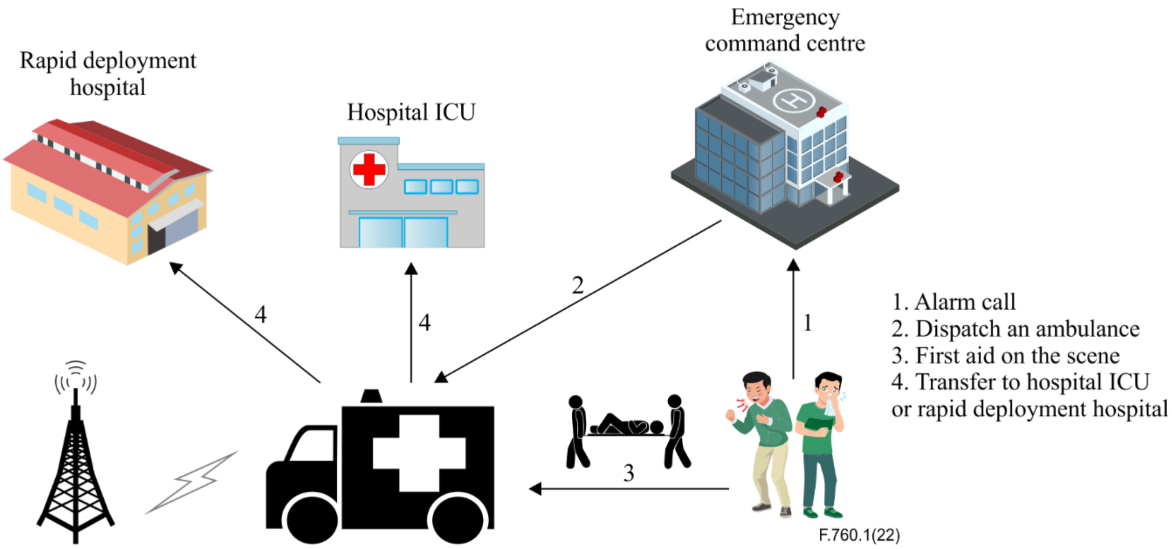


**Figure I.3 – Emergency rescue for public health emergencies**

### I.7.4 Post-conditions

The emergency command centre has successfully found the source of infection and cut off the route of transmission to protect other people from disease.

# Bibliography

[b-3GPP TR 22.826] 3GPP TR 22.826 V17.2.0 (2021), *Study on communication services for critical medical applications*.

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