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International Telecommunication Union
Standardization Sector

Recommendation

# ITU-T F.780.4 (09/2023)

SERIES F: Non-telephone telecommunication services

Multimedia services

# Reference framework, requirements and scenarios for telemedicine systems

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# Recommendation ITU-T F.780.4

## Reference framework, requirements and scenarios for telemedicine systems


**Summary**

Recommendation ITU-T F.780.4 describes the reference framework, requirements and scenarios of telemedicine systems. A telemedicine system is an important application of ICT in the medical field, especially against a background of unbalanced medical resources, and can realize the optimal allocation of medical resources and benefit people in areas with less developed medical resources.

It recommends the framework, functional requirements and scenarios of telemedicine systems, i.e. the necessary hardware and software foundations for telemedicine.

The Recommendation is suitable for the development, construction and evaluation of telemedicine systems in various countries and regions.



**History** *

| Edition | Recommendation | Approval | Study Group | Unique ID |
|---|---|---|---|---|
| 1.0 | ITU-T F.780.4 | 2023-09-13 | 16 | 11.1002/1000/15628 |

**Keywords**

Framework, requirements, scenarios, telemedicine.


* To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

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## Reference framework, requirements and scenarios for telemedicine systems

### 1 Scope

This Recommendation describes the reference framework, requirements and scenarios for telemedicine systems. The scope of this Recommendation includes:

– Reference framework for telemedicine systems;

– Functions and technical requirements for telemedicine systems;

– Scenarios for telemedicine systems.

The reference framework and requirements given in this Recommendation is recommended not to be taken as restrictive.

### 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 E.164] Recommendation ITU-T E.164 (2010), *The international public telecommunication numbering plan*.

[ITU-T G.711] Recommendation ITU-T G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

[ITU-T G.719] Recommendation ITU-T G.719 (2008), *Low-complexity, full-band audio coding for high-quality, conversational applications*.

[ITU-T G.722] Recommendation ITU-T G.722 (2012), *7 kHz audio-coding within 64 kbit/s*.

[ITU-T G.722.1] Recommendation ITU-T G.722.1 (2005), *Low-complexity coding at 24 and 32 kbit/s for hands-free operation in systems with low frame loss*.

[ITU-T G.728] Recommendation ITU-T G.728 (2012), *Coding of speech at 16 kbit/s using low-delay code excited linear prediction*.

[ITU-T G.729] Recommendation ITU-T G.729 (2017), *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction (CS-ACELP)*.

[ITU-T H.235] Recommendation ITU-T H.235 (2005), *Security and encryption for H-Series (H.323 and other H.245-based) multimedia terminals*.

[ITU-T H.239] Recommendation ITU-T H.239 (2014), *Role management and additional media channels for ITU-T H.300-series terminals*.

[ITU-T H.261] Recommendation ITU-T H.261 (1993), *Video codec for audiovisual services at p×64 kbit/s*.

[ITU-T H.263] Recommendation ITU-T H.263 (2005), *Video coding for low bit rate communication*.

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

[ITU-T H.323] Recommendation ITU-T H.323 (2022), *Packet-based multimedia communications systems*.

## 3 Definitions

### 3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

**3.1.1 telemedicine** [b-WHO]: The delivery of health-care services, where distance is a critical factor, by all health-care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities.

NOTE – Tele-health, also known as e-health, is different from telemedicine because it refers to a broader scope of remote health care services than telemedicine. While telemedicine refers specifically to remote clinical services, tele-health can refer to remote non-clinical services, such as provider training, administrative meetings, and continuing medical education, in addition to clinical services [b-HealthIT.gov].

### 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

**3.2.1 telemedicine system**: An information system which can realize remote collection, transmission, processing, storage and query of medical information, and provide remote patient consultation, guardianship, ward round, assist diagnosis, guide examination, treatment, operation, teaching, information service and other special medical activities of the information system.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAC-LD Advanced Audio Coding, Low Delay

AES Advanced Encryption Standard

BFCP Binary Floor Control Protocol

B/S Browser/Server

CIF Common Intermediate Format

DDoS Distributed Denial-of-Service

DICOM Digital Imaging and Communications in Medicine

DNS Domain Name System

ECG Electrocardiogram

EMR Electronic Medical Records

ESB Enterprise Service Bus

ETL Extract-Transform-Load

FPS Frame Per Second

GK Gate Keeper

GTP General data Transfer Platform

| | |
|---|---|
| HD | High Definition |
| HDMI | High-Definition Multimedia Interface |
| HIS | Hospital Information System |
| HL7 | Health Level Seven |
| HTTPS | Hypertext Transfer Protocol Secure |
| IHE | Integrating the Healthcare Enterprise |
| IPSec | Internet Protocol Security |
| IPv4 | Internet Protocol version 4 |
| IPv6 | Internet Protocol version 6 |
| LDAP | Lightweight Directory Access Protocol |
| LED | Light Emitting Diode |
| MAC | Media Access Control |
| MCU | Multicontrol Unit |
| QoS | Quality of Service |
| SIP | Session Initiation Protocol |
| SMP | Symmetrical Multiprocessing |
| SNMP | Simple Network Management Protocol |
| SRTP | Secure Real-time Transport Protocol |
| SSH | Secure Shell |
| SSL VPN | Secure Sockets Layer Virtual Private Network |
| SVC | Scalable Video Coding |
| TLS | Transport Layer Security |
| VLAN | Virtual Local Area Network |
| VPN | Virtual Private Network |

## 5 Conventions

None.

## 6 Introduction

Telemedicine is the use of telecommunications technology, holographic imaging technology, new electronic technology and computer multimedia technology to provide, enhance or expedite health care services by accessing off-site databases, linking clinics or physicians' offices to central hospitals or transmitting X-ray or other diagnostic images for examination at another site.

Telemedicine will be the main trend of the future development of the medical and health industry. It not only reduces the cost of time and space, representing an economy for patients and doctors, but also provides powerful impetus and technical support for optimizing the allocation of medical resources worldwide and for building a more equal and better world.

## 7 Reference framework of telemedicine systems

The reference framework of telemedicine systems consists of layers, namely the network layer, information exchange layer, resource layer, service layer and application layer, and the video audio system and security guarantee. Figure 1 shows a typical framework.

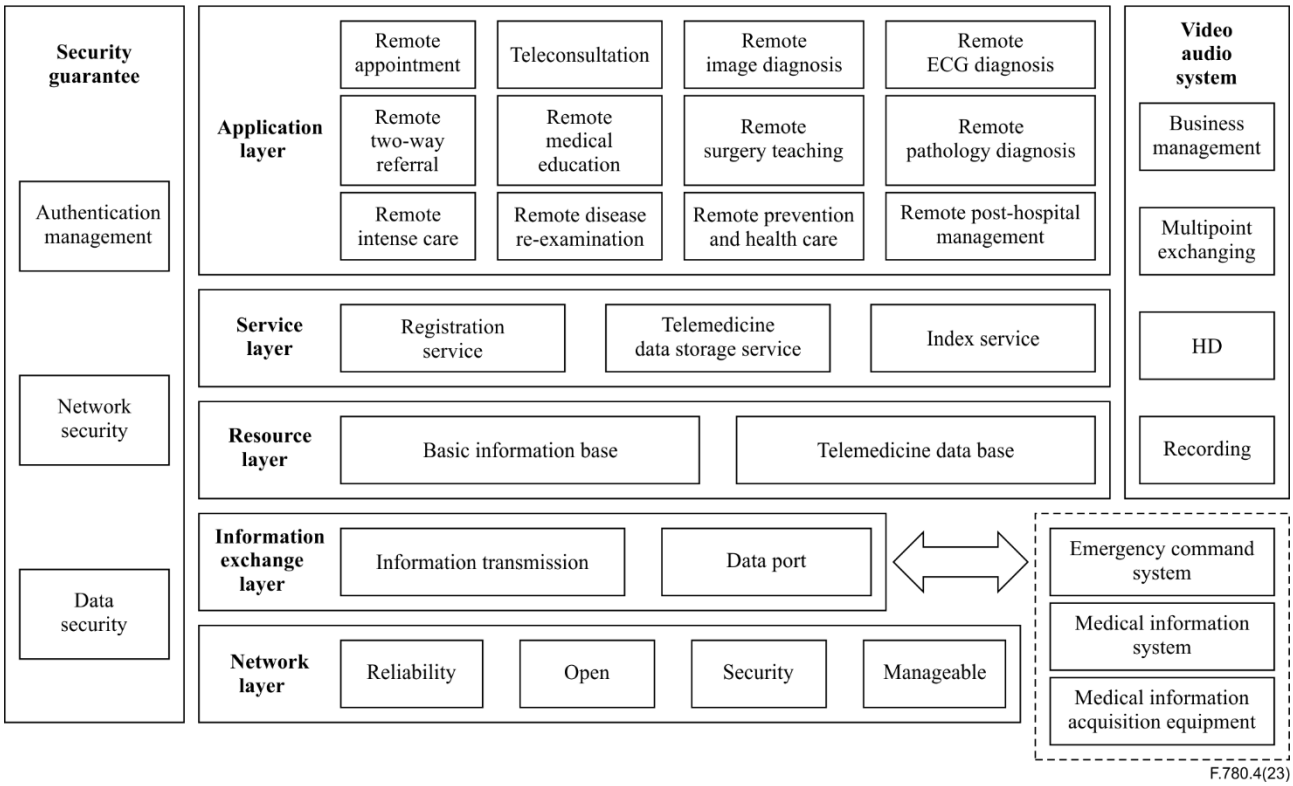


**Figure 1 – Framework of typical telemedicine system**

NOTE – In Figure 1, the boxes in the dotted lines refer to external systems.

The functions of each part of the system are described below.

### a) Network layer

The network layer is the network foundation of telemedicine. The network of the telemedicine system is required to be reliable, open, safe and manageable, support the coordination of medical information inside and outside the hospital, ensure the normal work of the audio-video system and realize various applications of the telemedicine.

### b) Information exchange layer

According to the business process, the information exchange layer exchanges data with other information systems through the data interface or message transmission, providing message sharing, data reporting and other functions, meeting the requirements of information exchange and collaborative application of clinical information cross-hospital and cross-region.

The telemedicine system can exchange data with the external emergency command system, medical and health information system and medical-information-collecting devices through the information exchange layer.

### c) Resource layer

The resource layer provides the basic information base and telemedicine database, in which the telemedicine database stores documents, images and videos. The data of the resource layer can be structured data, unstructured data (documents, audio and video materials), structured document data and application service resource, etc. It supports coordinated telemedicine work cross-region, assists

data statistical analysis services and provides information services for the interconnection between telemedicine supervision and resource service centres in various regions.

**d) Service layer**

The service layer provides services including registration service, storage service and EMR index service, supporting various telemedicine applications in the application layer.

**e) Application layer**

The application layer provides telemedicine applications including remote appointment, teleconsultation, remote image diagnosis, remote electrocardiogram (ECG) diagnosis, remote two-way referral, remote medical education, remote intensive care, remote surgery teaching, remote pathological diagnosis, remote disease re-examination, remote prevention and health care and remote post-hospital management.

**f) Video audio system**

The video audio system is the tool to realize various applications of telemedicine and it has the functions of video audio business management, video audio multipoint switching, video audio high-definition access, recording and playing, etc.

**g) Security guarantee**

The telemedicine system is recommended to ensure the safety of the system through authentication management, network security, data security, etc.

## 8 Functions and technical requirements of telemedicine systems

### 8.1 Application layer

The application layer includes, but not limited to, that described in clauses 8.1.1 to 8.1.12.

#### 8.1.1 Remote appointment

##### 8.1.1.1 General

Remote appointment allows the inviter to complete the appointment registration abd appointment inspection and the invitee to complete the relevant application acceptance and information feedback.

##### 8.1.1.2 Basic functions

The basic functions include:

a) Appointment arrangement. Fill in the appointment form, query the schedule and select the number source, submit and modify the appointment form, submit the patient's medical records, browse and print the appointment form, etc.

b) Appointment management. Manage appointment process, remind appointment process, query appointment record, manage medical record data, etc.

#### 8.1.2 Teleconsultation

##### 8.1.2.1 General

Teleconsultation is applicable to the process in which the inviter applies to the invitee for teleconsultation, the invitee accepts the invitation, conducts the teleconsultation and gives diagnosis opinions and reports.

##### 8.1.2.2 Basic function

The basic functions include:

– Consultation appointment. Fill in the application form, submit and modify the consultation application form, query the information of expert database, organize and transmit electronic data, query the consultation application, etc.;
– Consultation management. Manage consultation process and medical record materials, browse the consultation report, follow-up and evaluate the consultation service, etc.;
– Consultation service. Browse the medical record materials, discuss the illness with audiovisual interaction, write medical notes on whiteboard and compile and publish consultation reports.

### 8.1.3 Remote image diagnosis

#### 8.1.3.1 General

Remote image diagnosis is applicable to the process in which the inviter applies for remote image diagnosis, the invitee accepts the application, carries out remote image diagnosis and issues diagnosis opinions and reports, and the process that a number of medical institutions in the region are networked to form an image centre for the centralized storage, diagnosis and management of images.

#### 8.1.3.2 Basic functions

The basic functions include:

– Application. Fill in the application form, submit and modify the consultation application form, query the diagnosis institute and the application, etc.
– Data sending and receiving. Send and receive different data.
– Images browsing, enhancement and analysis. Browse, enhance contrast, enhance edge the original image, extract and quantitatively analyse the pathological features, computer-aided diagnosis, image retrieval based on image features.
– Quality control and statistics. Image quality statistics, technician evaluation, collectively evaluation, report writing quality statistics, overall quality statistics of technician image, report diagnosis quality statistics, etc.
– Publication, browsing and querying of diagnostic reports.
– Medical case study. It provides a platform for doctors to study and improve, especially for refresher doctors and interns, who can query and browse the reports they care about, and make comparative study and borrowing.

### 8.1.4 Remote ECG diagnosis

#### 8.1.4.1 General

Remote ECG diagnosis is applicable to the process in which the inviter applies for remote ECG diagnosis, the invitee accepts the invitation, conducts remote ECG diagnosis and issues diagnosis opinions and reports, as well as to the ECG examination requirements of pre-hospital emergency centre.

#### 8.1.4.2 Basic functions

The basic functions include:

– Application and appointment. Accept the appointment registration and examination registration of patients as well as the registration of patients' examination information, scan and query application forms, and distribute patients' examination reports. Remote EDG diagnosis provides the functions of allocating appointment time for patients, querying appointments within an assigned time period, registering the patient list, scanning and photographing paper application forms and seamlessly connecting with the hospital information system (HIS);

– Analysis and diagnosis. Professional ECG doctors make professional analysis and diagnosis according to the data collected by the ECG equipment. Remote EDG diagnosis provides the functions of instant reminder of the arrival of ECG examination data, analysis of ECG, report writing and printing, management of medical records, etc.;
– Report browsing and analysis. Remote EDG diagnosis provides the tool for clinician to browse the ECG reports and ECG waveform, e.g., [b-ISO/TS 22077]. The doctor's browsing workstation can be embedded into the outpatient workstation, resident workstation and EMR system, which supports the doctor's browsing workstation and can perform online waveform analysis, processing and measurement.

### 8.1.5 Remote two-way referral

#### 8.1.5.1 General

Remote two-way referral is applicable to the management process of all medical and health service institutions for patients transferred in and out.

#### 8.1.5.2 Basic functions

The basic functions include:

– Referral application. Respond to the referral request of general practice, other service components or system modules, and submit a referral application to the designated referral institution. Remote two-way referral provides the functions of filling in the referral application form, submitting and modifying the referral application, querying the consultation institution and the referral application, etc.;
– Referral management. Remote two-way referral includes transfer management and reception management, which supports the inviter to cancel transfer, print referral form and transfer out again, and also supports the invitee to accept or refuse the invitation. It provides the functions of referral process management, medical record management, referral process reminder, referral record query, etc.;
– Patient information feedback. The discharge information of the patient can be automatically acquired from the invitee's HIS, sent back to the inviter according to the information of referral records or to the patients' reminder, referral record query, etc. and on to the designated referral institution;
– Follow-up. Remote two-way referral provides follow-up records, a follow-up plan, query of follow-up records and reminder.

### 8.1.6 Remote medical education

#### 8.1.6.1 General

Remote medical education is applicable for hospitals and experts providing professional training, teaching, medical record discussion and technical support for grass-roots doctors through audio, video and courseware.

#### 8.1.6.2 Basic functions

The basic functions include:

– Teacher management. Teacher registration, information query and modification.
– Student management. Student registration, information query and modification.
– Course management. Video course query, video on demand, real-time training.
– Courseware management. Video management, courseware management, video sharing and courseware synchronization.

– Process management. Make the course study plan, record the course training and query progress.
– Credit hour management. Application for credit hours, credit hour card printing, etc.

### 8.1.7 Remote intensivee care

#### 8.1.7.1 General

Remote intensive care is a process in which the inviter applies to the invitee and provides the clinical data of patients who are critically ill, the invitee accepts the application, carries out remote intensive care and issues diagnosis opinions and treatment guidance opinions.

#### 8.1.7.2 Basic functions

The basic functions include:

– Application and appointment, data sending and receiving, browsing and analysis, quality control and statistics, report publishing and browsing, evaluation of service;
– Real-time acquisition and transmission of vital signs parameters and continuous dynamic monitoring, diagnosis suggestions, treatment suggestions and other medical activities sent between the inviter, the invitee and the patient;
– 24-hour continuous dynamic observation, providing the invitee with real-time continuous monitoring data of patients and giving early warning of abnormal situations;
– Storage and management of vital signs parameters, including data recording, management, query and statistics;
– Bedside videoconference, which facilitates remote interactive communication between inviters, invitees and patients;
– Remote control of the video pan/tilt in real time, observing the patient from multiple angles and switching pictures quickly.

### 8.1.8 Remote surgery teaching

#### 8.1.8.1 General

Through the application of teleconsultation technology, images of clinical diagnosis or surgical site are required to be recorded in real time and remotely sent to remote surgical teaching.

#### 8.1.8.2 Basic functions

The basic functions of a telemedicine system in the context of remote surgery teaching include the following:

– A telemedicine system is required to support application and appointment, service evaluation and other process management functions;
– An operating room is required to support multiple remote classrooms to watch the operation at the same time;
– A telemedicine system is required to enable the medical experts to connect to the same operating room or multiple ones at any point in the telemedicine system for operation guidance or discussion;
– A telemedicine system is recommended to support real-time recording of surgical images and scene videos;
– A telemedicine system is recommended to support static photography and dynamic recording of the operation process;
– A telemedicine system is recommended to support storage, playback and management of high-quality audio and video of operations;

– A telemedicine system is recommended to support the function of real-time live broadcast and recording of audio and video information of operation;
– A telemedicine system is recommended to support the function of real-time interactive audio-video call between operating room and medical experts;
– A telemedicine system is recommended to support monitor high-definition TV or LED TV in surgical field;
– A telemedicine system is recommended to support remote microcontrol function of surgical field camera;
– A telemedicine system is recommended to support remote pan/tilt control function of the camera in operation field and other cameras in the operation room.

### 8.1.9 Remote pathology diagnosis

#### 8.1.9.1 General

Remote pathology diagnosis is the process in which the inviter applies for remote pathology diagnosis, the invitee accepts the application, conducts remote pathology diagnosis and issues diagnosis opinions and reports.

#### 8.1.9.2 Basic functions

The basic functions include:
– Application and appointment, service evaluation and other process management functions;
– Digital scanning function of pathological sections, which converts pathological sections into digital sections;
– Zoom in, zoom out, mark and other post-processing functions of virtual digital slices;
– Uploading patient's information and downloading report;
– Statistics function of relevant data.

### 8.1.10 Remote disease re-examination

#### 8.1.10.1 General

Remote disease re-examination is for patients with serious diseases who have received offline initial treatment in the hospital. It is the process in which the inviter applies to the invitee for re-examination, the invitee accepts the application, conducts disease diagnosis and issues diagnosis opinions and reports.

#### 8.1.10.2 Basic functions

The basic functions include:
– Re-examination appointment: Filling in the application form for re-examination visit, submitting and modification of the application, query of the information of expert database, organization and transmission of electronic data, query of the application, etc.;

  Re-examination management: Re-examination process management, medical record data management, first visit report browsing, follow-up management, re-examination service evaluation, etc.;

  Re-examination service: Medical record data browsing, audio-video interactive disease discussion, whiteboard writing and interaction of medical record data, preparation, release and modification of re-examination report, re-examination report template management, etc.

### 8.1.11 Remote prevention and health care

#### 8.1.11.1 General

Prevention and health care focuses on disease prevention and health promotion by assisting the inviter in self-monitoring and observation. When the body has not yet shown symptoms of disease, an abnormal situation is detected by other means, and targeted treatment is given.

#### 8.1.11.2 Basic functions

The basic functions include:

– The ability to receive health data from mobile health monitoring devices;
– The ability to upload health data to the mobile terminal of the invitee in the form of questionnaire survey;
– The ability to provide intelligent guidance according to the symptoms of the inviter and give advice on disease prediction and the relevant department;
– The ability that the inviter can save or delete personal data;
– The ability of providing disease prevention knowledge and popularizing health knowledge;
– The ability of displaying the health data of the inviter to the invitee.

### 8.1.12 Remote post-hospital management

#### 8.1.12.1 General

Remote post-hospital management includes outpatient service post-hospital management and leaving hospital post-hospital management. The main purpose of remote post-hospital management is to provide extended post-hospital medical care services. Further follow-up of the patient's disease condition and lifestyle has been achieved to receive better therapeutic effect.

#### 8.1.12.2 Basic functions

The basic functions include:

– The function of receiving health data of mobile portable sign monitoring equipment and the function of lifestyle management and recording;
– The ability of regular follow-up recording;
– The ability of comparison and analysis according to the results of follow-up and re-examination;
– The ability of providing disease prevention knowledge and popularizing health knowledge;
– The ability of in-hospital connection;
– The ability that patients can make a consultation appointment directly when they need.

## 8.2 Service layer

Service layer includes, but not limited to, that described in clauses 8.2.1 and 8.2.2.

### 8.2.1 Registration service

#### 8.2.1.1 General

Registration service provides registration management services for patients, medical service personnel, medical and health institutions/departments and medical and health terminologies.

The system is required to provide unique identification for these entities. All kinds of entities have their own registration databases, such as patient registration database, medical service personnel registration database, institution registration database and terminology registration database, which support one single entity having multiple identifiers.

#### 8.2.1.2 Patient registration service

The basic functions include:

– Registration of new patients;
– Updating patients' information;
– Validating patient identity;
– Merging patient identities;
– Querying patient information.

#### 8.2.1.3 Medical service personnel registration

The basic functions include:

– Registration of new medical service personnel;
– Updating medical service personnel information;
– Validating medical service personnel identities;
– Merging medical service personnel identities;
– Querying medical service personnel information.

#### 8.2.1.4 Medical and health institutions/departments registration

The basic functions include:

– Registration of new medical and health institutions/departments;
– Updating medical and health institution/department information;
– Suspension of medical and health institutions/departments;
– Querying medical and health institution/department information.

#### 8.2.1.5 Medical and health terminology registration

The basic functions include:

– Providing batch import and export of terminologies;
– Sorting and browsing terminologies;
– Maintaining the relations of terminologies;
– Managing version of terminologies;
– Maintaining mapping relationship of terminologies;
– Synchronizing terminologies with other systems.

### 8.2.2 Telemedicine data storage service

Telemedicine data storage service provides patient basic information repository, electronic medical record repository, health file information repository, consultation information repository, image data repository and teaching resource repository.

The basic functions include:

– Reception of documents, images and video data materials;
– Registration of documents, images and video data materials to index base;
– Providing documents, images and video data materials to users.

#### 8.2.2.1 Index service

The basic functions include:

– Registration of static documents which include the patient's case information and the document catalogue and summary information related to the event information;

– Supporting the function of querying and displaying related medical static document index according to medical events or patient information.

## 8.3 Resource layer

The resource layer includes, but not limited to, that described in clauses 8.2.1 and 8.3.2.

### 8.3.1 Basic information base

The basic information base includes the basic information of the patient, information of medical and health personnel, information of medical institution (department), medical and health terms.

The basic information base is generated from the registration service of the telemedicine system, which provides uniform, complete and accurate basic information and unique identification for these entities.

### 8.3.2 Telemedicine database

#### 8.3.2.1 Document repository

The document repository stores activity-based and standard-compliant clinical documents in a clear, safe and lasting way.

The document repository is recommended to select the appropriate document to register according to the content type of clinical documentation and respond to the request of document retrieval.

#### 8.3.2.2 Image repository

Medical image storage is required to follow the current international standards such as DICOM 3.0 and HL7, and to conform to the IHE framework. The whole system has high security, high reliability, high compatibility and sustainable scalability. It can realize the reception, transfer and printing of images, and support lossless or lossy compression storage mode of images.

#### 8.3.2.3 Video repository

The video repository is required to be based on web structure for the convenience of daily maintenance and remote education.

The video repository is required to be more flexible in data management. It can centrally manage all the materials in distance education projects, or divide the materials according to types or disciplines, manage them separately and divide the large material library into several small material libraries.

## 8.4 Information exchange layer

### 8.4.1 General

The information exchange layer exchanges data with other information systems through data interface or message transmission according to the business process, including but not limited to enterprise service bus (ESB), symmetrical multiprocessing (SMP), general data transfer platform (GTP), extract-transform-load (ETL) and multicontrol unit (MCU). The telemedicine system is required to exchange data with the external emergency command system, medicine and health information system and medical information acquisition equipment.

The information exchange layer includes, but not limited to, that described in clauses 8.4.1 to 8.4.4.

### 8.4.2 Emergency command system

The telemedicine information system is connected with the emergency command system, and the video site is used to connect with the hospital network, providing dynamic audio and video information of the scene and the treatment process, so as to realize the linkage of information-sharing and treatment in emergency response. This can not only enable patients to obtain a diagnosis and

treatment through remote video, but also help medical staff to report the latest situation of patients to the command centre at any time and analyse any potential new diseases.

### 8.4.3 Medical information system

The medical information system mainly includes the electronic record system, hospital information system, laboratory information system, clinical information system, ECG diagnosis system, image diagnosis system, pathological diagnosis system and other medical information systems. Through the docking of the telemedicine information system and medical information system, information-sharing and business collaboration between hospitals can be realized.

The telemedicine information system is connected with the regional health information platform, providing real-time information of telemedicine supervision and business services, and sharing the original health records and electronic medical records, so that the regional health information platform has the comprehensive management function of telemedicine business.

If a medical institution has established a hospital information integration platform for data sharing, it will realize the docking with the telemedicine information system through the platform mechanism, reduce the number of data interfaces, and realize information-sharing and business collaboration between hospitals.

### 8.4.4 Medical information acquisition equipment

Medical information acquisition equipment mainly includes the multiparameter vital signs monitor, digital imaging equipment, digital electrocardiogram, ventilator and other items of medical information acquisition equipment, which are mainly used to collect the vital signs, blood sugar, blood pressure and other data of patients.

## 8.5 Network layer

### 8.5.1 Basic functions

The functions of the network layer are recommended to include, but are not limited to, the following:

– Reliability: The stability and reliability of the network are the key guarantee for the normal operation of the application system. When designing the network, commercial network products are required to be selected, the network architecture is required to be designed reasonably and reliable network backup strategies are required to be formulated to ensure that the network has the ability of fault self-healing and of supporting the normal operation of the system to the maximum extent.

– Openness: Open protocols (such as IPv6, etc.) that support international standard network protocols, international standard large-scale dynamic routeing protocols, etc., are conducive to ensuring smooth connection and interoperability with other networks and future network expansion.

– Security: The network layer is required to improve the overall security of the network through an equipment mechanism and networking scheme.

### 8.5.2 Network quality and requirements of QoS

The network quality and QoS requirements are as follows:

– Network latency is required to be less than 50 ms;

– Jitter is as low as possible, and is recommended not to exceed 20 ms;

– Packet loss is recommended not to exceed 5%.

## 8.6 Video audio system

### 8.6.1 General

The remote video audio system is required to comply with the basic video communication protocols of [ITU-T H.323] and SIP. The video audio system includes, but is not limited to, that described in clauses 8.6.1 to 8.6.5.

### 8.6.2 Business management

The technical requirements of business management are recommended to include:

– Unified communication management system supports B/S architecture, and realizes functions such as equipment management, registration and authentication, conference management, conference control and reporting statistics;

– GK server requirements: Supports large-capacity node registration to realize equipment registration and authentication;

– Network requirements: Business management is required to support IPv4 protocol stack, and IPv6 protocol stack is recommended to facilitate subsequent expansion.

The requirements of user authentication management are as follows:

– User authentication is required to be managed according to the organizational structure;

– User authentication is recommended to be configurable only by the administrator of the telemedicine system;

– User authentication management is recommended to support hierarchical and decentralized management.

– System authentication and resources are required to be managed according to the structure of enterprise organization;

– The same MCU or venue is recommended to be distributed to multiple organizations.

The requirements of equipment management include:

a. Equipment capacity management:

   1. The platform can be extended to manage multiple equipment and meeting places.
   2. The equipment (MCU, meeting place) is required to be managed according to the organizational structure.

b. Supporting the management of mainstream video terminal equipment, and supporting the remote addition and management of MCU and terminal equipment, viewing the brand model, GK registration status, SIP registration status, MAC address, video capability of the terminal, software version number and other information of the terminal or MCU, and remotely modifying the device configuration in real time, such as remotely opening and closing GK registration, remotely modifying [ITU-T H.323] ID, [ITU-T E.164] number, DNS server address.

c. Supporting automatic device discovery. Devices (MCU and terminal) will be automatically identified by the management platform after joining the system. After discovering the devices, view and configure the information of the devices, and support configuration backup and remote recovery of the managed devices.

d. Supporting system alarm management to remotely view the alarm information of managed devices (terminals and MCU), classifying alarms based on alarm types, and quickly obtaining the operating status of managed devices.

e. Supporting remote view of logs of managed devices.

f. Supporting remote management and control of recording and playing server devices.

### 8.6.3 Multipoint exchanging

The requirements of multipoint exchanging include:

– Supporting scalable architecture design and embedded operating system. Smooth upgrade of system capacity can be achieved by adding boards. Each board of the device has at least two 1000 Mbit/s RJ-45 interfaces and two optical fibre interfaces, which support IPv4 and IPv6 for future expansion.

– Supporting SD (standard definition, a video format with a physical resolution below 1280P × 720P), HD (a video with a vertical resolution of 720 or greater), HD mixed conference and multipoint conference and rate adaptation. Each participating terminal can join the conference at the same time with different protocols ([ITU-T H.323]/SIP), different bandwidths (64 K–8 Mbps), different audio and video codes ([ITU-T H.263]/[ITU-T H.264], etc.), [ITU-T G.722]/[ITU-T G.711]/AAC-LD), different resolutions (CIF/4CIF/720P 30FPS, 60FPS/1080P 30FPS, 60FPS) and can support multiple groups of conferences at the same time. The number of conference groups is not limited by the number of mixed networks and mixed speeds.

– System capacity. The port resources of the MCU can be randomly allocated according to the video definition through manual designation, so as to maximize the resource utilization, and MCU port resource allocation does not need to restart MCU equipment.

– Multichannel cascade support. Multiple venues of lower MCU can be transmitted to higher MCU through multiple independent video channels.

The requirements of audio and video technology include:

– Video requirements. Support international standard video protocols including [ITU-T H.261], [ITU-T H.263], [ITU-T H.264] basic profile, [ITU-T H.264] high profile, [ITU-T H.264] SVC, etc. Support 1080P60 frames, 1080P30 frames, 720P60 frames and 720P30 frames and be downwardly compatible with 4CIF and CIF image formats;

– Audio requirements. Audio and video technology is recommended to support international standard audio protocols, including [ITU-T G.711a], [ITU-T G.711u], [ITU-T G.722], [ITU-T G.728], [ITU-T G.722.1C], and support broadband voice coding [ITU-T G.719], AAC_LD audio protocols with 20 kHz frequency response;

– Multi-screen support. Support a variety of multiscreen types and multiscreen mode switching. Multiscreen per port is supported, and the terminal equipment participating in the conference can select the multiscreen combination mode required by its own venue through the remote-control keys, without affecting the clarity and multiscreen viewing mode of other venues. Adding the auxiliary stream into the multipicture, so that the terminal equipment which does not support [ITU-T H.239] can receive the auxiliary stream information.

– Dual-stream support. Support [ITU-T H.239] dual-stream and binary floor control protocol (BFCP) dual-stream, static dual-stream and dynamic dual-stream. The bandwidth of the auxiliary stream can be set manually as required, and the maximum image format of the auxiliary stream is 1080P 60FPS. Supporting the auxiliary stream adaptation function, in a high-definition and standard-definition mixed conference, terminals with different video decoding capabilities can receive auxiliary stream information with different definitions, to ensure that the low auxiliary stream receiving capability of a certain conference venue will not affect other conference venues.

The requirements of safety and stability include that:

– Multipoint exchanging is required to support the hot backup of the main control board and media board, and the main control board will not affect the meeting being held during the switching process, and supporting the redundant backup of dual power supplies;

– Multipoint exchanging is required to support encryption of media, signal and management such as [ITU-T H.235] Advanced Encryption Standard 256 (AES256), SRTP, TLS, HTTPS, SSH, SNMPv3, etc., providing a secure channel for authentication and encrypted communication, preventing users from being counterfeited, protecting conference information from being intercepted and translated during transmission, and fully guaranteeing the security of conference information;
– MCU equipment has strong anti-packet loss capability. Under 10% packet loss, the voice is recommended to be smooth and clear, the video is recommended to be clear and smooth.

### 8.6.4 High-definition audio and video system

The requirements of HD audio and video system include that:

– HD audio and video system is recommended to use embedded operating system, but not use pc or industrial pc architecture;
– HD audio and video system is recommended to provide multichannel high-definition video input and multichannel high-definition video output interfaces, and support HDMI and video graphics array (VGA) interfaces;
– HD audio and video system is recommended to support multichannel audio input and multichannel audio output interfaces, with standard microphone interface and digital audio interface.

The technical requirements of video and audio include that:

– The video is required to support [ITU-T H.263], [ITU-T H.264] and [ITU-T H.264] SVC image coding protocols. Image format is required to support 1080P50/60 frames, 1080P25/30 frames, 1080i50/60 frames, 720P50/60 frames, 720P25/30 frames, 4CIF, CIF.
– The audio is required to support [ITU-T G.711], [ITU-T G.722], [ITU-T G.722.1], [ITU-T G.722.1C], [ITU-T G.728], [ITU-T G.719], [ITU-T G.729A], AAC-LD, etc., and to support at least three broadband audio protocols above 20 kHz and to support two-channel stereo function.
– The high-definition audio and video system is required to support [ITU-T H.239] protocol under standard [ITU-T H.323], BFCP under standard SIP protocol, and 1080P effect of main and auxiliary streams, up to 1080P60 frames of main stream, and 1080P60 frames of auxiliary streams.
– The high-definition audio and video system is required to support receiving and sending auxiliary streams at the same time when holding point-to-point meetings.

The technical requirements of network access include that:

– Network access is recommended to have good network adaptability. Under the maximum network packet loss of 20%, the image is recommended to be smooth and clear, so as to ensure the progress of the meeting;
– The terminal is recommended to support a 1080P60-frame high-definition conference with 768 kbit/s conference bandwidth, with normal function and smooth audio and video; under the 512 kbit/s conference bandwidth, a 1080P30-frame high-definition conference is recommended to be held with normal functions and smooth audio and video; under the 384 kbit/s conference bandwidth, a 720P30-frame high-definition conference is recommended to be held, with normal functions and smooth audio and video.

The system functions and safety requirements include:

– Supporting [ITU-T H.235] signalling encryption under [ITU-T H.323] protocol, Under SIP, supporting TLS and SRTP encryption, and supporting the AES media stream encryption algorithm;

– Supporting the LDAP address book, which can download and update address book entries directly from the address book server, supporting LDAP access authentication and encryption, supporting the network address book synchronization function and updating the contact directory through the address book server.

The requirements of relative devices include that:

– The digital microphone is recommended to support 360-degree omnidirectional pickup, with a maximum pickup distance of more than 5 metres;

– The high-definition audio and video system is required to support adaptive echo cancellation, automatic gain control and automatic noise shooting;

– The sampling rate is required to not be less than 48 kHz;

– The high-definition audio and video system is required to support turning sound off and on through the microphone's touch panel.

### 8.6.5 Network recording and playing

The technical requirements of network recording and playing system include that:

– The network recording and broadcasting server is recommended to support B/S architecture, which can be accessed through a web page to realize the functions of on-demand and live broadcast;

– The network recording and playing system is required to support IPv4 protocol stack and IPv4 single networking. It is recommended to support IPv6 single networking or IPv4/IPv6 hybrid networking to facilitate the subsequent expansion;

– The network recording and playing system is recommended to record a maximum of 30 1080P30 meetings at a time;

– The network recording and playing system is recommended to support simultaneous recording of one channel of high-definition and one channel of signposted images, and each branch node is recommended to select high-definition or standard-definition on-demand viewing according to the network status;

– The network recording and playing system is recommended to support dual-stream recording of the conference, and the secondary stream recording is recommended to support HD recording;

– Network recording and playing is required to support recording of single-point, peer-to-peer and multipoint meetings;

– Network recording and playing is required to support controlling the process of conference recording, including recording, pausing, stopping and selecting the source of recording;

– Network recording and playing is recommended to support live broadcast onto PC, smartphones, tablet platform and on-demand videos;

– Network recording and playing is recommended to support browser plug-in free live broadcast and on-demand broadcast;

– Network recording and playing is recommended to support previewing recorded pictures and text indexes on the browser;

– Network recording and playing is recommended to support the synchronous playing of main and auxiliary streams and sounds in the process of live broadcast and on demand;

– Network recording and playing is recommended to support switching the screen layout, when the browser broadcasts live or on demand;

– Network recording and playing is recommended to support that the users can pause (play), locate, stop, play full screen (cancel full screen), and adjust the volume of the on-demand content, when the browser is playing on demand.

### 8.7 Security guarantee

Security guarantee includes, but not limited to, the following:

#### 8.7.1 Authentication management

The system requires strict multilevel setting management of user rights of various medical institutions, departments, experts, patients, etc.

The basic functions include:

– Authorizing and distributing the rights of different users;

– Distribution of rights for diagnosis and browsing of different reports;

– Distribution of rights for writing, reviewing, revising and browsing different medical records;

– Encrypted storage and transmission of all code.

#### 8.7.2 Network security

##### 8.7.2.1 Security of network architecture

The security requirements of network architecture include that:

– The bandwidth of each part of the network is required to ensure that the access network and the core network can meet the needs of peak business;

– Network architecture is required to define the priority of bandwidth allocation according to the important order of business system services, and give priority to important hosts in case of network congestion;

– Network architecture is required to divide different network segments or VLAN, according to factors such as the work function, importance of each department and the importance of the information involved;

– All kinds of network equipment such as router, switch and MCU is required to have telecom access cards;

– The key network equipment, such as the core switch, firewall, application server, secure access equipment and database service, is recommended to adopt dual-machine hot standby technology, which makes the whole network business processing capacity have redundant space.

##### 8.7.2.2 Network isolation

The requirements of network isolation include that:

– The security relationship between different network areas is recommended to be defined through network partition, and security equipment is recommended to be set at the data sharing gateway between different centres;

– Network isolation is required to adopt firewalls to isolate each security areas;

– Network isolation is required to have the function of access control between different application systems.

##### 8.7.2.3 Network access

The data centre exit of a telemedicine system is required to deploy anti-DDoS for safety protection. It is required to have second-level protection response capability. It is required to have attack type defence including IPv6 attack protection, and zero misjudgement for attacks.

##### 8.7.2.4 Intrusion detection and defence

The requirements of intrusion detection and defence include that:

– Intrusion detection and defence is required to have a continuously updated feature database to ensure a detection rate of more than 99%;
– Intrusion detection and defence is recommended to support message detection for critical paths and identification of application protocols;
– Intrusion detection and defence is recommended to support integration strategic configuration and unify the entrance of strategic configuration;
– Intrusion detection and defence is recommended to support IPv6 technology to facilitate the future expansion of the system.

#### 8.7.2.5 Network transmission

The requirements of network transmission include that:

– The data is recommended to be transmitted by IPSec virtual private network / secure sockets layer (VPN/SSL) VPN encryption technology;
– Network transmission is required to support a mainstream encryption algorithm to ensure trusted access of far-end medical institutions or mobile terminals;
– Secure access gateway is recommended to support dual-machine hot standby.

#### 8.7.2.6 Network security audit

The requirements of network security audit include that:

– Audit records are required to be made on outgoing documents and contents, and suspicious leaks are required to be tracked through query and statistics of audit database;
– Network security audit is recommended to detect the content of web, IM, and mail according to pre-set or user-defined sensitive data keywords to prevent the data containing key information from flowing out of the enterprise;
– Network security audit is recommended to keep a log of daily behaviour;
– Network security audit is recommended to locate illegal behaviours to find potential bad users and prevent reputation risks.

### 8.7.3 Data security

#### 8.7.3.1 Data-acquisition security

The requirements of data-acquisition security include that:

– Data acquisition security is required to ensure the authenticity of data collected by the system, and have the ability to identify data forgery;
– Data acquisition security is recommended to use a unified data-acquisition channel to guarantee the safety of data collection of medical information resources;
– Data acquisition security is recommended to safely classify medical information resources, and designate different collection methods to collect medical information resources of different levels.

#### 8.7.3.2 Data storage

The requirements of data storage include that:

– Data storage is required to adopt fragmented distributed discrete storage technology to preserve medical information resources, and it is required to have at least two copies of data locally. The data is required to be stored in different racks after being forcibly fragmented.
– The stored meta information is required to be deleted during the recycle of storage resources, and each physical bit of the logical volume is recommended to be overwritten with a clear "zero" to ensure that its original data cannot be recovered by software.

– Data storage is required to use SSL to realize end-to-end transport layer encryption, use a symmetric encryption key to realize user signature verification and storage request encryption, and use the MD5 algorithm to realize message body encryption.
– Data storage is recommended to create data storage area isolation; different levels of security data adopt different protection measures.
– Data storage is required to provide authentication control of data storage access, establish corresponding access rules and assign a professional to manage the authentication of data storage.

#### 8.7.3.3 Data transmission

The requirements of data transmission include that:

– Data transmission is required to adopt encryption and other effective measure to realize the confidentiality of transmission of virtual machine image files, system management data, identification information and important business data;
– Data transmission is required to be able to detect that the integrity of virtual machine image files, system management data, authentication information and important business data is damaged during transmission, and take necessary recovery measures when integrity errors are detected;
– Data transmission is required to have redundancy protection on the transmission channels of business data, control data and management data, the channels are required to be isolated from each other, and the fault detection, repair and isolation are recommended to be completed separately.

#### 8.7.3.4 Data deletion

The requirements of data deletion include that:

– Data deletion is required to provide means to help clear the data left over by data migration between different centres, business termination, natural disasters, contract termination, etc.;
– Data deletion is required to ensure that the disk storage space is completely eliminated before being released or distributed to other users;
– Data deletion is required to ensure that data in the host computer's memory (e.g., RAM) is completely erased before being released;
– Data deletion is required to provide means to eliminate all the copies of data;
– Data deletion is required to provide technical means to prohibit the recovery of destroyed data.

#### 8.7.3.5 Data backup and recovery security

The requirements of date backup and recovery security include that:

– Data backup and recovery security is required to provide a local data backup and data recovery function, perform a complete data backup at least once a day, and store the media off-site;
– Data backup and recovery security is required to provide a non-local real-time backup function, and use the communication network to make a copy of real-time data to the disaster backup centre;
– Data backup and recovery security is required to provide the fast recovery ability of the virtual machine;
– Data backup and recovery security is required to support backup and recovery based on disks.

# Appendix I

## Application scenarios for telemedicine

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

This Recommendation presents four application scenarios, which are applications of remote disease re-examination, remote surgery teaching, remote intensive care and remote post-hospital management.

### I.1 Scenario 1: Remote disease re-examination

Patients use the re-examination appointment service through the telemedicine system, select the corresponding department and the visiting doctors, according to their disease conditions, complete the offline re-examination appointment and initiate the remote disease re-examination service.

The invited doctors obtain the information of the re-examination patients through the telemedicine system, manage the process of re-examination, obtain the patients' medical records, discuss the condition with the patients through video audio system and remote whiteboard writing, compile the report of re-examination, and conduct follow-up management for the patients.

After completing the remote disease re-examination, inviters evaluate the service of the re-examination and the invited doctors through the telemedicine system.

### I.2 Scenario 2: Remote surgery teaching

Medical institutions apply for surgical teaching courses in the telemedicine system, including but not limited to surgical live broadcasting, recording and replaying, surgical guidance, case discussion, medical record sharing and other training, and fill in the teaching content and object-oriented course.

The trainees apply and attend surgical teaching courses through the telemedicine system or its mobile terminal. After the remote surgery teaching course, the trainees can query the course application record, attendance record and review the course recording and playback in the system.

### I.3 Scenario 3: Remote intensive care

The inviter submits the application for remote intensive care through the telemedicine system, and the invitee obtains the patient's medical history data through the system to learn the patient's medical history and condition.

The invitee obtains the vital signs data of the patient in real time through the telemedicine system, analyses the patient's condition, and provides diagnosis and treatment guidance. The two side doctors carry out bedside video discussion, and finally make an evaluation. The remote intensive care is completed.

### I.4 Scenario 4: Remote post-hospital management

After leaving the hospital, patients can obtain their own physical signs data at any time through the mobile health monitoring devices assigned or designated by the doctors, and upload the data to the telemedicine system through the mobile terminal.

The invitee checks the patients' physical signs and data in time through the telemedicine system to provide reference and suggestions for follow-up treatment and rehabilitation. The time of post-hospital management adjusts dynamically according to the patient's condition and recovery condition. Generally, the time of leaving hospital post-hospital management is longer than that of outpatient service post-hospital management.

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Published in Switzerland
Geneva, 2023