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Health informatics — The architecture of internet healthcare service network

Informatique de santé — L'architecture du réseau de services de soins de santé sur internet

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Foreword

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This document was prepared by Technical Committee ISO/TC 215, *Health informatics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

With the development of computer and network technologies, the internet has been applied widely in healthcare services, giving rise to ‘internet healthcare’. Internet healthcare is a new type of telehealth that uses the internet for online diagnosis and treatment. It can provide users with medical and healthcare services over a distance, thus improving the accessibility and efficiency of healthcare services.

The booming industry has now naturally formed a complicated internet healthcare service system composed of related healthcare service organizations, users, operators, and other stakeholders and participants. Participants provide internet-accessible healthcare services based on their facilities and abilities, such as online consultations, electronic prescriptions, schedule medical appointments, and e-referral services. Across different organizations, healthcare services collaborate, connect and exchange information, fulfilling users' healthcare needs and forming the internet healthcare service network. Although the internet healthcare service network is developing rapidly worldwide, a unified architecture or engineering implementation methods are not yet included. Without those, services scattered across different healthcare organizations are delivered loosely, making it difficult to cooperate effectively.

This document describes the reference architecture and typical internet healthcare service network deployment schemes. It aims to help all internet healthcare participants to reach a consensus on concepts and terminology. It can further guide the construction of internet healthcare service network, promoting the development of the entire industry.

Health informatics — The architecture of internet healthcare service network

1 Scope

This document provides the architecture of internet healthcare service network, including:

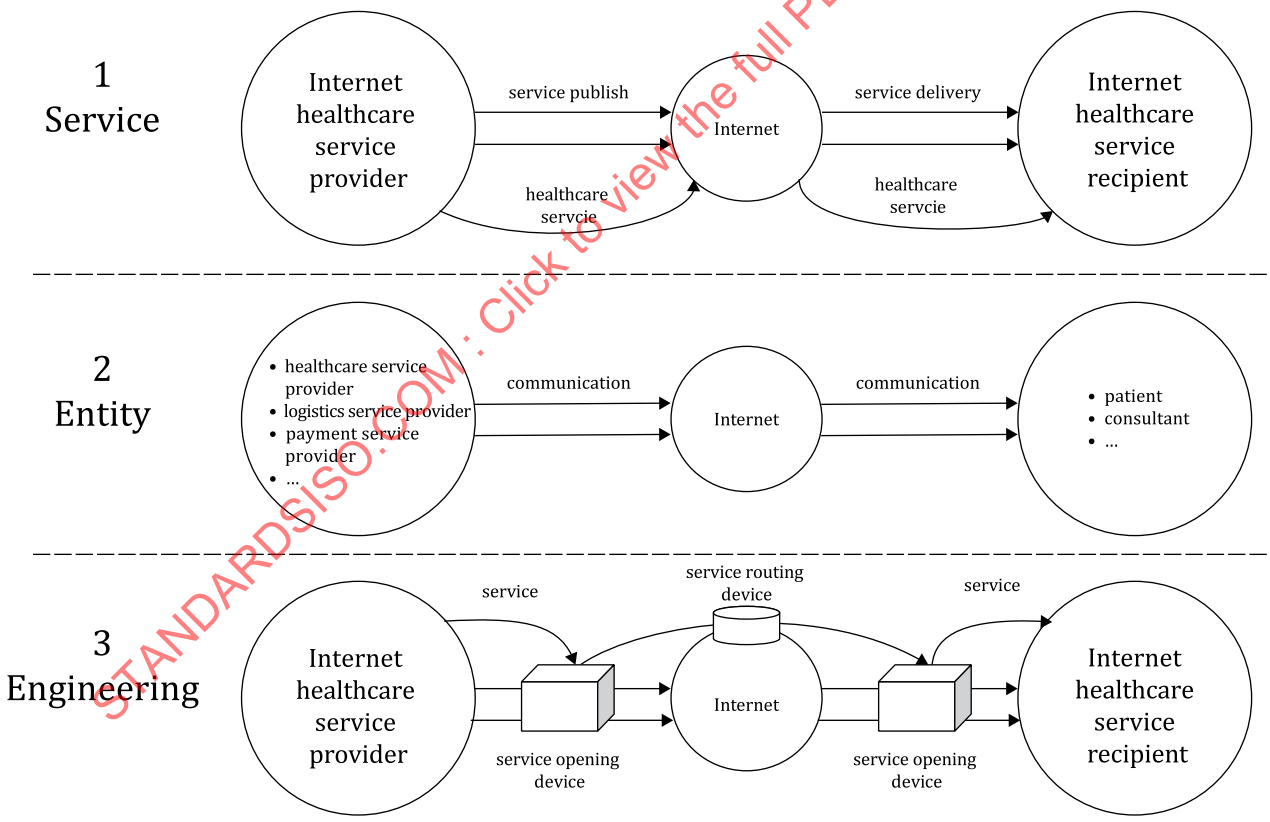
— overview of internet healthcare service network;

— infrastructure and deployment scheme of internet healthcare service network;

— security of internet healthcare service network.

This document mainly focuses on the engineering architecture and infrastructure deployment of healthcare information transmission among various healthcare organizations through services, as shown in Figure 1. The implementation of information systems and healthcare services within organizations is demonstrated in Annex A.

This document applies to the construction and application of internet healthcare service network.



Key

1 service delivery via internet

2 entities of provider and recipient

3 scope of this document

Figure 1 — Scope of this document

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
internet healthcare
internet-based telehealth

Note 1 to entry: Internet-based technologies deliver healthcare and transmit health information over both long and short distances.

Note 2 to entry: Telehealth utilizes all kinds of information and communications technologies, rather than internet technology only.

3.2
internet healthcare service
healthcare service activities undertaken via internet

3.3
service provider
organization, or part of an organization, or individual that manages and delivers a service or services to customers

[SOURCE: ISO/IEC 20000-1:2018, 3.2.24, modified — "or part of an organization, or individual" was added to the definition.]

3.4
service recipient
patient
subject of healthcare
healthcare actor with a personal role, who seeks to receive, is receiving, or has received healthcare services

[SOURCE: ISO 13940:2015, 5.2.1, modified — "services" was added to the definition.]

3.5
internet healthcare service network
IHSN
overlay network built on the internet to deliver healthcare services and transmit healthcare information over long distance

3.6
service opening device
device that opens services for healthcare organizations or other *service providers* (3.3) in *internet healthcare service network* (3.5)

3.7
service routing device
device that locates the target services and relays the service request/response in *internet healthcare service network* (3.5)

3.8
service backbone network
network built by *service routing devices* (3.7) that connects multiple *service access networks* (3.9)

3.9
service access network
network that connects services to *service opening devices* (3.6) for healthcare organizations or other *service providers* (3.3)

3.10
forwarding rate
number of tasks that can be transmitted by the networking equipment in a given time

3.11
capacity
maximum amount of information that a device can manage

3.12
throughput
measure of the amount of work performed by a device over a given period of time

[SOURCE: ISO/IEC 2382:2015, 2122878, modified — "computer system" was replaced by "device" in the definition and notes to entry were deleted.]

3.13
reliability
ability to perform as required, without failure, for a given time interval, under given conditions

[SOURCE: ISO/IEC 30144:2020, 3.7]

4 Overall architecture of internet healthcare service network

Built on traditional computer network, internet healthcare service network (IHSN) is an overlay network constructed by service opening devices and service routing devices. During the operation of IHSN, services within healthcare organizations or other service providers shall be opened to the network through service opening devices and routed to service recipients through service routing devices.

The architecture of IHSN is shown in Figure 2; it shall consist of one service backbone network and at least one service access network. Service backbone network shall be constructed by one or more service routing devices, which may connect multiple service opening devices and other service routing devices, transmitting healthcare services among different service access networks. Service access network shall be located at the edge of an IHSN, connecting healthcare services with service backbone network.

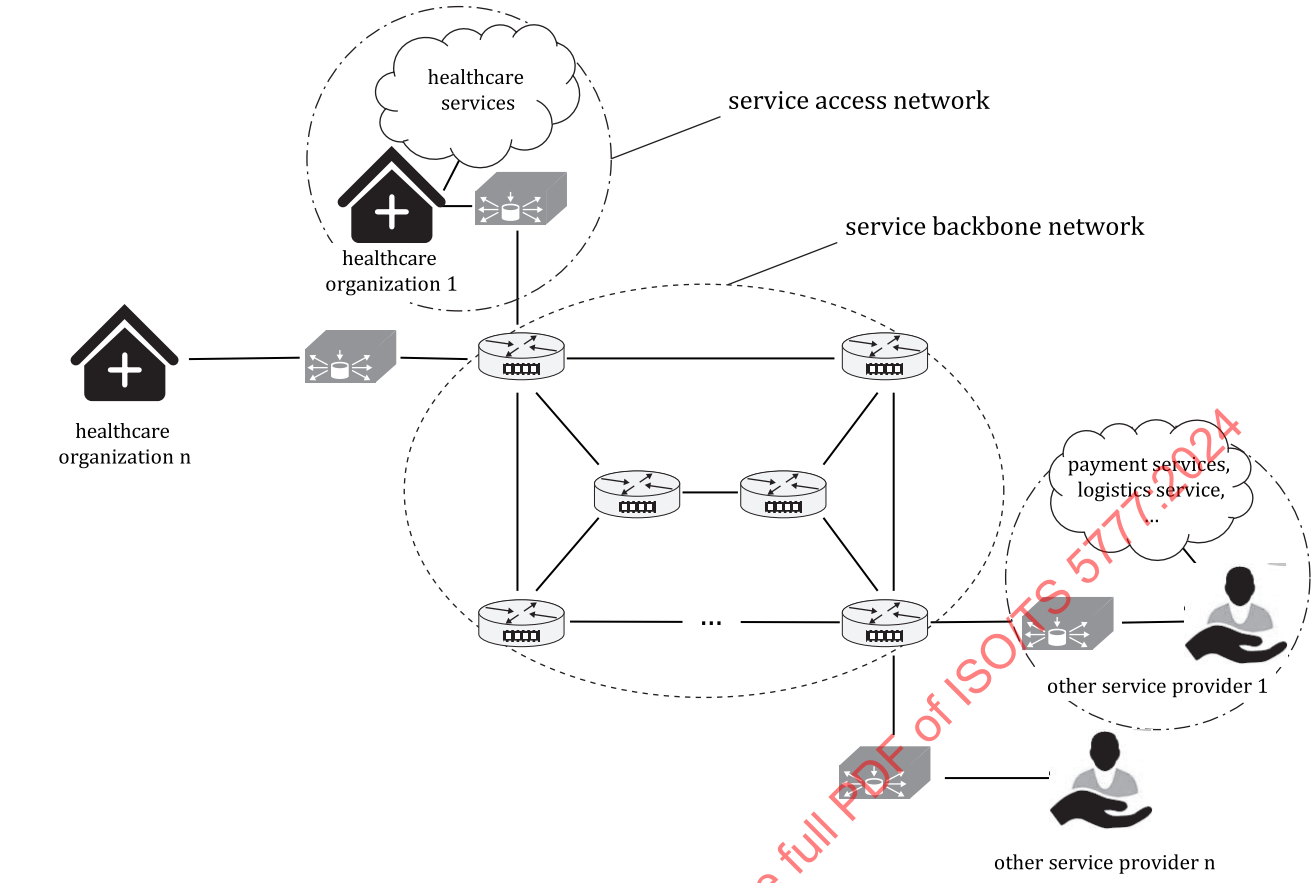


Figure 2 — Overall architecture of IHSN

5 Infrastructure of internet healthcare service network

5.1 Service opening device

5.1.1 Functional requirements

Service opening devices shall be located at the access network of a healthcare organization with its role to connect services into IHSN. Functions of service opening devices shall include:

— network access: access to IHSN by registering to the corresponding service routing device;

— service publish: healthcare organizations or other service providers publish their own services to IHSN;

— service query: allow services to be discovered once published to IHSN;

— service forward: relaying service request/response between the access network and backbone network;

— service control: management of internet healthcare services;

— system management: including user management, privilege management, resource management, log management, and transaction management;

— service security: including access control, audit control and data security.

5.1.2 Technical characteristics

As one of the core devices for building internet healthcare service network, service opening device's performance determines the number of services accessed by the entire network and the service invocation performance. When selecting the appropriate service opening device, the following technical characteristics shall be considered.

— Forwarding rate: refers to the total number of service requests (from internal service recipients and the connected service routing device) and service responses (from internal service providers and the connected service routing device) that can be transmitted by a service opening device in a given time. The forwarding rate can be assessed as follows:

  Forwarding rate = total number of service requests and service responses / transmission time (s)

— Service capacity: refers to the maximum number of services that can be handled by a service opening device.

— Throughput: refers to the amount of service information (such as service requests, service responses) that a service opening device can process in a given time. The throughput can be assessed as follows:

  Throughput = service information traffic (bit) / process time (s)

— Reliability: refers to the probability that a service opening device can perform any required functions without failure under stated conditions for a specified period.

5.2 Service routing device

5.2.1 Functional requirements

Service routing devices shall be located at the backbone network with its role to connect different access networks. Functions of service routing devices shall include:

— network connect: access to IHSN as well as connect service opening devices and other service routing devices;

— service opening device management: monitor the current status of related service opening devices;

— service address: address target service and relay service request/response among multiple service access networks;

— system management: including user management, privilege management, resource management, log management and transaction management;

— service security: including access control, audit control, communication security and data security.

5.2.2 Technical characteristics

As another core device for building internet healthcare service network, the performance of service routing device determines the service forwarding rate and service invocation performance of the entire network. Similar to service opening devices, the following technical characteristics shall be considered when selecting the appropriate service routing device.

— Forwarding rate: refers to the total number of service requests and service responses (from service opening devices and other service routing devices) that can be transmitted by a service routing device in a given time. The forwarding rate can be assessed as follows:

  Forwarding rate = total number of service requests and service responses / transmission time (s)

— Device capacity: refers to the maximum number of service opening devices that can be handled by a service routing device.

— Throughput: refers to the amount of service information (such as service queries, network topology) that a service routing device can process in a given time. The throughput can be assessed as follows:

Throughput = service information traffic (bit) / process time (s)

— Reliability: refers to the probability that a service routing device can perform any required functions without failure under stated conditions for a specified period.

6 Deployment scheme of internet healthcare service network

6.1 Star topology

Small service networks, such as those at the local level, shall construct their IHSN in a star topology (see Figure 3). Each participant (healthcare organizations and other service providers) shall be independent in this deployment scheme. Internet healthcare services shall be opened to the network through service opening devices. Each service opening device shall connect to a unique service routing device for service transmission.

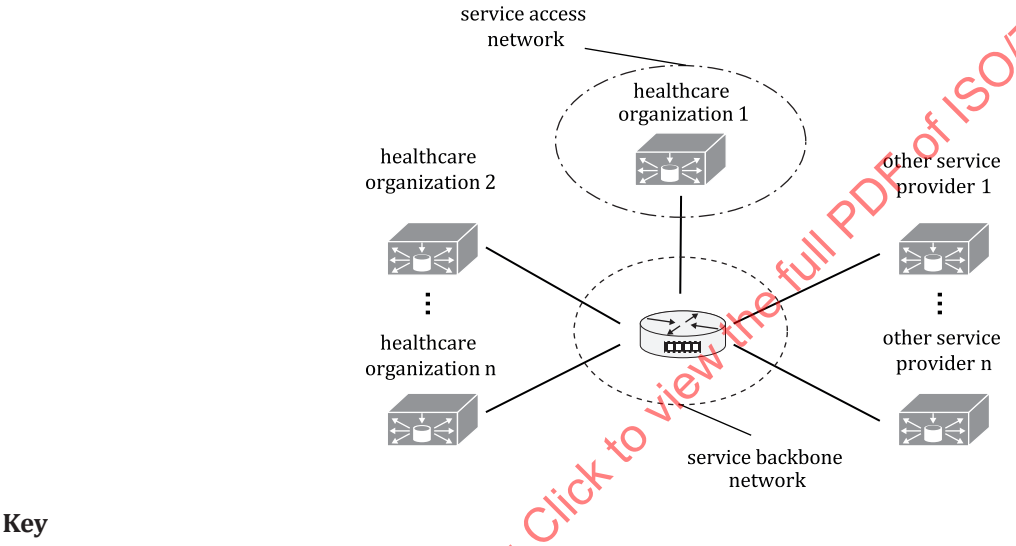


Figure 3 — Star topology

6.2 Tree topology

Large and medium-sized service networks, such as provincial/jurisdictional level, shall construct their IHSN in a tree topology (see Figure 4). In this deployment scheme, there should be a subordinate relationship between several healthcare organizations (such as hospitals of different types and sizes and outpatient clinics for primary and secondary care). Various participants (healthcare organizations and other service providers) shall open services through service opening devices. Each service opening device shall connect to a service routing device at the same layer. Service routing devices from different layers shall communicate with each other to realize service transmission among healthcare organizations from different layers.

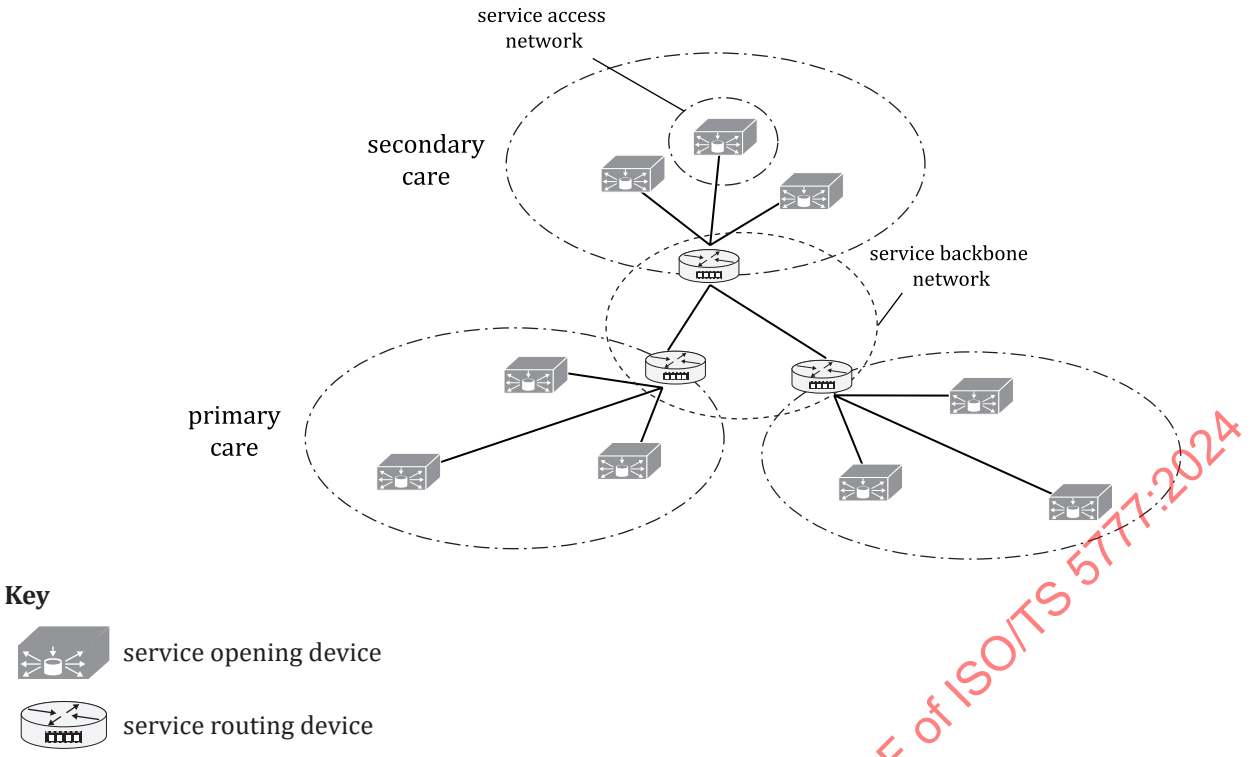
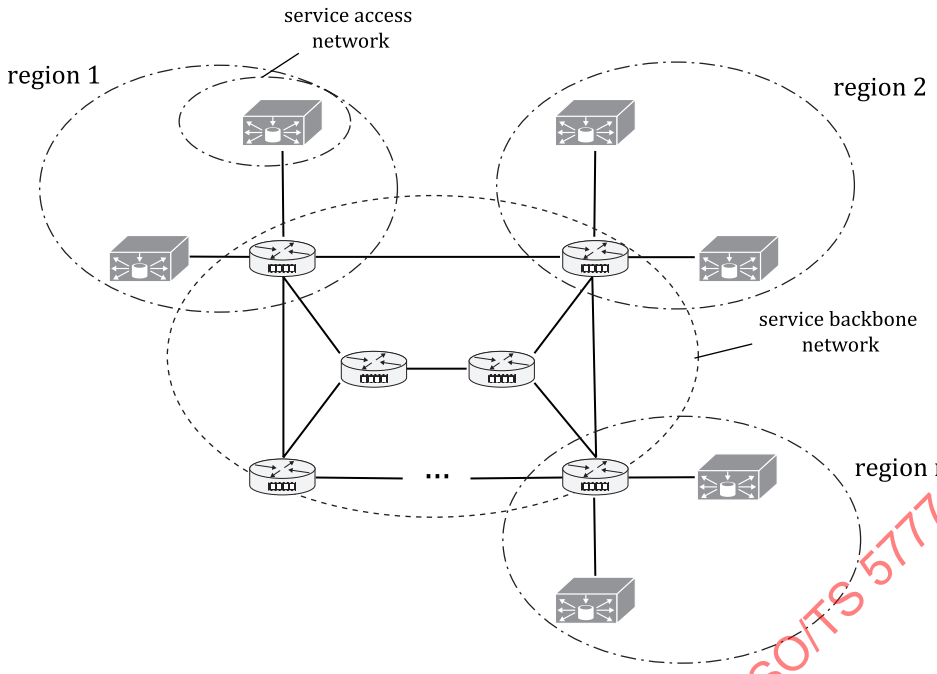


Figure 4 — Tree topology

6.3 Mesh topology

Super-large service networks, such as those at the national (supra-national) regional level, shall construct their IHSN in a mesh topology (see Figure 5). In this deployment scheme, many healthcare organizations distributed widely shall be considered. Various participants (healthcare organizations and other service providers) shall open services through service opening devices. Each service opening device shall connect to the nearest service routing device based on location. Service routing devices shall build the backbone network to realize service transmission among service opening devices.



Key

service opening device

service routing device

Figure 5 — Mesh topology

7 Security of internet healthcare service network

7.1 Category of privacy information

Information requiring protection in healthcare field shall at least include:

— personal healthcare information;

— healthcare knowledge (e.g. data on drugs, devices);

— data on health professionals and staff;

— data on different participants;

— statistical data on information services;

— log data on service devices.

7.2 Network security requirement

7.2.1 Access control

The following items shall be considered:

— responsibilities and procedures for the management of service devices;

— use of a gateway (e.g. firewall, GAP) to cross over networks;

— segregation of roles, for example normal users, administration;

— authentication for accessing various information services.

7.2.2 Communication security

The following items shall be considered:

— use of cryptographic techniques;

— a definition of the sensitive or critical information and an agreement for the use of these data;

— the secret keys;

— detection of and protection against malware.

7.2.3 Audit control

The following items shall be considered:

— traceability and non-repudiation of service invocations;

— monitoring of the running of information services;

— logs of system operator activities;

— event logs of exceptions, faults and security events.

7.2.4 Data security

The following items shall be considered:

— avoidance of unauthorized access;

— accurate and complete records of the backup copies;

— encryption of the privacy information;

— protection against malware.

Annex A
(informative)

Implementation of IHSN

A.1 General

IHSN contains internet healthcare service recipients, internet healthcare service providers, and internet healthcare service repositories, and they collaborate to implement service opening, service discovery and service invocation through service opening devices and service routing devices. Internet healthcare service providers provide healthcare services, and internet healthcare service recipients use these services, while the internet healthcare service repository is the bridge between providers and recipients. The following is the detailed implementation of IHSN.

A.2 Service opening

Service opening is the process by which internet healthcare service providers publish their services to IHSN. It includes the following steps.

a) The internet healthcare service provider accesses IHSN through a service opening device.

b) The internet healthcare service provider registers the service information to service opening device.

c) The service opening device sends the service information to the corresponding service routing device.

d) The service routing device broadcasts the service information to the whole service network.

A.3 Service discovery

Service discovery is the process though which internet healthcare service recipient finds the services to meet the needs of IHSN. It includes the following steps.

a) The internet healthcare service recipient searches for services needed by the service opening device.

b) The service opening device sends the search request to the corresponding service routing device.

c) The service routing device forwards the request to the destination devices according to the routing strategy.

d) The service routing device returns the result to the internet healthcare service recipient according to the routing strategy.

A.4 Service invocation

Service invocation is the process by which an internet healthcare service recipient calls the service and gets the result from IHSN. It includes the following steps.

a) The internet healthcare service recipient needs to perform the corresponding authentication (apply for the secret key, etc.) before the service invocation.

b) The internet healthcare service recipient sends a service request to the local service opening device.

c) The service opening device forwards the request to the destination opening device via the service routing device.