

# Implementation and Application of "One Network Unlimited" Medical Internet of Things

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## Abstract

This paper introduces the implementation and application of "One Network Unlimited" medical Internet of Things (IoT). It introduces the implementation methods of "One Network Unlimited" medical IoT, including sensor technology, intelligent embedding, RFID and cloud computing technology. The specific applications of the "One Network Unlimited" medical IoT are discussed by using the literature analysis method. Through the introduction of this paper, we can see that "one network infinite" medical IOT has a wide application prospect in hospital management, which can improve hospital management efficiency and service quality, and provide patients with safer, more comfortable, and more convenient medical services.

## Keywords

Medical Internet of Things; One Network Unlimited; Sensor technology; Cloud computing; Artificial intelligence; Telemedicine; Intelligent health management

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## 1 Introduction

Nowadays, China's medical information has entered a new stage, using Internet of Things (IoT) technology to build electronic medical systems, is the new trend in medical information construction development.

The severe shortage of medical resources, the increasing public demand for medical quality and safety, the aging population, and rising medical costs are not the only problems faced by China, but healthcare reform challenges are recognized as matters of concern as well. Information technology has been recognized as a lever for healthcare reform, playing an important role in ensuring security,

reducing costs, and improving efficiency. Most hospitals in China have completed the construction of network infrastructure, hospital information system (HIS), laboratory information system (LIS) and electronic medical record systems<sup>1</sup>. However, there are gaps in the transmission of information from the resident's and nurses' workstations to the patient's bedside. In a hospital, doctors, nurses and patients are not in a fixed position, but they are always on the move. Therefore, hospitals have a natural demand for mobile health, and wireless network is the key to supporting mobile health.

In hospitals, there are many medical wireless Intranet data applications, Internet of Things mobile applications, and

extranet/public network applications in hospitals. If the establishment of a wireless network is disorderly, it will inevitably cause the mutual interference between the systems. For example, there are a wide variety of wireless Wi-Fi products, including three major operators, external network apps, self-built hospitals, and other project products<sup>2</sup>. These external wireless networks interfere with each other and seriously interfere with the use of internal wireless networks. Another problem with haphazard building is that each mobile app is repeatedly pulling wires across the ceiling. At the same time, each system has its own wireless base station installed on the ceiling, so the failure rate of active equipment such as the base station on the ceiling will be relatively high. The ceiling is an open environment, which increases the management and maintenance cost of switches on the hospital Intranet. In addition, the port of the ward is exposed in the public area, which makes it easy to be tampered with and eavesdropped. This can cause serious threats to the security of the hospital's Intranet data. Moreover, frequent lifting of the ceiling, whether it is from construction drawing or maintenance, will disrupt the normal operation of daily medical business and increase the probability of nosocomial infection<sup>3</sup>.

Medical IoT is the network foundation of various application systems in the hospital. To improve the efficiency and safety of clinical treatment, the hospital IoT will create a "One Network Unlimited" platform. The "One Network Unlimited" medical IoT system is a medical system that can monitor patients' physiological indicators and environmental data in real-time. This paper will introduce the implementation and application of "One Network Unlimited" medical IoT system and discuss its future development trend in the medical field<sup>4</sup>.

## 2 The Realization of "One Network Unlimited" Medical Internet of Things

### 2.1 "One Network Infinite" Medical Internet of Things Construction Ideas

1) Basic network system of the Internet of Things completes a variety of different standards, different frequency points of the Internet of things signal coverage. 2) Real-time reception and distribution of IoT sensing data (data engine) receives data from sensors and distributes data to different application systems. 3) The Internet of Things application system displays application data and manages policies. 4) Data interface platform interconnects with IoT application system and hospital HIS/ESB data interchange. 5) Internet of Things operation and maintenance monitoring system monitors the running status of IoT application systems and hardware devices to provide data support for system optimization.

### 2.2 "One Network Unlimited" Medical Internet of Things Infrastructure Platform Construction

"A network of unlimited" medical IoT infrastructure platform construction uses a set of base stations in a ward model, in which the model can reduce the amount of network maintenance, ultra-wideband antenna system, adapt to the loose coupling / tight coupling, hospital selection is not limited, as shown in Figure 1.

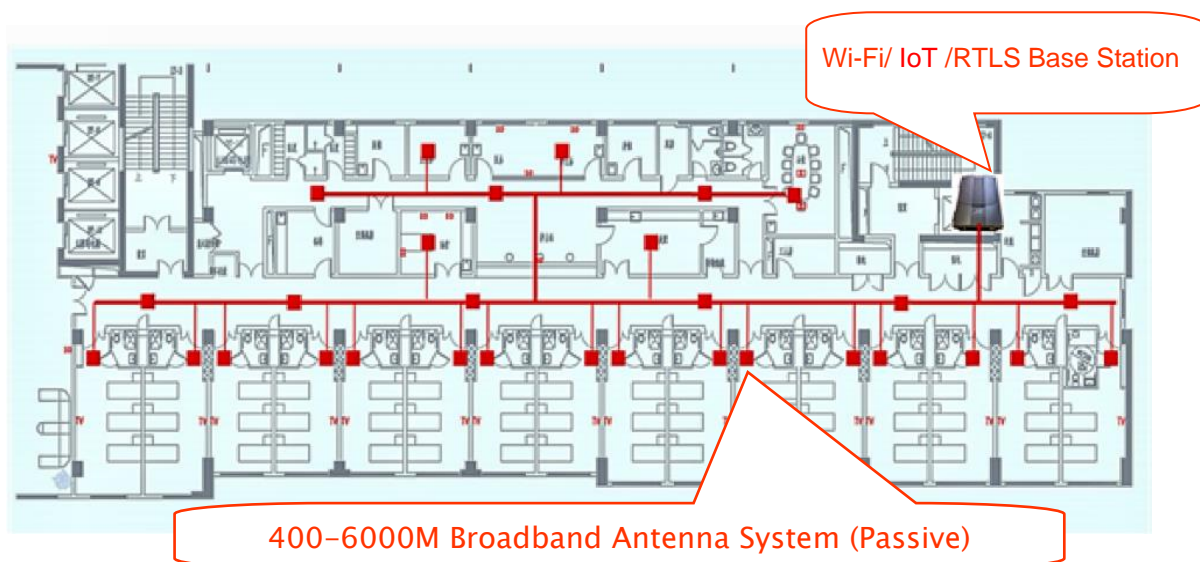
### 2.3 Key Technologies for the Implementation of "One Network Unlimited" Medical Internet of Things

In view of the existing technology base of IoT and the special characteristics of the medical system, the medical IoT field adopts a 3-layer technology architecture of sensing layer (undertaking information collection), network layer (undertaking information transmission) and application layer (completing information analysis, processing, and control decision). The implementation of "One Network Unlimited" medical IoT system requires the

comprehensive use of various technical means<sup>5</sup>.

Sensor technology is the basis for the implementation of the "One Network Unlimited" medical Internet of Things system, through which sensors can achieve real-time monitoring and data collection of physical quantities of patients'

medical personnel, and medical equipment. Sensors can collect various types of data, such as vital signs data, body temperature, heart rate, respiration, blood oxygen and other index data, equipment operation status, etc., to provide basic data support for system data collection and analysis<sup>6</sup>.



**Figure 1.** "A network of infinite" medical Internet of Things infrastructure platform construction diagram.

Smart embedding technology can enhance the processing power of the network front-end, improve the efficiency of data processing and increase the network's adaptive capabilities. Objects with smart embedding technologies will have certain processing and stimulus feedback capabilities. Smart embedding technology enables objects to interact actively or passively with users and is one of the key technologies of IoT<sup>7</sup>.

RFID is a non-direct contact automatic identification technology, i.e., a leading technology to obtain data related to the target object through automatic identification of radio frequency signals<sup>8</sup>. Radio frequency identification system is mainly composed of 3 parts: tag, reader and antenna. Its advantages are: (1) recognition work without human intervention; (2) can adapt to a variety of working environments; (3) data access speed; (4) multiple tags can achieve instant

interference-free identification; and (5) convenient and simple operation process.

The "One Network Unlimited" medical IoT system needs to handle a large amount of data, including patient data, device data, and medical big data. These data need to be stored, analyzed, mined, and shared, and rely on cloud computing technology. Cloud computing technology can provide powerful computing and storage capabilities, enabling real-time processing and data sharing.

Artificial intelligence technology is the key technology to realize the intelligence of "One Network Unlimited" medical Internet of Things system, including machine learning, natural language processing, image recognition, intelligent recommendation, and other technologies<sup>9</sup>. Artificial intelligence technology can realize intelligent analysis and processing of medical data, such as case diagnosis, risk prediction, drug development, etc.

The implementation of "One Network Unlimited" medical Internet of Things system requires the comprehensive use of a variety of technical means, while also considering security, privacy protection, standardization, and other issues. In the process of implementation, system design, data collection, data processing, data analysis, and data sharing are required to provide strong technical support for the digital and intelligent transformation of the medical industry.

### 3 Application Research of "One Network Unlimited" Medical Internet of Things

#### 3.1 Information and Method

##### 3.1.1 Literature Search

Using the CNKI cross-library search platform of China Knowledge Network, exact matches were selected using the search formula "(SU=Medical OR SU=Medical OR SU=Health)" NOT (KY=Regulatory System KY=Aquaculture KY=Automated Oxygenation) AND KY=Internet of Things". The dates were limited from the year 2018-2022. 418 relevant papers were retrieved, and 220

papers on medical IoT applications were retained for analysis after manual screening of original literature, in addition to news information and journal catalogues.

#### 3.1.2 Research Methodology

The bibliographic co-occurrence analysis system (BIOCOMB) was used to conduct a bibliometric analysis of the search results' title entries. The frequency of the main subject terms was extracted and counted, and high-frequency subject terms were intercepted to construct a word-part matrix. Cluster analysis was performed using SPSS.

#### 3.2 Analysis Result

##### 3.2.1 Keyword Analysis

After extracted by BIOCOMB, the frequency of occurrence is more than 10 times, 10 keywords as high-frequency keywords, the top 5 words are IoT, smart medical, IoT technology, medical IoT and application. The distribution of the top 10 high-frequency keywords of medical IoT application papers in China from 2018 to 2022 is shown in Table 1.

**Table 1.** Top 10 distribution of high-frequency keywords for medical IoT application papers in China, 2018-2022.

Keywords	Frequency of occurrence	Percentage (%)	Cumulative percentage (%)
Internet of Things	113	10.6805	10.6805
Smart healthcare	44	4.1588	14.8393
IoT technology	36	3.4026	18.2420
Medical IoT	35	3.3081	21.5501
Application	18	1.7013	23.2514
Artificial intelligence	16	1.5123	24.7637
Medical equipment	14	1.3233	26.0870
Big data	10	0.9452	27.0321
Cloud computing	10	0.9452	27.9773
Application scenario	10	0.9452	28.9225

##### 3.2.2 Clustering Results of Keywords

The word part matrix generated in BIOCOMB was imported into SPSS tool

for clustering analysis, as shown in Figure 2. From the clustering results in Figure 2, the dashed line as the boundary can be clustered into 6 categories, representing

the main application direction of medical IoT, which can be summarized as the following 6 aspects: (1) the construction of smart medical as well as digital hospital, reflecting the change of service management in medical IoT; (2) RFID, sensors, intelligent embedding technology and other IoT technologies in the management of medical equipment; (3) IoT technology is widely used in hospital management; (4) through IoT technology to improve the intelligence and convenience of medical services; (5) the application of IoT in medical health management, including the change of medical service model (mobile medical, telemedicine, intelligent medical, regional medical) and the change of guardianship model (remote guardianship); and (6) the use of the Internet of Things, big data and other technologies to collect, analyze, sort out and store information and data of medical service recipients.

### *3.3 The Application Effect of "One Network Unlimited" Medical Internet of Things*

#### *3.3.1 Intelligent Medical Construction*

Smart medicine applies IoT technology to the medical process, which can realize the automatic positioning, monitoring, identification, and management of things associated with medical treatment for scene analysis and improve the intelligence level of the medical process. Combining IoT and medical information technology, through the construction of smart medical and IoT, regional electronic medical records and health records are established, medical big data and cloud computing are gradually upgraded, and the planning and construction of the smart medical system are improved, providing a professional collaboration, and sharing platform for health information management and decision making, regional and industry information integration.

#### *3.3.2 Intelligent Medical Device Management*

One of the main challenges in the process of medical device management is the wide variety of medical devices, their huge quantity and difficulty in management. The application of IoT technology in the process of medical device management can realize the process of automatic identification, positioning, monitoring, and management of medical devices by the Internet, and improve the quality and efficiency of medical device management. Through medical Internet of Things systems, medical institutions can realize the intelligent management of medical equipment. Medical institutions can monitor the use of equipment in real-time, timely detection of equipment failure and abnormalities, improve the efficiency of equipment use and extend the life of the equipment.

#### *3.3.3 Smart Hospital Management*

With the continuous development and application of IoT technology, its application in hospital management is becoming more and more widespread. IoT technology can provide a comfortable treatment environment by monitoring the temperature, humidity, air quality and other information in patients' wards through smart sensors. At the same time, it can realize the rapid identification and positioning of patient identity through intelligent identification technology. It can realize the intelligent management of medical resources, including real-time monitoring and scheduling of medical staff, beds, drugs, and other resources to ensure the full utilization of medical resources. IoT technology can also monitor and manage personnel and objects in the hospital in real time through intelligent identification technology to prevent the occurrence of unexpected events.

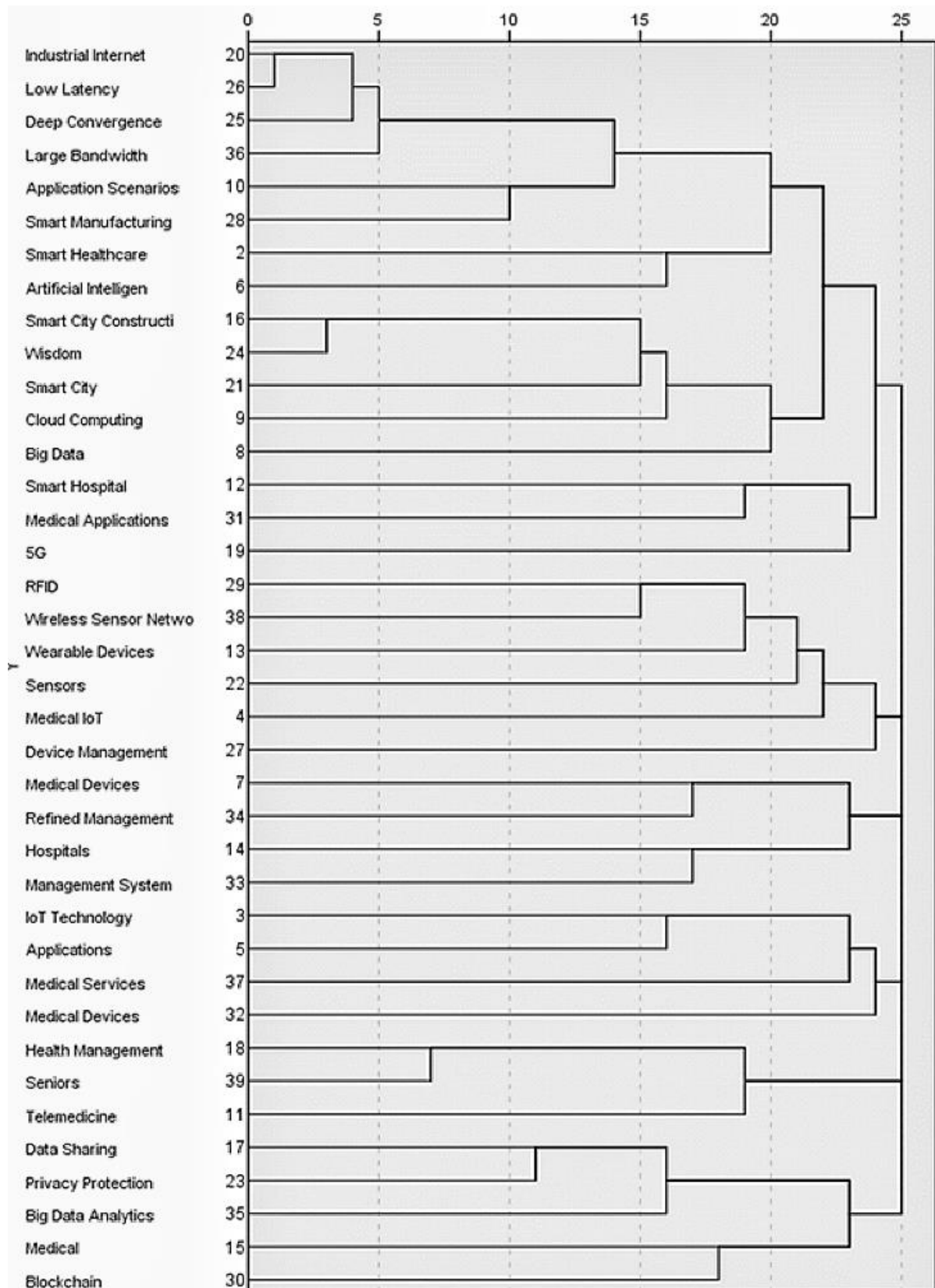


Figure 2. Clustering diagram of the word-part matrix of medical IoT literature.

### 3.3.4 RFID Access Card Service

With the development of digital healthcare, RFID access card, a comprehensive smart card that covers all aspects of a patient's visit to the hospital, is created. The application of RFID access cards can greatly improve the management of hospitals compared to other management information systems, allowing medical staff, patients, and relatives to feel well taken care of. The RFID tag placed in the RFID access card provides a detailed display of the patient's past medical history and medical history, and because the card includes RFID functionality, doctors and medical staff can read and save the patient's medical history anywhere, at any time, using the card. Patients or their families can also use the card to go to the appropriate department for examination, treatment, and medication pickup without having to go back and forth between the doctor and the appropriate department for payment and pricing, which also improves the efficiency of the doctor's visit.

### 3.3.5 Intelligent Health Management

With the development of the aging population, health issues are getting more and more attention. The development of IoT technology has enabled some patients with chronic diseases to keep track of their health status through IoT-based smart medical health systems. Many information technology companies have also entered the field of smart health, producing a variety of smart devices to monitor the health status of patients. With the development of IoT technology, hospitals and communities have realized resource sharing. The remote mode of IoT allows high-level doctors to treat serious patients so that they can receive timely and effective treatment, and greatly shorten the duration of the treatment to avoid deterioration due to time consuming procedures. On top of that, it will help to relieve the pressure faced by hospital reception.

### 3.3.6 Medical Big Data Analysis

Through the "One Network Unlimited" medical Internet of Things system, medical institutions can collect a large amount of patient data and medical equipment data to achieve the analysis and mining of medical big data. These data can provide medical institutions with more comprehensive and accurate medical services and provide data support for the development of the medical industry.

## 4 Discussion

The application of "One Network Unlimited" medical Internet of Things has huge development potential, but there are still some problems in practical application that need to be gradually discussed and improved.

The industry lacks common standards. There is no standard uniform to follow. The construction of the Internet of Things is only based on the development of its own hospital, with low compatibility and poor expansion. By collecting relevant national health departments existing larger scale<sup>10</sup>, the application of a mature medical institutions of information, the general standards for applicability widely, guide the vendor development compatible software supporting system, to facilitate the medical treatment unit for a matching system – standard upgrade, further enhance the data sharing and processing functions of the Internet of Things.

The construction of the Internet of Things platform is scattered. Some of the existing IoT platforms used by investors are only effective in solving targeted problems, and there is no interaction between platforms, which cannot realize the sharing of resources inside and outside the hospital. It can be considered<sup>11</sup> to strengthen the application of integrated platforms in the subsequent construction process, to improve the utilization rate of resources in the hospital.

The current data processing methods and medical applications are not fit well, resulting in low data utilization<sup>12</sup>. It is necessary to strengthen the integration of multiple disciplines and adopt a system scheme that is more suitable for the

special requirements of medical data, to improve the utilization rate of big data.

The data collected by the medical Internet of Things system involves a large number of patients' personal privacy information. Thus, it is crucial to ensure that the security of data is highly protected. You may consider cooperating with communication companies to strengthen the firewall level by laying private networks. Adding multiple layers of keys to cloud data can guarantee medical data security<sup>13</sup>.

## 5 Summary

As people pay more and more attention to health, the needs of the medical industry are becoming more and more diversified and personalized. The "One Network Unlimited" medical Internet of Things system will have a broad application prospect in this context. The system can realize the sharing of medical information, automatic collection and processing of patient data, intelligent deployment of medical resources, etc., and provide support for the digital and intelligent transformation of the medical industry. In the future, the "One Network Unlimited" medical Internet of Things system will also be combined with other emerging technologies, such as blockchain and human brain-machine interface, to achieve more secure, intelligent, and efficient medical services. At the same time, the system will also face challenges in data privacy, security, standardization, and management, requiring in-depth research and discussion in technology, law, and ethics.

In short, the "One Network Unlimited" medical IoT system is an important means of digital and intelligent transformation of the medical industry and has wide application prospects and market potential. In future development, we need to continue to innovate, improve the technology and management system, and make greater contributions to the health of mankind.

## Conflict of Interest

The researcher claims no conflicts of interests.

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## Author Contribution

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Methodology: Dou, H.  
Formal analysis: Dou, H.  
Visualisation: Dou, H.  
Writing (original draft): Dou, H.  
Writing (review and editing): Salji, M. R.  
Validation: Salji, M. R.  
Supervision: Salji, M. R.  
Project administration: Salji, M. R.

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