

The Integration and Upgrading of Technology and Health Empowerment in Internet Healthcare

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Abstract

according to the requirements for the new business format of smart health in the main objectives of the national economic and social development in the 14th five year plan, closely follow the internet medical, take the construction of a healthy city in Wenzhou as the goal, and combined with the current actual situation of Wenzhou City smart health Co., Ltd. (hereinafter referred to as "our company"), improve the performance by designing and optimizing the system architecture, service links, server conversion and upgrading, It is conducive to improving customer experience and efficient service availability. With the development of Internet medicine, promote the integration and upgrading of technology and health business, provide strong technical support for the concept of future Internet medical construction, and put forward the concept of "shared nurse" to explore the ability of how to build a smart and healthy city.

Keywords

Internet Medical; Integration and upgrading; "Shared Nurse".

1. The proposal and policy prospect of Internet medical treatment

General Secretary Xi Jinping pointed out in sanming, Fujian province, that health is the most important indicator of a happy life. Health is 1, followed by 0. Without 1, no amount of 0 is meaningful. "Health is no. 1", which speaks to the hearts of the people, demonstrates the original aspiration of the CPC to "seek happiness for the Chinese people and rejuvenation for the Chinese nation", and embodies the deep and sincere feelings of the people that the CPC Central Committee with Comrade Xi Jinping as the core always puts people's life safety and health first. In the 14th Five-Year Plan for economic and social development, the word "health" appeared three times, respectively referring to the country's efforts to achieve sustained and healthy economic development, significantly improve the physical and mental health of the people, and improve the public health system.

Party and state leaders attach great importance to health, and healthy development has been a top priority. Frequent at present, the country's new policy drive the industry to accelerate the development of hospital information system construction, electronic medical records, the new electronic medical record ratings and other normative text, making the Internet health policy has evolved from the major policies of the vast range of into specific details, "to promote the development of" Internet + medical health "opinion". The development of the Internet medical industry will have a clearer path, and the Medical insurance Bureau will introduce more policies and new control methods. The supporting

information system is also facing the prospect of upgrading and new construction, making the prospect and application of Internet medical treatment more and more clear.

2. Industrial analysis of the development of Internet medical treatment

Medical treatment is the Internet would be big data, Internet of things, such as 5 g combining information technology and traditional medical industry, has made the Internet in the health industry the main body, the whole chain cover, in consultation, diagnosis and treatment, rehabilitation, health care, prevention, etc. The whole process depth fusion, realize the whole process of individual health services, health service system become a kind of new formats. With the growing market demand and the support of many policies, the Internet medical industry is growing rapidly. From the original online appointment and consultation to 5G video cloud diagnosis and treatment, the business scope continues to expand, and the medical resource chain is gradually opened up, forming a relatively complete Internet medical industry chain. Research shows that medical services can fully exploit and utilize existing medical resources through mobile Internet and information technology, which can alleviate the imbalance between supply and demand of medical resources to a certain extent.

2.1 Development of Internet medical industry in foreign countries

According to the survey data, global health spending is expected to grow at a compound annual growth rate (CAGR) of 3.9% between 2020 and 2024, with the fastest growth in Asia and Oceania (5.3%) and the transition economies of Central and Eastern Europe (5.2%), while Latin America is the slowest (0.7%). At present, the penetration rate of mobile Internet in the global medical industry has reached 10%. Since 2013, global mobile medical has entered a stage of rapid growth, and consumer-oriented mobile medical services have huge market value. The global mobile health market has grown from \$1.5 billion in 2009 to \$4.6 billion in 2017 and is expected to top \$10 billion by 2025, according to CSMG. At the same time, the trend of medical mobile has attracted the attention of the capital market. According to a Rock Health report, global investment in biotechnology and traditional medical devices fell 4% and 16% respectively in recent years, with venture capital firms showing strong interest in companies in areas such as Internet medical applications, telemedicine services, data analytics and smart wearable devices. For the fourth year in a row, healthcare VCS set a new record in funding in 2020, raising more than \$16 billion, up 57% from 2019 and the biggest increase since 2011. A number of venture capital institutions focusing on investing in the healthcare industry have completed the establishment of new investment funds, including well-known venture capital firms and so on.

In the United States and Europe, vc investments completed in 2020 rose 47 percent to \$51 billion. Investment in all healthcare segments has broken records, with the VC-backed biopharma and DX/Tools sectors performing well in the fight against the COVID-19 pandemic. These two sectors also saw the biggest investment growth in 2020 compared to 2019. HealthTech, which provides a new model for patient treatment and clinical trials, is also in the spotlight because of various social distancing and stay-at-home orders.

2.2 Development of the Domestic Internet medical industry

Driven by the national medical reform process, thanks to the policy liberalization of medical e-commerce and the popular concept of knowledge payment, Internet medical has achieved rapid development, with thousands of mobile medical apps, and the scale of China's Internet medical market approaching 198 billion yuan in 2020. With favorable policies, with the further popularization of Internet medical treatment, the market size will continue to grow, or nearly 284 billion yuan in 2021. At present, the overall situation of Internet medical treatment in China is in the stage of accelerating development.

In terms of industry, the medical IT industry has improved its prosperity and market concentration. Tertiary hospital informatization in hospital information integration platform, clinical medical big data platform for the construction of the new platform is given priority to, the secondary and hospital

information system should be perfected under the maturity as an aid to improve the level of diagnosis and treatment, thus accelerate medical orders for IT vendors, 2021 WeiNing health business income is 2.267 billion yuan, up 18.79% from a year earlier. At the same time, policy-driven medical informatization construction will be promoted from point to area. Small and medium-sized enterprises will be gradually eliminated from the market due to weak delivery capacity and single product structure, and industry resources will be tilted to large enterprises.

From the perspective of the development of medical enterprises, Internet medical business has entered a period of accelerated growth. Ping an Hao Doctor, whose main business is "Internet + medical services", has been listed successfully and obtained a high valuation, with a total market value of over HK \$50 billion. Ali Health, whose main business is "Internet + medicine", has seen explosive growth in performance. In 2021, the annual revenue growth rate is 61.7%, and the stock price has doubled since this year. The four cloud businesses of Weining Health have excellent performance, and the operating indicators of cloud medicine, cloud medicine and cloud insurance are beautiful. It is expected to achieve profitability this year. In addition to the development of enterprises, the promotion of prescription outflow accelerates the development of prescription sharing platform, and Internet medical treatment usher in a new track of ten billion yuan.

3. The integration and upgrading of technology and business promoted by the development of Internet medical treatment

With the promising prospect of Internet medical treatment, the development of technology should also keep pace with The Times. Technological transformation and upgrading has become a new proposition, but also a huge challenge.

3.1 Discussion on current mainstream technology

At present, the mainstream architecture is the distributed cluster mode, where services are called through THE RPC mode. One project corresponds to one business, and different projects are deconstructed to achieve low code coupling. Each project can focus on its own relevant business development, knowing the upstream and downstream relationships of services and exposing corresponding services to provide external invocation. Through the above processing, the realization of system modularization makes the reuse degree higher, the development and release speed more efficient, more expansibility, team collaboration process will also be improved, but in the complex network, the performance of traditional RPC call becomes increasingly prominent.

3.2 Poor performance of traditional RPC calls

3.2.1 Network transmission mode problem

Traditional RPC framework or remote service (process) invocation based on RMI adopts synchronous blocking IO. When the concurrent pressure of the client or network delay increases, synchronous blocking IO will cause frequent blocking of IO threads due to frequent wait, and the IO processing capacity will decline.

3.2.2 Problem of serialization method

Java serialization mechanism is an object encoding and decoding technology inside Java, which cannot be used across languages; At present, it is difficult to support interconnection between heterogeneous systems. The code stream after Java serialization needs to be able to be deserialized into the original object (copy) by other languages. Compared with other open source serialization frameworks, the code stream after Java serialization is too large, which will lead to extra resource consumption whether it is network transmission or persistent to disk. Poor serialization performance, especially high CPU resource usage.

3.2.3 Thread model problem

Synchronous blocking OF IO will lead to the occupation of 1 thread for each TCP connection. Thread resources are very precious resources of JVM virtual machine. When THE I/O read and write block

leads to the timely release of threads, it will lead to a sharp decline in system performance, and even lead to the virtual machine cannot create new threads.

3.3 Research on improving link transmission efficiency

(1) In order to improve the efficiency of link transmission and speed up the response of services, NIO framework is adopted as the infrastructure and the new RPC call technology based on Netty is developed by ourselves. That is, Netty (NIO framework) is used to replace the traditional communication framework based on Java serialization + BIO (Synchronous blocking IO). The group test was conducted for many times for every 1W requests, and the average value of each group was counted. Then the analysis concluded that the efficiency of the new RPC request was about 1.6 times that of the HTTP request, and the performance was significantly higher than that of the HTTP request. The test data was shown in Figure 1. It can be seen from Figure 1 that the transmission performance of the new RPC communication using binary transport protocol is faster than that of HTTP protocol, indicating that the call of the new RPC is more appropriate than that of HTTP protocol. In the actual scenario, the traffic request response increases exponentially than this, and it can also be seen that the performance gap will expand. We also adopted a more convenient, faster and safer way of data serialization for object transmission between different processes, so as to improve data transmission and reduce the mode of content occupying too much transmission space.



Fig. 1 RPC versus HTTP

(2) Through the data serialization perspective to change the original traditional binary data mode, the world's Internet companies have also made some attempts. GRPC is Google's recently announced open source software, based on the latest HTTP2.0 protocol, and supports many common programming languages, can directly and a variety of language services for efficient interaction. Thrift was originally developed by Facebook as a cross-language RPC framework for internal systems. It was contributed to the Apache Foundation in 2007 as part of the Apache open Source project, supporting multiple languages. Dubbo, the earliest open source RPC framework in China, was developed by Alibaba and opened source at the end of 2011. Apache Dubbo is a high-performance and lightweight open source Java service framework.

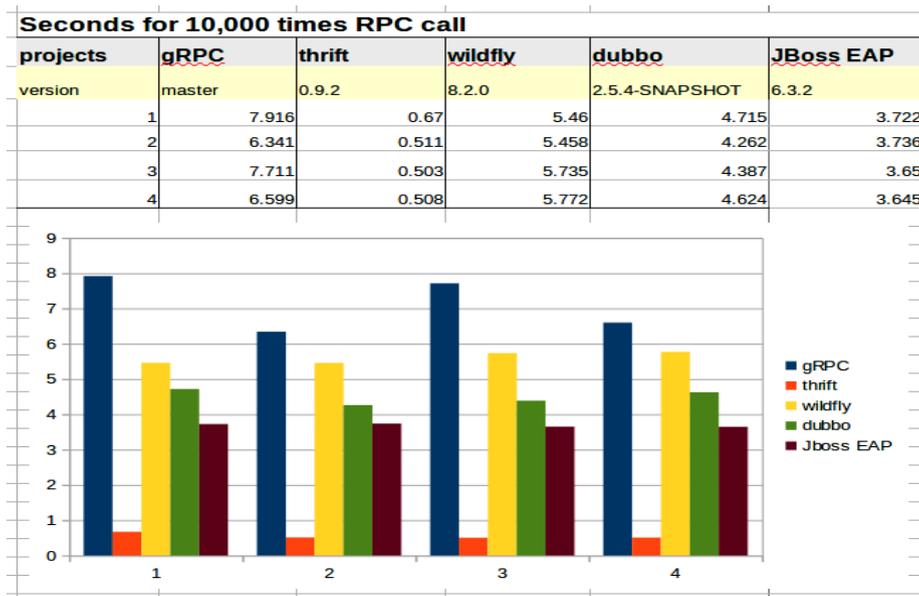


Fig. 2 comparison of 10000 remote calls to RPC

After running 10,000 remote RPC calls continuously for four rounds of testing, the duration after 10,000 calls was recorded as shown in Figure 2. Figure 2 shows that Thrift is the most efficient and at least one order of magnitude ahead, while the performance data of the other three projects are in the same order of magnitude. They are JBossEAP, Dubbo, Wildfly and gRPC from high to low. Therefore, the above data serialization processing will greatly improve the transmission efficiency during RPC transmission. The technical team of our company also set up two test servers and conducted the pressure test results . It can be seen from Figure 3 that there is a significant gap between Tomcat and Netty only when the concurrency reaches 10000, while Jetty is twice as bad as Tomcat and Netty when the concurrency is below 2000. Even if the concurrency reaches 10000, Jetty's NIO is also worse than Tomcat's BIO. With data serialization, new RPC has better performance than traditional serialization.

4. Project implementation based on technological evolution

To sum up, our technical team has done a lot of optimization and testing in server-side and RPC communication to meet the growing needs of users and businesses. We can respond to our business services in seconds or even tens of milliseconds when a large number of user requests come in. At present, most services use Nginx as load balancing and Netty as basic RPC architecture. After such improvement, system services have been applied to 32 business services of our company, such as Internet hospital, prescription platform and operation platform, meeting the availability and efficiency of 99.999% of services. Support health Wenzhou App users to obtain a large amount of medical information and third-party partners of the data business.

Adopting NIO architecture of Netty and developing distributed RPC service, a system architecture with independent intellectual property rights has been formed. The architecture has been in service in medical projects for more than 10 years. It has experienced continuous tempering of each project and full-link testing from the change of system architecture to the application of actual scenarios. It is a customizable system-level architecture that can meet the needs of different projects. At present, the architecture has been used in "Internet Hospital", "Shared Nurse", "Unified payment and settlement platform", "Health Mall" and other projects. It provides corresponding countermeasures and solutions for project risk control through technical means, providing strong technical guarantee for project landing.

5. The rise of "shared nurse" under the development of Internet medical treatment and the upgrading of technology integration

"Three points of treatment, seven points of nursing" shows the importance of nursing work, at the same time, the masses of elderly care, chronic disease care, hospice care, home care and other multi-level and diversified health care services demand is increasing, and the "shared nurse" to provide on-site nurse services will better meet this demand. "Shared Nurse" is a new Internet medical platform (hereinafter referred to as "the Platform") built based on our company's mature technical architecture. Through the platform, patients can sign contracts with nurse practitioners on the platform and make an appointment with nurses according to their needs, providing them with services such as injection, infusion, catheterization and atomization. For patients, it not only solves the problems of "difficult to see a doctor" and "long waiting time" in the hospital, but also eliminates the need for family members to spend special time with them, which can effectively reduce the occupation of medical resources and improve the efficiency of hospital operation. The mode of "shared nurse" breaks through the restraint of traditional medical profession and brings real convenience to the masses.

5.1 Technology enables "shared nurse" security issues

While bringing convenience, it also brings challenges and worries about some social problems. How to ensure the personal safety of the nurse when the nurse visits the home, whether the nurse has the ability to calmly solve the emergency during the nursing, and which party is responsible for the identification of medical malpractice. According to the above situation, our company provides corresponding countermeasures.

5.1.1 The platform is equipped with nursing work recorder and provides positioning tracking and one-button alarm functions

The platform cooperated with China Mobile and Hikvision to build intelligent nursing work recorder and one-button alarm device (as shown in Figure 3), which can supervise nursing operation and standardize nursing skills of nurses, and better deal with emergencies. At the same time, the platform introduces a positioning and tracking system to ensure that the location information of nursing staff can be obtained at any time, providing convenient conditions for dealing with emergencies and opening green channels.



Fig. 3 Nursing recorder

5.1.2 Establish triple risk prevention and control measures and other safety functions

First, we adopt the evaluation model to comprehensively evaluate all service objects. Only after passing the evaluation of doctors and nurses, nurses can provide nursing services at home and reduce safety risks. Second, set emergency contacts. In case of an emergency, as long as you press the "Emergency Help" button, the system will send SMS messages to all the emergency contacts. Third, jointly with China Land Insurance Company, we launched the first comprehensive protection insurance for Internet nursing services to guarantee the safety of the whole process of hospitals and nurses for the nursing service platform -- "Net nurse".

In addition to the above three measures, we have also developed corresponding safety functions: blacklist mechanism, which enables blacklist of service objects with bad records to reduce service risks of medical staff; Dual evaluation mechanism, based on historical medical records data evaluation and face-to-face online evaluation contract mechanism, to ensure the safety of patient services; One-click complaint, patients are not satisfied with the service, can complain online at any time; Service records, service process records (text, text and voice) will be uploaded after the service is over for service traceability; Electronic signature to ensure that the service record is true and valid

5.1.3 Relevant departments should improve relevant laws and regulations

Actively cooperate with relevant departments to formulate a sound risk avoidance system, incorporate the "shared nurse" mode into the scope of medical liability insurance, and require both nurses and patients to purchase medical accident insurance and personal accident insurance. In addition, relevant departments should also improve the laws and regulations on medical safety responsibility, clarify the responsibilities of the platform, nurses and patients, and guide their standardized development.

5.1.4 To establish specialized mediation and dispute handling institutions

The government needs to establish specialized mediation and dispute handling institutions to ensure that when nurse-patient disputes occur, both sides can be timely and effectively adjusted and dealt with, so as to relieve the tense nurse-patient relationship to a certain extent.

5.1.5 Bank custody fund management to avoid the risk of liquidation

Jointly with INDUSTRIAL and Commercial Bank of China and China Construction Bank, they shall be responsible for the clearing and settlement of funds to ensure the safety and compliance of funds. While nursing fees are open and transparent, it will also ensure the safety of funds and compliance of settlement.

5.2 The practical significance of "shared nurse"

The mode of "shared nurse" can make both nurses and patients achieve a win-win situation. For nurses, they can earn income while giving full play to their professional abilities. For patients, it solves many problems of the elderly in medical treatment and pension. Not only that, but also to relieve the strain on medical service resources. However, there are still some challenges in the implementation and promotion of the mode of "shared nurses", which is a process of continuous trial, problem discovery and problem solving. It requires not only the supervision and improvement of the operating platform, but also the attention and strong support of the government, and the follow-up of laws and regulations.

6. Our company's role in urban health

Our company will help Wenzhou to carry out the upgrading construction of future community health scene and healthy city, establish a complete population health file through information means, improve the service efficiency and accessibility of medical institutions, promote the gradual equalization of grassroots medical services, and further improve the overall medical level of Wenzhou. In the end, the deepening of wenzhou "medical, health care, medicine," linkage reform, strengthening "of traditional Chinese medicine (TCM) hospitals, doctors," overall development, establish the maintenance public welfare, to mobilize enthusiasm and protect health of sustainable urban future community running mechanism, achieve precise leading examining ", solve once upon a time a doctor to find a hospital, find which hospital and the doctor's pain points.

With the deepening of business, the technical team of our company keeps exploring and upgrading technology, from data link to self-research and optimization of Web server, which greatly improves the performance of data timeliness. Our company takes cloud application platform as the backbone and smart medical and health basic OS as the base to build a new generation of products and services ecosystem and share the health cloud era. From the perspective of architecture, smart medical and health basic OS serves as a technology center, data center and polymorphic intelligent connection platform, which opens up the boundary and interconnects of G, B and C terminals. Through the platformization of various applications and services, various products and service modules can be

deployed in cloud or hybrid cloud mode. Open to a third party due to the platform, G, B and C side will enjoy abundant resources and services, so as to build up a new Internet wisdom and medical mode, slow disease medication reminder and doctors, for example by 5 G cloud video on follow-up appointment on time, make no longer limited by space and time between doctors and patients.

On the basis of technology polymorphism, build the operation and maintenance cloud platform and medical and health application cloud platform; On the basis of business polymorphism, medical and health service operation platform should be established to build the foundation of Internet medical treatment. In this ecosystem of public hospitals, health institutions, medical insurance and third-party large health service institutions, patients' medical service consumption needs are fully met through data operation, product operation and business operation.

7. Conclusion

The development of the medical and health industry is closely related to the national economy and people's livelihood. China's medical and health services are facing new challenges due to industrialization, urbanization, an aging population, and the changing disease spectrum, ecological environment, and lifestyle. Under the joint promotion of macro policies and technological development, Internet medical applications in China are blossoming. The development of these applications will play a huge role in alleviating the unbalanced distribution of medical and health resources in China, realizing the vertical flow of high-quality medical resources, providing real-time, convenient and high-quality services for the convenience and benefit of the people, improving medical experience and alleviating doctor-patient conflicts.

The transformation and upgrading of science and technology brings imaginative space to business development, enables doctors and patients to break the time and space restrictions, enables towns and townships to enjoy municipal medical resources, and alleviates the shortage of regional medical resources. Of course, there are still many technical problems to be solved, and many challenges and difficulties to be sorted out and faced, which need time and scientific and technological progress to solve. I believe that our Internet medical care will take a big step forward to serve our people.

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