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# Research on Informatization Construction of the New Generation "wisdom water network" Based on "Water Profile"

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***Abstract*-At present, with the rapid development of the new generation information and communication technology, the development of the global intelligent water network has been from the theory to reality, and the operation efficiency of water resources has been greatly improved. Wisdom Water Network is a new generation "man - water" interaction idea on the basis of the intelligent water network. We use scientific monitoring and management methods through the Internet of things, the Internet, sensor networks, cloud computing, big data and other advanced technologies and ideas to improve the intelligent interactive ability of water network, so as to promote the coordinated development of water ecology, water environment and water resources. This paper mainly discusses the basic concept of big data wisdom water network, the present status of water network big data and the overall structure of wisdom water network and its related technologies. In order to realize the "wisdom" characteristics of the new generation water internet, we creatively put forward the "Wisdom Water Profile" model, and finally built an omnidirectional, multi-level and three-dimensional interactive wisdom water network decision service platform. Theoretically, it has certain reference value for the informatization construction of water network in China.**

***Keywords-wisdom water network; big data; cloud technology; wisdom water profile; semantic web***

## I. INTRODUCTION

The big data wisdom water network is a new concept that relies on the rapid development of intelligent water network and the web3.0. In order to understand the basic meaning of the wisdom water networks, we must understand the relationship of big data, intelligent water network and the wisdom of the water network.

### *A. The Concept and Connotation of Big Data*

Big Data is a creative term that was first proposed by the famous futurologist, *Alvin Toffler*, in the *Third Wave* of the book, and since then, the concept of Big Data and analysis methods have attracted worldwide attention. In 2011, A McKinsey Global Institute report characterizes the main components and ecosystem of big data that makes Big Data from the cloud to reality. At present, the concept of Big Data does not have an accurate definition. In Wikipedia, Big data is a term for data sets that are so large or complex that traditional data processing applications are inadequate to deal with them [1]. And now, Big data can be described by the following characteristics: Volume, Velocity, Variability, Value, Veracity.

Generally speaking, the big data mainly contains two research directions as follows: for one thing, some people focus on the research on the mass data itself of Big data by analyzing its characteristics; for another, people mainly focus on the research on theory and application of Big data by exploring its ideas. In the second section, we will discuss the status quo of water-related massive data. In the third section, we propose the construction method and technical ideas about the wisdom water network decision service platform.

### *B. The Concept of Intelligent Water Network*

With the rapid development of sensor technology and communication technology, the concept of intelligent water network has been widely promoted, which is an emerging water network construction idea. Intelligent water network is mainly composed of physical layer, measurement and control layer, data acquisition and transmission layer, data management and display layer, data fusion and analysis layer. Compared with the traditional water network, the " intelligent" of the intelligent water network is mainly embodied in the fusion and analysis of the offline sensor network data [2].

### *C. Water Network from Intelligent to Wisdom*

Wisdom water network is not just another statement of intelligent water network. Compared with the intelligent water network, the core of the wisdom water network emphasizes the wisdom participation of all people, which pay more attention to the subjective initiative. Through the combination of the existing intelligent water network architecture and on-line Internet data mining techniques, we can ultimately change the way of human-water interaction to achieve leap of water network wisdom from the "Off-line management of Internet of things" to the "the whole network integration of Internet of things and the Internet".

Massive data processing in the wisdom water network depends on the big data analysis platform. We can deal with online and offline massive data from the whole chain for water resources acquisition, utilization and recycling by using big data and cloud computing theory, techniques and methods. Through the wisdom water network platform to get the valuable information, we can improve the speed of induction and response and the processing capacity for real-time and dynamic data, and ultimately achieve personalized water-related service.

Now the most important applications of network is retrieval service. This paper proposes a new solution for wisdom water network, which is the "people - objects - water" interactive network based on Internet +. By constructing "Wisdom Water Profile" space model and utilizing the advantages of "high data distribution - easy information aggregation" under the cloud platform, we can finally realize Cross-validation, Harmonization Analysis and forecasting between internet public sentiment data and measured data of Internet of Things. These details are described in Chapter Ⅳ.

## II. STATUS QUO OF WATER NETWORK BIG DATA

### *A. The Status Quo of Water Resources*

We are facing severe problems about water resources, water environment and water ecological in china, mainly as follows:

*1) Uneven spatial and temporal*

- Per capita water supply is insufficient.
- More water resources in the south than in the north.
- Coastal water resources are more than inland water resources.
- Water resources in mountainous are more abundant than plains.
- The distribution does not match between productivity and water resources.

*2) Low recycling rate*

At present, most of the sewage treatment plants have cost and technical barriers, including high energy consumption, low efficiency, low degree of automation and so on. In sewage treatment enterprises, the specialization, automation and intelligence level of operation management is not high, resulting in information disjunction among policy makers, managers and executors, all of which lead to the low utilization rate of water resources [3].

*3) Lack of propaganda management*

As the water network laying underground, cannot quickly perceive pipeline leakage and predict burst pipe, real-time and visualization is greatly limited, resulting in a lot of water loss. There are considerable management challenges. Propaganda is not in place, resulting in people on the water ecosystem does not have a clear overall understanding. There is not enough interaction between people and water [4].

### *B. A General Survey about Water Network Big Data*

At present, a lot of information system for water affairs management has been constructed, which plays an important role in improving irrational water resources allocation and rational utilization of water resources. However, with the rapid development of new generation information technology and the rapid expansion of business data, the previous information platform is obviously unable to meet the current storage, analysis and decision requirements for massive data, mainly reflected in the following aspects:

*1) Social water network of big data*

*a) Feed water system*

At present, China has more than 40 national water quality monitoring stations, nearly 200 local water quality monitoring stations, more than 4,500 water plants, only drinking water quality safety testing indicators contain 106 items. Water plants and Water Quality Monitoring Center are constantly uploading large amounts of dynamic data to the data warehouse.

*b) Water distribution system*

The latest data show that nearly 500 million households in China. According to the proportion of urban and rural water meter popularization and the water-supply Institution of "One Household One Water Meter", it is estimated that the number of household water meter is not less than 345 million, and these water meter records the massive user water quantity information. At the same time, with the continuous progress of science and technology, intelligent water meter with real-time and dynamic characteristics is gradually popularized and used. As a result, the data types we get will be more complex and diverse, and the data size will assume the geometric series growth.

*c) Drainage system*

As of the end of 2013, the country has more than 3,200 urban sewage treatment plants.2015-2020, as many as 20,000 urban sewage treatment plant plans to be built, the drainage network of integration and interaction will be a very serious problem. In addition, the current existing drainage control projects up to 62 items, with the pollutant detection indicators become more standardized and strict, data attributes will be more complex. The expansion of the water plant and the increase in the number of detection indicators will result in data size of exponential continuous growth [5].

*2) Natural water network of big data*

*a) Watershed data*

Currently, the country has been divided into 16 key monitoring areas of groundwater, and has built more than 20,000 underground monitoring stations. Each monitoring station carries on the real-time data acquisition, the data uploading and the data tracking to the surrounding river basin of water quality, its minimum time interval achieves the second level or the minute level. With the gradual improvement of water quality monitoring system and the gradual reduction of data acquisition time granularity, we will get more valuable water quality data to carry out mining analysis [6].

*b) Meteorological data*

Meteorological conditions have a very good influence on the region's water environment and water security. At present, there are more than 20,000 meteorological observation points in China. The satellite and radar regularly return meteorological information including more than 30 elements such as rainfall, environmental humidity and soil water potential [7]. These data are growing at an annual PB level, so we need higher storage and computational power to process the data [8].

*3) Internet big data*

The core of the wisdom water network is the participation of people, with the Ideas of green and Environmental Protection rising, people are increasingly eager to acquire and share information about the water environment around them. In addition, the growing popularity of the global PC and smart phones are generating more and more water-related data from the post bar, forums and other Web-side. In 2015, global IP traffic have reached 966EB/year, which contains a large part of the water-related data. Making good use of these data and fully mining the wisdom of the people are the Internet to give us the greatest wealth.

## III. THE GENERAL ARCHITECTURE OF WISDOM WATER NETWORK PLATFORM AND ITS RELATED TECHNOLOGIES

Big data wisdom water network platform includes three core components, as shown in Figure 1:

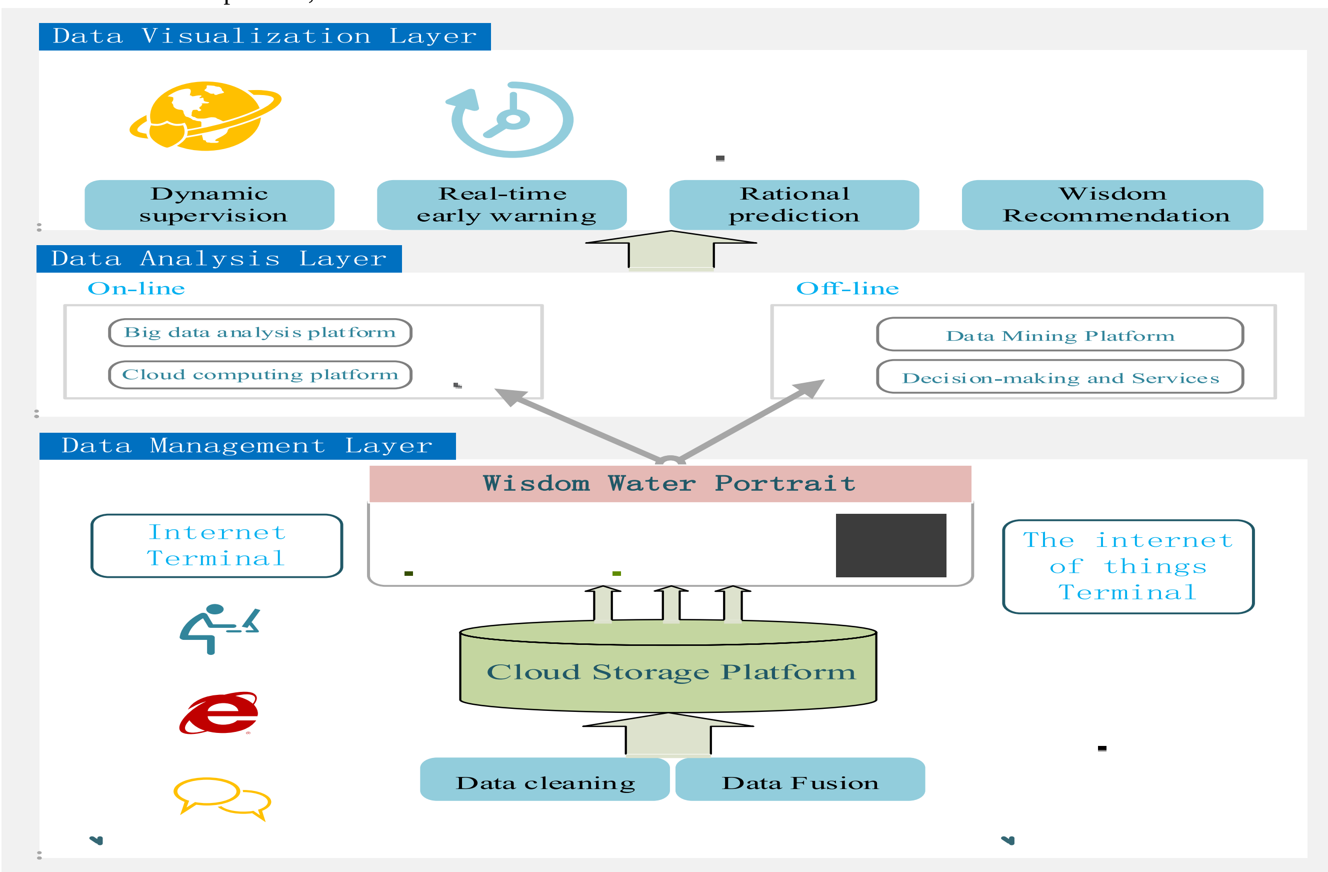


Figure 1. The architecture of Wisdom Water Network platform.

### *A. Data Management Layer*

*1) Data acquisition*

*a) Internet-side data acquisition*

On the Internet side, we are mainly faced with a large number of unstructured video, voice, text and geographic displacement data. We can use a general web crawler with a high recall rate to crawl these data, but will get a lot of irrelevant topic data, which obviously affects later data analysis. In order to obtain meaningful data resources, we use the semantic-based crawler technology to acquire the water-related network public opinion data [9]. In this paper, we build a semantic crawl interface, and use WordNet lexical ontology to infer the semantic relevance of the data itself, and finally get the topic-related data [10].

*b) Physical-side data acquisition*

Here, we mainly face all kinds of semi-structured and structured data from sensors and intelligent water meters. Through the existing water network front-end collector, we can obtain massive and real-time data. But these original data of format and attributes are inconsistent, which is difficult to be integrated and utilized. Therefore, we mainly use ETL-related technology to deal with front-end extraction of data, which is converted into a standard format.

*2) Data cloud storage*

*a) Online data access*

Through intelligent cloud storage technology, we will upload all the scattered data to a unified cloud service equipment. Data users can access and analyze these data conveniently , when and where they need it, through the network cloud service platform. Intelligent cloud platform will break down barriers around the interconnection between the data, so that you can achieve full information exchange between the various data sources.

*b) Offline data access*

Cloud storage can solve the problem of connectivity between data, but the user-oriented customization capabilities and on-line computing capacity is poor. In the face of different application requirements, we build different local lightweight large-scale distributed data storage system in different areas, which uses the "application-oriented storage" to store massive data resources. This approach breaks the performance bottlenecks of centralized storage servers in traditional storage systems, improves access efficiency, security and reliability of the system, and its scalability also matches the distribution characteristics of nodes in the water network [11].

### B. Data Analysis Layer

Analysis layer includes the platform of big data analysis and cloud computing and the platform of data mining and decision-making.

*1) Big data analysis and cloud computing platform*

Big data analysis and cloud computing platform mainly includes distributed processing, hybrid multi-structure data processing and cloud computing technologies. Through the distributed processing technology, we can connect the platform of different locations and functions over the network, and ultimately achieve the harmonization of information processing tasks. The hybrid multi-structure data processing mainly analyzes the unstructured public opinion data from the World Wide Web and the structured data in the data warehouse, and achieve the mining and prediction of the association relation among the data in the water network, provides the basis for decision-making. Facing massive data of real-time processing request, cloud computing platform can provide us with strong technical support [12].

*2) Data mining and decision-making platform*

Data mining and decision analysis platform mainly contain two important functions as follows:

- Making evaluation and decision-making for the current state and features;
- Providing scientific basis of decisions for the future status and trends.

It is a key problem to analyze the “Wisdom Water Profile” quickly and accurately by using the more popular machine learning and the deep learning technology to integrate the data effectively in analyzed data layer.

### C. Data Visualization Layer

Data visualization can provide a clearer and more intuitive sense of the data, dynamically displaying the exterior and interior information of data and some potential associations. We present the data to the user in a simple, friendly, easy-to-use graphical, intelligent form through dynamic images, mapping relations or tables, and finally achieve similar VR’s visual effects [13]. Therefore, the water information display platform in the whole system cannot be ignored.

In this platform, we make full use of 3S (GIS, GPS, RS) and other spatial information technology to build different granularity, multi-resolution, multi-type spatial water network data system in the natural water network and social water network. The real-time data of the monitoring points and the water network are read into the big data dynamic visualization platform through different data interfaces, and then the dynamic display is carried out after data cleaning. At the same time, we combine the current water network status data with the network public opinion data to realize the interactive decision-making, and extract the data from the knowledge base to push real-time content for the current problem. In this layer, anyone can clearly see "where the water comes from and where to go" to achieve real-time interaction of people and water [14].

## IV. WISDOM “WATER PROFILE”

Wisdom Water Profile is a new concept of water ecological model; its core content is as follows:

Identify different sets of private labels and attributes according to the actual situation of water-related objects;

Identify common sets of labels and attributes between different water-related objects;

Construct a net-like semantic model according to the relation between the label concepts.

The first step to achieve the deployment and utilization of internal resources among the private water-related objects, and the object itself has the characteristics of "high cohesion, low coupling"; the second step to achieve the semantic interaction and sharing of information between private water-related objects, which is good for information reuse and decision reuse. The Water Profiles combine profile granularity and the time-space characteristics to integrate the massive real-time data collected by Internet of Things and Internet, and finally establish a multi-level three-dimensional water ecology model from watershed, region, city, community to user.

In this hierarchical system platform, each Water Profile includes five main parts, which are connected by semantic web: determining the attribute of the object label, selecting the appropriate data, constructing the grid semantic model, foreground prediction and intelligent recommendation. Finally, we construct a solid spatial layout model of time, space and object granularity, as shown in Figure 2.

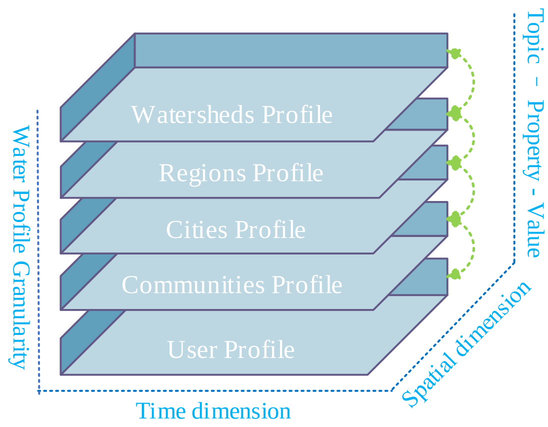


Figure 2. Wisdom Water Profile spatial layout model.

### A. The "Water Profile" of Watersheds and Regions

Here, we mainly focus on the exploitation and utilization planning of water resources, including river basin flood, agricultural irrigation, comprehensive control of soil erosion and water loss, simulation and maintenance of water quality, construction of large-sized hydro projects and the protection of ecological water use in nature reserve and many other key elements. These elements are connected by semantic relations, and are constructed into a multi-layer net-like semantic model with "topic-attribute-space-time", as shown in Figure 3.

This profile solves the problem of allocation and scheduling of water resources at the macro level, and integrates the regional climate information model to ensure the unification of water resources development and utilization status and water security capability.

### B. The "Water Profile" of Cities and Communities

Water is the blood of the city. In this layer, we mainly consider the natural and social properties of water resources, focusing on a series of urban water functions such as demand in households, urban and industrial water supply, flood control, sewage disposal, rainwater collection and water recycling, etc.

By constructing city - community water profile, we promote the coordination of urban water environment, water security, water ecology, and ultimately ensure the unified allocation and management of water resources [15]. Partial multilayer semantic network structure of water profile in this layer is shown in Figure 3.

### C. The "Water Profile" of User

User water profile is the smallest particle in the whole profile, which is also the core component of the wisdom water network structure, mainly involves the user's precision data layer and intelligent data layer.Precision data layer that records the user's daily water habits, the user's spatial displacement information and a series of water-related data by using the current intelligent Internet of Things technology; intelligent data layer mainly involves the user's network interactive information.

By means of big data analysis and data mining techniques, we can identify each individual's personalized tags about water status and water behavior, thereby building the user's wisdom water profile. Users can understand their own water-related information through this platform, while the platform will also guide and improve people's water-related habits by using the user's water ecological portrayals to achieve more dynamic interactions between people and water, and to promote the clarity of entire water eco-chain such as source of water, water intaking, water delivery, water supply, water consumption, drainage, water treatment, water reuse and so on [16]. Partial framework for personalized user water profiles is shown in Figure 3. With the coming of the innovation 2.0 age of knowledge-oriented society, the concept of Internet+ shall gradually interiorize. The public wisdom has brought new decision-making basis for the traditional water affairs, and the whole people participation has given the brand-new meaning for the water network construction.

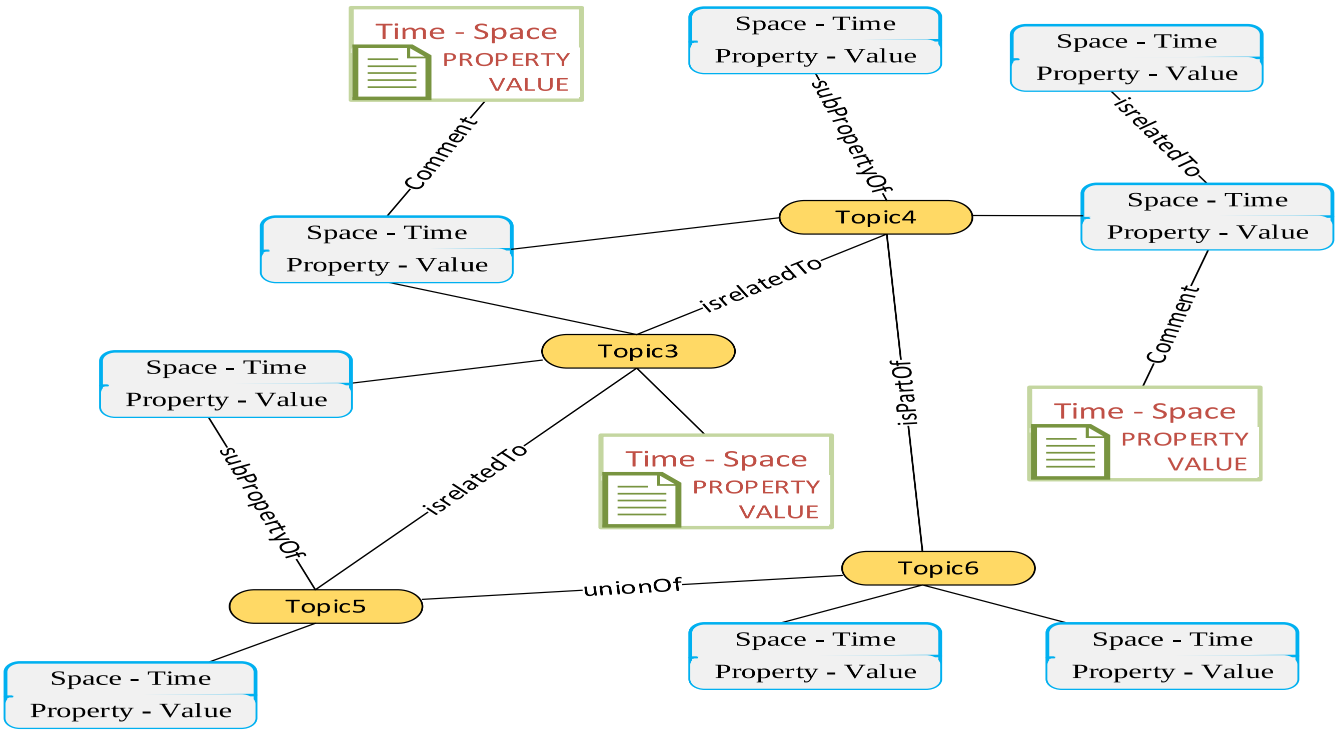


Figure 3. The Semantic Grid frame of WISDOM WATER PROFILE.

In the semantic grid frame, the green part represents the public opinion data; the blue part represents the business data; and the yellow color indicates the characteristics of the profile, which represents different characteristics in different water profiles.

Through the machine learning and self-learning technology, we apply the fusion analysis of the whole network and whole basin data to excavate the relationship among different profiles, and finally construct a hierarchical water interactive platform of semantic wed at national level, basin level, region level and user level. It can real-time forecast the potential problems and the long-term demand by acquiring the present and past water information data to achieve "early management of the early detection problems, or governance before the problem occurs", so as to form a Wisdom water network mode of "dynamic supervision, real time early warning, scientific decision, rational prediction, integrative management and rational allocation", which is the core of the role of water ecology profile. At the same time, in the process of the interaction between profiles, we should pay attention to the overall, true, accurate, and reliable evaluating data, the real-time update of data and online model modification and so on.

## V. CONCLUSION

Intelligent water network and water information platform has been a long-term development in China, which is to provide a premise and guarantee for the development of wisdom water network. But, there are still a series of problems and challenges, as follows:

- Data interoperability is not smooth and the standards of terminal water network equipment are not unified, leading to the information island situation still exists.
- Using cloud computing means that data is transferred to the machines beyond user's sovereignty. Then, how to ensure that the user information and privacy or business data don't leak out or be stolen is what users most concern about.
- The Internet, the Internet of Things, and sensor networks generate huge amounts of data all the time, but how to find out the potential value of these data has not yet formed a clear and systematic idea.

Faced with these problems, this paper puts forward the innovative information construction ideas of the new generation "wisdom water network" based on "Water Profile", using the superiority of the big data and cloud computing technology. Wisdom Water Network is an innovative and sustainable interactive network of Everyone Involved and Everyone Dedication, and its biggest innovation is that uses the idea of Big Data and Wisdom Water Profiles to deal with the problem of current massive water-related information. We can make full use of big data and cloud computing technology to mining the massive data of the Internet and the Internet of Things as well as the dynamic associations of water-related objects between physical network, information network and management network, and finally build a hierarchical water profile dynamic model. At the same time, we open up the interaction barriers between the information through integration capabilities of hierarchical water profile dynamic model, thus solving the water-related management informatization business refinement + intelligence + service requirements. Through the research of the wisdom water network, we turn water information network into a kind of multi-layer dynamic perceptual neural network, and finally realize coordinated and sustainable development of water resources.

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