

The Data Concentration Collection Technology Scheme for Public Utilities

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ABSTRACT: Collection and acquisition of water meter, electric meter, heat meter and gas meter is an effective way to improve the intelligence and automation level in the energy field. In this paper, the data collection technology scheme of public utilities was introduced. Using construction achievements and experience in the electric field, through the data integration of water, electric, gas and heat model, the requirements on shared storage for the four kinds of meters' data was reached from the database level. According to the actual situation of the field of flexible networking, the difficulty of centralized data collection and centralized communication from four meters was solved through sharing upstream channel and employing the downlink channel with a variety of communication technology. In the 'four meters' data collection and data processing, the technology of used memory based data bus, the information flow of data processing model and address space mapping of real-time database improved the system's efficiency and performance. Finally the goal of public utilities data collection and comprehensive application are achieved.

KEYWORD: Multi-application of polymorphism; Shared channel; Exclusive data channels; Data processing model; Distributed storage

1 INTRODUCTION

The National Development and Reform Commission and the National Energy Administration issued the "The guidance on promoting the development of smart grid," proposed "perfect information resource sharing mechanism in coal, electricity, oil and gas field, support water, gas, electricity collect copy, construct dynamic data integration platform of cross-industry energy operation (Zhao Jianghe et al, 2012), encourage share and reuse of energy and information infrastructure". The related enterprises of water, electricity, and gas and heat industry in some province are actively surveying and preparing for this job.

In electric power industry, the provincial power company all establish electricity information collection system of provincial centralized mode (the following are abbreviated the "use and collection system"), this system are constituted by the master station system, communication channel, collection terminals (Lv Guangxian et al, 2014), smart ammeter and others in architecture, from the function covers electricity user data acquisition management, cost management and control and other basic application, also carry out the line loss analysis, preventing electricity-stolen and advanced application functions; The current electricity utilization information acquisition coverage rate is 70%, gathering success

rate is 97%. State Grid Corporation of China has worked out electricity utilization information acquisition system "complete collection (Zhao Ziyang et al, 2011) (Xu Zhiqiang et al, 2015), full coverage, full cost control" construction target, according to this target, the provincial power company all intensified transformation efforts on smart ammeter, but also upgrade and rebuild master station system and communication channel (Zhao Jianghe et al, 2009). At present, electric mining system after the upgrading and rebuilding with advanced technology, powerful, stable running, strong scalability, can be compatible with a variety of communication message and support various downlink channel communication technology (Shi Hui et al, 2007), and support processing and storage of the mass data. The affiliated companies of water, gas and heat are more local or regional company, the company scale is small, automated collection construction start late, most companies give priority to artificial meter reading, the working efficiency low. These companies establish separate automated collection system, the difficulties is larger in capital, technology, personnel, communication channel aspects and so on.

To implement the national energy conservation and emissions reduction strategy, further implement the "convenient for the people, for people, benefit the people" service measures, accelerate the construction of "smart city", comprehensively utilize

public resources, and further enhance the service level of social public utilities. Electricity utilization information acquisition system application fields are developed, relying on information collection system meter, terminal, communication channel and main station resources in provincial electric power company of State Grid Corporation of China electricity (Song Lei et al, 2004) (Jin Rongjiang et al, 2010), establish public utilities data acquisition platform, intensely collect ammeter, water meter, gas meter, heat meter data (the following are abbreviated the "four meters are one"), unified billing, unified paying, it can realize energy information resources sharing cross-industry, completely change public utilities management service mode (Xiong Hua, 2012). To improve the overall intelligent control and automatic management level in energy field.

2 CENTRALIZED DATA COLLECTION OF SYSTEM ARCHITECTURE

The centralized data collection platform architecture of public utilities is shown in figure 1, this architecture learn from electric power industry utilization and collection system to design, make full use of its collection terminal and channel resources (Yang Yongbiao et al, 2012) (Wang Jiye et al, 2015), and cover the various types of water, gas and heat table, complete the four tables for one and centralized data collection.

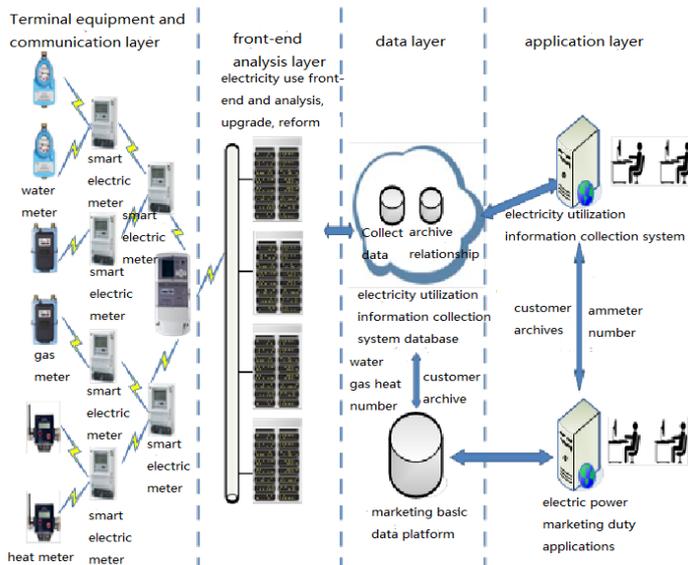


Fig.1 System Architecture of Data Collection

The whole architecture is divided into terminal equipment layer, network communication layer, front resolution layer, data layer, application layer five parts. Among them, the terminal equipment layer, water, electricity, gas, heat meter by communication module to link the upper smart meters or gathering module of concentrator, the collected data will

be uploaded to the front analysis layer of main station (Zhan Tongping, 2014); the front analysis layer makes the data for data analysis and uploading to data layer based on the water, electricity, gas, heat meter communication protocol; the data layer integrate water (Liu Bing et al, 2007) (Xu Kunyao et al, 2011), electricity, gas and heat data model through public utilities data platform, and form a integrative panoramic data model, through the public utilities platform for accessing real-time collecting data of four tables for one, the data platform and collecting static archives information and collecting information; The application layer calls data to display data and report query and other business functions (Cao Zhigang, 2013), meanwhile, the marketing business application implements customers' files and synchronization of ammeter number through interface, and complete unified accounting and payment of water, electricity, gas and heat.

3 CENTRALIZED DATA COLLECTION OF SYSTEM ARCHITECTURE

3.1 The Integrated Data Modeling Technology

Establishing water, electricity, gas, heat integrative panorama public resources data model is the basis of accomplishing the data concentration acquisition, the each industry respectively maintain private data model of their industry, the data model standard differences among industries are big, the data model can't share and exchange information. IEC61970 standard (Liu Haitao et al, 2008) (Wang Yiming, 2010) in the field of electric power is widely used, and the technology development of derivation, combination, checking of the model, it establishes the foundation for the energy industry and superior and the subordinate coordination model in industry. Since the electric power industry started earlier in the field of automated collection control, which have mature electric power equipment and model customer files model description standard, data model of public utilities platforms are expanded based on the electric power industry data model standard. Building integrated data model mainly includes model adaptation, model splicing, model validation, model dynamic analysis, model check, model release, eventually form panoramic data model that can support public utilities concentrated collection. The key nodes of model maintenance process of integrated data model as shown in Fig.2.

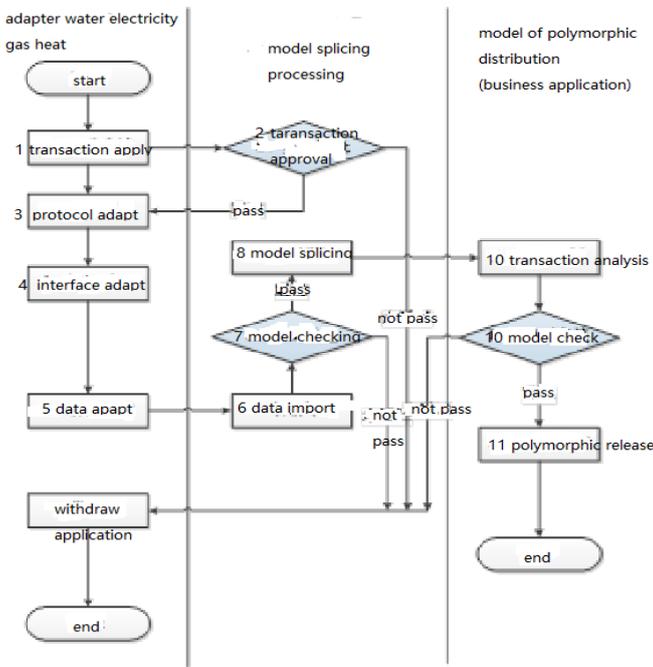


Fig.2 Integrated Data Modeling Map

3.1.1 The standardized data import based on adapter

The collecting platform of public utilities reuse the existing water, electricity, gas and heat data model, follow the principle "source and terminal maintenance, whole sharing" to construct. The electric power user model of the electric power industry used provincial centralized mode to maintain and administer, water, heat, gas user model are maintained and administered by local industry company, customer model provides the source and terminal in communication protocol, service interface, data format, there is a big difference. Heterogeneous systems facing data integration need to build the data model sharing standard, the collection platform of public utilities adopts IEC61970 standard which is widely used in the electric field to extend, form the common information model/component interface specification, and implement effective information integration and sharing.

Follow standard model sharing criterion, standards adapter are developed, the adapter aims software or services, which is oriented to heterogeneous systems and achieve information exchange and share standard data format conversion, communication protocol conversion or service interface conversion and so on. Adapters can combine with water, electricity, gas and heat industry system to distribute and deploy, which also can be combined with public utilities platform to centralized deploy. Adapter includes protocol adapter, interface adapter, data adapter. Protocol adapter is responsible for converting the TCP/IP, JDBC, Web services, JMS, and other heterogeneous communication protocols into standard communication protocol, and provide information exchange with information channel of integrated administration; The interface adapter is re-

sponsible for encapsulating message format, interface adapter encapsulation convert Verb (Verb), name (Noun), information source (Source), TimeStamp (TimeStamp), message ID (MessageID), and correlation ID (CorrelationID), AsyncReplyFlag (AsyncReplyFlag), and aiming at the coding and compression information of message content, and achieve message matching route, the data adapter uses the data dictionary mechanism formats to realize transfers between private form and data standard message, the data dictionary is based on the standard and faced model object' abstraction, abstract data object, correlation among objects, data object attribute, correlation between domain, the private data format and the standard model object are configured mapping relationship in the dictionary, through the data adapter to convert the data model to CIM and XML format model file that followed IEC61970 standard.

3.1.2 Integrative panorama data model stitching

The public utilities platform monitors transactional message of water, electricity gas, heat model, and get standard CIM XML model files from adapter layer, model file analysis and validation are completed by CIM file processor, model processor are analyzed CIM file based on data dictionary, analytic results takes model objects as a unit to store in the exclusive memory space. Custom data model validation libraries, model validation library are divided into error, warning type. Error type belongs to the basic semantics of data model, grammatical errors, alarm type cannot meet the requirement of the individual application, error type data model need to retreat the transactional application, the alarm type data model can continue to maintain process. Based on the data model library, integrated the model object stored in the memory, and completed whole and efficient checking of the model.

The model stitching is one of the key technologies that construct panoramic model of public utilities integrated. The panoramic data model of public utilities are divided into basic model and extended model, basic model is the default access model, the extended model is customized by the application layer, model reduction program automatically cut out redundant data model, ensure capacity of model minimized. The water, electricity, gas and heat are isolated; the model integration program is responsible for stitching the industry model, industry data model abstract the user object, the user object are abstracted by ID number, username, user address key attributes. System used the characteristics recognition technology based on user object, positioning water, electricity, gas and heat common user entity, support hand stitching of user objects that failed to identify matching users, after model stitching excess boundary equipment are cut off, guarantee the user object only, and register model bounda-

ry, facilitate boundary secondary stitching model change.

3.1.3 Model polymorphic application checking issued

Panoramic integrated data model need to support water, electricity, gas and heat four major business applications, model checking procedures provide transactional analysis and model verification, polymorphic distribution and other core functions. System through memory load transactional and online run model, and compare and analyze, form level transaction attribute analysis report; application decision-makers review model based on transaction analysis report, model checking support first instance and second instance multilevel checking mechanism; Maintenance model supports running state, future state, polymorphic integration maintenance, running state and future state can turn, polymorphic mechanism realizes model advanced maintenance, real-time release. When model released, it can dynamically generated water, electricity, gas and heat four panoramic application online model, there are not interference among data resources. Then, model integration maintenance is formed, dynamic split into several operating model. Polymorphic multi-applied model is released is shown in Fig.3.

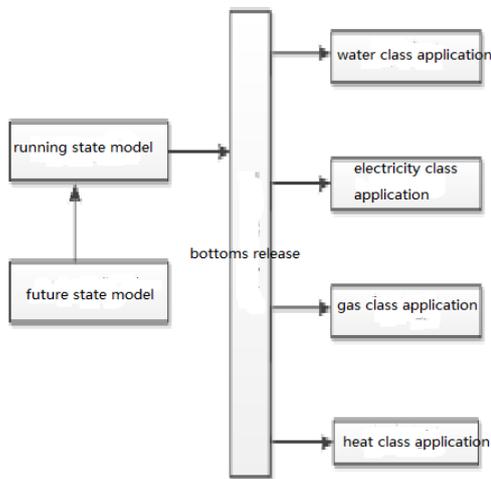


Fig.3 Structure of Multi Application Model

3.2 Resources Sharing of Communication and Collection Terminal

The public utilities centralized data acquisition platform take concentrator as boundary and divide into uplink and downlink channel. The uplink channel mainly includes wireless public network, 230 MHZ wireless private network, optical fiber private network and remote telecommunication technology. The downlink channel of smart ammeters is given priority to the carrier and RS485 communication technology; the communication technology that wa-

ter, gas and heat table downlink channel mainly adopted are the M-BUS bus, RS-485, micro-power wireless, wireless public network, power line carrier, etc. At present, the comparison and analysis advantages and disadvantages of these communication technologies are as follows:

Table 1. The comparative analysis table of communication technology

Communication technology	Advantage	Disadvantage
M-BUS bus	Wiring is simple, can supply power for meter, communication stability anti-interference ability is strong.	Need to wiring, may damage the residents' household facilities, communication efficiency is low.
RS-485	Data communication rate is high, the load quantity is big, and communication stable anti-interference ability is strong.	Need to wiring, may damage the Residents' household facilities, and must be equipped with external power supply.
Micro-power wireless	No wiring, no communication cost, flexible networking, transfer rate is higher.	Affected by the environment, the communication distance is short, must be equipped with external power supply or backup power supply.
Wireless public network	No wiring, without being limited by the distance, the communication rate is higher.	The high cost of equipment operation, can't give meter power supply, must be equipped with an external power supply.
Power line carrier	Relying on the power line, no wiring, power area management mode can be introduced.	Draw power lines to gas meter, it may bring security hidden danger.

3.2.1 Concentrated data collection adopts typical networking mode

In power collection system, except change user, transformer terminal unit connected to the concentrator by 485 other means, the rest of the majority of low-pressure household table is through the carrier module to connect the collector and concentrator. In public utilities centralized data acquisition platform, household as the unit, the installation position of water, gas and heat meter are generally more concentrated and not too far from ammeter. Combined with the above-mentioned advantages and disadvantages of several kinds of communication technology, under the premise that residents' household facilities are not destroyed, the following figure is recommend for the typical networking platform. Uplink channel and concentrator directly share and use uplink channel and concentrator of electricity utilization information collection system, water, gas, heat meter collecting data is transmitted from the concentrator to the gateway of front. In the downlink channel, water, gas and heat table can be directly communicated with the concentrator by micro-power wireless; and also can be communicated with energy

meter by carrier, it also can be communicated concentrator by micro-power; then also can be communicated with collector through micro-power wireless, again by the collector through carrier are connected to the concentrator. In addition, the downlink channel also has networking mode based on the M-BUS, RS-485, electric power carrier and above several communication technology network flexibly allocated, the principle is broadly similar, it does not mention in this paper.

power meter, collector are replaced into a dual mode module (i.e., carrier module and micro-power wireless module), finally, the gateway front, concentrator, collector, intelligent ammeter are upgraded software functions, the gateway front can correctly analyze upload and download message water, gas, heat meter, the concentrator, collector, four meter can accurately complete the related commands of centralized copy ammeter.

3.3 Distributed Collection and Processing Based on Multi-tier Architecture



Fig.4 Sharing Structure of Channel and Acquisition Terminal

As shown in Fig.4, the uplink channel and concentrator directly share and use uplink channel and concentrator of electricity utilization information collection system, the collected data of water, gas, and heat meter is transmitted from the concentrator to the front of gateway. In downlink channel, water, gas and heat table can be directly communicated with the concentrator by micro-power wireless; also can be communicated power meter with micro-power wireless and, also can be communicated with ammeter with concentrator by carrier; can be communicated with collector through micro-power wireless, and then the collector is connected to the concentrator through carrier. In addition, the downlink channel also also has networking mode based on the M-BUS, RS-485, electric power carrier and above several communication technology network flexibly allocated, the principle is broadly similar, it does not mention in this paper.

Based on Fig.4 pattern, in order to realize four tables for one and centralized data acquisition technology solutions, the concentrator, power meter and other equipment need to make the necessary modification. First, water, gas, heat table are changed into meter with micro-power wireless module, then the communication module concentrator, intelligent

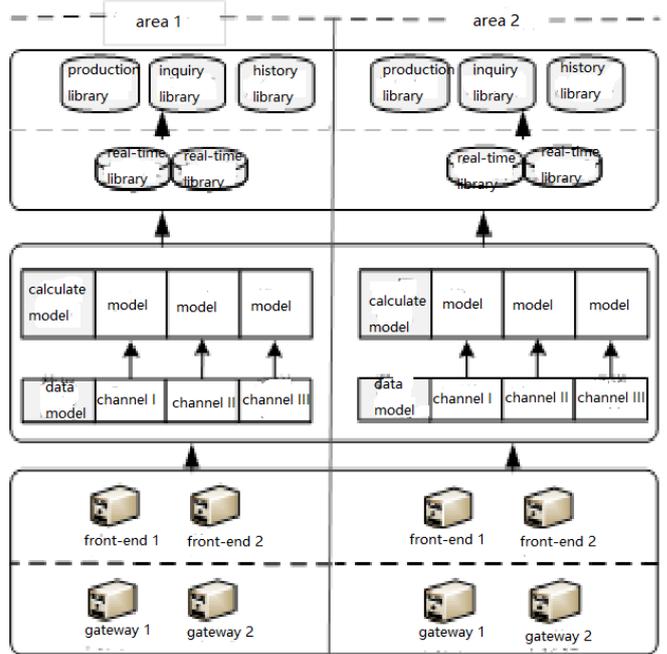


Fig.5 Multi-Tier Architecture of Distributed Processing

As power users' electricity utilization "complete collection, full coverage, full cost control" continued to promote, the number of customer profiles, terminal system access increasingly expanded, and power distribution, transport and supervision, dispatch, maintenance and other professionals are put forward high density data requirements on the electricity utilization information, forecasts utilization information collection data will be increased to 65 GB in medium province in future, the collected main station system retained data for 3 years at least, the data volume will reach 70 TB, additionally the data acquisition of water and gas hot industry, systematic main station will be faced new challenges in data collection processing and data storage. The collection platform of public utilities use the frontend features split on the architecture, the data bus of information flow, the data processing model based on exclusive channel, real-time database that support efficient storage, distributed data processing and storage technology realize the public utilities data efficiency, high frequency data collection. The dis-

tributed data collection structure of multi-tier architecture is shown in Fig.5.

3.3.1 *The split technology of front-end processor*

Front-end processor is divided into communication and collection front-end. Communication front-end is mainly responsible for link maintenance between the electricity utilization information collection system and the terminal; collection front-end is mainly responsible for analyzing and dealing with uploading message of terminal. This technology realizes collection terminal link maintenance and message analysis and decoupling, electricity utilization information collection master station can judge the required network resources and computing resources based on the current terminal access situation, when network resources turn up bottlenecks and expand communication front-end, computing resources turn up bottlenecks and expand collection front-end. Front-end processor splits communication front-end and collected front-end technology to solve two problems, one is to realize the longitudinal load of electricity utilization information collection; the second is for resource bottleneck category (network resources and computing resources) and pointedly expand hardware resources, the resources of upgrading hardware are minimal.

3.3.2 *The bus technology of data*

The distributed collection front-end are carried out message protocol analysis based on responsibility area, and release the analysis results to the data bus based on memory, and the data bus and distributed collection front-end matching, the data bus provides information push model to release subscription, it also provide processing mode of flow event, data bus form several data channels on the basis of business divisions, this channel is exclusive data channels based on the business, exclusive data channel can reduce the logic data capacity, it facilitates the rapid retrieval of information.

3.3.3 *The processing technology of data model*

Business exclusive data channel unit based on the data bus, abstract data calculation process and task dispatch model, when the exclusive data channel changes, real-time release data processing model and task dispatch model, data processing model based on exclusive data real-time processing data, and according to the need to start the task dispatch. Achieve efficient processing and order dispatch data.

3.3.4 *The storage technology of efficient data*

After data processing, the system converts event-based unstructured data into structured data and stored in the real-time library, real-time library provides efficient data access for system, avoid data backlog and lost that huge amounts of data in a short

time cannot be deposited in the relational database. Real-time library data provide periodic batch into historical library technology, realize the storage of historical data.

3.3.5 *The distributed technology based on responsible area*

Distributed data collection technology based on dynamic responsible area: communication front-end and collection front-end all adopt distributed construction mode, distributed component unit can be many cities, a city, many administrative regions, a region, according to the load pressure of communication front-end processor and collection front-end processor and the unit is dynamically adjust. So as to realize the lateral extension of electricity utilization information acquisition master station system.

4 APPLICATION PROSPECTS OF CENTRALIZED DATA COLLECTION

Water, electricity, gas, warm are four important energy industries on people's livelihood, involving thousands of households. The meter copying, accounting, charge, operation and other works also involve a lot of manpower and material resources. Relying on the existing electricity utilization information collection system master station and the marketing business application system, the centralized data collection technology is adopted, realize water, electricity, gas and heat four table data collection, storage, promoting public utilities data integrated copy, integrated settlement, integrated payment, integrated operations, it will greatly reduce the labor costs, improve service quality, realize the resource sharing, reduce overlapping investment. At the same time, it also will promote development of smart city; enhance the overall operations level of the public sector.

Four tables for one and the concentrated collection system can realize online monitoring of metering device and real-time collection of related important information of the users' water, gas, electricity and heat, it timely, completely and accurately provide basic data for other systems, it provides analysis, decision to each link in enterprise operation and management with data support, it provided information basis for realizing the intelligent two-way interactive service; it can also use the abnormal events handling mechanism that system provided, automatically record detailed information of abnormal event, timely trigger the management processing of abnormal event, fast and effectively locate abnormal location, shorten the abnormal processing time.

The electric power system reform that the power supply enterprise facing can through the unity of four tables collection system, prepare strategy for

the power system reform. Before electricity selling open, expand the terminal market share, preempt resources, make water, gas, heat companies rely on power supply enterprise, prevent other electricity companies to find water company in future; power supply enterprises can also use Internet + management thinking, through the unity of four tables system, can achieve customers' information resources, and give some key users with personalized energy saving, security energy utilization, and use the demand of side management energy and other value-added services, and provided a basis for the subsequent value-added business development.

5 CONCLUSION

The public utilities data facing concentrated collection technology is that a deepening application in electricity utilization collection system in the field of public utilities. State Grid Corporation has put the "the unity of four tables" data collection applications as an important measure in order to speed up the scientific development in the new situation. According to "SGC Marketing Department on accelerating the unity of four table collection application notice requirements, electric power company established the pilot promoting leadership group in a number of province, edit "the unity of four tables" work plan", issued the pilot construction plan; actively communicate and coordinate with the local government departments, water, gas and heat company; electricity utilization information collection master station are perfect and marketing system supporting function are upgraded, strive for the realization of centralized collection in public enterprise data.

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