

# Power System Data Management Design

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**Abstract**—In this paper, a definable scheme for grid management information and data management in power system automation is proposed, and a software technology framework and implementation method are established to provide an effective and flexible data management method for grid operation analysis and management. Power system data management method mainly organizes its storage and service by defining grid data application view. This method can extract application characteristic data for management and service for different applications, and ensure the data requirements of power system simulation analysis, calculation and management. At the same time, the information model and view definition method of the full data of power grid provide the basis for the full-time management of the whole data of power system.

**Keywords**—data manage; grid data view; data management framework; data management architecture

## I. POWER GRID DATA PROBLEMS AND MANAGEMENT PROPOSAL

The application of modern intelligent power grid management realizes the whole power grid data based on provinces or even large regions of the country. The intellectualization of power grid and the super-large-scale management of large-scale areas require the reform of data management technology of power grid regional management.

The management of power grid is mainly based on the regional management of power grid, such as power grid dispatching centers at all levels as the regional management unit of power grid, providing the management functions and purposes of different power grid construction units, and generating different data information of power grid, so as to complete the intelligent management of power grid and realize the requirements of stable and safe power supply of power grid.

For different purposes of power grid management, the grid data information needed is also different. For example, for power grid applications with advanced management purposes such as power grid dynamic simulation, on-line SCADA/EMS data, off-line data models and parameters of power grid dispatching automation are needed. Different purposes of power grid management, such as operation, dispatch and planning, depend on their data and information. It can be seen that any analysis of power grid management, its data sources and data use methods are staggered and complex.

Power grid data resources are highly complex due to the structure and composition of power grid and complex operation mechanism, its management system, region, type and other

factors, as well as the short-term effectiveness of responding to changes and application requirements.

For this reason, this paper proposes a technical scheme for the definition and management of large area power grid data management. In view of the current characteristics of power grid data and management, and aiming at the intellectualization and super-large-scale management of power grid, the technical design and deployment measures and methods of power grid data management and maintenance are proposed to effectively manage complex power grid data and provide high-quality applications for different power grid management purposes.

## II. TECHNICAL AND METHOD

### A. Power Grid Data and Management

Power grid management includes dispatching, planning and operation. Multi-source grid management functions generate multi-grid data, usually a set of related or similar views of power system data. There are a lot of overlaps and redundancies in these data, which make the data scale huge and increase the complexity and difficulty of management.

Therefore, how to realize the effective management of multi-source and multi-metadata in defining (large) regional scale power grid is the basis and urgent problem for the intelligent management of stable operation and large-scale operation of power system.

In order to manage complex data information of power grid, through conceptualization of the basic and management information of power grid and its components, a unified standard specification and structure description of power grid data information are defined, and the concept of full data information model of power grid is proposed and defined, which is mainly used for unified representation, unified storage and data management of power grid data. Management services.

And the concept of power system/grid data view is put forward, that is, grid area management is a set of grid data set established for specific applications of departments, which can be defined as power system or grid data view. The power grid data view is a subset of the time section extracted and defined in the full data and data model of the power grid based on the data of management application. For example, the planning data of a certain time is a view of the grid planning data of a specified time, so as to facilitate the data definition and extract the management service definition needed by the grid management.

The core idea of the power grid data management scheme is to manage the full data view of the power grid, that is, the collection and management of all information of the existing managed power grid data in the power grid area. By establishing its effective management, data extraction and service methods, Data view of regions of the "power grid" for any application can obtain.

Data management is a holographic view of power grids in the whole domain and process time domain, and it is a view of full data representation of power grids in time and space. It should include the power grid data sequence or time-varying layout defined by the full data model of the power grid.

After defining the application and management view and model of power grid data reasonably, according to the characteristics of data and power grid application, a flexible and effective data service and management method is established to provide basic rules and means for the utilization of power grid data.

Obviously, the main of power grid data management method is to define highly representable and achievable data model and management framework, reduce data size and complex redundancy relationship, and ensure data quality; define flexible and easy-to-implement methods to complete data definition.

The technical scheme will solve many problems in power network data management.

1) the power grid area management of the power grid data is highly efficient and efficient, and its data are managed and deployed on demand.

1. Power grid data of regional management is highly and efficiently shared, and is managed and deployed on demand.

2. On-demand generation of customized area and customized management data. It can define power grids in different areas, divide them from big to small, or merge them from small to large. It can generate power grids data views for different regions and different management purposes at any time and quickly according to application requirements.

3. Customized processing of power grid regional management data to achieve data source independence. By establishing rules and corresponding data service mechanism, the whole data view and management of power grid only focus on power grid data, without knowing its source and management area.

4. Customized processing of grid time data can realize the special management of grid area data with time and state definitions. Power grid data are divided into two categories: online and off-line. Generally, on-line data usually reflect the view information of power grid data with certain characteristics in a very short period of time; off-line data is usually a kind of view information of power grid data with a long span of time. By customizing the differences between them and the characteristics of full data view of power grid area data, customized processing can support the management requirements of power grid area data to full data view in all directions and all time domains.

## B. Technical Principles for Power Grid Data Management

The purpose of power grid data management is to enable all kinds of data to be effectively managed and to provide efficient data services for simulation analysis applications for various power grid management purposes and other power grid management application systems.

The data source and use of power grid are complex, including data from data acquisition unit (equipment) to dispatching center through different layers and management system processing, data from different applications and functions in management system, etc. All kinds of data have different data definitions and meanings, and they can be used for different applications.

Power grid data management is multi-objective, which requires the organic combination of reasonable technical methods and in-depth data processing and analysis methods. Generally, the following principles should be followed:

1. Establish the basic data model based on the demand of power grid data application. The minimal redundancy integrated data model set of power network monitoring data, simulation analysis and calculation data is achieved.

2. To build horizontal and vertical data models, which are complementary, added and mapped. Generally, the establishment of horizontal data model obeys the principle of data model complementarity, and establishes the mechanism of automatic transformation model. Longitudinal data obeys the principle of directly adding model and processing corresponding mapping relationship.

3. Model hierarchy. The core of power system data is the power network environment, that is, the static and dynamic information of power network topology and components. The information representation model of these data is stable and is the "core data model" of power grid data. The monitoring system data, generally corresponding to the dynamic information of the core data model, has the characteristics of time series. The monitoring system can establish a convenient data processing model as a data model of different levels and levels.

The data of simulation application and other management systems are additional data sets of data at specified time in the core of power grid. For example, power flow calculation is a set of analysis and calculation results based on specified power grid topology environment and equipment operation parameters. Horizontal data model is generally an extension of core data model.

4. Establishing model intelligent management mechanism. The data model defined by the system may be inconsistent with the data source. Establishing an automatic and transparent model data processing mechanism for data processing is an effective means to ensure the accuracy, efficiency and efficiency of model data.

## C. Technical Methods

Appropriate technical methods are needed for grid data management. Research on the main technical methods,

focusing on the description of software implementation. Include:

**Integrated model technology.** It mainly establishes a unified data model for all kinds of applications and management data in the scope of research, including representation, storage, operation, management, service definition and so on. The model management mechanism and method are established.

**Intelligent data management technology.** This paper mainly analyses and extracts data attribute characteristics, and establishes general management and service methods such as quality and consistency. Establish automatic and wizard templates for different types of data processing, automatic loading of data processing services, etc.

Intelligent data management is embodied in data storage, service and other levels and aspects.

### III. DATA MANAGEMENT FRAMEWORK DEFINITION AND TECHNOLOGY IMPLEMENTATION METHOD

Through the establishment of data management framework and technical framework of power grid area data and the implementation of software system, the definable management of all data of customizable area, management service and management purpose of power grid area is completed.

Definable meanings include the definition of power grid area, management definable and data visualization for management purposes.

#### A. Data Management Framework

The core method of data management is the management framework of power grid data includes the definition of power grid information model, data management specifications and power grid data view specifications, which provides a unified format for power grid data representation, data storage, data interaction and data service. These definitions may be based on relevant international standards, national standards or practical specifications.

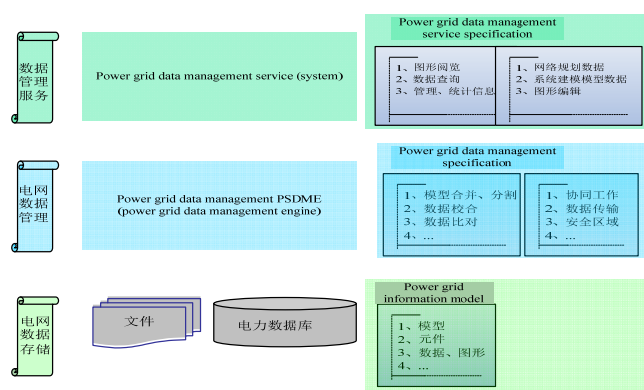


FIGURE 1. DEFINITION, REPRESENTATION AND STORAGE OF POWER GRID DATA AND MANAGEMENT SPECIFICATIONS

As shown in the figure, the power grid information model is a unified and standardized definition of the [database/file]

storage model that can manage the full data information of the power grid, realizing the unified specification definition and description of the power grid data resources. Based on this, the service interface definition of maintenance and management of power grid regional data and the unified storage and management of power grid data are realized. The grid information model supports current standards and specifications as well as practical guidance documents. For example, IEC61970-CIM and E-Style.

The specification of power grid data view is the process and description information of power grid data view defined for setting the goal of power grid area management and setting the goal of power grid area management. Unified description is to establish uniform specification and standard of service based on data view, such as establishing mode data view, stability analysis grid data view, and process description with uniform data view specification. Data definitions for grid management services.

Data service, through the distributed power grid management data maintenance services in local areas, completes the unified management requirements of data in large areas; data management of large area power grid mainly through the unified storage of complete time-domain data management established by regions. And a powerful data service function of the new power grid data view is defined.

Power grid data management is based on the distributed management area through the management of power grid area data, and is realized through the distributed data maintenance service mechanism defined by the technical framework. That is to achieve large regional data unified requirements, while completing regional autonomy management needs.

The data management framework meets the needs of distribution, deployment, maintenance, centralized storage and unified management of power grid data by establishing an applicable software system.

#### B. Software Technology Implementation Framework

Based on W/S and C/S, the functional structure framework of the software system is established, and the flexible and configurable support for the grid data management framework is achieved through the establishment of grid data management services and appropriate service deployment.

**Grid Data Management Service Specification:** Unified definition of grid data management service interface, unified definition of grid information model and unified definition of grid data management specifications, facilitate the immediate integration of data management services and data management operations.

The software technology of data management includes mass data storage technology for UHV power grid. And service and rule-based data management services are considered to support the transparency of power grid data sources and the need for on-demand integration.

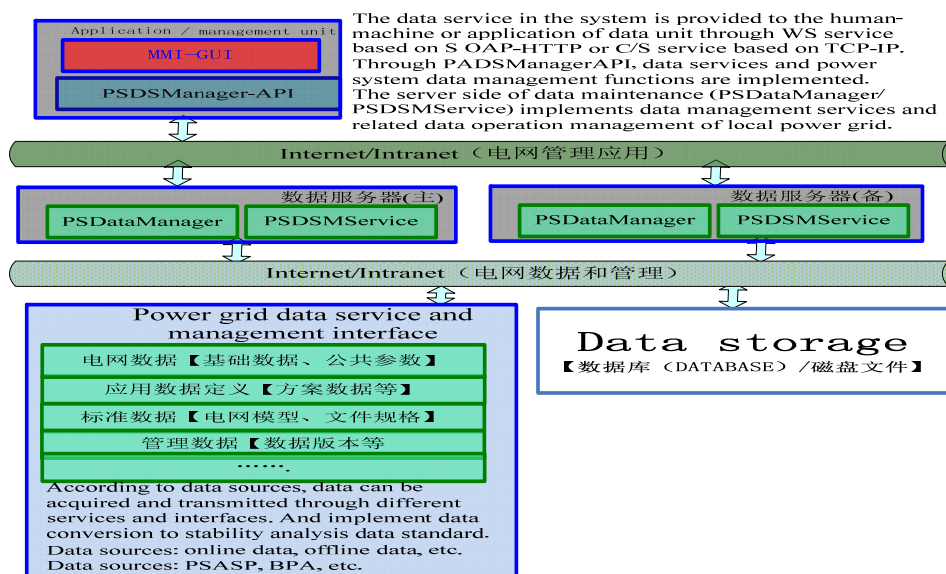


FIGURE II. POWER GRID DATA AND MANAGEMENT SYSTEM STRUCTURE

#### IV. REALIZATION OF SOFTWARE OF TECHNICAL SCHEME

To describe the implementation process of definable power grid full data management technology by establishing the data management framework of power grid regional data in the operation system "XXXX Intelligent Cooperative System".

##### A. Define Data Management Framework

1. Power grid information model: compatible with data structure defined by PSASP 6.2, describing power grid parameter information, etc., and using IEC61970-CIM model to compensate for errors.

2. Grid Data Management Specification: Definition Specification Based on Voltage Level Data Management Specification, Management and Access Right Matching.

3. Power grid data view specification: define planning data, PSASP computing related data view management.

4. Distributed autonomous management: Data management services are deployed in line with power grid regional management, data view management is managed locally according to unique management, and centralized data service management rules required by unified management are unified.

5. Application data services: deploy application data management service requests according to the application of management purposes. Including tidal current application data.

##### B. Software Technology Framework

1. Software system technical structure standard W/S+C/S; W/S is the service client deployment and data unified management service center service structure for power grid area management. C/S is a local management service mechanism in the unified data management center and the client side of power grid area management.

2. Grid Data Management Service Specification: The standard WSDL is adopted to define the grid data service interface, and the service space is divided and defined according to the management function class.

3. Big data storage: Oracle database and distributed storage file system.

##### C. Operation System Construction

1. Definition of basic norms. It includes power grid data information model, power grid data management specification and data view specification definition.

2. Establish data storage system. It includes the establishment of Oracle database and the directory of distributed file system, the definition of file structure, the division of privileges and settings, etc. Including PSDB - power system database, PSFS - power system distributed file storage system.

3. Establishing software system, mainly including PSDS-Power System Data Service (Service Program); PSDS4XXX-CEND-Power System XXXX Data Service Client Component; PSDM-Data Management (Management Database, Distributed File System).

##### D. Frame Characteristics

The data management system based on the software framework has good compatibility and diversity in data diversity and data transmission support.

In the data transmission part of the data management system construction, it supports the technology realization of C/S and W/S separately and in combination; at the same time, it supports various protocols and mechanisms including SOAP, TCP/IP, UDP, IPC and so on for different technology implementation; it also supports various open source communication components.



Data type specifications, data management and service requirements in the construction of data management system can be defined by data structure described in simple language and description of data management and operation requirements (such as IDD and IDL).

#### E. Power Grid Sand Table Data Management System

Power grid sand table simulation system is based on power system analysis and calculation. For setting research goals, the deduction process and results of setting goals based on basic power grid environment are presented through sand table adjustment control and visual simulation. Among them, the management of large data in power grid is the core foundation of power grid sand table deduction and the performance guarantee of simulating and deducing power system characteristics.

#### V. CONCLUSION

The defined power grid data management scheme described in this paper can manage the data of different customized areas and different management data in a unified way. At the same time, the power grid application management data view for different management purposes can achieve the principles of unified management of power grid data, matching and management of distributed maintenance and basic power grid distribution structure. Consistent management.

This technical scheme is implemented in the intelligent cooperative management system of power grid, sand table simulation system of power grid, on-line simulation technology research of large power grid and other systems and research topics. It can also customize efficient power grid data management for different scale power grid application systems.

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#### REFERENCES

- [1] DAMA Data Management Knowledge System Guide, DAMA International, translated by Ma Huan, published by Tsinghua University Press
- [2] Data engineering theory and technology, Dai Jianwei et al., National Defense Industry Press.
- [3] Large-scale Data Mining and Distributed Processing in Big Data Interconnection, Anand Rajaraman et al., translated by Wang Bin, published by People's Posts and Telecommunications Publishing House
- [4] Soap version 1.2 [S] <http://www.w3.org/TR/2007/REC-soap12-part1-20070427/>
- [5] Robert van Engelen. gSOAP 2.8.13 User Guide [J]. GENIVIA INC, GENIVIA
- [6] Zhonghua. Guo , Design of Power Grid Data Management Plan [R]. Beijing: China Electric Power Research Institute, 2012.
- [7] Power Grid Operation Data Exchange Specification Q / GDW 216 - 2008
- [8] Power System Data Markup Language -- E language specification Q / GDW 215 - 2008
- [9] Power System Safety Guidelines and Standards Compilation (Second Edition) Power System Research Institute
- [10] Jianhua Li, Cao Lu, Zhuangkan Qin. Research on East China Power Grid Computing Unified Data Management Platform [J]. East China Power, 2013, 41 (1): 69-72
- [11] Mao Li, Hong Jia, Yanming Li and others. New Data Model for Cloud Data Management [J]. Computer Engineering and Design, 2012, 33 (10): 3870-3876
- [12] Fang Li, Yong Chen, Songshu Zhangsushu, et al. [J]. Research on Related Technology of Large Power Grid Unified Database Construction [J]. Power grid technology, 2013, 37 (2): 417-424
- [13] Hongwei Bai, Zhiwei Ma, Yaqi Song. Processing of Smart Grid Status Monitoring Data Based on Cloud Computing [J]. East China Power, 2011, 39 (9): 1485-1488
- [14] Baoyan Song , Hongmei Zhang, Yan Wang and others. Data Storage Methods Supporting Large-scale Smart Grid [J]. Computer applications, 2012, 32 (9): 2496-2499, 2537
- [15] Dewen Wang. Power Data Center Infrastructure and Key Technologies Based on Cloud Computing [J]. Power System Automation, 2012, 36 (11): 67-71, 107
- [16] Jie Ding, Houwei Xi, Haiyun Han, etc. Data-intensive Cloud Storage Strategy for Smart Grid [J]. Power system automation, 2012, 36 (12): 66-70, 100
- [17] Hongyin Chen, Subin Bo, Weidong Li, et al. Research and Application of Global Grid Resource Aggregation Architecture [J]. Power grid technology, 2012, 36 (2): 35-42
- [18] Yan Chen, Ruochen Song. Design and Implementation of Data-level Disaster Recovery System for Power Grid Enterprises [J]. East China Power, 2011, 39(10): 1694-1696
- [19] Yuezhong Tang, Qianfu Ruan, Jinzhang Gao, etc. Development of Integrated Data Platform for Power Grid Enterprises [J]. Power Grid Technology, 2009, 17:37-43