A Data Integration Platform Research of Power Grid Whole Life Management Based on BIM

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***Abstract*—Power grid is a complicated and huge system, many links are involved during its life-cycle, and serious information exchange and sharing problems can be found between these links, they restrict the level of power grid's informatization construction. With the presentation of building information modeling (BIM) and the application of IFC standard, the research for building different life cycle stages of information exchange and sharing is strongly pushed forward as well as gained good results. The successful application of BIM in construction business provides great chance for grid whole life data information integration and sharing. After intensively studying every link's business and data characteristics of power grid, cooperated with the BIM theory, this paper comes up with a method that applies BIM theory into power system data integration and sharing, with an electric power data integration platform construction scheme based on BIM, by which grid full life cycle of data integration and sharing problem can be successfully solved.**

Keywords-BIM; power grid; data integration; sharing, whole life

I. INTRODUCTION

Power grid concerns the national economy lifelines, to ensure its safety and validity, our country is putting more and more efforts into its development, for example, more than 450 hundred million was pouring into power grid construction during the "eleventh five years" plan in one province, in addition to some necessary maintenance and technical improvement expenses, the average cost will be up to hundreds million. However, power grid corporations are facing serious business problems now, on the one hand, coal's price is under a steady rise, leading to the rising cost of generating electricity, while the price is supervised by the government, there is little chance left to gain profit. On the other hand, with the expansion and deprecation of the company, maintenance cost is also increasing. Therefore, it becomes a burning question to manage a whole life intensive control of power grid, including planning, reconnaissance, design, manufacturing, construction, operation, maintenance and marketing. And all these efforts are aiming at reducing each link's production cost, increasing investment benefit, and strengthening the power grid ability of disaster prevention and mitigation.

In order to accomplish a whole life control, information data such as power network planning, network survey, power grid design, power grid construction and power grid operation, scheduling trend, production operation and maintenance, electric energy measurement is necessarily needed, this data is multi-source heterogeneous, involving multiple department's information system, with the characteristics that geographical position, network structure and the data type are not identical. Information resource establishes its own system, it has poor timeliness, difficult to share or adapt to the requirements of global analysis and decision, so we have to organically integrate the isolated data, so as to lay a complete and unified data base for the whole life grid intensive control.

BIM is crowned as the trigger of the second revolution of construction design field. It's targeted at radically solve the information fault between different stage application systems, such as project planning, design, construction and maintenance management, etc. To realize the whole process of project information management or even building life-cycle management (known as BLM).With the deepening research into BIM at home and abroad, construction engineering life-cycle management concept of BIM gains fruitful results in the construction area. Mean while, the launching of "Architectural design and construction integration information sharing technology research" and the "eleventh five years" plan makes the research into BIM and its responsible data integrate platform become gradually mature. So we have the confidence to apply BIM into grid whole life management just like it is applied to construction area, based on the successful experience to promote grid whole life intensive management process. On the basis of

studying BIM and data integration platform construction experience, the comparison between grid whole life management and construction area, this paper suggests it is possible to apply BIM theory into grid whole life management, and build a grid data integrate platform based on the BIM thoughts.

II. BIM APPLICATION CHARACTER

The definition of BIM given by The American national standards institute of technology is: BIM is a engineer data model on the ground of three dimension digital technology, integrating construction project related information together, it is the digital presentation of project facilities entity and functional characteristics. A perfect information model can connect the data, processes and resources of life period in different phase of a construction project, also can draw a perfect description to the given engineering object, can be used by the project's participants. BIM owns single data resource, it can solve the consistency problem between distributed, heterogeneous engineering data and the global shared matter, it also supports dynamic engineering information creation, management and sharing of the project's life-cycle.

Generally speaking, BIM has characters as follows:

(1)digital

(2)Spatialz3D

(3)Measurable: quantifiable， dimension-able， and query-able

(4)Comprehensive: encapsulating and communicating design intent ， building Performance ， constructability，and include sequential and financial aspects of means and methods):

(5)Accessible: to the entire AEC/owner team through an interoperable and intuitive interface

(6)Durable: usable through all phases of a facility's life

To put it in a simple way, BIM is a visualization model that faces the whole project and the whole process, not only does it adapts to the design stage of construction, but also to the construction stage and the maintenance and management phase. Compared to construction, power grid regulation is more complicated and more links involved, but they also have some similar points, for example, the same requirements, here is the comparison:

① Construction engineering comprises planning, design, construction and operation, the same goes to power grid regulation, but it's more complex, and there are serious problems, such as information asymmetry.

② There might be conflicts between different links of construction engineering, including time and space conflicts; power grid management also has some conflicts, they both need unified coordination means and methods.

③ Every link of construction needs mass visual representation and analysis, to intuitively control the whole process. Power grid regulation also needs multi-dimension visualization.

④ During the planning, design and construction stage, both construction engineering and power grid regulation need to draw lots of paintings.

⑤ Construction engineering requires that BIM can be used during every stage, similarity; power grid regulation needs a persistent information model to ensure whole life persistent management applications.

Based on the analysis above, we can tell there are similarities between construction engineering and power grid regulation, just like CAD can be applied to power grid management; BIM can do the same job. So what BIM means in this paper is apply itself to power grid regulation, realizing grid intuition, and efficient, visual management.

III. POWER GRID BIM BASIC CONFIGURATION

The process of power grid regulation is highly complicated and huge, many professions, departments, and corporations are included, such as owner, planning, design, construction, operation, maintenance, marketing, the data is collected from all directions, in addition to various format, during different stages, and application requirements are not the same. So the key technical problem to build a power grid BIM is to solve mass data storage and distribution of heterogeneous data sharing.

To solve the problem, first we have to draw a general subject field division of the process, according to power grid planning, design, construction, operation, maintenance, marketing; we divided them into following process:

TABLE I. MAIN THEME DOMAIN DIVISION IN GRID MANAGEMENT PROCESS

Subject field	description
planning	Describe the production and operation of enterprises in the process of the planning information，including new substation, basic line information and The project of electricity, load forecasting.
design	Describe the design information for the new project, including new substation internal structure, external connection, and power supply line to, basic structure.
construction	Describe construction information for the new project, including the construction unit, the contractor information, supplier information, construction schedule information, assets input information, quality supervision and information.
operation	Describe power grid dispatching load information, such as grid electricity, power grid scheduling information, grid tide, substation access, load forecasting warning
maintenance	Describe enterprise's daily equipment assets management and maintenance information, including equipment parameter information maintenance, tour information, maintenance information, defect information, hidden information.

Subject field	description
marketing	Describe the enterprise's electricity marketing information, including high endanger and important customer information, electric power demand information, quantity forecast information, price information, meter reading information.

According to the analysis above, this paper comes up with a power grid BIM basic configuration. The basic thought is following the grid construction progress and needs creates different BIM at different stages, that is, from project planning to design, construction, operation, maintenance, marketing etc, according to their requirements to build the corresponding son information model. These models can endogenesis evolving, by collecting data, expanding and integrating from the upper level to create the current phase model, or aiming at a special application integration model data, to generate a son information model. Power grid BIM basic configuration is a network structure system which comprises data layer, model layer and application layer. As it's shown in fig1:

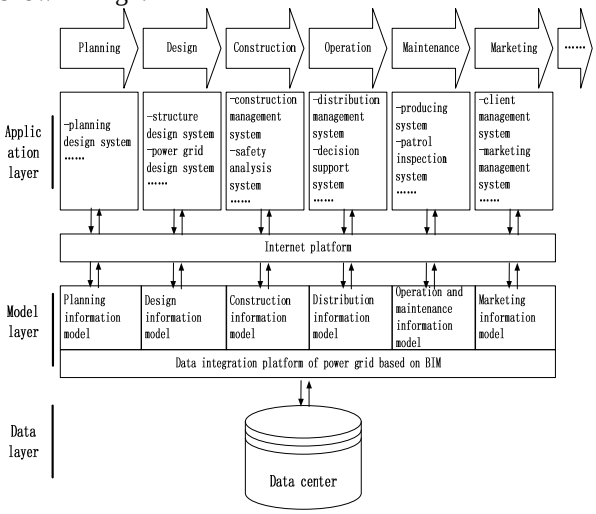

Figure 1. The power grid BIM basic configuration

(l) Data layer: On the ground of the mentioned grid main theme domain analysis, data layer is a data center build on the basis of data warehouse and data mining technology, to store every theme domain's data information. The data center combines real-time database with relational database, the storage mechanism also combines cross table with longitudinal table, to ensure the efficiency of read and storage. The way builds the database should be subject-oriented, integrated, variable, real-time, and fine grain size, also it should be capable of extracting, transforming and loading data; be able to increase, query, modify, delete, directly facing the front application; Support enterprise instant on-line analytical processing(OLAP), satisfying short decision analysis.

(2)Model layer: it is a corresponding son information layer builds on a power grid BIM database, aiming at every stages and applications during the whole life of power grid, realizing BIM model data reading, preservation, extraction, integration, validation and 3 d display. These models can be facing stage level planning information model, design information model, construction information model, scheduling information model, operation and maintenance information model and marketing information model, or a son information model according to an application subject, such as construction cost information model, construction safety information model, customer management information model.

(3)Application layer: by using the operating mode that network technology supports project's each party distribution, upon the corresponding phase information model or application son information model, getting the required model data, it supports based on BIM technology of all kinds of application system application and data sharing. In this BIM configuration, the building of power grid BIM actually equals to power to the whole life period engineering data accumulation, expansion, integration and application process. Pointing for application or stage to create son information model, finds a plausible way to realize BIM and grid BIM data integration platform and grid BIM database and its corresponding data storage, tracking and expansion mechanism, efficiently solving mass data storage and distribution of heterogeneous data consistent, coordination and sharing problems.

IV. POWER GRID DATA INTEGRATED PLATFORM BASED ON BIM

A power grid data integration platform based on BIM, mainly composes by data interaction and conversion, application logic and data storage three modules.

Data interaction and conversion: because standard file can read and write the data of national standard data exchange file, and compatible with national standard application software data interaction, we can realize information model of import and export. As for non standard file or local standards, custom standard data, through data conversion interface, we can also realize information sharing and exchange.

Application logic: it comprises:1)management of user's authorities, it provides different operating competence and user management for different project participants, for instance, grid design personnel can create, modify, side besides, check the limits of component model, while field engineers only have the checking right. 2) Creating, deleting and modifying data, it means operations such as create, delete and modify BIM data. 3) Data extraction and integration, the data in BIM's database can be extracted in different ways by various customers, then they are integrated according to the given application theme, finally to build a new son information model. 4) Data storage and merge, it means storing the extracted and integrated data into BIM database, the system will automatically merge and organize them. 5) Data change notification, if the read only data extracted by administrator is changed by others, the system

will send a notice to the administrator, informing him of the changed data.

Data storage module, by using the database access device, we can easily get access to the database. Currently, the BIM data integration platform can do the following jobs: model data reading, preservation, extraction, integration and validation. It can also support applications like power grid planning, design, construction, operation, maintenance, marketing if they are based on BIM technology, realizing the whole life-cycle information sharing of power grid.

V. CONCLUSION

BIM is crowned as the trigger of the second revolution of construction design field. It promotes the research of information sharing and exchange during different stages facing to construction. According to grid life-cycle management of each link and information characteristics, this paper combines building information model BIM concept with power grid management, and comes up with power grid BIM configuration, by creating son information models that either adapt to different stages or facing up to the requirements, and then expand it into for power grid life-cycle management of the whole life cycle information model, this lies a possible path for the application of BIM. The power grid data integration platform based on BIM establishes a good power grid BIM data storage, tracking and expansion mechanism, efficiently solves mass data storage and distribution of heterogeneous data consistent, coordination and sharing problem, also realizes each stage between application of data integration, sharing and exchange such as power grid planning, design, construction, operation, maintenance, marketing, etc, laid the foundation for the realization of the power grid based on BIM whole life life-cycle management.

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