Three Dimensional Information Sharing Platform of Power Transmission and Transformation Based on Grid Information Model (GIM)

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Abstract. Grid information model (GIM) is a technical standard formulated by State Grid Corporation of China to meet the needs of three-dimensional design of power transmission and transformation projects [1]. According to the characteristics of GIM data, this paper studies the design of distributed computing technology and service architecture to realize the online analysis and optimization of GIM data, so as to improve the efficiency and performance of GIM data analysis. Based on WEBGL technology, with the help of 3D tiles' LOD ability and the openness of format, a 3D information sharing platform for power transmission and transformation is built to realize the efficient and smooth loading, display and sharing of GIM 3D data on the web.

1. Introduction
At present, from the perspective of information technology and engineering technology, State Grid has systematically analyzed the application of key points and digital technology in each stage of power transmission and transformation engineering informatization, and put forward the concept of grid information model (GIM). Based on the geographic information system (GIS), GIM digitizes the elements of power grid, integrates the information of each element in the whole life cycle with the information model as the carrier, and realizes the efficient, accurate and comprehensive application of information [2].

In the 20 years of the development of 3D GIS software, the initial 3D GIS software is local coordinate system small scene. In 2005, Google Earth was officially released to promote the development of 3D GIS display from small scenes to spherical scenes. In 2009, with the development of two-dimensional and three-dimensional integration technology, GIS manufacturers launched two-dimensional and three-dimensional integration platform software respectively. In 2014, the wide application of tilt photography automatic modeling technology reduced the acquisition cost of 3D data, while osgb 3D tile technology also promoted the development of 3D GIS technology. In the following years, the wide application of BIM and GIS promoted the three-dimensional GIS from macro to micro. In terms of new IT technologies, WebGL, AR / VR, distributed computing and other technologies are also applied to 3D GIS technology, which also promotes the development of 3D GIS technology. GIM
and GIS is an important direction of the development of three-dimensional GIS technology of power grid and the technical basis of information sharing of smart grid.

2. GIM online resolution service

In order to improve the loading efficiency of 3D model in Web 3D platform, the hierarchical loading mechanism of 3D model based on cesium 3D tiles technology is used. Using GIM parsing service, GIM data is transformed into a unique slice format composed of configuration files and tiles of different levels. The pyramid of GIM three-dimensional model is constructed in advance, and the pyramid model is loaded in different levels and blocks in the browser. Its display effect and loading efficiency have been significantly optimized. To some extent, it overcomes the performance bottleneck that hinders the GIM 3D model from loading and displaying efficiently and smoothly on the web 3D platform.

The process of GIM analysis is to extract structured data and unstructured 3D model data from GIM files, and keep the relationship between structured data and unstructured 3D model data. The structured data is stored in the PG database for easy retrieval and query. The unstructured 3D model data is transformed and sliced to generate cesium 3D tiles data. Using cesium3d tiles for data organization and multi tree scheduling can reduce the bandwidth occupation of 3D model in network transmission, improve rendering speed, and realize smooth and smooth switching of GIM 3D model in different levels of display.

Unstructured 3D model data is based on the characteristics of Gim data, and automatically sets different granularity (such as grid block for civil engineering, object block for electrical equipment), error ratio, reduction ratio, block domain value, block strategy, triangular mesh reduction, display effect, etc. Through the draco compression algorithm to compress the vertices, reduce the hard disk storage and data transmission time of the triangle network at the same time. Using crn texture compression algorithm to reduce the consumption of texture on display memory, these data steps are changed into processing service module. The processing service module automatically composes the whole processing service according to the characteristics of Gim data, thus avoiding many times of I/O and improving the capability of GIM automatic parsing.

The efficiency of single processing service is still very low in large-scale GIM data analysis. We will transform single service into distributed processing service. With the help of the load balance of F5 and nginx, we can realize multi machine cluster distributed computing to improve the efficiency of GIM automatic analysis. Considering the large amount of disk space occupied by the 3dtiles data generated by the GIM model, there is a risk that if there are many engineering tasks uploaded, the disk space will be insufficient and the task conversion will fail or even the disk will be damaged. So the system disk early warning function is created. When the user creates the task, the user needs to be warned before submitting the task if the disk occupied size exceeds the maximum threshold set by the system. When a single task starts parsing, the parsing thread stops and a new disk warning record is added if the disk footprint exceeds the maximum threshold set by the system. At present, GIM online analysis service has been online in State Grid headquarters, greatly reducing the workload of operation and maintenance, and achieving good application results.

3. Three dimensional information sharing platform for power transmission and transformation

In the past decade, 3D service has been a private format of a certain manufacturer. If you want to build such a 3D platform, you basically need to bind the products of this manufacturer. At present, the three-dimensional GIS platforms used by different provinces and networks of State Grid are different. The data such as image, terrain and vector can already be shared. The data such as point cloud data, artificial model, tilt photography, BIM and GIM are all converted into the private format of the manufacturer, and cannot be shared. With the emergence of cesium 3D tiles open format, we also have a foundation in open sharing. Point cloud data, artificial models, tilt photography, BIM, GIM and other data can be converted into cesium 3D tiles. The open-source S3M of hypergraph also refers to the "spatial 3D model data format" standard formulated by cesium 3D tiles. 3D tiles and S3M of
hypergraph can realize mutual transformation, providing an open 3D format standard for data sharing between different 3D platforms.

GIM online analysis service has realized sharing at the data processing level. Processing unstructured 3D model data of GIM into cesium 3D tiles. Based on cesium 3D tiles, through real-time coordinate transformation, cross domain processing and other technologies, with the help of F5 and nginx to achieve load balancing, a power transmission and transformation engineering information sharing platform is built to meet the concurrent needs of large users. Realize 3D data service publishing and web 3D front-end display, share 3D data service externally, provide 3D service interface and call examples.

In order to improve the display efficiency of the three-dimensional web front-end of the information sharing platform for power transmission and transformation projects, the performance of the front-end is optimized, mainly including the cache mechanism, scheduling strategy and memory management. The R-tree index is used to support dynamic data addition and removal. In order to save network overhead and improve the data interaction ability to a certain extent, the front-end cache is used, that is, once the data is loaded, the resources occupied by it are not released, but only the data rendering is controlled. In order to reduce the volume of solid data to be processed in the rendering cycle, a fast index and an overall description of the data set are added to the batch model loading, and finally the efficiency of 3D model loading is improved. Cesium's 3D tiles use hierarchical details (HLOD) to adaptively load and optimize 3D models. By increasing the skip level of detail, the load time and memory consumption are reduced by about 30-50%, and the performance impact is smaller when loading, and there is no performance difference in the stable state when there is no tile loading.

![Fig1.Before optimization](image-url)
Fig2. After optimization

The practice in State Grid headquarters and Fujian pilot proves that cesium 3D tiles, after online analytical processing by GIM, has certain data sharing ability by publishing 3D data service through transmission and transformation engineering information sharing platform. At the same time, through targeted performance optimization to achieve zero client efficient and smooth display in the web 3D front-end, to meet the requirements of GIM 3D data visualization. Through the construction of data service and application service cluster, the large concurrent use requirements of large users can be realized.

4. Outlook and summary

Through GIM online analysis service, the unified processing of GIM data can be realized, and the unified processing of GIM data within the national network can greatly reduce the subsequent operation and maintenance workload. With the help of cesium 3D tiles open format, reference to the S3M development process of open-source hypergraph, combined with the characteristics of GIM data, develop an open 3D data standard for grid 3D application, form a 3D data sharing format with independent intellectual property rights, meet the requirements of State Grid headquarters and provincial 3D platform data sharing, and lay the foundation for the realization of national grid 3D one map.

On this basis, make full use of these design results to study and establish a general GIM and open 3D data sharing format, and promote the information construction and information sharing in the whole process of power transmission and transformation project [5]. At the same time, further research and application of Internet of things technology will be strengthened, application platforms such as 3D digital review, 3D simulation construction, visual construction management, visual material procurement and supply management, online monitoring and visual management will be built, data flow and business integration of power grid companies will be promoted, and conditions will be created for the construction of power grid digital twin system.

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