Research and development of "Internet + training" collaborative simulation platform

Jin Wang¹, Jie Li², Yi Kang¹, Ping Wu², and Aichun Sun³, *

¹State Grid Gansu Electric Power Company, 730033 Chenguan District Lanzhou, China
²Gansu Power Training Center of State Grid Gansu Electric Power Company, 730033 Chenguan District Lanzhou, China
³Beijing Kedong Electric Control System Co. Ltd, 100192 Haidian District Beijing, China

*Corresponding author: sunaichun@sgepri.sgcc.com.cn

Abstract. This article introduces a development method of "Internet + training" collaborative simulation platform. It explains in detail how to make full use of Internet technology to bring convenience to the development of power system simulation training platform, and to solve the problem of coordination of simulation calculation. The method can effectively use the computer resources of the training system, avoid the waste of resources of the training system on the simulation computing platform, and reduce the investment in hardware equipment. Finally, this article verifies the feasibility of the development method proposed in the article through a practical case.

1. Introduction
In the context of the "Internet +" era, the rapid development and application of information technologies such as cloud-based mobile and artificial intelligence have provided new ideas for power system simulation training. The rigid traditional training method of "classroom + blackboard" is replaced by a new training method based on Internet technology that is networked, graphical, and real-time interactive. In particular, the combination of the "Internet + training" training mode and power system simulation technology can provide students with intuitive, dynamic and timely presentation of learning and operating effects, which greatly improves learning efficiency.

However, the introduction of "Internet + training" also brings new technical challenges to the research and development of simulation training systems. The "Internet + training" system actually provides a complete simulation training environment that can be operated independently for each student. In order to ensure the learning effect of each student, the computing power of the simulation platform of the "Internet + Training" system increases linearly with the increase in the number of online learning students. Secondly, "Internet + training" system teaching-related data, such as power grid models, teaching examples, evaluation methods, etc. must be synchronized and consistent for each online student; finally, "Internet + training" introduces a new teaching model, such as "students watching", Teaching practice methods such as "multi-person collaboration" require that the simulation results be visible not only locally to the students, but also to other relevant online students and teachers.
2. System architecture design
The training system adopts hierarchical, componentized and service-oriented (SOA) architecture ideas to establish a multi-functional level system architecture of the platform. Through in-depth study of the architecture of each functional sub-layer, an open technical architecture of the simulation platform is proposed. The "Internet + training" system simulation platform is divided into network platform layer, basic function layer, smart function layer, and user application layer. The overall structure is shown in Figure (1). The network platform layer includes database and related basic services, and basic function layer. Including theoretical knowledge learning, network examination, training management and user query services for scheduling, monitoring, and operation. The intelligent function layer includes learning behavior collection, adaptive learning and knowledge-based gamification simulation learning, and the user application layer includes IE browsing and computer.

![Diagram](image_url)

Figure 1. The overall architecture of the "Internet + training" simulation system.

3. Co-simulation platform design
The collaborative simulation platform focuses on the following three aspects to solve the existing technical problems and better serve the "Internet + training" system

3.1. Local/Remote dynamic switching simulation system
The system needs to prepare enough simulation computing capabilities for the students who are online at the same time, and these simulation computing capabilities can only be idle during non-training time, resulting in a waste of resources. Due to network security factors and system maintenance costs, it is impossible to rent computing power on the Internet at any time on demand. Therefore, we used the training students' local computer computing power as a supplement to the simulation system's computing power, and designed a local/remote dynamic switching system, as shown in Figure (2). To meet the needs of simulation calculation.

When the training system sends a simulation request, the trainee first runs a set of simulation performance static evaluation program on the student's computer. This program contains a set of typical simulation calculation examples. By recording these simulation calculation times, the local computer's calculation ability is evaluated. When the student's local computing power exceeds the minimum computing, power required by the simulation system, the evaluation program sends a request for registering a simulation instance to the training system. After receiving the registration request, the training system writes the student's computer information into the simulation computing registry. At the same time, the simulation timer on the student's computer is set to zero, and the simulation task sent by
the training system is received and executed. When the simulation calculation task is completed, the timer stops timing and records the current simulation calculation time. According to the recorded simulation time, once again evaluate whether the computer simulation performance of the student side meets the minimum computing power requirements. If the local simulation computing ability of the trainees cannot meet the basic requirements of the system, they will send a simulation calculation request to the simulation server and use the resources on the simulation server for simulation calculation.

Considering that the local computer software and hardware environment of the trainees is more complicated, it is possible to run other programs or hardware operating environment changes at the same time during the training process, which will affect the computing ability, so we use both static and dynamic evaluation methods to evaluate the local computer simulation. Computing power to ensure the running effect of the simulation platform.

Figure 2. Simulation calculation dynamic switching process.
3.2. Training data version incremental synchronization system

"Internet + training" includes a data resource component, also called a data resource library. Its main function is to provide storage, access and operation capabilities for heterogeneous massive amounts of training knowledge, resources and data. Data resource components include learning behavior record library, learning feature model library, simulation resource library, test question library, system database and other modules. These data are kept in the training system in database or json format. Because the local computer hardware of the students will not always be online, the software will not always run, and the data cannot always be synchronized. Therefore, before running the training software, the trainees must update their local relevant data to realize the training function normally. Since the time and version of the last update of the data on the student’s computer are uncertain, in order to reduce the amount of data transmission and the number of data transmissions, the "version + increment" method is adopted to synchronize the training data on the student’s computer.

![Diagram](image)

**Figure 3.** Schematic diagram of the data resource structure of the training system.

First, the trainee's local program sends a data synchronization request to the training system, and the training system responds to the latest version number of the current data. Locally compare the latest version number with the local data version number. If the two version numbers are the same, the synchronization process ends. If the version numbers are inconsistent, compare the main version numbers of the two sets of data. If the main version numbers are the same, the local program sends the local version number to the training system, and the training system sends the current version number to the latest version of all incremental file lists and File hash check value. After receiving the list, the local program sends incremental file acquisition requests to the training system in turn, and receives incremental data files sent by the training system. After receiving all incremental data files, verify that the file hash value is correct. If there is an incorrect hash value file, re-send the request for obtaining such a file to the training system and download the file again until all files are correctly obtained. Then the synchronization program sequentially unpacks all incremental data files and overwrites the old data files, and restarts the local data service. If the main version numbers are inconsistent, first send a request for obtaining the main version number data file, and after obtaining the complete main version data, obtain the latest version data on this basis. The data flow is shown in Figure (4) the version incremental data synchronization flow.
Figure 4. Version incremental data synchronization process.
3.3. Dynamic Data Source Agent System

There is no independent data source of the traditional training system in the design of this system. Both basic training data and simulation calculation results may be distributed on the local system or the host of the training system. At the same time, some training applications, such as "student training bystander" and "multi-person simultaneous exercise", need to access dynamic data on other students' machines. In order to facilitate the management and distribution of all data, this system has designed a virtual data source agent system. For all trainees' computers, they have a virtual data source registered on the host of the training system, and the data in the data source is dynamically specified by the system based on training requirements. This not only guarantees the flexibility of use in program implementation, but also facilitates unified management.

![Diagram of Dynamic Data Source Agent System]

**Figure 5.** Dynamic Data Source Agent System.

4. Conclusion

Through the local/remote dynamic switching simulation system, the computer resources of the students are effectively utilized. After calculation and the practice in the Gansu Province company project, we only used 10% of the hardware input of the traditional training simulation calculation, which completed all the simulation calculations. And there is still enough hardware redundancy to ensure that the system can still work normally when the number of students increases.

Through the training data version incremental synchronization system, the training data distribution and the amount of synchronized data are effectively reduced, and the user training preparation time is reduced. Through practice, this system can reduce the amount of data transmission by 60%, reduce the waiting time of users by 2 minutes on average, and improve the experience of students using this system.

References

[1] Xiaogang Deng, Xiong Zhou, Xiaoyi Yang, Classroom management system development based on "Internet +" [J]. Innovative Education Research,, 2019,7(03)

[2] Du Juan.The exploration and application of simulation system in the training of integrated operation and maintenance personnel [J].Guizhou Electric Power Technology, 2017,20(06):61-63.

[3] Huang Haining,Du Haizhou,Wei Chunfeng,Design and Implementation of an Interactive Training System for Substation Operation and Maintenance Based on Mobile Internet Technology [J].Journal of Shanghai University of Electric Power,2018,34(04):371-374+390.

[4] Gao Linfei, Yang Zhenyi, Shi Chaoyin, Research on optimization method of multi-energy integrated monitoring platform based on Internet +, communication and network, 2020, 28(19), 10 3-106,112.