Design of Electric Power Intelligent Traffic System under Adaptive Dispatching Duty Mode

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Abstract. Influenced by the multi-dimensional parallelism of the self-adaptive scheduling duty mode, the overload risk of the traffic system is high. Therefore, the design and research of the electric power intelligent traffic system under the self-adaptive scheduling duty mode are proposed. —SOM-3588, the high-performance core board of AI, is the development board of the system, and —FK-NSVU, a standard 6U 5HP VPX architecture product, is the switch of the system. After extracting the scene features of adaptive scheduling duty from the aspects of multi-batch and operation time of complex tasks, taking into account the objective needs of the actual adaptive scheduling duty mode scene, and taking the balance as the guide, the traffic resource allocation is designed pertinently. In the test results, the CPU occupancy rate of the design system is always below 30.0% in different task situations, and the overload risk is extremely low.

Keywords: Adaptive scheduling duty mode; Electric intelligent traffic system; AI high performance core board; Exchanger; Multi-batch; Operating time; Situational characteristics; Resource allocation;

1 Introduction

From a practical point of view, the self-adaptive dispatching duty mode can monitor the operation state of the power grid in real time, and in case of abnormal situation, it can quickly adjust the configuration of the duty personnel, strengthen the emergency response capability, and ensure the stable operation of the power system [1-3] . From the perspective of economic benefits, the self-adaptive dispatching duty mode can reasonably arrange the configuration and operation mode of generators according to the load of the power grid, optimize the utilization of power generation resources, reduce the cost of power generation, and also help to reduce carbon emissions and protect the environment. In the actual implementation stage of adaptive scheduling duty mode [4-5] , the importance of traffic system to adaptive scheduling duty mode is self-evident. First of all, the traffic system is the key link to realize the information transmission of dispatching duty mode. Through the traffic system, the personnel on duty can receive and send dispatching instructions at any time, know the operation status and load of the power grid, and ensure the stable operation of the power system [6-7] . Secondly, the traffic system can improve the efficiency and accuracy of scheduling duty mode. By means of digitalization and automation, the traffic system can avoid the problems of human error and untimely information transmission, and improve the accuracy and timeliness of dispatching instructions. By analyzing the research and development of power traffic system at this stage,

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we can find that with the continuous development of artificial intelligence and big data technology, power traffic system is developing towards intelligence. Through intelligent technology [8-9] , the traffic system can automatically identify and classify voice information, and improve the efficiency and accuracy of information processing. At the same time, intelligent technology can also help the traffic system to realize functions such as automatic response and automatic transfer, and improve service efficiency and quality. At the same time, as an important part of the power system [10-11] , the security of the power traffic system has attracted much attention. At present, researchers are working hard to improve the security of power traffic system, including strengthening the encrypted transmission of voice data and preventing malicious attacks. At the same time, in order to cope with natural disasters and other emergencies, the power traffic system also needs to have the ability of rapid recovery and disaster recovery [12-13] . On this basis, the modern power traffic system is developing towards integration and openness. Through the integration with other power systems, the traffic system can better serve the whole power system and improve the operating efficiency and stability of the power system. At the same time, openness also enables the traffic system to better adapt to different scenarios and application requirements [14-15] . Among them, the traffic system based on IP PBX technology performs well in operation performance, but its application scope is limited; The research of traffic system based on big data has also made some achievements, but the technology is still not mature enough.

On this basis, this paper puts forward the design and research of electric power intelligent traffic system under adaptive scheduling duty mode, and analyzes and verifies the performance of the design system through comparative testing.

2 Hardware design

2.1 Development board selection

SOM-3588, the high-performance core board of AI, is the development board for designing the power intelligent traffic system under the adaptive dispatching duty mode. SOM3588 adopts the flagship chip of Ruixinwei RK3588, integrates 6Tops NPU and high-performance quad-core Mali-G610 MP4 GPU, and adopts SODIMM314Pin standard interface, which can expand rich display interface and industrial application interface, and cooperate with open backplane design materials and open source SDK. Figure 1 shows the configuration of its onboard structure.

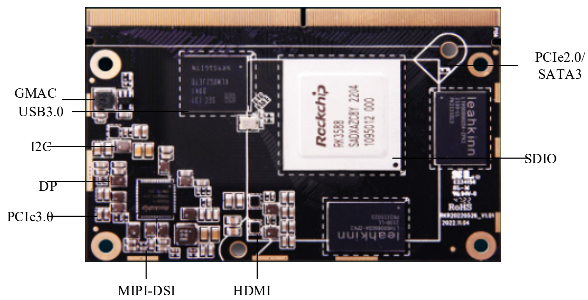

Fig. 1. On-board resource configuration of SOM-3588 core board.

In terms of processor configuration, it is equipped with a CPU configuration of 4 x Cortex-A76+4 x Cortex-A55 and a GPU configuration of Mali-G610 MP4 (4x256KB L2 Cache). With the NPU of 6 TOPS, it supports the mixed operation of INT4/INT8/INT16, which can realize a series of frameworks based on TensorFlow/MXNet/PyTorch/Caffe. Moreover, the SOM-3588 core board also integrates 48MP ISP with HDR&3DNR. Therefore, in the encoding and decoding stage, the executable sections of video decoding include 8K@60fps H.265/VP9/AVS2, 8K@30fps H.264 AVC/MVC and 4K@60fps AV1.

In terms of resource allocation, SOM-3588 core board supports many operating systems such as Android, Ubuntu, Debian, Buildroot, RTLinux, etc., and provides powerful, stable and reliable product support for various AI application scenarios. The RK3588 eight nuclear 64-bit flagship processor is adopted to give the product more imagination. With Android12.0, Ubuntu Desktop Edition and Server Edition, Debian11, Buildroot,RTLinux kernel, we can deeply customize the development service layer based on Linux system kernel, realize remote upgrade and management of equipment, and greatly improve the convenience and efficiency of later operation and maintenance.

2.2 Exchanger selection

The real-time exchange of traffic information is the key to ensure the application effect of electric power intelligent traffic system under adaptive scheduling duty mode. Therefore, FK-NSVu, a standard 6U 5HP VPX architecture product, is used as the switch of the traffic system designed in this paper, which can realize 200G data exchange function at most. In the specific architecture design, FK-NSVU adopts Fengke data exchange architecture, which provides four groups of GTH 16x data writing and 4096 port shunting. Regardless of this, FK-NSVU also converts the custom protocol into a standard network protocol, which is used for high-speed signal processing and direct cloud processing. Table 1 shows its specific configuration.

Table 1. FK-NSVU Switch Configuration Information.

Number	Allocation	Parameter
1	Product status	6U VPX rear board card (the same size as the front board card), with a height of 5HP
2	Number of ports	4096
3	Network interface and protocol	Panel: 2-way 100G (supporting QSFP28 type optical modules) Panel: 1 channel 10G (supporting SFP+optical modules) Protocol: Standard UDP
4	Customized interfaces and protocols	VPX connector: 16 sets of GTH 4x interfaces; Protocol: 8-way Aurora 8x 10Gbps
5	network bandwidth	Effective transmission rate of each 100G network ≥ 86.4Gbps Each 100G supports 2048 device connections Support two 100G data replication and diversion mechanisms
6	Function Introduction	Real time conversion of Aurora protocol data to 100G UDP protocol data; Real time conversion of 100G UDP protocol data to Aurora protocol data; Supporting simultaneous sending and receiving of data; Support configurable network ports and Aurora data channels, with configurable and saved functions, and automatic operation

		upon power on; Support 100G interface access switch operation; Support multiple devices (1-2048) to connect to a 100G interface through a switch for data transmission and reception simultaneously
7	working temperature	Standard temperature: 0 ° C to+55 ° C; Military temperature: -40 ° C to+85 ° C
8	Power consumption and heat dissipation	Power consumption ≤ 60W, compatible with air cooling and conduction cooling
9	size	25mm x 262mm x 165mm

With the parameter configuration shown in Table 1, FK-NSVU can adapt to the data exchange requirements in different application scenarios, avoid the situation that the queue waiting time exceeds the threshold range to the greatest extent, and provide reliable guarantee for the stability of the power intelligent traffic system in the adaptive scheduling duty mode designed in this paper.

3 Software design

3.1 Adaptive scheduling on-duty scenario feature extraction

In the mode of adaptive scheduling on duty, the corresponding task scenario has the characteristics of complex structure. In view of this, this paper first extracts the characteristics of adaptive scheduling on duty scenario from two aspects: multi-batch and operation time of complex tasks.

For the complex power adaptive scheduling duty mode, the main factors that distract the attention resources of the traffic system are the parallelism of multiple tasks and the diversity of information sources. In view of this, this paper uses the integration mode of task parallel processing to analyze the specific situational characteristics. Among them, the batch nature of the adaptive scheduling on-duty scenario can be expressed as

$$u_{k+1}(t) = u_k(t) + re_k(t) + \Phi e_k^a(t) \quad (1)$$

Among them, $u_{k+1}(t)$ represents the specific information of $k+1$ batch tasks in the adaptive scheduling duty scenario after task parallel processing integration, $u_k(t)$ represents the specific information of k batch tasks in the adaptive scheduling duty scenario, r represents the transmission power parameters of the adaptive scheduling duty scenario state data, $e_k(t)$ represents a reselection coefficient representing an adaptive scheduling duty scenario, Φ represents a region selection parameter, $e_k^a(t)$ represents the a time switching parameter in the power adaptive dispatching duty scenario.

Correspondingly, the operating time characteristics of the adaptive scheduling on-duty scenario can be expressed as follows

$$T = \frac{W_1 e_k(t) + W_2 e_k^a(t)}{\lambda} \tag{2}$$

Among them, T is the operation time characteristic parameter representing the self-adaptive scheduling duty scene, W_1 and W_2 respectively represent the time cost cardinality when the power adaptive scheduling duty scene is reselected and switched, λ represents the gain of fitness constant in the process of adaptive scheduling on duty.

According to the above-mentioned way, the scene characteristics of power adaptive dispatching duty mode are extracted, which provides a reliable basis for the allocation of subsequent traffic system resources and ensures that it meets the task requirements in different situations.

3.2 Balanced allocation of traffic resources

Combined with the extraction results of the scene characteristics of power adaptive dispatching duty mode in part 2.1, when allocating specific traffic resources, this paper fully considers the objective needs of the actual adaptive dispatching duty mode scene, and carries out targeted design with balance as the guidance.

Firstly, the adaptive scheduling on-duty scenario in multidimensional environment is expressed as

$$\begin{bmatrix} X(t) \\ Y(t) \\ Z(t) \end{bmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{bmatrix} x(t) \\ y(t) \\ z(t) \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} \tag{3}$$

Among them, $X(t)$ 、 $Y(t)$ and $Z(t)$ respectively represent the task execution states of self-adaptive scheduling on duty scenarios in different dimensions, $x(t)$ 、 $y(t)$ and $z(t)$ represent specific task information, a_{ij} is the elements that represent the self-adaptive scheduling on-duty scenario include personnel, equipment, b_1 、 b_2 and b_3 represents the transitional resource requirements under the guidance of features.

In this paper, the allocation of resources is mainly to reduce b_1 , b_2 and b_3 . Therefore, combined with the scene characteristics of power adaptive dispatching duty mode, the resource allocation result of this paper can be expressed as follows

$$f(t) = u_{k+1}(t) \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} * (T - t_0) \tag{4}$$

Among them, $f(t)$ indicate that result of traffic resource allocation, t_0 represents the reference operation time of the adaptive scheduling duty mode scenario.

According to the above-mentioned way, the balanced distribution of traffic resources in the adaptive scheduling duty mode is realized, and the overload situation is avoided.

4 System testing

4.1 Test preparation

When analyzing the practical application effect of the system designed in this paper, a comparative test is carried out based on a power environment. The specific implementation scheme of adaptive scheduling duty mode in test environment is analyzed. In the process of data acquisition and monitoring, smart meters and sensors are installed, which need to have real-time data acquisition function and can transmit data to the data center. Smart meters and sensors should be able to collect operating data of power system, such as voltage, current and power factor. At the same time, in order to collect external data such as meteorology and environment, it needs to be integrated with the power environment monitoring system. A data transmission network is established to ensure that data can be transmitted to the data center in real time for subsequent data processing and analysis. In the stage of big data analysis and artificial intelligence, it is necessary to process and analyze the collected power environment data. This includes data cleaning, sorting and conversion, as well as data analysis and prediction based on artificial intelligence algorithm. Through artificial intelligence algorithm, the power environment data is deeply mined to predict the future power demand and supply. For example, using time series analysis, regression analysis and other methods, the historical data are analyzed and modeled to predict the future power demand and supply trend.

According to the prediction results, it provides decision support for scheduling duty.

In the aspect of manual scheduling on duty, on the basis of automatic scheduling on duty, the manual scheduling on duty scheme is formulated according to actual needs. This includes determining the number, responsibilities and work contents of the personnel on duty. Manual scheduling on duty is mainly responsible for monitoring the abnormal situation of the system, dealing with complex problems and performing special scheduling tasks. For example, for complex power system anomalies or emergencies, manual dispatching on duty can intervene in time and formulate corresponding countermeasures according to the actual situation. Through the cooperation with automatic dispatching system, manual dispatching on duty can realize the fine management of power system.

On the basis of the above, the traffic system designed in this paper is applied, and the traffic system based on IP PBX technology and the traffic system based on big data are set as the control group respectively.

4.2 Test results and analysis

When analyzing the performance of different systems, this paper takes the performance of different tasks in the adaptive scheduling mode of the test environment as the evaluation index, among which the CPU utilization rates of the three test systems are shown in Figure 2 respectively.

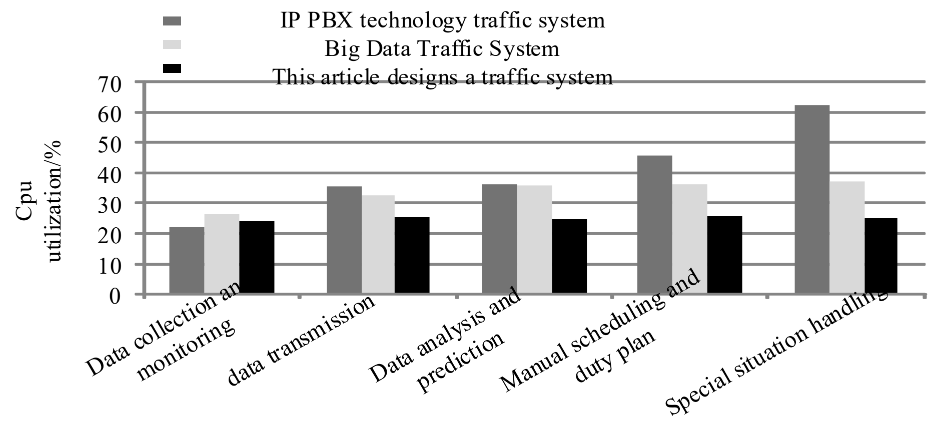

Fig. 2. CPU utilization comparison chart.

Comparing the operation of the three traffic systems with the test results shown in Figure 2, it can be seen that the CPU occupancy rate of the traffic system based on IP PBX technology is obviously high, reaching 45.76% and 62.37% respectively, which has certain overload risk. The traffic system based on big data is relatively stable for the execution of different tasks in the adaptive scheduling duty mode, and the CPU occupancy rate is stable below 40.0%. However, from a macro perspective, it may be unsuitable for some power environments. By contrast, in the test results of the traffic system designed in this paper, the CPU occupancy rate is always stable below 30.0% during the execution of different tasks in the adaptive scheduling duty mode, and the maximum is only 25.88%. It shows that it can adapt to different application environments and achieve stable output.

5 Conclusion

For power system management, the self-adaptive dispatching duty mode can automatically adjust the configuration and work plan of duty personnel according to the running state and load of the power grid, so as to ensure the stable operation of the power system. This mode can reduce manual operation and intervention and improve work efficiency. Moreover, through the adaptive scheduling duty mode, the power system can dynamically adjust the number and distribution of duty personnel according to the actual situation and optimize the allocation of human resources. During the peak load period, the number of personnel on duty can be increased to meet the demand; In the trough, the number of people on duty can be reduced to avoid manpower waste. In this paper, the design and research of electric power intelligent traffic system under adaptive dispatching duty mode are put forward, which shows good running performance. The design and research of this paper is expected to provide comprehensive data support and information guarantee for dispatching duty mode. Through integration and data sharing with other systems, the traffic system can provide comprehensive power grid operation data and information for dispatchers and help them make accurate judgments and decisions.

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