Analysis of the Power Grid Automation System Architecture Based on Distributed Scheduling

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Abstract. As the core content of urban power dispatching operation in the new era, power grid automation can ensure the safety and stability of urban power consumption on the basis of reducing resource consumption. Using the distributed scheduling method in the system can not only improve the quality of power transmission, but also improve the speed of system operation. Therefore, on the basis of understanding the distributed task scheduling method, this paper analyzes the independent task dynamic optimization level scheduling algorithm based on MPSoC, and carries on the in-depth understanding of the practical application effect, so as to prove the positive role of distributed scheduling in the application of power grid automation system.

1. Distributed task scheduling method

1.1. Defining the movement device
The power grid automation system integrates the moving device and its corresponding channel, and uses the remote control and telemetry functions of the device to build a connection channel between the two. Telemetry function refers to the transformation of the analog quantity of the system into the receiving end of the dispatching center. The process of transformation of the analog quantity is telemetry, while the remote control function refers to the use of the dispatching end to control the information received by the system, so as to achieve the work goal of remote control. The motion device has two functions, one refers to the storage program type, the other refers to the wiring logic type, the former is the use of fixed wiring way to build, and the latter is the use of hardware circuit to design and constitute. As shown in Figure 1 below, it is the distributed scheduling structure used in the current power grid automation system.
The global mobilization monitoring center is the first-level equipment of the system operation, the equipment layer belongs to the second-level equipment of the system, and the interval layer and the management layer are the third-level and fourth-level equipment. In the grid automation terminal area, the grid control and monitoring work is placed under the distributed system, which can ensure the effectiveness of the overall system operation and define the motion devices for distributed scheduling[1-4].

1.2. Mutex conversion

In the past, in order to improve the efficiency of the system, the power grid automation will choose redundant configuration, that is, the two-machine backup structure. It is in accordance with 1:1 processing facilities to clarify the location of the mirror node. At this point, the requirements of different facilities vary, and the mutex conversion process becomes more and more complex. In order to ensure the effectiveness of information transmission during automatic operation of power grid, task scheduling that can be realized by 1:n processing facilities must be designed to meet the operation requirements of the plant station system. At the same time, distributed task scheduling is based on 1:n processing devices as the core to complete task scheduling, so each execution of the task will change with the service node. Substation and information transmission task analysis is performed according to the requests sent by N nodes. N is selected between 0 and N-1, and different values will obtain inconsistent effectiveness. Under the condition of n=1, the backup system node is dynamic. Under the condition of n=n-1, the backup system nodes are mutual, and only in this way can the effectiveness of system operation be satisfied. There are many service nodes in distributed dispatching which can be sent to the next task through negotiation among them.[5]

In the case that the service node is 2, the two nodes belong to the execution command of task scheduling. Nodes N2 schedule N1 and N3 to execute tasks. In the process of node submission, a mutex is built randomly between N1 and N3. After the mutex conversion operation is completed, proceed to the next task. Check to see if N3 has completed the conversion. If not, you cannot proceed to the next step. The task scheduling of all nodes can be independently designed, which can improve the effectiveness of system operation while completing 1:n processing devices.
1.3. Data scheduling

From a practical point of view, distributed scheduling can transfer all the service requests of the system scheduling monitoring center to the substation, and an execution node needs to be selected before each request is sent. The specific operation steps are as follows: first, transfer the task request to the computer; Second, the dispatcher has to find the required nodes in the data. Thirdly, service request scheduling is adjusted to 5S every 2S; Fourth, assuming that the service request sent by the global scheduling monitoring center is valid and the time will not exceed 2s, then the DMVLAC algorithm can directly select a node. Fifth, the dispatcher puts forward the request of service node in the global dispatching monitoring center; Sixth, the dispatcher needs to wait for 100s until the number of executions reaches 2 times. If there is no response, the dispatcher needs to move to step 2. Seventh, the dispatcher should combine DMVLAC algorithm to regard A node as the executive, and then move to the ninth step; Eighth, the dispatcher should wait until 200s after making the request, assuming no response, then it is necessary to move to the fourth step to continue the operation; Ninth, when the dispatching fails, the grid system will automatically present the result to the user. Tenth, modify the dispatch mutex, assuming that a failure requires re-measuring the node of the service data. Eleven, end dispatch.

2. Analysis of dynamic optimal-level scheduling algorithm for independent tasks based on MPSoC

At present, most of the independent task scheduling algorithms based on priority take the task value or the deadline constraint as the main scheduling criteria, and some take the time occupied computing resources as the main scheduling criteria, but many algorithms are oriented to static multi-core environment. This paper mainly studies the task scheduling content based on priority in the heavy-core processor on-chip system (MPSoC). The specific structure is shown in Figure 2 below:

![Fig. 2 Schematic diagram of distributed multiprocessor architecture](image)

At present, the dynamic optimization level scheduling algorithm of independent tasks is one of the important topics of practical research, and it has been widely used in the real-time task scheduling of single or multi-core systems. Especially for the operation of modern power grid system, it can quickly deal with the internal business of the system and guarantee the effectiveness of task scheduling. The structure of the independent task scheduling model based on MPSoC is shown in Figure 3, and the specific attribute parameters are described in Table 1:
Fig. 3 Structure diagram of MPSoC-based independent task scheduling model

Table 1. Parsing of basic attribute parameters

| The serial number | Symbol   | Describe                                                                 |
|-------------------|----------|--------------------------------------------------------------------------|
| 1                 | $V_i$    | The total value of the mission                                           |
| 2                 | $C_i$    | The estimated execution time of the task                                |
| 3                 | $P_i$    | Task Executed Time                                                       |
| 4                 | $D_i$    | The relative deadline of the task, i.e. the deadline for completion when the task is ready |
| 5                 | $W_i$    | Accumulated waiting time after the task is ready                         |
| 6                 | $RT_i$   | The running time of the task on each physical core in this scheduling cycle |
| 7                 | $VC_i$   | The virtual core associated with task $T_i$ during this scheduling cycle |
| 8                 | $VC_{num}$ | The number of physical cores in the virtual cores associated with the task is referred to as virtual kernel granularity |

In the study of virtual nuclear resource allocation algorithm, the research core of VPD algorithm is MPSoC system. This algorithm involves two aspects. The first is the task state recognition algorithm with the behavior pattern as the core, which can be used to call and record the LLCMR of the last level of the task during the execution of the task. Not only the operation is fast and the cost is small. As shown in the following formula,

$$ AL = \frac{\sum_{i=1}^{n} LLCMR_i}{n} $$

(1)

In the above formula, LLCMR$_i$ represents the LLCMR of the ith interval. The following formula represents the beginning of a new phase:
\[
\frac{AL_{\text{curr}} - AL_{\text{prev}}}{AL_{\text{prev}}} > \text{Threshold}_1
\]

(2)

Threshold1 is a threshold, and AL\text{CURR} and AL\text{PREV} are behavior characteristics. Continue to record the LLCMR of the two clock intervals, assuming that the actual change is smaller than the threshold of Threshold2, then this stage has started to stabilize, the specific formula is:

\[
\frac{AL_{\text{curr}} - AL_{\text{prev}}}{AL_{\text{prev}}} > \text{Threshold}_2
\]

(3)

The second is virtual nuclear resource allocation algorithm (VPD). Assuming that VPS represents the running speed of the virtual core, the formula can be obtained:

\[
VPS = \frac{AL_{\text{avg}}}{AL_{\text{base}}}
\]

(4)

In the above formula, Al represents the Average LLCMR under the existing conditions, and Al represents the virtual core Average LLCMR based on a single core. Combined with the above formula analysis, the execution speed of a single core at this time is 1.

Assuming that VPE represents the execution efficiency of existing virtual cores, the following formula can be obtained:

\[
VPE = \frac{VPS}{NC}
\]

(5)

The preliminary calculation formula for the first increase in the number of physical cores of the virtual core is as follows:

\[
\text{NEW} = \text{NC} = \left\lfloor \left( VPE - \text{vpe}_\text{threshold}_{\text{min}} \right) \times a \times \tan \theta + 2 \right\rfloor
\]

(6)

In the above formula, \( \alpha \) represents the conversion ratio between VPE difference and core number difference, which is set as 10 in this study. \( \theta \) represents the Angle coefficient, which is taken as 65 in this paper, and VPE-Thresholdmin represents the minimum execution efficiency threshold of the system design. Because different tasks have different accelerative curvature, in the actual test, the above formula calculated a hit rate of 53%.

And research the DPS - CCS scheduling algorithm, mainly divided into dynamic priority dispatching strategy and global scheduling policy two aspects, the former need to combine the value, time emergency degree, and take up the calculation and analysis of factors, such as computing resources, which need to build the task scheduler comprehensive maintenance tasks on the basis of the organization structure, resource allocation and complete the task priority. Taking the global scheduling strategy as an example, combined with the analysis of the model diagram as shown in Figure 4 below, it can be seen that when the task is in the key value (Ti) of the red-black tree, the following formula is in line with it:

\[
\text{key}(t_i) = D_y \Pr_i - W_i
\]

(7)

Assume that N represents the total number of physical tasks on MPSoC, and M refers to the maximum number of MPSoC running tasks obtained according to task dynamic priority analysis under the existing scheduling cycle, and Key (Ti) \( \leq \) Key (Ti +1). The specific formula is as follows:

\[
\sum_{i=1}^{m} \text{VC}_\text{num}_i \leq n \leq \sum_{i=1}^{m+1} \text{VC}_\text{num}_i
\]

(8)

3. Result analysis
In this paper, the summarization of DPS-CCS algorithm, IPD algorithm, GEDF algorithm and LLVDF algorithm are used for comparative analysis. The task completion situation, cumulative value completion probability and system extra cost of the four algorithms are mainly collected, and the average value is calculated to ensure the fairness and fairness of measurement and analysis. It should be noted that practical inquiry should be carried out in the same task load and target environment[6].

By choosing a 16-way AMD Opteron6272 server, running Ubuntu 11.04, Linux kernel version 3.14.2, virtual kernel allocation algorithm using C++ in user mode. Combined with Cilk standard test task analysis as shown in Table 2 below, the results as shown in Figure 5 below can be obtained:

| Load name | The size of the | Load description |
|-----------|----------------|-----------------|
| FIB       | 50             | Fibonacci series |
| HEAT      | Particle size: 10, row number: 8192, column number: 8192 | Heat diffusion problem based on finite difference method |
| STRASSEN  | Matrix size: 4096×4096 | Strassen matrix factorization |
| CK        | The search depth of both sides is 10,13 | Checkers algorithm |
| LU        | Matrix size: 4096×4096 | LU matrix factorization |
| FFT       | Sequence size is $2^{28}$ | Fast Fourier Transform |

![Fig. 4](image) **Comparison analysis of algorithm performance under static homogeneous multi-core processor system environment**

Above analysis shows that in the static homogeneous multi-core processor system environment, the DPS - CCS algorithm will integrate research time emergency degree and did not complete the value of the probability that two factors, and can dynamic explicit task priority, all operations can provide effective resources for task scheduling, so the overall application performance is extremely high. By comparing the task completion in the picture, it can be seen that DPS-CCS algorithm is higher than IPD algorithm and LLVDF algorithm, exceeding 18.67% and 64.8% respectively. In the probability of completion of cumulative value, DPS-CCS algorithm is also higher than the
three kinds, exceeding IPD algorithm by 35.27%, HVF algorithm by 27.69%, and GEDF algorithm by 15.51%.
In addition, in the above system environment, although the task completion rate of IPD algorithm is low when the number of cores is small, the corresponding task completion rate and the cumulative value completion rate are also constantly improving when the number of cores continues to rise. LLVDF algorithm will prioritize high-value tasks and require a long completion time, which proves that the task processing of this kind of algorithm needs to occupy too many processing resources, making it difficult for tasks with low value to obtain effective resources and more likely to miss the deadline. Under the condition that the load continues to increase, although the overall task completion rate is too low, since most high-value tasks have been completed, the cumulative value completion rate is very high, which can be close to the IPD algorithm. GEDF algorithm will group tasks and operate according to the principle of minimum task length first, so the actual task completion rate is higher than that of HVF algorithm. However, because the overall value is low, the application advantage cannot be shown in the cumulative value completion rate[7].

4. Conclusion
To sum up, in the construction and development of power grid automation system, distributed dispatching, as an effective method to guarantee its operation management, has always been the focus of research and analysis by researchers. In this paper, it is found that DSP-CCS algorithm and VPD algorithm are used in the dynamic optimization level scheduling algorithm of independent tasks based on MPSoC, which can not only effectively complete the problem of independent task scheduling, but also simplify the practical operation and better conduct dynamic priority task scheduling. Therefore, the automation system of power grid construction in the future period, the staff must be in mastering the system structure and application technology, on the basis of learning more about the research achievements of research scholars at home and abroad for distributed scheduling, and applied to the practical work, this helps from the security system on the basis of quality and safety of operation.

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