

Study on design method for anti-collision in large scale network control software

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Keywords: control software; anti-collision; task scheduling;

Abstract: the anti-collision problem of large network control software is studied. With the increase of the control task amount of large network control software, the randomness for network control is enhanced, the traditional anti-collision design algorithm is hard to establish the accurate anti-collision model when facing with the randomness, results in failure for large network control task. In order to avoid the disadvantages, an anti-collision design method in the large scale network control software is proposed based on time slot ALOHA algorithm. The ALOHA anti-collision task scheduling model is established, and the relationship between the optimal time slot and control module is calculated, so as to get the relation of system among the number of time slot, the number of control module and the number of scheduling efficiency. On the basis of this relationship to search the critical point of time slot values, avoid the conflict phenomenon in the large scale network control software to maximum extent. The experimental results show that, by using this algorithm can effectively improve the effect of preventing conflict in large scale network control software.

1 Introduction

With the rapid development of network technology, the operation speed of large scale network control software has been gradually improved. During the running process of large network control software, task scheduling is a core part affecting network control efficiency[1-3]. In task scheduling, assuming a large number of control tasks are conflicting, the control efficiency of the network control software is reduced as a result [4,5]. Therefore, anti-collision algorithm in large-scale network control software has become a hot problem to research in the field of computer, and has been concerned by many scholars [6-8]. At this stage, the main anti-collision algorithm in large-scale network control software includes anti-collision method based on genetic algorithm, anti-collision method based on particle swarm optimization algorithm and anti-collision method based on non uniformly distributed scheduling algorithm [9]. Task scheduling anti-collision algorithm is a hot problem to research in the field of computer, can improve the computing capability of whole network [10].

2 principle of anti-collision design method based on time slot ALOHA algorithm

In the process of designing anti-collision in large-scale network control software with the traditional algorithm, without considering the randomness of control task scheduling process, resulting in conflict phenomenon happened during the transmission process of control module. For this, an anti-collision design method in the large scale network control software is proposed based on time slot ALOHA algorithm.

2.1 establishment of ALOHA anti-collision design model

With the sharp increase in the number and species of the large scale network control task, control task also involved in more and more aspects, therefore, the control module in the large scale network control software has also increased, the scale of control task is getting larger. In the process of anti-collision designing for large scale network control software, the relationship between the optimal time slot and the control module need to be calculated, the detailed process is as follows:

Multiple Bernoulli mathematical model is utilized to research control task conflict problem in control module of large scale network control software. N time slots exists in the process of

control task scheduling, because the probability selected by each time slot are independent from

each other, the probability of being selected is $\frac{1}{N}$, the probability of not being selected is $1 - \frac{1}{N}$, assuming there are N time slots, the probability of all time slots are simultaneously selected is $r(r < n)$:

$$P\{x=r\} = C_n^r \left(\frac{1}{N}\right)^r \left(1-\frac{1}{N}\right)^{n-r} \quad (1)$$

According to the above formula, it can be learnt that when $r=0$, P_{emp} is the probability of time slot not being selected by system control module, the following formula is used to describe:

$$P_{emp} = C_n^0 \left(\frac{1}{N}\right)^0 \left(1-\frac{1}{N}\right)^n = \left(1-\frac{1}{N}\right)^n \quad (2)$$

If $r=1$, P_{mat} is adopted to describe the probability of same time slot selected by one control module, thus, the control task can be scheduled accurately:

$$P_{mat} = C_n^1 \left(\frac{1}{N}\right)^1 \left(1-\frac{1}{N}\right)^{n-1} = \frac{n}{N} \left(1-\frac{1}{N}\right)^n \quad (3)$$

Assuming that when $r \geq 2$, P_{col} can be used to describe the possibility of the same time slot selected by many control modules, in which case conflict will occur:

$$P_{col} = 1 - P_{emp} - P_{mat} = 1 - \left(1 - \frac{1}{N}\right)^n \left(1 + \frac{n}{N-1}\right) \quad (4)$$

According to the above method, the expectations of empty slot occurred in the N time slots can be calculated, the formula is as follows:

$$E_{emp} = N \left(1 - \frac{1}{N}\right)^n \quad (5)$$

The calculation formula for expected time slot number when only one control module is scheduled is as follows:

$$E_{mat} = n \left(1 - \frac{1}{N}\right)^{n-1} \quad (6)$$

The number of time slots when control management module have collision is a random variable, the calculating formula of expected value E_{col} is as follows:

$$E_{col} = N - N \left(1 - \frac{1}{N}\right)^n - n \left(1 - \frac{1}{N}\right)^{n-1} \quad (7)$$

When $\frac{dP_{mat}}{dn} = 0$, the control module scheduling efficiency is the highest, the relation between the number of control modules and the number of time slots can be described with the following formula:

$$\frac{dP_{mat}}{dn} = 0 \Rightarrow N = \frac{e^n}{e^n - 1} \quad (8)$$

The above formula is carried on with Taylor series, the following formula can be obtained:

$$N \approx \frac{1 + \frac{1}{n}}{1 + \frac{1}{n} - 1} = n + 1 \quad (9)$$

According to the above analysis, when the number of slots is greater than the number of control modules, the highest scheduling efficiency can be obtained.

2.2 implementation of anti-collision in large network control tasks

When the number of time slots is close to the number of control modules, scheduling efficiency of control system is the highest, but the estimated number of the control module is uncertain value, the protocol received by time slot is limited in the range of 2^Q , therefore, the number of time slots can

only meet $N \approx n+1$ basically in this range. Thus, the new adjustment scheme need to be adopted to search for a critical point, the critical point is the intersection of scheduling efficiency of time slot value N and $2N$, the point is acted as a critical point, when the number of the control module is less than the point, slot value is N , when the number of the control module is greater than this point,

$$\frac{dP_{mat}}{dn} = \left(1 - \frac{1}{N}\right)^{n-1} \left\{1 + n \ln\left(1 - \frac{1}{N}\right)\right\}$$

slot value is $2N$. The value of the critical point is obtained by and $\left(1 - \frac{1}{2N}\right)^{2n-1} \left\{1 + 2n \ln\left(1 - \frac{1}{2N}\right)\right\}$ simultaneously, namely the critical point can be expressed by the number of control modules:

$$n_N < n < 2N = \frac{\ln 2}{\ln\left(\frac{2N-1}{2N-2}\right)} \quad (10)$$

According to the method described above, the establishment of ALOHA anti-collision large network control task scheduling model, using the new adjusting method to search the critical point of slot values, ultimately avoid conflict happened in control task scheduling process of large-scale network control software.

3 Experiment results and analysis

In order to verify the validity of this algorithm, there is the need for an experiment. In the experimental process, simulation environment for large network control need to be built.

During the experiment process, the control task of large-scale network control software is increasing gradually. With the traditional algorithm and the proposed algorithm to process anti-collision operation of large scale network control software, the control time can be described by the following figure:

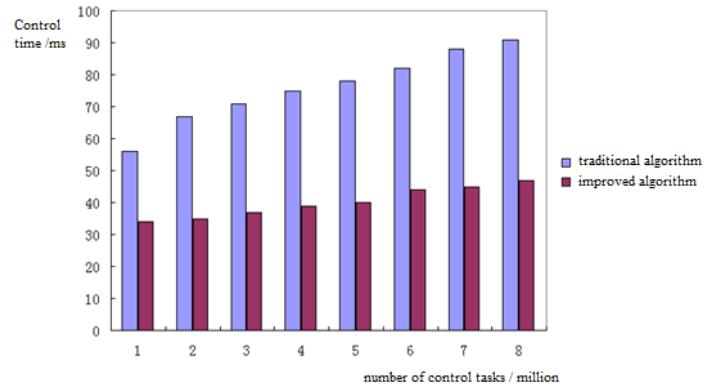


Figure 1 Comparison of control time obtained with different algorithms

On the basis of the above experiments to learn that, with the increasing control task number of large scale network control software, when the traditional algorithm used for control task scheduling, the probability of control task conflict is enhanced, and the control time is prolonged. While the proposed algorithm for anti-collision calculation, the defects are avoided, time consumed by control task scheduling is reduced.

The relevant data in the above experiment process is analyzed, so as to get the table 1 as follows:

Table 1 data table of large network control time

The number of tasks (million)	The control time of traditional algorithm (ms)	The control time of proposed algorithm (ms)
1	56	34
2	67	35
3	71	37
4	75	39
5	78	40
6	82	44
7	88	45
8	91	47

In the experimental process, with different algorithm control to schedule control task for large-scale network control software, the probability of conflict can be described by the following figure:

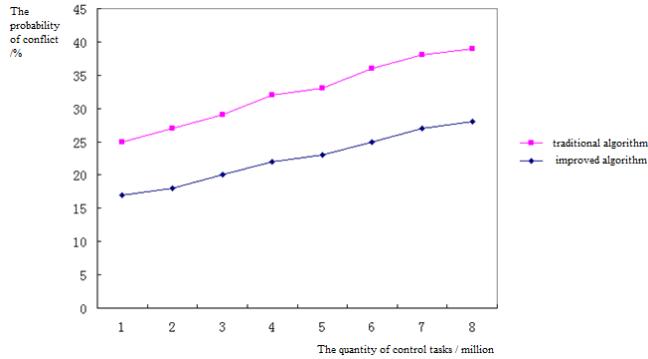


Figure. 2 Comparison of conflict probability of different algorithms

According to the above figure, it can be seen that when the control task quantity is big, the proposed algorithm has much lower collision probability.

Table 2 the data table of conflict probability

The number of tasks (million)	The collision probability of traditional algorithm (%)	The collision probability of proposed algorithm (%)
1	17	8
2	18	9
3	20	9
4	22	10
5	23	10
6	25	11
7	27	11
8	28	11

According to the method described above, the proposed algorithm used for designing anti-collision model can greatly improve the anti-conflict effects, achieve rapid and stable control of large scale network, and acquire satisfactory results.

4 Conclusion

Aiming at the defect of traditional algorithm that it is hard to establish the accurate anti-collision model when facing with the randomness, an anti-collision design method in the large scale network control software is proposed based on time slot ALOHA algorithm. The ALOHA anti-collision task scheduling model is established, and the relationship between the optimal time slot and control module is calculated, so as to get the relation of system among the number of time slot, the number of control module and the number of scheduling efficiency. On the basis of this relationship to search the critical point of time slot values, avoid the conflict phenomenon in the large scale network control software to maximum extent. The experimental results show that, by using this algorithm can effectively improve the effect of preventing conflict in large scale network control

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