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# An Improved Load Balancing Algorithm of Multi-TPM

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**Abstract**

This paper have accomplished Trusted Platform Module test and have succeeded in porting TPM Emulator from Linux to Windows. According to the TLBA Algorithm, this paper proposes an improved load balancing algorithm of TPM (A-TLBA). A-TLBA makes further optimization and perfection to TLBA. It reflects in the choice of the threshold and considered the heterogeneous environment. A-TLBA improves the efficiency of TPM, reduces the waste of resources effectively and increases the robustness of the algorithm.



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Keywords: Load balancing; Multi-TPM; TPM Emulator;

## 1. Introduction

With the development of information technology, information security becomes the focus of attention. In order to solve insecurity issues of computer and network structure and improve the security, it gives rise to the basic idea of trusted computing. Trusted Platform Module (TPM) is able to provide protection for platform when computer is starting [1]. Trusted Platform chip provides limited resources and performs inefficient. TPM has a heavy task under the condition of multi-system and multi-task. With the appearance of multi-TPM, this paper analysis the potential load imbalance issues between each multi-trusted platform module (multi-TPM) and proposes an improved load balancing algorithm (A-TLBA)

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based on TLBA algorithm. A-TLBA algorithm provides better than TLBA algorithm of load balance and efficiency.

## 2. The porting of vTPM

TPM Emulator is open source software for simulating a TPM chip. It meets the specification of TPM, and simulates the features provided by TPM chip. At the stage of the development of trusted computing, TPM Emulator has a great significance for TPM and the upper application development based on TPM [2].

Currently, TPM Emulator can only work on Linux, but the operating environment of Windows has a significant advantage. From the application of trusted computing point of view, TPM Emulator has an extremely wide application background when it works in Windows. For these reasons, the work of TPM Emulator porting to Windows is necessary. Beijing University of Technology have succeeded in porting TPM Emulator from Linux to Windows. The porting operation is as follows. First, it should port the GMP.GMP provides the underlying support for the cryptographic algorithms of TPM Emulator. Second, it replaces the TPM Emulator source code which is not compatible with Windows platforms. Finally, it writes a program to test the function of TPM [3]. The design of the local test model is shown in Figure 1[3]. A specific process of local test model is shown in Figure2 [3].

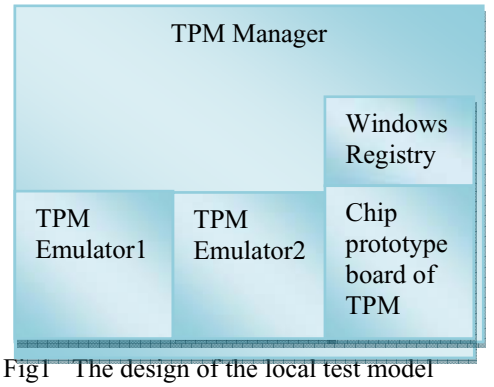


Fig1 The design of the local test model

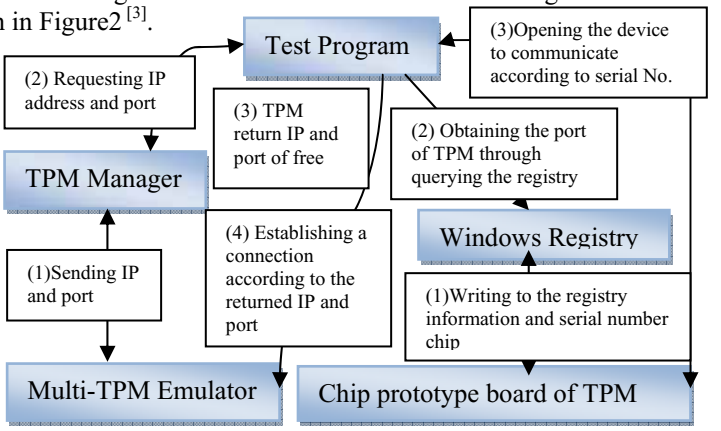


Fig2 The detail design of local test model

This paper have achieved multi-vTPM module using virtual technology and have succeeded in transplanting from Linux to Windows. Furthermore, we have designed TPM test programs which guarantee the accuracy of operations in windows system and have finished the test command set. Based on above all, we propose an improved load balancing algorithm based on multi-TPM (A-TLBA).

## 3. Load balancing of multi-Tpm based on virtualization

Based on analysis of the TLBA, the paper puts forward the following two improvements: firstly, the divided of threshold has to be more discrimination. Secondly, the algorithm needs to consider the case of heterogeneous cluster. According to the TLBA algorithm, this paper analysis and improves TLBA algorithm, and proposes an improved load balancing algorithm based on TPM (A-TLBA).The following describes the specific A-TLBA algorithm improvements.

### *3.1. Transfer Policy*

Threshold is a buffer mechanism for slow down the node load balancing activity. It makes the load balancing activity to carry out load balancing operation only under the relative deterioration of the system

state. The mechanism of the load threshold uses inaccurate information to make effective decisions [4], and avoids scheduling pouring effectively [5].

The choice of threshold plays a decisive role in the effect of regional partition. The threshold is initially used to determine the graphic image segmentation, in order to distinguish the colour difference between images. There are three threshold methods in image processing: two-apex method, iterative method and dajin method. Two-apex method has good effect only when the numerical difference is bigger. Iterative method makes the threshold segmentation effect is good, but the treatment effect is not ideal on the fine point of image. Dajin method divides image based on the image's gray features. Dajin method's effect is ideal [6]. Combining the characteristics of TPM and the method of the threshold, the paper chooses dajin method for the average threshold differentiates.

Algorithm is described below：

Begin

1. TPM's minimum load value: Tmin.
   TPM's maximum load value:
   Tmax; t=Tmin；
2. t is the division points;N is the number of TPM.
   If (Load>t)
   Then: num+1; maxload+=load; wmax=num; w0=wmax/N; u0=maxload/wmax;
3. If (Load<t)
   Then: num+1; minload+=load; wmin=num; w1=wmin/N; u1=minload/wmin;
4. The overall average: u= w0* u0+ w1* u1；
5. g= w0*( u0-u)2+ w1*( u1-u)*2， turn step2.Each cycle time t=t+1,end for t= Tmax；
6. When the value of g is a maximum, t is the optimal threshold.

End

### *3.2. Location Strategy*

In heterogeneous cluster, each node of the processing power and resources are not identical, so Smallest K-subset Algorithm in heterogeneous should be fully considered each node of the actual ability [7].

Based on these thoughts and combed the resource capacity of TPM, the paper realizes the Smallest K-subset Algorithm based on resources (RK algorithm).This paper locates node combing the node CPU's usage.

Begin:

1. Algorithm calculates the TPM's CPU usage, and records Ci（i=1,2,…）；
2. Algorithm calculates the load of TPM, and records Ti（i=1,2,…）；
3. Wi=Ci*Ti(Wi means the load of TPM based on resources)；
4. It chooses a minimum of k Wi；
5. in the choice of k values as a random selection goal node.

End

### 3.3. Selection Strategy

With TLBA algorithm, A-TLBA algorithm adds the case of heterogeneous in the selection strategy.

Horchol-Balter and Downey[4] think that the migration process for the minimum running time in the heterogeneous nodes is shown in formula 3.

$$AGE_{\min} = \frac{f + \mu / b}{Q_1 - V_s / V_d \cdot Q_2} \quad (3)$$

*Vs* indicates the processing speed of the source node, and *Vd* indicates the processing speed of the target node. *Q1* indicates the number of the source node before the migration and *Q2* indicates the number of the target node before the migration. The cost of the process migration is $f + \mu / b$ $f$ indicates the fixed migration costs of the preemptive migration, *u* indicates the memory spending of the migration process, *b* indicates memory bandwidth [4].

## 4. The analysis of experimental data

### *4.1. Experimental and the Comparison of the Different Algorithm*

We have designed two experimental environments.

1) Environment: TPM1, TPM2, TPM3, TPM4;
   Algorithms: Random algorithm, Polling algorithm, TLBA algorithm
   Numbers of task: twenty.
2) Environment: TPM1, TPM2, TPM3, TPM4;
   Algorithms: TLBA algorithm, A-TLBA algorithm
   Numbers of task: twenty.

The results are as follows.

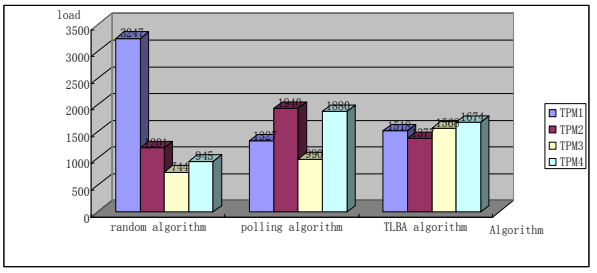


Fig.3 The load at different algorithms Ⅱ

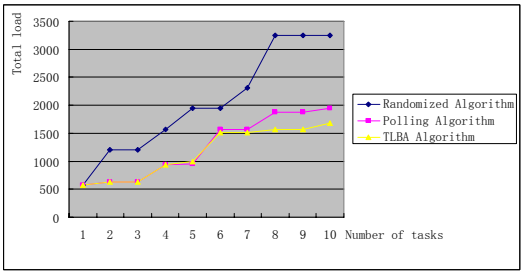


Fig.4 The load at different algorithms Ⅱ

As shown in figure 3, vertical axis represents the load, abscissa represents the random algorithm, polling algorithm and TLBA algorithm. Analysis shows, TLBA algorithm than the random algorithm increases by 50.1%, and over the polling algorithm improves by 15.5% on the balance of the load. Figure 4 shows the task execution time，TLBA algorithm in the implementation of the overall efficiency than the random algorithm increases by 25.6%, and over the polling algorithm improves by 4.3%.

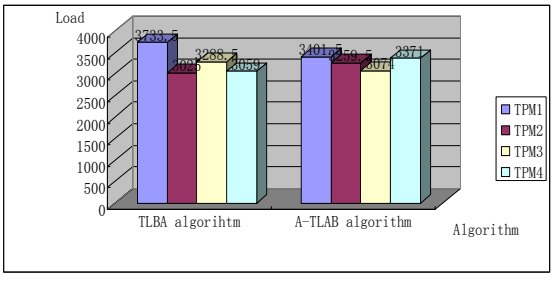


Fig.5 The load at different algorithms

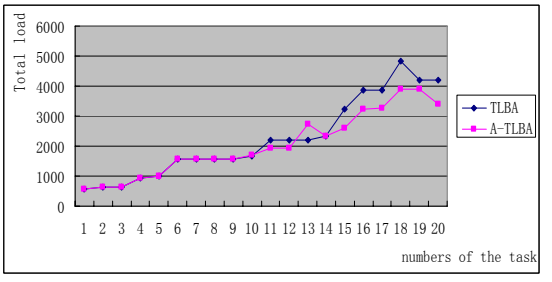


Fig.6：The load at different algorithms

As shown in figure 5, vertical axis represents the load; abscissa represents the TLBA algorithm and A-TLBA algorithm. We can see A-TLBA algorithm is better than TLBA algorithm in the load balance.

Analysis shows, A-TLBA algorithm than the TLBA algorithm increases by 12.3% on the balance of the load. Figure 6 shows the task execution time，A-TLBA algorithm in the implementation of the overall efficiency than the TLBA algorithm increases by 4.7%.

### *4.2. The analysis and comparison of the experimental results*

According to the experimental data and the graph in above, the paper analyses and summarizes random algorithm, polling algorithm, TLBA algorithms and A-TLBA algorithm.

1) Random algorithm: Owing to choosing process migration randomly, it makes some TPM have a heavy load while others may be in idle mode. Therefore, this situation wastes resources and increases the burden of some TPM.

2) Polling algorithm: In this situation, some nodes have a little task and process fast while some other nodes have a lot of task and process slowly. Therefore, it has to wait for a long time and wastes time and resources.

3) TLBA algorithm: This algorithm collects load condition of nodes and execution time of tasks instantly. It divides the nodes into overload and light load. In this way, the task will be distributed to the light load reasonably. The algorithm can achieve a moderate load of node. At the same time, it also improves the executive efficiency.

4) A-TLBA algorithm: This algorithm optimizes the threshold based on TLBA algorithm. It makes the load degree of distinction more apparent, and increases algorithm's robustness.

## 5. Conclusion

According to the features of TPM, this paper designs an improved load balancing algorithm of TPM (A-TLBA). A-TLBA makes further optimization and perfection to TLBA. It has completed unified dispatching of TPM's resources. Furthermore, it has solved problems of limited processing speed and the waste of time. At the same time, it has also carried out a more reasonable distribution of multi-trusted platform.

## Acknowledgements

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