A Dynamic Load Balancing Scheme Using Thresholds in Structured P2P Networks

Jonghyeon Yoon[1], Jaemin Hwang[1], Hyunkyo Oh[1], Jongtae Lim[1], He Li[1], Kyungsoo Bok[1], Jaesoo Yoo[1]*
[1]Chungbuk Nattional University, Korea
E-mail : {jhyoon13, hjm, ohk916, jtlim, lihe,ksbok, yjs}@chungbuk.ac.kr

1. Introduction

Many P2P applications have been developed because a P2P network is more scalable and robust than a client-server network. Load balancing among nodes is very important since the load is concentrated on a particular node in structured P2P networks. There are the two types of loads such as static load and dynamic load in the structured P2P networks. In general, the static load of a node is less impact on the network performance. On the contrary, dynamic load that is generated by actions such as uploads, downloads, and routing has become the cause of network congestion and the delay of response time.

Many studies have been in progress in order to resolve load balance problems in structured P2P networks. XianfuMeng proposed a dynamic load balancing scheme [1] using two thresholds. According to two thresholds, load states can be classified into 3levels and the load can be only transferred from overloaded nodes to under-loaded nodes. Load information that is classified based on the range of load is managed by multiple load management nodes.

The nodes in P2P networks act in order to obtain their maximum benefit. [2] The incentive mechanism [1] encourages nodes to actively participate in the load balancing process. However, the incentive mechanism has some disadvantages. In spite of the incentive, there exist nodes that set low thresholdssince it only encourage them to participate in load balancing. Nodes may also setinappropriate threshold values because each nodemay not know an appropriate threshold value. In this paper, we proposed a dynamic load balancing scheme based on the threshold of adjacent nodes in structured P2P networks in order to solve the problems of the existing schemes.

2. The Proposed Scheme

In this paper, a threshold is defined as the load ratio of a node. The proposed scheme has two thresholds such as overloaded threshold T_O and under-loaded threshold T_U. We perform load balancing in heterogeneous structured P2P networks according to load status classified by load ratios. The proposed scheme classifies load status into 3levels. If the load of a node is more than T_O, the node is overloaded status. If the load of a node is lower than T_O and more value than T_U, the node is middle-loaded status. If the load of a node is lower than T_U, the node is under-loaded status.

The existing load balancing scheme[1]is based on Chord[3]. Figure 1shows the ring-type identifier space of Chord and the properties of a node. N1 ~ N8 are nodes in the identifier space. Each node has the information of adjacent nodes as well as its local load information[1] and local threshold. The predecessor represents *n*previous nodes in the identifier space. The successor represents*n*next nodes in the identifier space. *U_threshold*and *O_threshold*denotesunder-loaded threshold and overloaded threshold, respectively.

When the network is first organized, the proposed scheme obtains the thresholds of all nodes in the network and calculates the average a_{high}, and $a_{low}$of T_O and T_U. The criteriab_{high} and b_{low} are calculated by average valuesa_{high} and a_{low} and reference valuesr_{high} and r_{low}. If T_O of*a* node is lower than b_{high}, $T_O$is raised to $\alpha\%$. IfT_U of a node is lower than b_{low}, T_U is raised to $\alpha\%$. According to this calculation rule, each node reflects its own threshold and the threshold of a node with relatively lower threshold becomes close to the average valuesa_{high} and a_{low}.

After this process is performed or new nodes are inserted to the network, the nodes obtain the average values of thresholds of adjacent nodes including themselves. If the average threshold is higher than the threshold of the node, the threshold of the node is modified to the average threshold. On the other hand, if the average threshold is lower than or equal to the threshold of the node, the threshold of node is not changed because the average threshold of a whole network become lower by low threshold of each node. Figure 2shows the pseudo code in the computation process of the average threshold.

* Corresponding author : yjs@chungbuk.ac.kr
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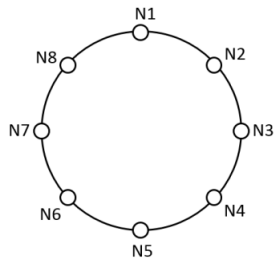

N1	N3
predecessor : (N7, N8)	predecessor : (N1, N2)
successor : (N2, N3)	successor : (N4, N5)
U_threshold : (25)	U_threshold : (38)
O_threshold : (80)	O_threshold : (67)

Figure 1. Identifier Space and node property

```
01: function ave_threshold {
02:       u_thr = Node.u_thr
03:       o_thr = Node.o_thr
04:
05:       for (i = 0; i < n; i++) {
06:             u_thr = u_thr + Node.predecessor[i].u_thr
07:                   + Node.successor[i].u_thr
08:             o_thr = o_thr + Node.predecessor[i].o_thr
09:                   + Node.successor[i].o_thr
10:       }
11:
12:       u_ave = u_thr / (2n + 1)
13:       o_ave = o_thr / (2n + 1)
14:
15:       if (Node.u_thr < u_ave)
16:             Node.u_thr = u_ave
17:       if (Node.o_thr < o_ave)
18:             Node.o_thr = o_ave
19: }
```

Figure 2. Pseudo-code on average threshold computation

3. Experimental Evaluation

In this simulation, we set α to 10 and*n*to 5 and the total number of nodes is 1000. Figure 3showsthe threshold values of each node. In Figure 3, *Init_O_Thr* and *Init_U_Thr* mean the threshold values of each node when our scheme is not applied. *Prop_O_Thr* and *Prop_U_Thr* mean the threshold values of each node when our scheme is applied. As a result, we can see that the average thresholds of a whole network are raised from (68, 27) to (75, 33), andthe standard deviation of thresholds is reduced from (10, 10) to (4, 4). Figure 4showsload ratios according to load distribution. The proposed load balancing scheme based on the threshold computation process changed the load status ratios from overload 30%, middle-loaded 41%, and under-loaded 29% to overload 11%, middle-loaded 63%, and under-loaded 26%. The standard deviation of load ratios was reduced from 28 to 20.

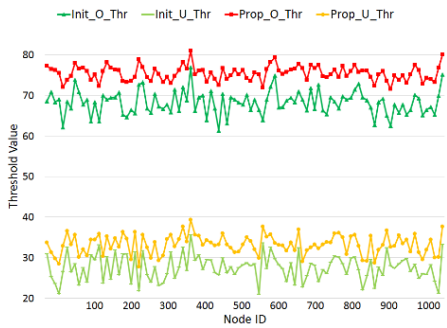

Figure 3. Threshold values of each node

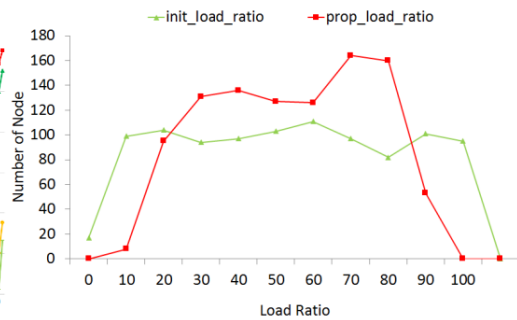

Figure 4. Load ratio according to load distribution

4. Conclusion

In this paper, we proposed a dynamic load balancing scheme based on a threshold computation process in structured P2P networks. According to this threshold computation scheme, each node sets its own threshold and the thresholds of all nodes in network are set evenly. The simulation results have shown that the proposed dynamic load balancing scheme reduces the standard deviation of thresholds by setting thresholds more evenly and the standard deviation of load ratios by transferring the load from overloaded to under-loaded. As a result, our scheme could fairly set thresholds and distribute the load efficiently.

5. References

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