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A SOLUTION FOR REPLICA CONSISTENCY MAINTENANCE IN UNSTRUCTURED PEER-TO-PEER NETWORKS

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Abstract: - Recently Peer-to-Peer (P2P) networks have become an attractive architecture for file sharing. Distribution of copies of the files in the network is a desirable approach to better file sharing. The important issue related to this approach is replica integrity. In this paper, we propose a strategy based on a subset of nodes that is able to broadcast update message to nodes which are not in the subnet to keep replicas consistent in unstructured P2P networks. We employ MP algorithm to construct the desired subnet and consider bandwidth and degree of node as factors to minimize the size of the subnet. The results of our simulation in PeerSim simulator show that the proposed algorithm is more efficient and effective than the previous works and it has high scalability and reliability in unstructured P2P networks.

Keywords*:* Unstructured Peer to Peer network, Replica Consistency, Update Message, Connected Dominating Set, Bandwidth

1. Introduction

Peer-to-Peer networks have become as one of the most popular distributed network architecture on the Internet. A *P2P* network is a paradigm that nodes' roles and capabilities are equivalent. Stability, scalability, autonomy and symmetry are characteristics that distinguish *P2P* architecture from others architectures. P2P networks can be classified based on node connectivity and the network topology as unstructured or structured. Structured networks use a global and constant topology. In this type of *P2P* networks, distributed hash table is used to store data information of nodes. Network nodes according to identity assigned to them are communicating with the specified of neighbours. A key is attributed to each file in the network that created by hash function. Instead, an unstructured *P2P* networks have no stable topology and nodes randomly connect to each other and build network (Druschel *et al.*, 2002), (Shen *et al.*, 2010), (Vu *et al.*, 2009), (Buford *et al.*, 2009), (Meng *et al.*, 2012).

In *P2P* networks, data replication is a solution that a file be available when it is needed and it also ensures load-balance of the system. The main requirement from replication is replica integrity. Therefore, it is necessary to manage update of replicas to keep replicas consistent and propagate update messages containing information about changes. (SriguruLakshmi *et al.*, 2013), (Hasan *et al.*, 2005), (Vijendran & Thavamani, 2012)

In this paper, we propose a replica consistency maintenance algorithm based on a connected subnet of network nodes. Wu and Li's (2006) marking process (*MP*) is a simple and distributed algorithm for the calculation of this connected subnet. Many parameters can be considered to reduce the size of the subnet such as node's id, degree, energy or its' bandwidth (Ramalakshmi and Radhakrishnan, 2012). In this paper, we select the minimum subnet according to *MP* algorithm and two reduction rules that considered the bandwidth and degree of node as factors.

The rest of the paper is organized as follows. Related work is discussed in Section 2. The marking process and the reduction rules are defined in Section 3 and also a detailed description of the connected-dominating-set based replica consistency maintenance algorithm in unstructured P2P networks is presented in this section. Section 4 provides the simulation results.

2. Related Work

Data availability is one important explanation to distribute replicas across different nodes. For modifiable replicas, creating a change in one replica, will violate consistency of replicas and therefore answers to the queries will be different (Gray *et al*, 1996), (Thampi, 2010), (Martins *et al*, 2006). In structure *P2P* networks, *DHT* guarantees replica consistency maintenance. In unstructured *P2P* networks, many techniques have been proposed to enforce consistency and to relieve this problem (Shen & Liu, 2013), (Shen, 2010), (Li *et al.*, 2008), (Wang *et al.*, 2007), (Nakashima & Fujita, 2013), (Chen *et al.*, 2005), (Wang *et al.*, 2009).

Flooding is the simplest algorithm to implement for keeping replica consistent in unstructured *P2P* networks. In this algorithm, each node forwards every receiving update messages to all its neighbours except the one which it receives message. Generating a large number of duplicate update message is the major problem of this algorithm (Clarke *et al*, 2001), (Barjini *et al.*, 2011).

Meng *et al.*, proposed an algorithm that inserts the update path information in update message by clone, variation and crossover operations. Child peers add the update path information of theirs parents in path information that called clone operation. Peers insert their IDs and their child peer IDs into message by variation operation. Crossover operation is used by joint peers that merging the path information of different paths is their responsibility (Meng *et al.*, 2012). Although, high update success rate is the paper advantage, but multiple duplicated update messages are received by peers (Meng *et al.*, 2014).

Ant colony model is employed by Meng *et al*. (2014) for replica consistency maintenance. Ant walks forward and updates replicas. File's pheromone is updated in ant's coming back. Each peer modifies its' replica by receiving ant. At the end of the TTL (Time to Live), ant returns the passing paths. Ant colony algorithm does not guarantee network scalability.

3. Proposed Algorithm

3.1 Connected Dominating Set Construction Algorithm (B-CDS)

In given an undirected graph$G = (V, E)$, a dominating set is a subset $S \subseteq V$ of its nodes such that for all nodes $v \in V$, either $v \in S$ or a neighbour u of v is in S. If induced graph $\acute{G}(S)$ is connected, the subnet is called connected dominating set (Yang *et al.*, 2005), (Wattenhofer & Wagner, 2007), (Wu & Li, 1999).

In this paper we use the bandwidth and degree of nodes to determine minimum connected dominating set. Our algorithm for connected dominating set construction is based on bandwidth (*B-CDS*) and consists two phases: *CDS* Computation Phase and Reduction Phase. Wu (2006) proposed a simple decentralized algorithm for the determination of connected dominating set based on marking process. We have used *MP* for computation phase.

Ramalakshmi and Radhakrishnan (2012) proposed two rules for energy stable connected dominating set construction using node energy level and velocity. In this paper, we modify the rules proposed by Ramalakshmi and Radhakrishnan (2012) with node degree and its bandwidth for reduction phase to minimize the connected dominating set size generated from the *MP*. First, we define some notations in table 1 then modify the *MP* and the rules.

Table 1: Notations

Notations	Comment
$N(v)$	Open neighbour set of node v
$N[v]$	Closed neighbour set of node v $N[v] = N(v) \cup \{v\}$
$Band_v$	Bandwith of node v
Deg_v	Number of neighbors of node v

In the *MP*, *CDS* consists of the nodes that have two neighbours that are not adjacent. Each node v send $N(v)$ to all its neighbours, and receives $N(u)$ from them. If node v has two neighbours u, w and w is not in $N(u)$ (since the graph is undirected u is not$N(w)$), then v marks itself being in the set *CDS*. Two rules are provided to reduce the size of the *CDS*.

In the following, we describe the rules to minimize the vertices in graph$\acute{G}$.

Rule 1: Consider two marked vertices v and u of$\acute{G}$. The marker of v is changed to F if one of the following conditions is satisfied:

i) $N[v] \subseteq N[u]$ in G and $Band_v < Band_u$
ii) $N[v] \subseteq N[u]$ in G and $\mathrm{Deg}_v < \mathrm{Deg}_u$ when $Band_v = Band_u$
iii) $N[v] \subseteq N[u]$ in G and $\mathrm{ID}_v < \mathrm{ID}_u$ when $Band_v = Band_u$ and $Deg_v = Deg_u$

This rule describes when the related neighbor set of node v in the *CDS* is covered by that of another node u, then node v can be removed from the *CDS*, if the bandwidth of v is smaller than u. If bandwidth of u and v are the same, degree is used to split them. If both bandwidth and degree of u and v are same, node's ID can be used to split them (Li *et al.*, 2010), (Ramalakshmi and Radhakrishnan, 2012).

Rule 2: u and w are assumed that two marked neighbours of marked vertex v inG'. The marker of v can be changed to F if one of the following states is satisfied:

1) $N(v) \subseteq N(u) \cup N(w)$, but $N(u) \not\subset N(v) \cup N(w)$ and $N(w) \not\subset N(u) \cup N(v)$ in G
2) $N(v) \subseteq N(u) \cup N(w)$ and $N(u) \subseteq N(v) \cup N(w)$, but $N(w) \not\subset N(u) \cup N(v)$ in $G$and one of the below states holds:
   A. $Band_v < Band_u$ or
   B. $Band_v = Band_u$ and $\mathrm{Deg}_v < \mathrm{Deg}_u$ or
   C. $Band_v = Band_u$ and $Deg_v = Deg_u$and $\mathrm{ID}_v < \mathrm{ID}_u$
3. $N(v) \subseteq N(u) \cup N(w)$ and $N(u) \subseteq N(v) \cup N(w)$, but $N(w) \subseteq N(u) \cup N(v)$ in G and one of the below states holds:
   A. $Band_v < Band_u$and $Band_v < Band_w$ or
   B. $Band_v = Band_u < Band_w$ and $\mathrm{Deg}_v < \mathrm{Deg}_u$ or $\mathrm{ID}_v < \mathrm{ID}_u$ when $Deg_v = Deg_u$
   C. $Band_v = Band_u = Band_w$then
      i. $\mathrm{Deg}_v < \mathrm{Deg}_u$ and $\mathrm{Deg}_v < \mathrm{Deg}_w$or
      ii. $\mathrm{Deg}_v = Deg_u < \mathrm{Deg}_w$ and $\mathrm{ID}_v < \mathrm{ID}_u$ or
      iii. $Deg_v = Deg_u = Deg_w$ and $ID_v = min\{ID_v, ID_u, ID_w\}$

The upper rule indicates that the neighbor set of node v in the *CDS* is covered by two connected nodes u and w in the *CDS* (Li *et al.*, 2010), (Ramalakshmi and Radhakrishnan, 2012).

3.2 Proposed algorithm to keep replica consistence based on B-CDS

A subnet of network can be created by a *CDS* to keep replica consistent (Atsan & Ozkasap, 2013), (). We employ the marking process and modify two reduction rules based on node degree and its bandwidth to create the connected subnet with minimum size. In this section we describe, how this subnet of nodes are responsible for propagating update message and replica consistency maintenance in the unstructured Peer to Peer networks.

The node which initiates an update sends update message to its neighbor in the dominating set, along the *CDS* to the dominator neighbor to each node that has a copy of updated file. Table 2 presents the proposed algorithm.

Table 2: Algorithm to keep replica consistence

```
The update is initiated by node S
IF (S is a non-CDS node)
    Sends update message to its CDS neighbor node
Else go step 1
    Step1: CDS node checks conflicts
   CDS node searchs its DHT and Finds RPs
    CDS sends update message to its RP and CDS neighbors
For (Each RP)
    nodes update its replica by reciveing message
For (Each  CDS node reciveing message)
   Go step 1
```

3. Simulation

In this section, the simulation results are presented. We implemented our algorithm, with *Peersim* simulator. To examine the performance of our algorithm in terms of the number of propagated update messages and the update time, we compare our algorithm with *flooding* and approach proposed by Meng that is denoted as *OPT* and ant colony algorithm presented by Meng *et al.* In our simulations, the number of nodes *n* has been set to 500, 600, 700, 800, 900 and 1000. There are 1000 different files in the network. Each file and its replicas are randomly distributed in the network, and each node provides 40 shared files in the network.

3.1 CDS Size

"Figure 1," presents number of nodes consisted in the *CDS* with different degree values 7, 8 and 9. As shown, with increasing of network size, *CDS* size increases. This increment is linear and it shows our result is optimal and depends on size of *CDS*, we can coverage all nodes in the network.

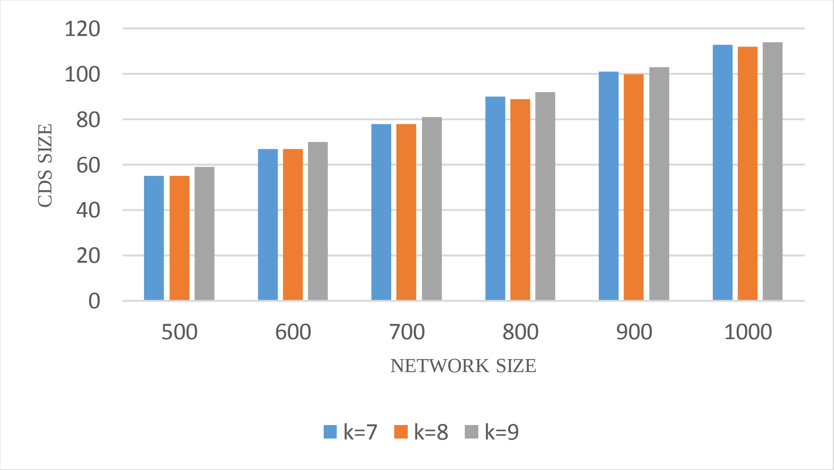

Figure 1: Evolutions of *CDS* size over network size

3.2 Update Message

As shown in "Figure 2," the numbers of update messages increase with the number of nodes for the four strategies. The numbers of update messages for *flooding* and *OPT* approaches both increase significantly with the increase of the number of nodes because of forwarding update messages to all of the nodes. Although, *OPT* by using clone, variation and crossover operations for the update paths propagates lower redundant update messages than *Flooding*. Ant colony has the best performance than *flooding* and *OPT* and broadcasts lowest messages. Our approach significantly reduces propagation of unnecessary update messages and it is because of using *CDS* with efficient broadcasting.

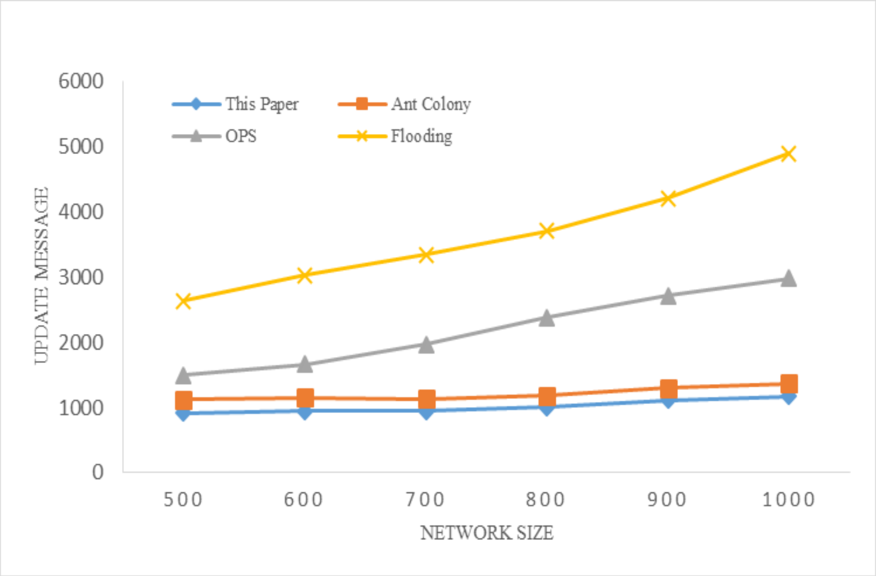

Figure 2: Evolutions of numbers of update messages over network size

3.3 Update Time

The other important performance parameter is update time which measures the difference between the time an update is initiated and the time all nodes having updated file successfully achieve the update message. As shown in "Figure 3," our strategy has a linear and short update time in the *P2P* networks. Linearity of our results as shown proofs that the update time depends only on the *CDS* nodes. *B-CDS* propagates update message in shortest time than others. In ant colony, ant' traffics and diagnose best path for update message take time.

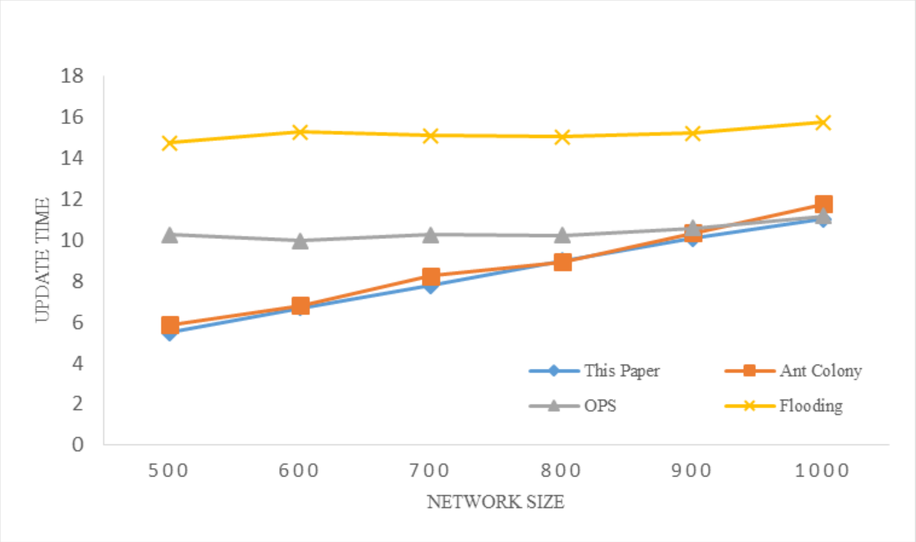

Figure 3: Evolutions of update time over network size

4. Conclusion

This paper focuses on addressing the issue of file consistency maintenance in unstructured Peer to Peer networks. In this paper we have proposed *B-CDS* algorithm. The *CDS* is constructed by using the marking process with the two reduction rules based on bandwidth and degree of nodes. In our approach new set of parameters has been used to keep selected *CDS* nodes reliable and more efficient. The simulation results show that our strategy scale well in terms of number of the redundant update messages and update time when the size of network increases.

REFERENCES

[1] Atsan, E., Ozkasap, O. 2008. SCALAR: Scalable Data Lookup and Replication Framework for Mobile Ad-hoc Networks. *2008 The 28Th International Conference on Distributed Computing Systems Workshops*.

[2] Barjini, H., Othman, M., Ibrahim, H., Udzir, N. 2011. Shortcoming, problems and analytical comparison for flooding-based search techniques in unstructured P2P networks. *Peer-To-Peer Networking And Applications*, *5*(1), 1-13.

[3] Chen, X., Ren, S., Wang, H., Zhang, X. 2005. SCOPE: Scalable consistency maintenance in structured P2P systems, 3, 1502--1513.

[4] Clarke, I., Sandberg, O., Wiley, B., Hong, T. 2001. Freenet: A distributed anonymous information storage and retrieval system, 46--66.

[5] Gray, J., Helland, P., O'Neil, P., Shasha, D. (1996)"The dangers of replication and a solution", ACM SIGMOD Record, vol. 25, no. 2, pp. 173-182.

[6] Buford, K., Yu, J., Lua, E. 2010. *P2P networking and applications*. Amsterdam: Elsevier/Morgan Kaufmann.

[7] Li, Y., Wu, Y., Ai, C., Beyah, R. 2010. On the construction of k-connected m-dominating sets in wireless networks. *J Comb Optim*, *23*(1), 118-139.

[8] Meng, X., Wang, Y., Ding, Y. 2012. An optimized strategy for update path selection in unstructured P2P networks. *Computer Networks*, *56*(17), 3744-3755.

[9] Meng, X., Zhang, C. 2014. An ant colony model based replica consistency maintenance strategy in unstructured P2P networks. *Computer Networks*, *62*, 1-11.

[10] Nakashima, T., Fujita, S. 2014. Tree-Based Consistency Maintenance Scheme for Peer-to-Peer File Sharing of Editable Contents. *IEICE Transactions On Information And Systems*, *E97.D*(12), 3033-3040.

[11] Ramalakshmi, R., Radhakrishnan, S. 2014. Weighted dominating set based routing for ad hoc communications in emergency and rescue scenarios. *Wireless Netw, 21(2)*, 499-512.

[12] Shen, H. 2010. IRM: Integrated File Replication and Consistency Maintenance in P2P Systems. *IEEE Trans. Parallel Distrib. Syst.*, *21*(1), 100-113.

[13] Shen, H., Liu, G. 2013. A Geographically Aware Poll-Based Distributed File Consistency Maintenance Method for P2P Systems. *IEEE Trans. Parallel Distrib. Syst.*, *24*(11), 2148-2159.

[14] Shen, X. 2010. *Handbook of peer-to-peer networking*. New York: Springer.

[15] SriguruLakshmi, C., Sivakumar, G., Venkatachalam, V. (2013). Survey on Caching and Replication Algorithm for Content Distribution in Peer to Peer Networks. *IJCSEIT*, 3(5), 17-32.

[16] THAMPI, S. (2010). SURVEY OF SEARCH AND REPLICATION SCHEMES IN UNSTRUCTURED P2P NETWORKS, NPA, vol. 2, no. 1.

[17] Vu, Q., Lupu, M., Ooi, B. (2010). Peer-to-peer computing. Heidelberg: Springer. Vijendran and S. Thavamani, "Survey of caching and replica placement algorithm for content distribution in Peer to Peer overlay networks", *Proceedings of the Second International Conference on Computational Science, Engineering and Information Technology* - CCSEIT '12, 2012

[18] Wagner, D., Wattenhofer, R. 2007. *Algorithms for sensor and ad hoc networks*. Berlin: Springer.

[19] Wang, Z., Das, S., Kumar, M., Shen, H. 2007. An efficient update propagation algorithm for P2P systems. *Computer Communications*, *30*(5), 1106-1115.

[20] Wang, Z., Datta, A., Das, S., Kumar, M. 2009. CMV: File consistency maintenance through virtual servers in peer-to-peer systems. *Journal Of Parallel And Distributed Computing*, *69*(4), 360-372.

[21] Wu, J., Li, H. 1999. On calculating connected dominating set for efficient routing in ad hoc wireless networks. *Proceedings Of The 3Rd International Workshop On Discrete Algorithms And Methods For Mobile Computing And Communications - DIALM '99.*

[22] Yang, C., Wu, J. 2005. Dominating-Set-Based Searching in Peer-to-Peer Networks. *Grid And Cooperative Computing*, 332-339.

A Brief Author Biography

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