Dual Bootstrap Server Based Superpeer Overlay Construction

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Abstract - Many two-layer hierarchy unstructured peer-to-peer (P2P) systems, comprising of superpeers and ordinary peers improved the performance of large scale P2P systems. The construction and maintenance of the superpeer overlay network play an important role in improving the performance P2P systems. One efficient method of constructing the superpeer overlay network is based on notion of Perfect Difference Networks(PDN).The construction and maintenance of network in this method is controlled by single bootstrap server. Such network is prone to single-point failures. The number of registration requests lost before getting up the failed bootstrap server and the delay in adding new peer to the network gets increased. The mechanism of maintaining and constructing the superpeer overlay network by making use of two bootstrap servers having slight different functionality proposed in this paper avoids single-point failures. It also ensures no loss of registration requests. The experimental results show that the delay in adding new peer to the network and number of registration requests lost are reduced.

Keywords- Unstructured P2P system; Perfect Difference Network; Superpeer; Bootstrap server;

I. INTRODUCTION

Designing of interconnection architectures is an important and difficult task in the implementation of high performance parallel and distributed systems[3] [5]. Network design or the system architecture is the one important factor to be considered inorder to enhance the performance of any computer network. The research in Parallel and distributed systems is mainly concerned with the process of interconnecting nodes and the way of maintaining the network which helps in achieving a reliable network construction. Some conventional unstructured P2P systems such as Gnutella[1] and KaZaA [2] showed many advantages in the execution of the large scale distributed applications and used both superpeers and ordinary peers. The network architecture in P2P systems at the beginning, considered all the nodes as an ordinary peers but later on some nodes which can perform better than the other nodes are marked as superpeers or ultrapeers and are introduced into the network. Two- layer hierarchy unstructured P2P systems comprised an upper layer of superpeers and lower layer of ordinary peers. Superpeers can act as servers to the ordinary peers and render their services to the ordinary peers. Network design involved various issues like how the connections between superpeer to superpeer and superpeer to ordinary peer, the degree of superpeers and the topology of the network. One efficient method is the construction of the superpeer overlay network is based on the Perfect Difference Network (PDN) developed on the notion of Perfect

Difference Graphs [4]. The maintenance of this network is done by single bootstrap server. The maintenance of the network includes attaching the new peer to the network, departing peers, maintenance and updating of superpeer table and many more. Put in simple words the reconstruction of the network as new peers join and existing peers leave is to be totally controlled by the bootstrap server. The maintenance of superpeer overlay network by single bootstrap server is not always advisable as it can cause single-point failure. The registration requests of new joining peers are to be handled by the bootstrap server. The failure of central administrator that is the bootstrap server causes the loss of registration requests. Apart from this the delay in adding the peer to the network also gets increased as there is no requests storage mechanism with the bootstrap server. This problem can be avoided by making use of two bootstrap servers of slight different functionality with storage mechanism.

II. RELATED WORK

The idea of avoiding single-point failures in superpeer overlay networks lead to the concept of multiple bootstrap servers. Making use of multiple bootstrap servers arised many design issues like on what basis the number of bootstrap servers has to be taken, which method is to be followed for synchronization of those bootstrap servers, should all or only some should receive the registration or departure requests and many more....

The first solution is that making use of multiple bootstrap servers depending on the size of the network that is depending on the total number of peers participating in the network. It is taken one bootstrap server for network involving 25 peers and an increment of 3 bootstrap servers for increment of peers by 100.For network having 125 totally (1+3) bootstrap servers, for 225 peers (1+3+3) bootstrap servers and so on. Although this avoided single-point failure s, it raised other problems like hardware cost, incompatible with lage-scale P2P systems, how the synchronization has to be established between those servers. It increased the overload on the network due to the packets used in achieving the synchronization. The loss of registration requests may also occur before the manual interference in getting up the failed server.

The second solution is that of taking the two bootstrap servers of same functionality. That is each can perform the entire task. Initially both the servers can process the requests, can maintain the superpeer tables and can send the updated table to the other. If at all any one of the bootstrap server fails, it does not cause single-point failure as the second one is functioning. Usage of two bootstrap servers with similar functionality require same hardware configurations which increases the cost of hardware. Other issues like what if both the servers fail in the same time, what if the second also goes down before getting up the first failed bootstrap server are also to be dealt with.

III. PERFECT DIFFERENCE NETWORK AND SUPERPEER OVERLAY NETWORKS

A. *Perfect Differnce Networks*

Perfect Difference Networks are constructed on the notion of Perfect Difference Graphs. PDS are predefined and the correlation among number of vertices, superpeer order, and Perfect Difference sets are as shown in the table 1.

Definition: A PDG is an undirected interconnection graph of $n = \delta^2 + \delta + 1$ vertex, numbered from 0 to n-1. Each vertex i is connected through undirected edges to vertices $(i \pm S_j)$ (mod n) for $1 \leq j \leq \delta$, where S_j is an element of the PDG $\{S_1, S_2, \ldots S_j\}$ of order δ.

Taking the example of $\delta = 2$, n=7 vertices and PDS {1, 3}. Here the vertex '0' is connected to (0±1)mod 7 and (0±3)mod7 that is the vertex '0' is connected to 1,6,3.4.

- *Ring edge*: The edge connecting consecutive vertices i and i± S_1(mod n).where S_1=1.For vertex 0:(0,1)and (0,6)

- *Chord edge*: The edge connecting non consecutive vertices i± S_j(mod n).$2 \leq j \leq S_j$. For vertex 0:(0.3)and(0,7)

- *Forward edges*: For vertex i the forward edges include the chord edge connecting vertices i and i+ S_j(mod n) and the ring edge connecting vertices i and (i+ S_1)mod n. For vertex 0 :(0, 1) and (0, 3) are forward edges.

- *Backward edges*: For vertex i.the backward edges include the chord edge connecting vertices i and i- S_j(mod n) and the ring edge connecting vertices i and (i+ S_1)mod n. For vertex 0 :(0, 1) and (0, 3). For vertex 0 :(0, 4) and (0, 6) are backward edges.

The network which has got the nodes interconnected in similar manner to that of Perfect Difference Graph is said to be Perfect Difference Network.
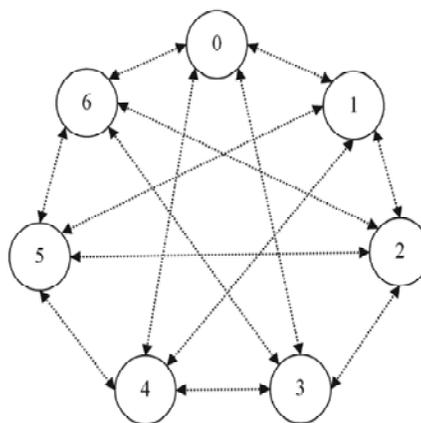

Fig.1: Perfect Difference Graph with seven vertices with PDS {0, 1}

In Fig. 1, the forward edges of vertex 0 are the edges connecting vertex 0 to vertices 1 and 3, respectively, while the backward edges are the edges connecting vertex 0 to vertices 4 and 6, respectively.

TABLE.1

Relation among number of vertices, superpeer order, and Perfect Difference sets

n	δ	Perfect difference sets
7	2	1,3
13	3	1,3,9
21	4	1,4,14,16
31	5	1,3,8,12,18
57	7	1,3,13,32,36,43,52
73	8	1,3,7,15,31,36,54,63
91	9	1,3,9,27,49,56,61,77,81
133	11	1,3,12,20,34,38,81,88,94,104,109
183	13	1,3,16,23,28,42,76,82,86,119,137,154,175
273	16	1,3,7,15,63,90,116,127,136,181,194,204,233,238,255

B. super peer overlay networks

Similar to the construction of Perfect Difference Network the superpeers are connected and further the ordinary peers are connected to the superpeers. The peers which have a fast internet connection such as upload speed of 1MB/S and download speed of 2MB/S are selected as superpeer. The construction and maintenance of superpeer overlay network by single bootstrap server represent single-point of failures and in the later sections we discuss how the network is constructed by making use of two bootstrap servers.

II. SYSTEM CONSTRUCTION

In the proposed method of construction and maintenance of the Superpeer overlay network, two nodes exist as an entry point for new nodes wishing to join the network. One node among it is termed as Main-Bootstrap Server (MBS) and the second one is named as Intermediate-Bootstrap Server (IBS). Both the bootstrap servers together are responsible for construction and maintenance of the network.   The Intermediate-Bootstrap Server is the first entry point for new nodes. Any node wishing to join the network sends the requests to IBS then request is forwarded to MBS then MBS process the requests, gives the response   and finally IBS gives response to the new peer. The functionality of both the servers is different from the functionality of the bootstrap server used in [7].

Functions of Intermediate-Bootstrap Server:

- Receive the requests from both new peer and existing peer

- Forward the requests to MBS

- Store the requests in queue if found MBS is busy or failed

- Receive the response from the MBS

- Forward the response to the peer that has requested.

Functions of Main-Bootstrap Server

- Receive the requests from IBS

- Process the request and either select or reject as superpeer

- Forward the response to IBS

- Maintenance of superpeer table

TABLE.2

Superpeer table maintained by Main-Bootstrap Server

Vertex ID	Address of super-peers	Forward connections	Backward connections	Status
0	IP_A	IP_B, IP_D	IP_E, IP_G	1
1	IP_B	IP_C, IP_E	IP_F, IP_A	1
2	IP_C	IP_D, IP_F	IP_G, IP_B	1
3	IP_D	IP_E, IP_G	IP_A, IP_C	1
4	IP_E	IP_F, IP_A	IP_B, IP_D	1
5	IP_F	IP_G, IP_B	IP_C, IP_E	1
6	IP_G	IP_A, IP_C	IP_D, IP_F	1

In the proposed system construction there are various cases defined on the basis of working status of both the bootstrap servers.

A. System construction when IBS and MBS are functioning

When a new peer wishes to join the network as an ordinary peer it sends the request to IBS. The request is forwarded to MBS after making sure whether the MBS is neither busy nor failed. The MBS on processing the request it gives IBS the list of superpeers that the new ordinary peer can get attached to. IBS further forwards the response to the new ordinary peer. Similarly when the ordinary peer needs to leave from the network it sends the departure request to the IBS, forwarded to MBS, MBS on updating the list of ordinary peers in the network and gives the permission to the peer to leave the network.
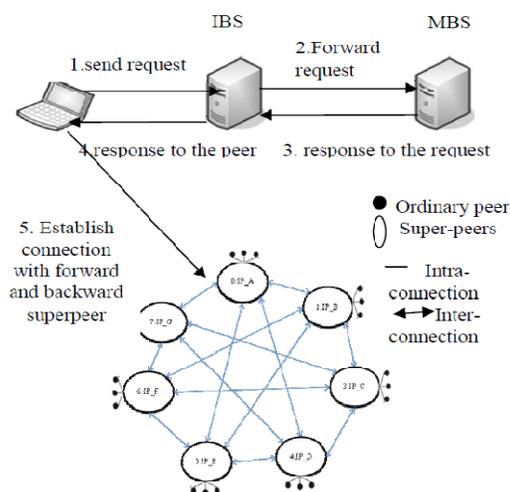

Fig2. illustration showing the new peer joining the superpeer overlay network when both the MBS and IBS are functioning

If the new peer is the superpeer then the procedure is same as the ordinary peer except that the MBS on receiving the request from the IBS it checks the internet speed of the new peer. If it is qualified as a superpeer MBS using the algorithm used in [4] for Extension of Topology to Accommodate New Superpeers the superpeer table is updated and gives the forward and backward connections it can occupy.

B. System construction when IBS is functioning and MBS is not functioning

As shown in the Fig.3 new peer which wishes to join the network issues the request to IBS. IBS forwards the requests to MBS and waits for 0.25 sec and if the response is not arrived due to timely failure or busy of MBS. IBS then gives the response to the peer. The response contains the default superpeer location and the new peer is attached to that superpeer. Then IBS stores all the incoming requests from the peers in queue format. Later MBS on coming up processes the request and either selects or rejects the new peer as superpeer. If the peer is the ordinary peer it sends no response else it updates the superpeer table as shown in Table.2 and sends response to the last request it received before failure. Then IBS asks the new peer to occupy new location also understands that MBS is functioning and forwards the stored requests one by one. On receiving the response to the next request sent it again sends the next stored request and the process continues. This ensures no loss of requests. Then there arises question that how long should the IBS wait for response if the MBS get failed. If MBS goes down for longer time what must be done. In proposed system construction it is taken a threshold time of 6.0 sec and if IBS do not get any response with in this time IBS sends the information to all the likely peers to stop sending any more requests for certain time taken randomly.
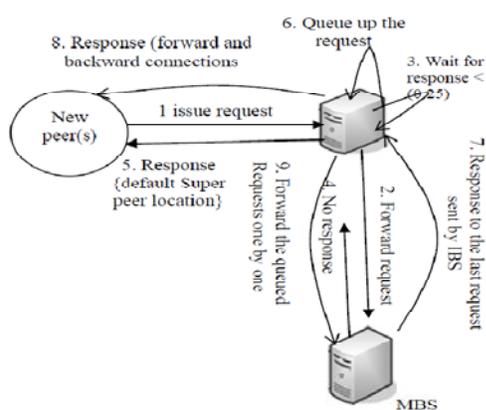

Fig3.diagram showing the process of system construction when MBS do not function for certain time

C. System construction when the IBS goes down for certain period of time

Till now we have discussed system construction on the basis of working condition of MBS there is also a condition of IBS failure. As in the previous cases the requests are issued to the IBS but the peer is unaware that the IBS went down. Thinking that the request may be lost in between it starts resending the request. If the IBS goes down for shorter time the resending of request do not add overload on the network also do not give much delay in construction process. If it goes down for longer time then the network construction gets stopped. So in order to avoid this situation the threshold time calculated as (time taken by request packet to reach MBS via IBS+Time taken to receive response from MBS via IBS+constant) where constant value is taken randomly depending on how frequently the MBS gets failed is calculated. In the proposed system, peer on waiting for this threshold value of time, peer can directly send the request to the MBS and can get response from the MBS. This conserves the time and helps in continuous process of construction without any disturbance to the network.

V. PERFORMANCE EVALUATION

This section presents the results showing how the performance of superpeer overlay construction is improved in terms of the reduced average delay in adding the new superpeers to the network and reduced number of requests wasted. To evaluate the performance of dual bootstrap server based superpeer overlay network the network is constructed using PDN topology taking δ=2. Two bootstrap servers are as the entry points in proposed system. We allowed the three cases discussed in earlier section of system construction and calculated the average delay in adding new peers to the network. At the first stage the MBS is set to fail and recover after random time. Both the servers are set with condition of going up and down randomly. Apart from this the average delay and number of requests wasted is calculated for the system construction using single bootstrap server. The input for generating the results is taken as the status of bootstrap servers over simulation time. If the bootstrap server is up plotted as 1 else 0. The delays are calculated for each request made in both the methods and plotted as shown in Fig.4 and the number of request lost in both the systems over simulation time is as shown in Fig.5

To make clear understanding of the results the average values are calculated and are as shown in the table.3

Table - 3

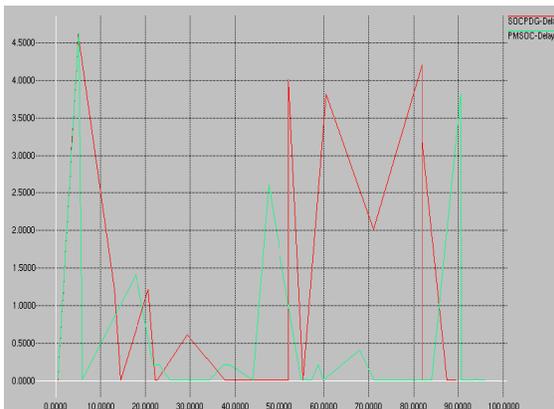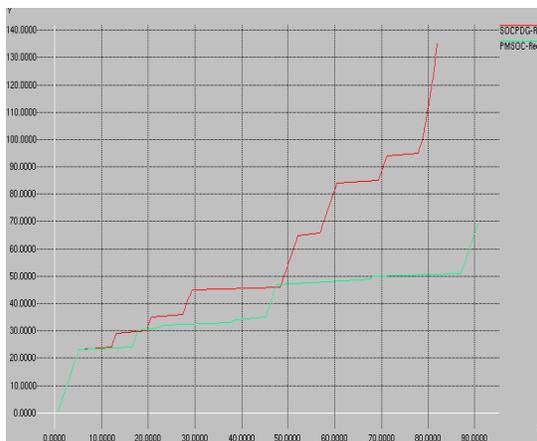| Parameter	Single bootstrap server based construction	Dual bootstrap server based construction
Average delay	1.82	1.256
Number of requests wasted	134	69

Fig 4. The average delay vs. simulation time

Fig .5 simulation results of number of requests lost vs. simulation time

VI. CONCLUSION

This paper has presented the method of using two bootstrap servers for constructing and maintaining superpeer overlay network based on PDG method. In addition, the failure of both the bootstrap servers is also handled. The experimental results have shown that dual bootstrap server based superpeer overlay construction reduced the number of requests lost and reduced the average delay in adding new peer as either ordinary or superpeer.

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