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A Dynamic Perfromance of Multi-Tier Clustered Architecture for Peer to Peer Overlay Networks

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Abstract: Structured peer to peer network has fixed structure that will be formed as fixed topology. If any of the node leaves or enters in the network, topology may vary. That will lead to load failure, link failure and resilience. To overcome these issues, proposed a new architecture as Multi-Tier clustered architecture (MCA) and it has more number of networks with different topologies. That different network will be connected via cluster head and it will be formed as overlay peer to peer network. If the value of M is equal to 3, multi-tier clustered architecture connects the three different topologies such as tree, mesh and star. Each topology selects its own cluster head and that cluster head will be connected to the cluster head of other topology network. Cluster head is used to monitor the network that reduce the issues occur due to the link failure, node failure and resilience and this will maintain the topology also. Simulation results have shown that the proposed technique reduces the delay and increases the drop rate and delivery rate.

Key words: Multi-tier, Peer to peer networks, overlay networks, topology maintenance, clustered architectur.

INTRODUCTION

Overlay network is formed through the peer to peer network and it has two different types based on their topologies. Structured peer to peer network has fixed topology with distributed systems and unstructured peer to peer network has not any fixed topology and this generates based on the random peers. Structured peer to peer network uses the distributed hash table for secure communication. Generally, peer to peer network has the high flexibility and it can communicate to any type of nodes. That will lead to contact the malicious nodes and that will degrade the network performance. To avoid that used the distributed hash table with key value pairs in each routing table. Based on the hash function, generates the key value that will be reserved for each peers in the peer to peer network. Combining the different type of peer to peer network is the overlay architecture. Based on the application, it has multi-tier level connected different type of network. Connecting multiple networks has different types such as underlying and overlay. Underlay network is connecting bottom of the network and the overlay network is connecting the top of the network. In overlay network, all the nodes are moved to top of the network for better transmission. Topology maintenance is major task in the peer to peer overlay networks because different types of network are connecting inside in the network. Resilience is another issue in this peer to peer overlay networks that leads to link failure, single point failure and reduce the capacity of the network.The nature of the peer to peer exhibits some following features:

- Less robustness
- High quality of services
- Low routing overhead
- Good performance and improvement
- High collision

Buyukkaya *et al.* (2015) suggest the networked virtual environment for the peer to peer overlay networks. This networked virtual environment is mostly used in the multiplayer online games, military applications and social virtual words. Tahta *et al.* (2015) presents the robust trust management model for peer to peer network with the genetic programming. Due to the flexibility of peer network, it has faces many security attacks. To avoid that used a robust trust management model.

Literature review: Zhou *et al.* (2016)explains about the data prefetching scheme for peer to peer network to avoid

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the access delay and increase the quality of service. Ferreira *et al.* (2016) characterizes the SopCast technique which is one of the peer to peer application. Moustakas *et al.* (2016) discuss about the topology mismatch problem in structured and unstructured peer to peer networks. Meng *et al.* (2016) introduces the new trust model to avoid the issues occur in the rough trust model and simplistic trust model. Freitas (2016) proposed the microblogging network architecture with three different network. The first network is used to authenticate the users, second network is used to storing and assigning key for the users and the third network is used to disjoint the affected nodes using the bit tolerant protocol. Wjcik and Drmza (2016) discusses the high active peers in the peer to peer network to avoid the high traffic mechanism. Acampora *et al.* (2016) suggest the fuzzy type 2 logic framework for peer to peer networks.

MATERIALS AND METHODS

The topology aware routing (TAR) for peer to peer network has generated with the help of distributed hash table. This generates the key for each peer nodes for secure communication and also assign the node id for each node to maintain the topology. This technique is mainly focus on to reduce the delay and reduce the security issues. Another technique is to avoid the live video streaming, used the new technique is hybrid push-pull topology [HP2T] in peer to peer network. This has two different networks such as push tree topology for push the data from parent node to child node. Another as pull mesh topology for pull the data from the neighbor odes. Connecting these two different topologies, generates a hybrid push pull peer to peer network. This scheme is used to increase the quality of service suggested by Tran *et al.* (2016). These two existing techniques has high robustness and high routing overhead when maintain the topology in peer to peer network. To avoid these issues generates a new technique as "Multi-tier clustered Architecture [MCA]" for peer to peer network.

Proposed method: Multi-tier clustered architecture for peer to peer overlay network. Consider the different peer to peer networks that has been joined by using the overlay form. Here multi-tier represents the number of networks are joined in the overlay network. "Multi" word represents the more than two of networks are joined. This proposed scheme has three steps to generate a successful architecture that are shown in below:

- Creation of peer to peer network
- Cluster head selection
- Connecting the network to form the overlay structure

Based on these steps, the proposed scheme will be follow. Initially create the structured peer to peer networks with different structures for different type of networks. After that each network selects the cluster head. By connecting the cluster head, overlay network will be formed. This proposed is used to maintain the topology and increase the quality of services.

Description: The structured peer to peer network has to be fixed structure, but this has the different type of structures such as tree topology, ring topology, mesh topology, bus topology and star topology. Tree topology has parent node and leaf node, ring topology is in the form of circle, mesh topology is fully connected, bus topology has in the form of straight line and star topology has partially connected. These are the different type of topologies based on the requirement each topology will be assigned. Here Multi-tier clustered Architecture [MCA] uses the three different structured peer to peer networks with three different topologies such as tree topology, mesh topology and star topology.

Let consider the tree topology as Tg (V,E), Mesh topology as Mg(V,E) and star topology as Sg(V,E):

$$\text{Tree topology, } Tg(V,E) = \sum_{i=1}^{N} G(Vi,Ei) \tag{1}$$

$$\text{Mesh topology, } Tg(V,E) = \sum_{j=1}^{N} G(Vj,Ej) \tag{2}$$

$$\text{Star topology, } sg(V,E) = \sum_{k=1}^{N} G(Vk,Ek) \tag{3}$$

$$\text{The over lay network as, } Op(V,E) \quad \sum_{M\in i,j,k=1}^{N}\sum Tg(vj,Ej)\cup sg(vk,ek) \tag{4}$$

The network will be formed using the above equation. Here V as vertices and E as edges and N represents the number of nodes in the network. M represents the number of tiers and here used the 3 different architectures so that mentioned as Mϵ 3.

Figure 1 shows that the multi-tier clustered architecture when the M is equal to 3. Based on the M values, number of tiers will be generated. The tier selection will be in random and it can select any topology. After fixing the tier levels, topology selection will be made. Here selects the tree, mesh and star topology. Tree topology consist of parent node and leaf nodes. Parent node will be act as cluster head. Each cluster head should be connected to other topology network cluster head.

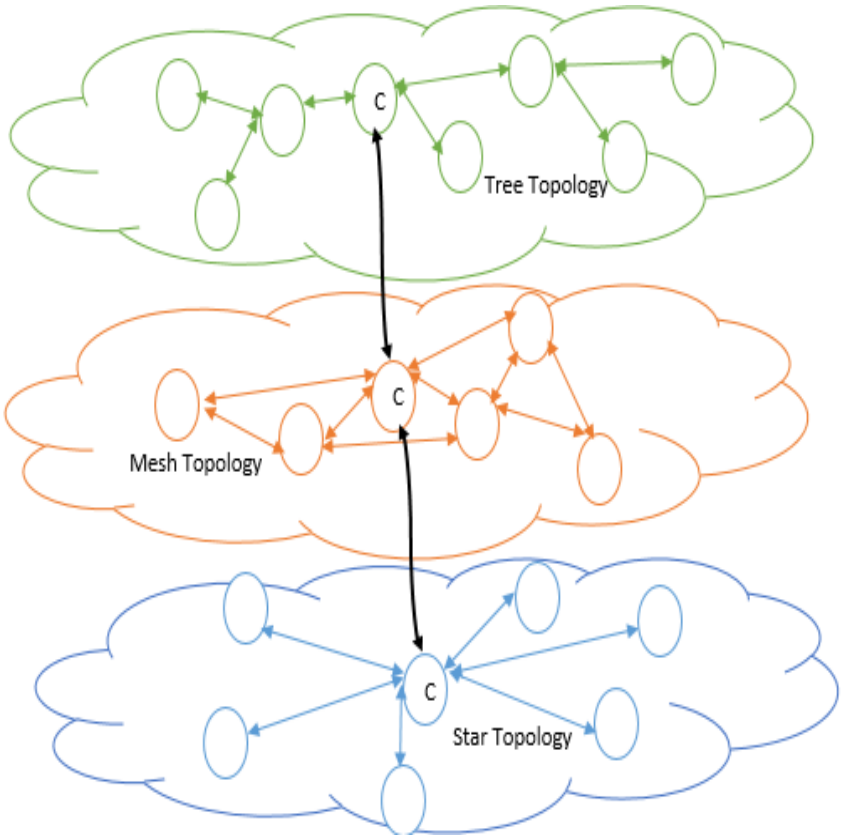

Fig. 1: Multi-tier clustered architecture, when M=3.

Mesh topology network architecture consist of all the nodes are internally connected. Cluster head selection is based on the more number of neighbor node. If any of the node carries more number of neighbor node that node will be assigned as cluster head. That cluster head should be connected to the other remaining topology network cluster head. Star topology consist of centralized node and neighbor nodes and then centralized node will be act as cluster head and that will connected to the remaining network cluster head. After connecting all cluster head, that will be formed as overlay network. Cluster head is used to monitor the cluster members and also intimate about the node changes that will reduce the resilience and link failure.

Algorithm A:

//3-tier network architecture//
If M=3
Select rand(topo) // select the three random topology
Case-1 tree → equation 1 // create network by using equation 1
Case-2 mesh → equation 2// create network by using equation 2
Case-3 star → equation 3// create network by using equation 3
End case
End if
//Case-1: Tree topology P2P network architecture//
Tg(Vi,Ei) ¥ i=1,2,3….n number of nodes
Tg(Vi,Ei)== P(Vi)UC(Vi+1) // P(Vi)- parent node, C(Vi+1) – child node
P(Vi)_C(Tg) // parent node as Cluster head
End
//Case-2: Mesh topology P2P network architecture//
Mg(Vj,Ej) ¥ j=1,2,3….n number of nodes
Mg(Vj,Ej)== N(Vj)UN(Vj+1) // N(Vj) as neighbor nodes
If N(Vj)>>N(Vj+1){No(Neig)}
N(Vj)_ C(Mg) // Node carrier high number of neighbor nodes - cluster head
End
//Case 3: Star Topology P2P network architecture//
Sg(Vk,Ek) ¥ k=1,2,3….n number of nodes
Sg(Vk,Ek)== C(Vk)UN(Vk+1) // C(Vk)- centralized node, N(Vk+1) – Neighbor nodes
C(Vk)_C(Sg) // centralized node as Cluster head
End
// Overlay Formation//
Connect {C(Tg), C(Mg), C(Sg)}// connect all cluster heads
Data transmission {C(Tg), C(Mg), C(Sg)}
While x=i or j or k
If (Vx leaves/enters)
{C(Tg), C(Mg), C(Sg)} intimate to all nodes
End if
end

Algorithm A states the process of the proposed Multi-tier clustered Architecture [MCA]. Initially, tire level has been decided. Based on the M values, number of peer to peer network with different topology has been selected. Each topology is constructed with set of rules and

principles. After that cluster head selection is proceed for each peer to peer network. Based on the topology nature, cluster head will be selected. All the cluster heads are connecting and form the overlay peer to peer networks. Data transmission will start between the cluster head and with their respective cluster members. If any of the node leaves or joins the network, cluster head will be intimated to their respective cluster members as well as other cluster head. This lead to maintain the topology in the peer o peer overlay networks. Cluster head is used to monitor the cluster members, so if any node failure or link failure that will be known by the cluster head with the help of cluster members. This lead to avoid the resilience and link failure.

RESULTS AND DISCUSSION

Simulation results shows that the proposed Multi-tier clustered Architecture [MCA] has analyzed using network simulator. The number of nodes are vary from 100-500 nodes and the physical medium is wireless medium. The constant bit rate of packet size is 1000 bytes and the interval time between the each packet is 0.01 seconds. The queueing size is 50 cm and the queuing time limit is 50 sec. The simulation ends within 200 sec. The performance has analyzed using different parameters such as drop rate, delay and delivery rate.

Figure 2 shows that the delivery rate analysis and it is defined as the ratio of number of packets successfully received with respect to the number of packets transmitted. The existing topology aware routing (TAR) and hybrid push-pull topology [HP2T] has reduces the delivery rate due to the less topology maintenance. The proposed multi-tier clustered architecture has analyzed in three different architecture by varying the number of networks. If the peer to peer overlay networks has 3 topologies are used that will be noted as MCA [M=3]. If the number of topologies as 5 that will be denoted as MCA [M=5]. If the number of topologies as 7 that will be denoted as MCA [M=7]. By varying the topology size, the proposed network performance has analyzed. When increasing the number of peer to peer networks with different topology, delivery rate also increases.

Figure 3 shows that the drop rate analysis which is defined as the ratio of number of packets received with respect to the difference between the number of packets send and number of packets received. The existing topology aware routing (TAR) and hybrid push-pull topology [HP2T] technique has high drop rate due to the resilience and link failure. The proposed multi-tier

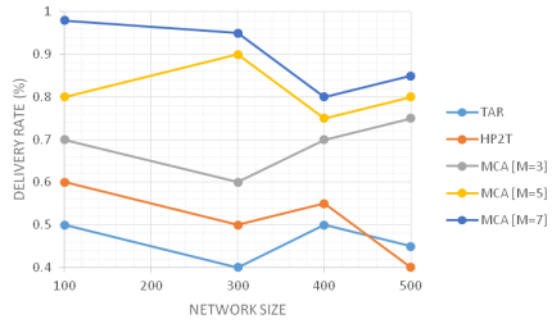

Fig. 2: Delivery rate

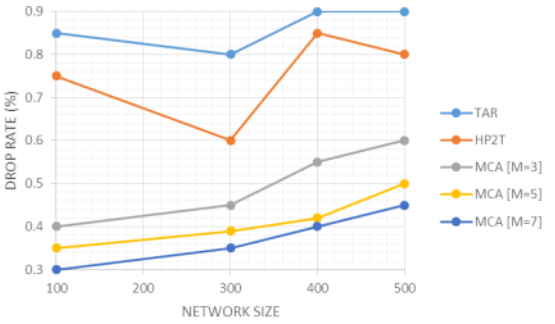

Fig. 3: Drop Rate Analysis

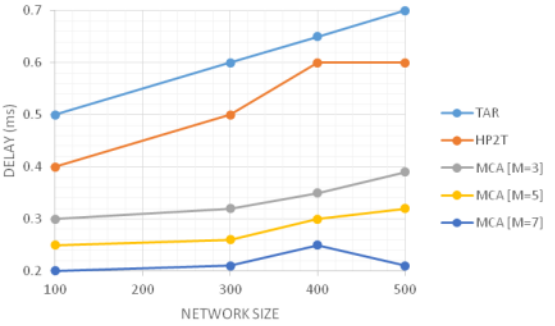

Fig. 4: Delay Analysis

clustered architecture reduces the drop rate by decreasing the resilience and link failure. With the help of cluster head, link failure and node failure will be monitored and that will intimate immediately to their cluster members. So this will reduce the drop rate.

Figure 4 shows that the delay analysis and it is defined as the time taken to transmit the data from source and destination.

This proposed multi-tier clustered architecture reduces the delay compared to the existing techniques such as topology aware routing (TAR) and hybrid push-pull topology [HP2T] method. Cluster head in the proposed multi-tier clustered architecture reduces the drop rate and that will decrease the delay.

CONCLUSION

The proposed multi-tier clustered architecture is used to maintain the topology and increase the network performance by avoiding the resilience and link failure. Here used the cluster head for each topology in the structured peer to peer network. If the topology changes, cluster head will intimate to the cluster members. That will avoid the issues occur due to the resilience and link failure. By using the cluster head can maintain the topology and if any node moves enters or leaves in the network. Simulation results have shown that the performance of the proposed multi-tier clustered architecture increases the network performance compared to the existing topology aware routing (TAR) and Hybrid Push-pull Topology [HP2T] techniques. By increasing the number of structured peer to peer networks with different topology, it increases the overall network performance.

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