Generic Topology Matching Algorithm of Structured P2P Network

Lili Pan

***Abstract*—Compared with the unstructured P2P networks, structured P2P networks have good expansibility and robustness. But structured P2P overlay network is directly based on logic network, not too much above the underlying physical network topology structure, which causes a serious topology mismatching between logical topology structure and physical topology structure. About the question, this paper proposed a protocol independent topology matching method, by combining the existing beacons node, adaptive matching algorithm with IP distribution strategy to construct the initial topological structure, and by optimizing node switching to maintenance the network topology. Simulation experiments show that the algorithm improve the matching degree of the network topology, and meanwhile with lower traffic cost.**

***Index Terms*—Data intensive web pages, knowledge presentation, ontology-based keyword library, web information extraction.**

I. Introduction

P2P is the key technology of the future network [1]. Focus on the study of P2P technology is P2P network topology structure and resource locator search algorithm [2]. Based on P2P topology structure can be divided into structured P2P and unstructured P2P, compared with unstructured P2P, a structured P2P network has potential efficiency, robustness, scalability, and the location of the data. Structured P2P network based on logical network, establish a query routing, select less logic the hop path as the optimal query path. Because of the overlay network logic neighbor nodes in a physical network often are far apart, so the logical topology structure and the physical topology does not match, routing in the actual physical network to go a lot of detours, cause a lot of unnecessary physical network data traffic.

According to the above problem, this paper proposes an algorithm, respectively from two aspects of the initial network with the topological structure of building and maintaining make improvements, to effectively solve the topology mismatch problem, and reduce communication overhead. It combines building network this the landmarks node, adaptive matching algorithm and IP allocation strategy, not only solved the worst case of falling into the same area, and improves the partition granularity; to maintain the initial topology structure with node exchange algorithm, optimize the switching frequency, under the condition of without changing the network structure, reducing the periodic detection of overhead.

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II. Related Work

There are three kinds of structured P2P network topology algorithm [3].

A. Topology Matching Algorithm Based on Time Delay

The method according to the node to the cardinal points of time delay to get physically close neighbor nodes. It mainly includes the landmarks cluster algorithm, adaptive topology matching algorithm and zoning algorithm. The landmarks cluster algorithm [4], it according node to landmarks nodes of network delay to sort these landmarks nodes, nodes of the same sequence assigned to the same box. This method is simple and good scalability, but it's too coarse granularity partition, it doesn't take into account the worst-- all the nodes could fall into the same box. Adaptive topology matching algorithm [5], it is the source node by TTL-k detection information, measure to detect the node RTT, ordering and selecting two minimum RTT value nodes, choose one of the domains to jump. This algorithm is simple and efficient, but still did not take into account all the nodes could fall into the same area. Node ID coding method [6], the ID space in overlays is mapped to the physical network, the first to use landmarks algorithm to rough location of nodes, secondly according to the IP address for precise positioning. This method only considers the node to join the construction of the network topology, without considering the node when leaving or failure maintenance of network topology, it is not suitable for high dynamic network.

B. Topology Matching Algorithm Based on Location-Aware [7]

It make location-aware data location based on physical topology distribution ID node, the node's Coordinate values can reflect the distance between the nodes, logical neighbor node is the physical neighbor node, so each jump has lower latency in the process of message routing, it are more efficient than the algorithm based on time delay. But it does not consider the heterogeneity of nodes, thus cause the node load imbalance.

C. Topology Matching Algorithm Based on Node Exchange

The basic idea of node exchange is: periodically switching node label. Because of the change of node label did not change the network structure, so the algorithm is independent

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agreement; in addition, this algorithm significantly reduces the average delay of overlay network. But, this kind of algorithm also has some problems, such as node number of exchange control problem [8].

The above each algorithm have advantages and disadvantages, this paper proposes a structured P2P algorithm that is independent of the protocol to the topology algorithm based on time delay and combined algorithm based on node exchange, to optimize the topological structure from the build and maintain two aspects.

III. The Basic Idea

The idea of algorithm below: landmarks node is used in the adaptive topology matching algorithm, combination of IP address allocation strategy to build the initial network topology. A method of control node exchange number is put forward, it use the event trigger nodes exchange algorithm to maintain the topology.

A. The Construction of the Initial Topology

This section will be three kinds of topology matching algorithm based on time delay, the combination of the specific implementation of the algorithm are as follows:

The first step: use ideas of landmarks node for adaptive topology matching algorithm. First the structured P2P network partition and number on the map, the serial number of the geographical position close also similar; after divided into several regions, each region to choose K nodes as regional landmarks node, to select a node from these nodes as the main landmarks node, the remaining node as candidate landmarks node. When main landmarks node failure, select from a candidate landmarks node as the main landmarks node, and add a candidate landmarks node; when the candidate landmarks node failure, directly add a candidate landmarks node.

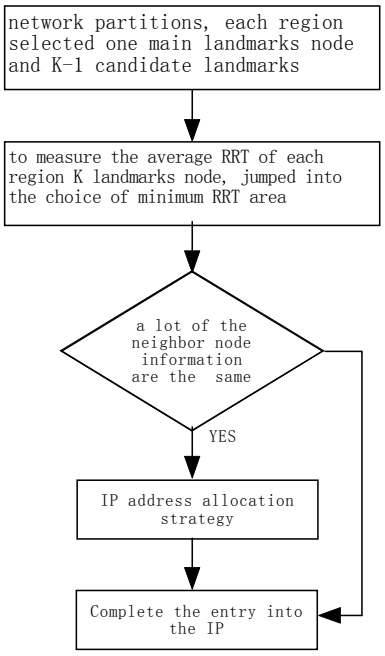


Fig. 1. Flow chart of the initial topology.

When a new node joins, it measure average RTT of node to all areas of main landmark nodes and candidate landmarks node; sort these average RTT value, choose regional of the minimum average RTT to jump. Although this method avoids that nodes of the adaptive topology matching algorithm in TTL-k detection are in the same area, which largely avoid the nodes in the same area, but still failed to completely avoid. Because it is limited that node routing tables stored information, so when this happens to appear a large number of adjacent nodes at the same information. For this case, the next step with accurate positioning. The next step will be accurate positioning.

The second step: because node of IP address is similar, node of location is similar too, it can reflects the neighboring relationship between nodes in a large extent, so the node IP address as a parameter to precise positioning of node, to find a neighbor nodes.

The landmark node matching algorithm for adaptive topology, together with the IP address allocation strategy, not only learned a matching algorithm of adaptive topology is simple and efficient, but also avoid the worst case of the adaptive topology matching – all nodes in the same area. To establish the initial topology process is shown in Fig. 1.

B. Maintenance of Topological Structure

Above, we consider the construction the network topology structure when nodes join, the initial topology structure is successfully established, in higher dynamic networks, nodes often join, leave or failure and so, therefore, continue to adjust and optimize the topology structure. Document [9] proposed a general topology matching optimization algorithm -- optimization topology matching based on node exchange, the basic idea is that it adjust by periodically the node labels to optimization network topology structure, this method can guarantee the network structure does not change. However, if the node's label changed overhead, it will affect the performance of network topology optimization. This algorithm controls the network overhead by controlling the number of nodes exchange, to improve the algorithm.

1) The basic idea of nodes exchange

The DHT network is constructed based on the physical network application layer on overlay network. The data and the nodes are uniformly mapped to key space by the consistent hash function, the data of N key stored in the N node label, if the node does not exists, the data is stored in the next node or nodes closest. DHT uses the label to manage a larger system, because the mapping is random, so establishing the overlay network can not match with the physical network. Fig. 2 shows a physical network composed of four nodes, among them, the number of between nodes represent the time delay between two nodes. Figure 3 shows the two overlay network, circle represents the entire label space, with the dotted line represents the logic connection between nodes. Assuming the overlay network distance between neighbor nodes is the shortest path length between them. For example, A → D distance in Fig. 3 (a) is equal to 12 in Fig. 2 A → B → D to calculate. In order to illustrate overlay network in Fig. 3 (a) is a mismatch, we assume that there is a query from A node to C node, the delay

is 10（A→B→C）or 23（A→D→C） are far greater than the physical network delay in 3. The fundamental reason is that each node and its label tied together, when a node joins the system, its position unchanged in overlay network. The idea of nodes exchange is to assure DHT effectiveness, the node label variable. Therefore should satisfy three requirements: first, the node labeling change should not change the P2P system structure. Second, node labeling changes cannot be arbitrary. Otherwise the system will become very fragile, easy to be used by hackers. Third, the node label change brings costs should be controlled.

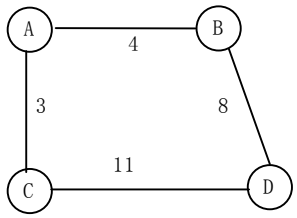
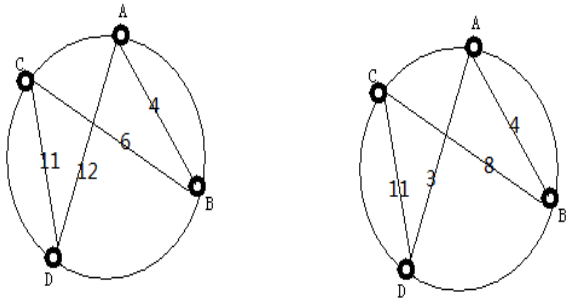


Fig. 2. A physical network composed of 4 nodes.



(a) Mismatch Overlay network. (b) Overlay network after exchange.

Fig. 3. Overlay network.

2) Nodes exchange conditions

The usual node exchange control method is detecting periodically, each node periodically to detect. But, when the overlay network has stabilized, the periodic detection becomes time-consuming and meaningless. If the neighbors of a node for a △T time change frequently, the algorithm that needs to be updated and optimized network topology.

The specific algorithm is as follows: if a period △T time, there is greater than or equal to N nodes join, leave or failure, then exchange and detect nodes; if △T time, node join, leave or failure is less than N nodes, will not detect and exchange. This algorithm avoids that frequent probe brings network overhead when the network tends to be stable.

3) Exchanging operation

When building the initial topology structure, each node *X* in the system is to obtain the address list and initial local delay information of it's all neighbors node, when the nodes exchange conditions, node *X* is detecting a random node *Y*, probe message is included in the TTL field.

At the beginning, set the TTL= *K*, every node, TTL-1. When TTL= 0, node *Y* is selected, node *X* and *Y* exchange their address list and initial information. Then the two nodes calculate local delay information after exchange. If two nodes exchange, the total delay time is shortened, the *X* and *Y* exchanging node label and routing table information, at the same time to notice his neighbor nodes change the routing tables, and to calculate the initial partial delay information. Otherwise two nodes information does not exchange. As shown in Fig. 2 and Fig. 3, the physical network matching with overlay network after the node exchange. Shown in Fig. 4, maintain the topology process.

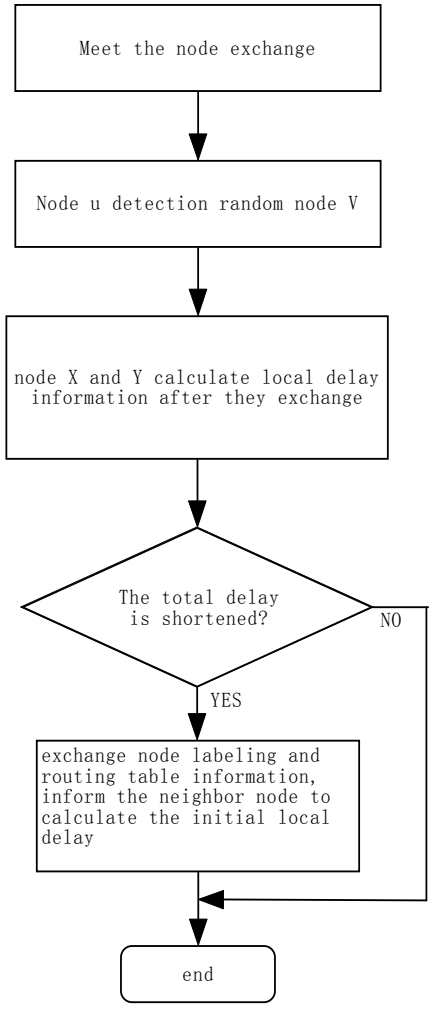


Fig. 4. Maintain the topology process.

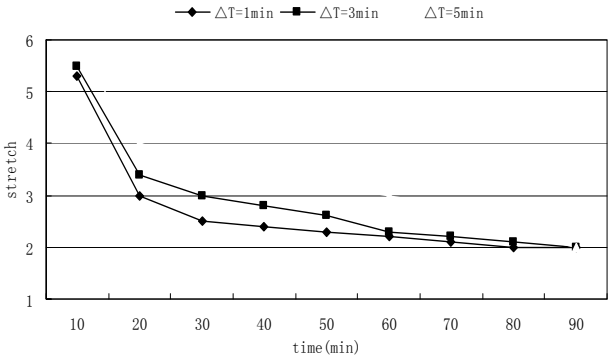


Fig. 5. Matching degree.

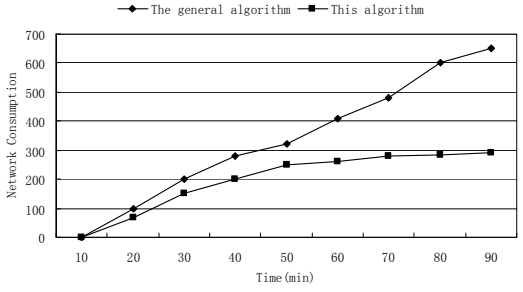


Fig. 6. Network consumption.

IV. Performance Analysis

Experiments using GT-ITM topology generator, choose Chord as the platform, about 600 nodes of network has carried on the simulation. Using stretch as measure degree of overlay network and the physical network matching, the smaller the stretch both the match. Fig. 5 shows the general periodic node exchange algorithm and this algorithm of $\triangle T$ were set to 1 minutes, 3 minutes, 5 minutes when the stretch changes with time. Fig. 6 shows the network consumption comparison about simply periodic node exchange algorithm and the algorithm, the network consumption mainly refers to the detection times and node number of exchange, the ordinate represents the sum of cumulative frequency, smaller network consumption is small. Experiments show that this algorithm has better matching topology, and save the network consumption.

V. Conclusion

This paper proposes a protocol independent algorithm, this algorithm optimization from the building and maintaining the initial topology structure, and the method to reduce the network overhead of the control node number of exchange. Simulation results show that it solves the mismatch problem Of overlay network and the physical network in a certain extent, and have less network overhead. Of course, this algorithm still has some problems, such as does not take into account the heterogeneity of nodes, node content exchange and other issues, the author will be solved in the future work.

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