The Research of Algorithm of QoS Routing Based on TCP/IP

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Abstract—This paper proposes an improved distributed QoS routing algorithm based on state statistic. It not only keeps the merits of simplicity and low link overhead in traditional distributed QoS routing algorithm, but also can reduce resource fragments and bandwidth admission ratio.

Index Terms—TCP/IP, Distributed QoS routing, resource fragments, state statistics.

I. INTRODUCTION

With the development of the international network, there is an increasing number of network services and real-time communication which have strict requirements on bandwidth, delay, delay jitter, packet loss rate. The significant feature of such services is that it requires network to be able to provide assurance for the end-to-end quality of service (QoS), that is to search for a network routing which fulfill a number of requirements, and also to balance the load of network link by using network resources effectively and rationally. Qos routing technology is the hot spot and difficulty of research on network technology in current field.

II. ALGORITHM OF TRADITIONAL DISTRIBUTED QOS ROUTING

Compared with the original routing algorithm, the distributed routing algorithm does not require the status information of each network node which maintains the entire network, but it only need to grasp the status information of adjacent node and link. Its routing process is not completed in the source node, but complete through the node’s calculation hop-by-hop. It’s obvious that distributed routing algorithm not only avoids complex path calculation, but also saves the processor time of maintaining the state of single network.

The traditional simple Qos routing algorithm is a distributed Qos routing algorithm that based on flooding. Before sending the user's business, the source node connection sends out Qos linking request and runs the Qos test in each port, not only finds the accessible path but also meets the output port of Qos index, and forwards this request to the port which has been tested, until this connection request reaches the destination node. This simple distributed Qos routing algorithm has obvious shortcomings. As shown in Figure 1, if node s wants to establish connection that bandwidth requirement is 5 with node d, in accordance with the above-mentioned algorithms, s-a-b-d may be chosen as the path of the connection. If this node s wants to establish the connection that the bandwidth requirement is 6 with node d, although there are still plenty of idle network bandwidth, but the path to meet the Qos requirements can not be found. This is the "resource fragmentation" problem, although there are plenty of available resources in a network, but as these resources are dispersed in some node irrelevantly, and the customer can not be served, eventually leading to the decline in the service quality.

In order to resolve the resources fragmentation problem caused by distributed Qos routing algorithm, the existing literature has proposed some methods. Such as the hybrid measure parameters method, the distributed routing algorithm based on detection, and the improved algorithm based on the delay. However, in the process of path finding, these algorithms either do not consider the impact of the state accuracy to path
finding in the network, or do not consider the statistical characteristics of link state. Thus, although it has certain validity, it is difficult to overcome the inaccuracy of status information in network effectively, and to improve the efficiency of impact on routing and the rate of bandwidth admission.

III. IMPROVED QOS ROUTING ALGORITHM

In this paper, the goal of the distributed routing algorithm that link can be counted by bandwidth state is to find a better available routing under an inaccurate status information. In consideration of the changes in the state statistical characteristics, it is to predict the state inaccuracy, and put the predict outcome to the process for access and routing. By the mean of probabilistic path finding, the routing process carries out a purposive, enlightening multi-path, to find the minimum cost path that meets their requirements for the business access.

Without loss of generality, the object of this research is communication network which is consist of limited nodes and two-way communication links. In the network \( G = (V, E) \), \( V \) is a collection of edge (link), and \( E \) is a collection of nodes. Among them, each node \( N(i) \) has a unique identifier, it reaches adjacent nodes \( N(j) \) through the adjacent link \((i, j) \in E\), and can be defined as hop count, bandwidth, delay, or other Qos parameters expecting to optimize according to some strategy or link characteristics. Some common parameters are defined as follows:

Definition 1: If \( D(i, j) \) is a delay in scale of link \((i, j)\) on the path \( p = (s, i, j, \ldots, k, d) \), set:
\[
D(p) = D(s, i) + D(s, j) + D(s, j) + \ldots + D(k, d)
\]  

Definition 2: If \( B(i, j) \) is a bandwidth-scale of link \((i, j)\) on the path \( p = (s, i, j, \ldots, k, d) \) set:
\[
B(p) = \min \left\{ B(s, j), B(s, j), B(s, j), \ldots, B(s, j) \right\}
\]

Through this definition, the recipient on one way will be able to know the accumulated value of \( D(p) \), \( B(p) \). Set \( D(p) \) as the cumulative value of delay, \( B(p) \) signifies the smallest available bandwidth of the path. When one detection via a link \((i, j)\), amends the \( D(p) \) and \( B(p) \) according to (3):
\[
D(p) = D(p) + D(i, j),
B(p) = \min \{ B(p), B(i, j) \}
\]  

These functions can be used for Qos forwarding tests of intermediate nodes, and also for carrying out decision for best path in destination node. However, the delay and statistical characteristics changes of bandwidth are not considered in this situation, and the forecast about the inaccuracy of state is needed, then use the forecast results for advantages and disadvantages analysis on the characteristics of the link, to carry out the purposive, enlightening, multiple constraint and multi-path detection, to find the best path which meets its requirements.

To lead into variable quantity: \( \Delta D(s, t) \) signifies the possible biggest change of the link delay in an update cycle.

\( \Delta B(s, t) \): signifies the possible biggest change of link available bandwidth in an update cycle;

Among which: \( \psi \) is the weighted parameters; \( f \) is the second-order statistics measure function, which describes the change state of two adjacent nodes. Formula (3) turns into (4)
\[
D(p) = D(p) + D(i, j) - \Delta D(s, t),
B(p) = \min \{ B(p), B(s, t) - \Delta B(s, t) \}
\]

VI. THE BEST PATH FUNCTION OF QOS TEST

In the network explorer packet via node i is defined as probe(i), when an probe(i) arrival, Qos tests is carried out in order to forward effectively and improve efficiency. As to the Boolean Qos forwarding conditions function of node j which is adjacent to node i is defined as:
\[
bw(i, j) \geq Qos_y \wedge D(i, j) + delay(link(i, j)) \leq Qos, condition(i, j, probe)
\]

Among which, \( bw(i, j) \) is the available bandwidth of link \((i, j)\); \( Qos_y \) is bound for the bandwidth request; \( delay(link(i, j)) \) is the propagation delay of the link \((i, j)\); Qos D is the connection delay constraints for the request.

In the destination node d, after receipt of the first probe, open timing to receive more feasible probe, and then select the optimal path by using a certain degree of decision-making mechanism. The detection package for candidate is a probe before reaching d and maximum
which the user needs for the bandwidth is $B_{\text{max}}$, define the decision function as follows:

\[ \text{str}(\text{probe}(i)) = \begin{cases} 1 & (a)B_{\text{max}} \\ 0 & (\text{other}) \end{cases} \]

In which, $a$ is the smallest available bandwidth to reached by the viable path, defined in the $B(p)$ field of probe. $\text{str}(\text{probe}(i)) = 1$ Signifies that the link can accept any request of bandwidth, network is in light load and no waste of resources. Delay scale should be considered at this time, if $\text{str}(\text{probe}(i)) = 0$ signifies network is in heavy load, the bandwidth scale should be considered at this time.

In which, $\text{probestr}$ signifies that the link can accept any request of bandwidth, network is in light load and no waste of resources. Delay scale should be considered at this time, if $\text{probestr} = 1$ signifies network is in heavy load, the bandwidth scale should be considered at this time.

**VI. COMPUTER SIMULATION AND ANALYSIS**

Fig 3 shows the acceptance rate of bandwidth by two algorithms under different load conditions. When the network load is lighter, the two rates are similar. When it is in a heavier load, the acceptance rate of bandwidth by improved algorithm (optimal) is much better.

Fig 4 shows when the improved algorithm is in a lighter network load,

**V. THE DESCRIPTION TO IMPROVE ALGORITHM OF THE DISTRIBUTED QOS ROUTING**

Distributed Qos routing algorithm is divided into three steps: detection, response, error handling. Detection and determine a tentative path to meet the Qos constrain, in this process there is no resources set aside. In the response phase, the destination node made a response to the first arrival explorer packet along the tentative path and reserve resources along the way, at the same time it abandoned the ones arrived later to ensure that there is only one connection established. As to the dynamic changes of network resources, an intermediate node may no longer meet the Qos constraints when receive the response. Then it will enter the stage of error handling at this time. and the process described as Fig. 2.

**Figure 2. The process of algorithm**

Two algorithms have a considerable delay by using the decision-making mechanism of statistic behavior. After the network load becomes heavier, there is an increase in the improved algorithm connecting delay. As testing conditions of Qos forwarders are improved, the improved algorithm is also less than the traditional one in the system overhead.
On the basis of existing literature, this paper proposes the distributed QoS routing algorithm based on Status accounting, and the QoS routing algorithm increases the accuracy parameter of constraints; at the same time improves the acceptance rate of bandwidth by using decision-making function, reduces the delay in connection. However, it is not the best forwarding test, and further improvements are needed in this regard.

VII. CONCLUSION

REFERENCES
