Experimental Study on Locality-aware Application Layer Multicast

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Abstract: This paper proposes Canicula, a locality-aware overlay multicast system. Its overlay network is constructed by node clustering based on network coordinate. According to the experimental results of both RDP and packets loss rate on PlanetLab, it shows that the performance of locality-aware overlay multicast is better than the other prevailing overlay multicast.

1 Introduction

In application layer multicast, nodes self-organize into an overlay network and transmit packets through the overlay. The overlay structure is very important to the performance of multicast.

In this paper, we present a locality-aware overlay system for streaming multicast. We analyze the experimental results on Planetlab, and compare the performance with other overlay multicast systems.

2 Related Work

Chainsaw [1] is a p2p overlay multicast system, which is based on a randomly constructed graph. Chainsaw's overlay is easy to construct, but because it doesn't consider the location of nodes, the random overlay will reduce the efficiency of packets transmitting.

Binning [2] is a scheme whereby nodes partition themselves into bins such that nodes within a given bin are relatively close to one another. The Binning scheme can optimize the overlay, but it essentially depends on the nodes' relative distance, which is not accurate.

HONet [3] is a hybrid locality-aware overlay based on network coordinate. Nodes self-organize into structured clusters based on network locality. HONet's clustering scheme is more accurate, but it takes more bandwidth cost to maintain the structured overlay.

3 System Description

To improve the shortcomings of Chainsaw, Binning and HONet, we design our system Canicula in three ways below. First, we consider the participating nodes' location to improve the efficiency of packets transmitting. Then, we use network coordinate to increase the accuracy of clustering. Besides, our overlay is unstructured, which can reduce the bandwidth cost and improve the flexibility.

Canicula is a locality-aware application layer multicast system. Its overlay structure is constructed by node clustering based on network coordinate. Figure 1 shows the overlay structure of Canicula.

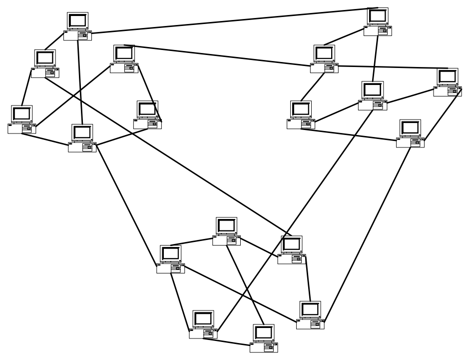

Figure 1: Canicula's overlay structure

A set of stable hosts are chosen as the landmark nodes. After joining in the system, each peer measures its network latencies to the landmark nodes. This set of latencies is the peer's network coordinate, which can identify its location in Internet.

Getting the network coordinate, any two peers can estimate their distance using triangulated heuristic [4] way, without any end-to-end measurement. If the distance is less than the cluster radius, which has been determined before, the two peers are thought to be in a cluster.

The maximum number of neighbors a peer chooses in its cluster is more than that in other clusters. Thus, the overlay can not only use the bandwidth sufficiently, but also assure the connectivity of the whole network.

Canicula is a pull-based system. Every peer maintains and informs its neighbors a window of available packets. When a peer receives the message about new packets from one or more neighbors, it picks one of them at random, and then sends request to obtain the new packets.

4 Experiments on Planetlab

We did experiments to evaluate the performance of our system on all available nodes of PlanetLab [5] in August, 2006. We also compared it to Chainsaw and Binning.

To assure the fairness of the comparison, it is important to make sure that the three overlays have the same average node degree. It is achieved by configuring the parameters each. In our experiments, the average node degree of the three overlays is set to 6, and the clustering radius is set to 40ms.

We use RDP (Relative Delay Penalty) and packets loss rate to evaluate the overlay's performance in application layer multicast.

RDP is defined as the ratio of two peers' network delay in overlay and their end-to-end delay. The smaller RDP is, the better the overlay fits the real network topology. Figure 2 shows the CDF of the three overlays' RDP. We can see that Canicula's RDP is the smallest, Binning's RDP is larger, and Chainsaw's RDP is the largest.

Packets loss rate is one of the most direct parameters to show the performance of multicast. In our experiments, the source peer produces new packets at a fixed rate (530kb/s), and distributes them into the overlay. Table 1 shows the packets loss rate of the three overlays.

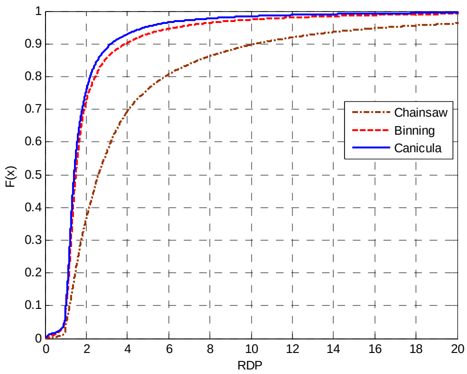

Figure 2: The CDF of the three overlays' RDP

Table 1 Packets loss rate of the three overlays

Overlay	Chainsaw	Binning	Canicula
Average packets loss rate	2.57168	1.99128	1.84039
Ratio of nodes whose packets loss rate is less than 1%	0.94961	0.95970	0.96478

From Table 1, we can see that Canicula and Binning's average packets loss rate is close, and Binning's is a little larger. Chainsaw's is the largest. The sequence of the ratio of nodes whose packets loss rate is less than 1% is Canicula, Bining and Chainsaw decreasingly.

In conclusion, according to the comparison on RDP and packets loss rate, Canicula's performance is better than Binning and Chainsaw.

5 Conclusion

According to the experiments on PlanetLab, we demonstrate that our locality-aware overlay is better than the random-only overlay, and the clustering scheme based on network coordinate is more accurate than that based on the relative distance. Considering the nodes' locality in Internet during the overlay construction can improve the performance of the application layer multicast.

References

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