Does One Size Fit All? The Impact of Policy on Multicast Mechanism for Future Network

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ABSTRACT

The rapid growth of diverse applications and services over the Internet poses significant challenges to the traditional multicast routing protocols. However, in most of the existing multicast routing protocols such as PIM-SSM, policy and mechanism are strict-coupling. This makes them hard to fit for different kinds of application demands. In this paper, we propose a Policy and Mechanism Isolation(PMI) multicast routing protocol, which aims at decoupling the policy and mechanism. Based on PMI, more provider policies, which further improve the effect and efficiency of the multicast mechanism, can be infused in to it. A parameter gradient-based multicast routing mechanism is presented to testify the flexibility of the proposed protocol. Preliminary results show that our mechanism is more adaptive than SPT, which is used in PIM-SSM.

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design—*Network communications, Internet*

Keywords

Multicast, PIM-SSM, Policy, State information

1. INTRODUCTION

As the emerging of diverse Internet services, e.g., IPTV systems, distributed gaming, broadcast video systems, etc., IP multicast has been drawn renewed attentions. The basic principles of multicasting is consistent with Nimrod's general philosophy of flexibility, adaptability and incremental change[1].

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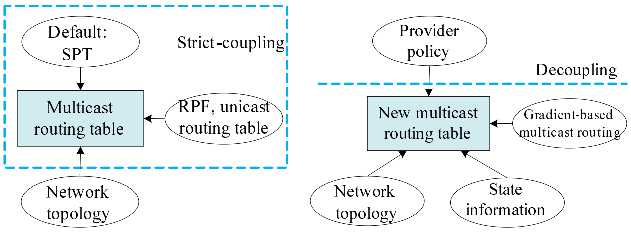


(a) PIM-SSM (b) PMI

Figure 1: Relationship between policy and mechanism.

However, most of the existing multicast routing protocols are not so flexible and adaptable to different types of applications. In the traditional multicast routing protocols, policy is not exerting impact on mechanism, and there is no clear boundary and separation between policies and mechanisms. For example, in the most standard IP multicast routing protocol, PIM-SSM(Source Specific Multicast) (see Figure 1(a)), which is widely used in IPTV systems, packets are routed using basic multicast routing service, the Shortest Path Tree(SPT). PIM-SSM is neither supporting QoS nor achieving the requirements of different application demands, because in PIM-SSM, the single multicast tree is constructed for all of the multicast sessions. Moreover, all of the data in these sessions are transmitted by the same single multicast tree. Besides, provider policies can not be infused into the current routing protocols[2].

To solve this problem, we studied the impact of policy on mechanism decisions in multicast. We proposed a policy and mechanism isolation multicast routing protocol–PMI, which aimed at addressing the diverse application demands problems.

2. POLICY-ENABLED MULTICAST ROUTING PROTOCOL

For the drawbacks of the existing multicast policies discussed in the last section, we design a new adaptive multicast routing protocol namely PMI (Policy and Mechanism Isolation)in this section.

Decoupling policy and mechanism In PMI protocol (see Figure 1(b)), more state information, such as network states, flow states and group states in the underlay mechanisms can impact the policy decision. Meanwhile, the policies provide different solutions for mechanisms to design the efficient routing mechanism.

Forwarding rules There is a mapping relationship between policy and mechanism. The paradigm and parameters adopted in the mechanism are an optimal solution under the policy decision. New multicast forwarding tables are formed. In fact, some application-aware components are usually added to routers as features to achieve special policies.

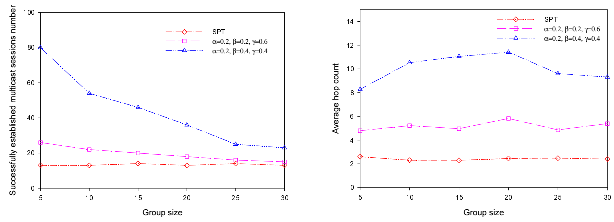
3. PRELIMINARY RESULTS

We propose a parameter gradient-based multicast approach in PMI for diverse multicast services, and the mechanism uses the steepest gradient search[3]. In a directed graph G($\mathbf{V}$,$\mathbf{E}$), where $\mathbf{V}$ is the node set and $\mathbf{E}$ is the link set. Let $\mathbf{S}$ be the multicast source node set: $\mathbf{S} \subset \mathbf{V}$, $|\mathbf{S}| = M$ and $\mathbf{D} \subseteq \{\mathbf{V} - \mathbf{S}\}$ is the set of all group destination nodes. A source node s_i transmits to its destination group $\mathbf{D}_i$, $|\mathbf{D}_i| = N$ and i=1,...,M.

For each destination node $d_j^i \in \mathbf{D}_i$, j=1,...,N, in a multicast group, the neighbor gradient between two nodes $u \in \mathbf{V}$ and its neighbor node $v \in \mathbf{V}$ from the source s_i at time t is defined as: $G_{u \to v,(s_i,d_j^i)}(t) = \alpha\varphi_v(t) + \beta l_{u \to v}(t) + \gamma h_{v(s_i,d_j^i))}$. φ_v denotes whether the neighbor node is on the tree or not. $l_{u \to v}$ is the residual link load between the link of node u and v, $h_{v(s_i,d_j^i))}$ is the relative hop count from node v to destination d_j^i compared to source s_i. The gradient is related with the group membership, residual link load and hop count and the weight of them are α, β, γ respectively, $0 \le \alpha, \beta, \gamma \le 1$ and $\alpha + \beta + \gamma = 1$.

The packets are always forwarded towards the direction of the steepest gradient. The gradient value between two neighbor nodes is distributed computed and updated periodically. Different parameters are corresponding to their flow types and diverse policies. We employ an evaluation module and configure different parameters. In this paper, $\alpha = 0.2, \beta = 0.2, \gamma = 0.6$ and $\alpha = 0.2, \beta = 0.4, \gamma = 0.4$ are set.

We implemented the adaptive multicast routing approach and proved it in simulator MCRSIM[4]. The network is a 100 nodes Waxman model topology. All the link capability is 100Mbps in the network. The video flow is chosen as the multicast flow and the its rate is randomly fluctuated between 5M–10Mbps. We compare our multicast routing mechanism with SPT which is employed in PIM-SSM. The performance results(see Figure 2) include the Successfully established multicast sessions number and Average hop count. Figure 2(a) illustrates that our gradient-based mechanism can establish more multicast sessions than SPT. That means our mechanism can make full use of the network resource and accept more multicast session requests. When $\alpha = 0.2, \beta = 0.4, \gamma = 0.4$, the result is better. It is because the link load has a higher weights and the flows are apt to stream through the "idle" links. Figure 2(b) illustrates that the average hop count in gradient-based mechanism is still in an acceptable range. When $\alpha = 0.2, \beta = 0.2, \gamma = 0.6$, it is a litter larger than SPT.



(a) Successfully established multicast sessions number vs. Group size

(b) Average hop count vs. Group size

Figure 2: Simulation result with synthetic network with 100 nodes.

4. CONCLUSIONS AND FUTURE WORK

We propose a flexible and adaptive multicast routing protocol named PMI to decouple the policy and mechanism. A parameter gradient-based multicast routing scheme is presented to testify that the policy-enabled protocol is feasible to be implemented by separating the policy from the mechanism. The future of our work will focus on issues of the control message in the protocol, the communications overhead and group management.

5. ACKNOWLEDGMENTS

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