

What Can P2P Do for Traffic Control in P2P Networks?

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1. INTRODUCTION

Recently, an ISP-driven cooperative approach is proposed to empowering ISPs for controlling traffic generated by P2P applications [?]. In this approach, an ISP and peers running a P2P application have a cooperative relationship where the ISP provides a *guidance*, i.e., network information to peers so that the peers select neighbors according to the guidance. This approach enables each party to gain better control and performance, e.g., ISPs gain a control over the P2P traffic, and peers accelerate the performance of the P2P application.

However, we observe that the existing approach defines *unilateral interaction* where only ISPs strive to tackle traffic control and guide the peers that in turn just follow the guidance given by the ISPs, even though the peers could actively help collect network information and refine the guidance. The incentives for the peers to participate in this scheme is that they will also benefit on their part in reducing the download completion time as shown in the existing work [?].

In the light of this observation, we propose *bilateral cooperation* between ISPs and peers to bring more benefit to both parties, where not only ISPs but also the peers actively provide information so that ISPs can issue a better guidance for the peers than in the existing unilateral interaction model. In more detail, we divide measurement work into two parts so as to collect the network information efficiently and also introduce the guidance including traffic bound which is missing from the existing work. Through simulations we show our proposal brings more benefit to both ISPs and peers than the existing approach such as P4P [?].

2. BILATERAL COOPERATIVE TRAFFIC CONTROL

A network operator manages a guidance server that generates and provides the guidance in its own network domain. Peers are divided into two groups: guided peers (i.e., peers who follow the guidance) and non-guided peers (i.e., peers who do not follow the guidance and non-P2P users). We distinguish the guided traffic—traffic following the guidance—

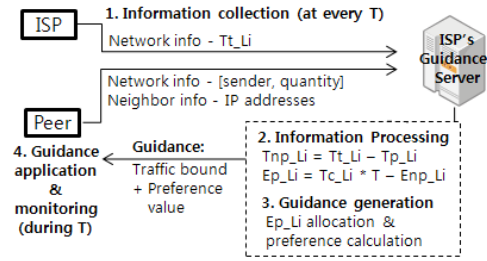


Figure 1: Overview of bilateral cooperation.

and the non-guided traffic so that we can utilize the existing traffic estimation techniques to set a traffic bound for the guided traffic. We believe that the guidance server can utilize the traffic estimation technique since it can provide the required information (e.g., load of links and routing path). Generation of a guidance is done at certain level of network scopes (NSes) like IP Prefix. The primary objectives of the network operator are to reduce operational cost of inter-domain links and a reduced maximum link utilization (MLU) of its intra domain links. Although two objectives are different, the basic requirement is similar: to make the traffic flow as they want. Thus, as a starting point of our research, we try to solve the second problem (i.e., minimizing MLU) first since we need to check how bilateral cooperation works in a small network (i.e., intra domain) and then can extend it to a larger network (i.e., interconnected multiple network domains). We assume that every guided peer is innocent user that will not report false information. The overall procedures are shown in Figure 1.

Cooperative Information Collection: At every time interval T , ISP collects the total traffic volume of its intra links (Tt_Li) (e.g., by sending SNMP queries to its routers) and the guided peers report measured guided traffic (including the peer who sent the data to themselves and the corresponding traffic volume) during the previous time interval T . The guided peers report their current neighboring peer information (i.e., IP address) additionally. Since the guided traffic is only generated by the requests of guided peers, the reports of guided peers are enough to calculate the guided traffic volume.

Processing the Collected Information: Processing the collected information consists of two steps: processing the network information and processing the neighboring peer information. The goal of the former is to estimate amount of traffic volume that can be used by the guided peers for next

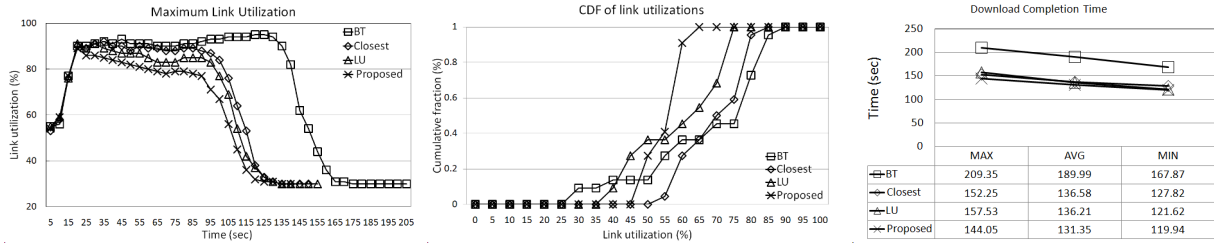


Figure 2: Simulation results.

time interval T . The guidance server calculates the guided traffic volume (Tp_Li) first¹ and then non-guided traffic volume (Tnp_Li) of the previous time interval T by subtracting Tp_Li from Tt_Li for each intra link. Then, the guidance server estimates the guided traffic volume for the next time interval T (Ep_Li) by subtracting the estimated non-guided traffic volume for the next time interval T (Enp_Li) from $Tc_Li * T$. Enp_Li is estimated by the traffic estimation technique based on Tnp_Li and Tc_Li is a link capacity. The goal of processing the neighboring peer information is to see a potential possibility of guided traffic generation. The calculated potential values are used to allocate the estimated guided traffic (Ep_Li). The guidance server calculates a potential value (P_NSmn) indicating how much guided traffic can be generated from NSn to NSm as follows: $P_NSmn = (AP_NSm * CP_NSmn) / (AP_NSm + CP_NSmn)$, where AP_NSm is a number of peers belong to NSm and CP_NSmn is a number of NSm's neighboring peers belong to NSn. The guidance server also calculates the potential value of each link (P_Li) showing how much guided traffic can be generated on the link. P_Li is a sum of P_NSmn values passing the link.

Guidance Generation: The guidance consists of the traffic bound and the preference value for each NS. The traffic bound is newly introduced metric and represents the total amount of guided traffic to be generated from the corresponding NS. The guidance server allocates the estimated guided traffic volume (Ep_Li) to NSes based on the corresponding potential values (P_NSmn and P_Li) as follows: $T_NSmn = Ep_Li * (P_NSmn / P_Li)$, where T_NSmn is an allocated traffic volume for guided traffic from NSn to NSm through link Li. The preference value is calculated as $1 - \max(\text{link utilization of the links between two NSes})$.

Guidance Application: During the next time interval T , the guided peers select neighbors based on the traffic bound until all the allocated traffic bound is consumed. The guided peers use the preference values as the guidance after consuming all the allocated traffic bound.

3. EVALUATION

For evaluation, we use ns-2 simulator on an intra network topology consisting of 10 NSes and 11 intra links that have 50Mbps capacity in both directions built from Rocket-fuel data. Each NS contains 20 guided peers (i.e., total 200 peers). We utilize BitTorrent as a P2P application (256KB chunk, 50MB content). For the non-guided traffic, we generate constant bit rate (from 0 to 15Mbps) flows between

a pair of NSes, assuming that the guidance server knows the non-guided traffic volume instead of using the traffic estimation technique. For the performance comparison, we simulate four different approaches: BitTorrent + no guidance (**BT**), BitTorrent + the guidance based on the network distance (**Closest**), BitTorrent + **Closest** + the guidance based on the link utilization (**LU**), and BitTorrent + **Closest** + the guidance based on the our approach (**Proposed**). Note that **Closest** and **LU** are common unilateral interaction approaches. In **LU**, the guidance only contains the preference value and the peers generate the traffic from NSes proportional to the corresponding preference values. The time interval T is set to 5 seconds. With the setting mentioned here, we run a simulation multiple times and show the average across results.

Figure 2 shows the simulation result including MLU, CDF of link utilization at 60 seconds, and download completion time. **Proposed** shows the lowest MLU among the four approaches since the peers try to adapt their traffic generation according to the the guidance so that the traffic is well distributed over the links. The link utilization and the distribution range of **Proposed** are shorter than the other approaches. The traffic in **Proposed** is more evenly distributed over the links than the other approaches. From the result, we conclude that the traffic bound generated by distinguishing the guided and non-guided traffic based on the bilateral cooperation plays an important role in the traffic control, i.e., minimizing MLU. In fact, **Proposed** reduces MLU by 40.42% compared to **BT**, by 32.07% compared to **Closest**, and by 18.84% compared to **LU**. **Proposed** also improves download completion time by 30.86% compared to **BT**, by 4.65% compared to **Closest**, and by 3.56% compared to **LU**. From this observation, we know now that **Proposed** is an efficient scheme enough to reduce MLU while enhancing the download completion time. Thus, we conclude that our bilateral cooperation can improve the performance more than the existing unilateral interaction approaches.

4. CONCLUSIONS

We propose bilateral cooperative traffic control utilizing information obtained from both parties and show its higher performance through simulations. We plan to extend our study to interconnected multiple network domains and see how the bilateral cooperation works in larger networks.

5. REFERENCES

- [1] H. Xie, Y. Yang, A. Krishnamurthy, Y. Liu, and A. Silberschatz. P4P: Provider portal for applications. in *Proc. of ACM SIGCOMM*, 2008.

¹Since ISP knows the detail of its network like a routing path, it can calculate Tp_Li from the peer's reports.