博士論文審査結果の要旨

博士論文審査委員会

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論文題目	Router-aided Approach for P2P Traffic Localization

〔論文審査の要旨〕

2014 年 8 月 30 日 14 時より，約 1 時間 30 分にわたって Hoang Van Hiep 君の博士論文最終審査が行われた．最終審査は公聴会形式により実施され，Hiep 君，審査委員会委員 5 名のほか，15 名の出席者があった．

まず Hiep 君より 50 分間のプレゼンテーションがあった．博士論文では，ピアツーピア（P2P）通信により発生するトラヒックをゲートウェイ（GW）ルータにより制御し，非効率トラヒックの発生を抑制するための手法について，(1)ピアリストパケットを GW ルータで検出して，接続先を近隣ピアに変更する手法，(2)映像要求パケットを GW ルータで検出して，接続先を近隣ピアに変更する手法，(3)接続先ピアの所在情報に基づいて，遅延挿入やパケット損失，帯域制限などにより接続先を制御する方法，(4)接続先ピアの情報を効率的に取得するためのルータ協調動作手法について検討を行った．これらの独創的な制御手法によって，P2P 通信により発生するトラヒックを局在化し，効率的な通信を実現することに成功した．なお，予備審査時に指摘された，博士論文の追加記載と実験結果グラフの修正，及び評価実験の追加についても，すべて訂正がなされた．

プレゼンテーションの後，約 30 分にわたり質疑応答が行われた．審査委員会委員からの質問では，主に本手法の適用方法や将来的な拡張方法について問われた．これらの質問に対し，個人ユーザの GW ルータだけでなくインターネット事業者（ISP）への導入の可能性などについて，的確に答えることができた．一般参加者からの質問についても同様に，明解かつ適切に答えた．

質疑応答の後，約 20 分にわたって論文審査委員会委員のみで議論を行い，合否判定を実施した．博士論文本体，及び最終論文審査ともに問題はなく，投票の結果全員一致で合格と判断された．

論　文　要　旨

Thesis Abstract

2014 年 07 月　02 日

※報告番号	甲 第　166 号	氏　名 (Name)	HOANG VAN HIEP

主論文題名　（Title）

Router-aided Approach for P2P Traffic Localization

内容の要旨　（Abstract）

Most peer-to-peer (P2P) applications including file sharing and streaming applications form overlay networks for communicating among peers that are oblivious to the underlay network topology. As a result, a large quantity of unpredictable traffic is generated on the Internet. In particular, the unwanted cross-domain traffic proves to be costly for the ISPs. This raises the problem of P2P traffic localization.

ISPs or network operators often control P2P traffic by bandwidth throttling or limiting and/or even blocking P2P systems in their network. However, this is not an overall solution for the fundamental concern of the ISPs, which is to reduce the cross-ISP/AS traffic. A variety of methods have been introduced to solve the problem, and many works proposed that the consideration of peer location would reduce the cross-domain traffic and conserve the bandwidth. To realize traffic localization, P2P systems must be essentially equipped with locality-aware neighbor peer-selection mechanisms. Almost all of existing approaches, however, focus on solving the problem on the application layer. Several modifications of the existing P2P systems are therefore inevitable as one of the following reasons:

- The enhancement of trackers to efficiently gather information of the underlay network and to provide this information to the P2P applications. On the P2P application side, an appropriate protocol to communicate with the enhanced trackers must be implemented.
- The modification of the P2P application software to upgrade the current neighbor peer-selection procedures because P2P applications currently only employ random and/or round-trip time (RTT)-based strategies.
- Both of the above.

In this dissertation I propose a novel approach for P2P traffic localization without any peer reaction. The proposed approach requires neither dedicated servers, nor collaboration between ISPs and P2P users, nor modification of P2P application software. In particular,

this dissertation offers the following main contributions.

First, I proposed a peer list modification method for traffic localization. The peer lists are modified for localizing before they arrive at the application. The experiments evaluating on a popular P2PTV, namely PPStream, prove the effectiveness of the proposed method on the problem of traffic localization.

Secondly, I proposed a video request packet redirection method for traffic localization. In this method, video data request packets that are sent to the peers not contained in the localized list are modified to redirect to peers in the localized list. Experimental results show that the method successfully realizes traffic localization on PPStream.

Thirdly, I proposed a novel method for localizing P2P traffic hierarchically with multiple levels including AS level, ISP level, and country level. The method is completely independent of P2P applications. The idea is that, if we intentionally degrade the quality of connection paths of inter-domain traffic, we can turn the inter-domain traffic into the intra-domain traffic since a querying peer will tend to remove the inter-domain connections and select the local connections instead. To achieve this idea, I proposed three different schemes including delay insertion, forcing packet loss, and bandwidth limitation. Experiments on different P2P streaming applications indicate that the hierarchical traffic localization method not only reduces significantly the inter-domain traffic but also maintains a good performance of P2P applications. This method is also the most significant contribution of this dissertation.

Finally, I proposed a router collaboration scheme to combine with the peer list modification scheme for traffic localization. In this method, the local peers are collected at not only one router but also many routers. Clearly, the peer list modification scheme will become much more effective in combining with router collaboration scheme because we will have more local peers in hand. This has been proven by experimental evaluation on PPStream.