X^{2BT} Trusted Reputation System: A Robust Mechanism for P2P Networks

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Abstract. Over the past few years, Peer-to-Peer (P2P) networks have grown extensively and dramatically changed large-scale file transfer. One of the most popular P2P network is the *BitTorrent* system. BitTorrent can efficiently distribute large files by optimizing the use of network bandwidth and providing scalability. Due to the open and anonymous nature of P2P systems BitTorrent also provides an ideal environment for distribution of malicious, low quality, or doctored information. A number of reputation systems, including P2PRep with its successors XRep and X^2Rep, had been proposed to address security weaknesses of Gnutella P2P file sharing networks. Although it has been claimed that these methods are also applicable to the other file sharing networks, it is not clear how to achieve this task. Moreover, some of the shortcomings of these reputation systems such as online-polling only and cold-start may be exploited by malicious attackers. In this paper, we propose a reputation system, called X^{2BT}Rep, which is an extension of the X^2Rep and for BitTorrent network. We show that the proposed system improves the security and the quality of information distributed over P2P networks.

Keyword: P2P, Reputation System, XRep, X^2Rep, and X^{2BT}Rep.

1 Introduction

Peer-to-peer (P2P) file sharing is one of the most significant technical models of the internet. Rather than traditional client-server architecture, P2P networks equip each node with an equivalent capability or responsibility and they can share computer resources and services via direct connections. Over the last few years, a series of P2P networks and channels, such as Napster [18], Gnutella [24], Kazaa [16], eDonkey [10] and BitTorrent [27], have been developed. Among them, BitTorrent is the most influential and innovative protocol [17,21], designed to be a large-scale file distribution tool. Studies in the most recent research [20, 25, 23] indicate that BitTorrent has consumed more than a third of the internet's bandwidth and is rapidly emerging as the preferred means of many

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content providers to distribute legitimate content, such as the free computer operating system, Linux.

One of the primary advantages of BitTorrent is the fact that resources and services can be easily contributed, searched and obtained. Also, it utilizes unused the upload capacity of downloaders, which overcomes the problem of *free-riding* (i.e. users prefer to download but refuse to upload [2]) that occurs in other P2P networks. As a result, network bandwidth can be used as efficiently as possible. Moreover, several other significant features, such as scalability, fault tolerance and diversity in service, provide BitTorrent with sufficient potential for future growth.

Along with the aforementioned advantages, inherent risks and threats with BitTorrent have become a stumbling block against further progress. First, due to anonymity, misbehaving users can arbitrarily distribute low-quality, even malicious content over the network without witnesses, such as Trojan horses and viruses. Second, it provides a good environment for malicious attackers to subvert systems in hiding, because of no enforcement rule of joining, leaving and staying in the system. Third, in a BitTorrent network, users can easily expose their private information when joining the system, such as users' IP address and port, and hence, users' privacy can be violated by adversaries.

Previous evidence and studies [1, 3, 22] show that reputation systems are a robust solution to protect P2P networks from malicious attacks. In a reputation system, the quality of a given resource/peer is determined by a user, based on historical information from other users [26]. The main advantage of such reputation systems is to protect against most known attacks and vulnerabilities, and simultaneously retain the characteristic of anonymity as well as maintaining minimal overheads. During the past few years, research has been conducted to develop several protocols of reputation systems to protect P2P networks, such as P2PRep, XRep, and X^2Rep. Unfortunately, these protocols are *only* designed for Gnutella-like P2P networks, which have a different architecture from BitTorrent. Therefore, none of them can be integrated into the BitTorrent protocol even though some proposals claim that they can be adjusted to any P2P systems. Moreover, they have shortcomings like online-polling only, cold-start and performance bottleneck problems.

1.1 Our Contribution

In this paper, we propose the *first* robust reputation system, X^{2BT}Rep, devoted to BitTorrent networks. It is an extension of the X^2Rep trust semantics algorithm. The outstanding advantage of X^{2BT}Rep is that it prevents all known attacks on BitTorrent-like networks. Other major contributions of X^{2BT}Rep are *credibility award* and *credibility chain exchange* algorithms. *Credibility award* is a method to overcome the cold-start problem, so that newcomers can participate in the system as quickly as possible. The method of *credibility chain exchange* improves trusted ratings sharing among all the peers, which avoids the limits of ratings sharing between peers with few interests in previous reputation systems.