Information Sciences 236 (2013) 33–55

Contents lists available at SciVerse ScienceDirect

Information Sciences

journal homepage: www.elsevier.com/locate/ins

Understanding the effects of P2P dynamics on trust bootstrapping ☆

Marc Sánchez-Artigas *, Blas Herrera

Universitat Rovira i Virgili, Department of Computer Engineering and Maths, Av. Paisos Catalans 26, Tarragona, Spain

ARTICLE INFO

Article history:
Received 23 January 2012
Received in revised form 28 September 2012
Accepted 16 February 2013
Available online 4 March 2013

Keywords:
P2P networks
Trust and reputation
Distributed systems
Stochastic analysis

ABSTRACT

Reputation and trust systems rely on historical information to account for uncertainty about the intention of users to cooperate. In open, dynamic systems like peer-to-peer (P2P) networks, however, forming trust relationships is often a lengthy and time consuming effort due to the anonymous and discontinuous participation of users. For example, the flow of transactions may be interrupted by unexpected user departures, precluding trustors from gaining the necessary experience to make an accurate trust evaluation. The problem is further complicated in the case that no previous direct and reputational evidence is available. This happens, for instance, when a new user joins the system for the first time or users form short-term, ad hoc groups around a shared goal, which is very common in P2P networks. In these cases, the problem is how to minimize the time to bootstrap trust between *volatile* users who are *unknown* to one another.

To shed light on this question, this paper presents an accurate model for capturing the influence of churn – the continuous process of node arrival and departure – on trust bootstrapping. Using our analytical model, we show that churn can be very problematic in real P2P systems and develop equations that allow system architects to compute the minimal transaction rate that achieves quick bootstrapping of trust. Also, we present an example of how our analytical framework can be used to design a viable solution for the trust bootstrapping problem in dynamic settings. The core idea is that users ask their social links to transact with strangers and together generate trust evaluations in a short time scale. Finally, we verify our theoretical results by simulation and confirm how a simple application of our framework can reduce bootstrapping times by 50% in environments with high churn rates.

1. Introduction

Peer-to-peer (P2P) systems have become very popular in the Internet in the last few years. Unfortunately, the open and anonymous nature of these systems have often lead to a serious lack of accountability, opening the door to abuses by malicious peers. To fight against peer misbehavior, a plethora of reputation systems have appeared in the last years with promising results [24,58,62,39,23,38,3,63,29]. However, the existing literature mostly focuses on the vulnerabilities and

☆ A preliminary version of this research was presented in the IEEE P2P'11. In this paper, we elaborate more on our stochastic analysis, providing new equations and theorems, in conjunction with an estimation of the effects of churn using measurements from real P2P applications. We detail more the simulation setup and provide new experimental results extending our simulations to 10 h. In addition, we provide a better description of the problem and a clearer exposition of the main contributions that cannot be given in a conference paper due to the obvious space constraints.

* Corresponding author.
E-mail addresses: marc.sanchez@urv.cat (M. Sánchez-Artigas), blas.herrera@urv.cat (B. Herrera).

0020-0255/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.ins.2013.02.034