Sybil Attacks and Their Defenses in Reputation Systems

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Abstract

1 Introduction

Reputation systems (described in section 2) allow entities, usually humans, to trust each other in the cyberspace based on their prior interactions (logical) or knowledge from other entities. For instance, online marketplaces such as Amazon or eBay often use a reputation system, and new buyers are more likely to buy goods from merchants with a high rating (a metric for reputation).

However, reputation systems are vulnerable to many types of attacks. The Sybil-attack, first described by Douceur[17], is an attack where an entity can assume multiple identities or Sybils, and then attack either another entity or undermine the whole reputation system (we discuss it in more details in section 3). In the marketplace example, the merchant could create multiple fake accounts and submitting a lot of positive feedback to the real account to boost the rating. It is one of the most important attacks because it leads to a large number of consequences including but not limited to spreading false information, ballot stuffing[6] and eclipse attacks[57]. Thus, preventing the Sybil-attack is likely to significantly increase the credibility of reputation systems.

Sybil-defence mechanisms come in various shapes and sizes. Some rely on a trusted third party (subsection 4.1), some introduce a cost in identity creation (subsection 4.2), some exploit the graph characteristics (subsection 4.3)

and so on. To the best our knowledge, there does not exist a recent and comprehensive survey that focuses on the Sybil-attack in reputation systems.

To this end, we survey the defence mechanisms proposed by various reputation systems to eliminate or minimise Sybil-attacks as well as general approaches that do not depend on any specific reputation systems. Note that Sybil-attacks do not only exist in reputation systems. Wireless sensor networks and more generally MANETs (mobile ad hoc networks) for example are also vulnerable, the attacker can cripple the routing algorithm or defeat distributed storage mechanisms[44]. Thus defence mechanisms that do not apply to reputation systems are outside the scope of this work and are not covered. On the other hand, since reputation systems are often also peer-to-peer systems, we do cover the more general defence mechanisms.

Our main contributions are the following.

1. TODO
2. TODO

2 Reputation Systems

Reputation systems are of interest in many scientific domains. In evolutionary biology, scientists study indirect reciprocity[45]. In experimental economics

First the definitions

- Truster
- Trustee
- Recommender
- Recommendation

One of the first systems - Beth 94[5] PGP (Zimmermann) 95[79] Use of direct and also indirect trust

3 The Sybil-Attack

Explain the sybil-attack

Important theoretical results: Sybil-proof[9] - symmetric reputation functions cannot provide Sybil-proofness, must use asymmetric reputation functions.

a test bed for sybil attacks[26]

Quantifying Sybil attack[37]

4 Defences

In this section we categorise various defence techniques against the sybil-attack in reputation systems.

4.1 Trusted Third Party

One of the earliest and best known reputation system is eBay[48]. The buyers and sellers rely on a trusted third party, in this case eBay, to gather and distribute feedbacks after every transaction. Even when there are no incentives to provide feedback, Resnick and Zeckhauser observed that feedback was provided more than half of the time[48], making eBay one of the most well-known online marketplaces.

In general, trusted third parties manage the issurance and verification of identities. Thus they can apply a fee on the peer for creating a new identity[47] or rate-limit the creation of new identities[17], making sybil-attacks more difficult. Furthermore, trusted third parties often have the ability to manipulate the identities. For example they could punish the attackers by disabling all of their identity when caught, making the sybil-attack much riskier especially when identities are costly.

Trusted third party is likely the most widely used technique in practice. Marketplaces such as Amazon or eBay, online forums such as Stackoverflow or Reddit, all use a form of trusted third party.

Unfortunately, a trusted third party is often a single point of failure. Moreover, being a centralised system, it is difficult to scale up to suit increasing user demands. In the remainder of this section, we focus on distributed techniques for preventing the sybil-attack.

4.2 Costly Identity Creation

4.2.1 IP Address

4.2.2 Low reputation for new users

4.3 Graph Techniques

EigenTrust[30] Theory[54]

4.3.1 Flow Based

BarterCast[40] SybilRes[13]

4.3.2 Topology

SybilGuard[75] SybilLimit[74] SybilInfer[12] SybilShield[55] - assuming sybils have bad connectedness SumUp[63] GateKeeper[64] - based on SumUp Social-network[65] - community detection

Distributed Sparse Cut Monitoring[]

Other systems are built on top: ReDS[2] suggests to use sybilimit or sybilinfer SybilProof-DHT[34]

4.4 Reputation Transfer

Trust-transfer[52]

4.5 Self Registration

P-GRID 01[1] Self-registration[16] - distributed registration based on IP address

4.6 Cryptography Based Techniques?

Secure-Overlay[36] - ID crypto and SSS Privacy-preserving[51] - blockchain? Proof-of-stake[14] SybilConf[60]

4.7 Content Driven

[8]

4.8 Unsorted?

Beth and PGP limits Sybil attack to some extent by using social graphs Beth 94[5] PGP (Zimmermann) 95[79]

Yu 00[72] CORE 02[41] XRep 02[11] Lee 03[33] Xiong 03[69] Feldman 04[18] Guha 04[20] Marti 04[39] ARA 05[23] Scrivener 05[43] FuzzyTrust Song 05[58] TrustGuard 05[59] Xiong 05[70] PowerTrust 06[78] Credence 06[67] P2PRep/Fuzzy 06[4] Regret[49, 50]

Histos and Sopras[76], doesn't really have structure? Beta[27] Confidant[7] MANETs Gupta et al.[22] PeerTrust[68] Pride[15] Gal-Oz et al. [19] communities are collection of knots, sybils can create their own knot? R2Trust[62] PerContRep[71]

Parental control[61] DSybil[73] Sok[3] Symon[29]

4.9 Does not handle Sybil-attack?

TrustMe[56] is a reputation that focuses on anonymity, no mention of sybil attack, not one of its focus?

H-Trust[77] does not mention sybil

Coner et al.[10] assumes clients cannot perform sybil attack

5 Related Work

Reputation Surveys: [38] [28] ? [25] [32] [53] ? [24]

Sybil Surveys: [35] [42] [46] [21] [31]

Other: [66]

6 Summary

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