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**Portability of Online Reputation :
Business and Technical Perspectives**

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Portability of Online Reputation: Business and Technical Perspectives

Zhuosong Duan

Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
In partial fulfillment of the requirements
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Abstract

Trust plays a crucial role in online commerce, collaboration and interactions in general. Reputation systems have emerged in recent years as a technology and tools for fostering trust in online interactions. These community tools help people make decisions on whom they can trust, encourage trustworthy behavior, and preclude dishonest and unskilled participants. Despite their successful use, today's reputation systems face many problems, one of which is the lack of portability. Since every existing reputation system is bound to a specific website, a user's reputation is locked in one community only, making the user unable to use that reputation outside the community. Portable reputation systems will solve this problem by making a user's reputation information accessible to any online entities s/he wishes to interact with. This thesis introduces the concepts of trust, online trust and reputation, introduces reputation systems, analyzes the importance of trust and reputation systems in online interactions, conducts a study on portability of online reputation, and proposes a model for reputation system which supports the feature of portability.

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Table of Contents

Abstract.....	i
Acknowledgements.....	ii
Publications.....	iii
Table of Contents.....	iv
List of Figures.....	vi
Chapter 1 Introduction.....	1
1.1 Motivation of the Research.....	2
1.2 Objectives of the Research.....	3
1.3 Organization of the Thesis.....	3
Chapter 2 Concepts of Trust, Reputation and Reputation Systems.....	4
2.1 Trust.....	4
2.1.1 Trust.....	5
2.1.2 Trustor and Trustee.....	5
2.1.3 Context.....	5
2.1.4 Time Slot.....	5
2.2 Online Trust.....	6
2.3 Reputation.....	10
2.3.1 Definition of Reputation.....	11
2.3.2 Characteristics of Reputation.....	11
2.4 Reputation Systems.....	12
2.4.1 Applications of Reputation Systems.....	13
2.4.2 Classification of Reputation Systems.....	14
Chapter 3 Trust and Reputation Systems in Online Interactions.....	17
3.1 Trust in E-Commerce and Online Interactions.....	17
3.2 Reputation Systems in Online Interactions.....	20
3.2.1 Overview.....	20
3.2.2 Important Factors in Reputation Systems.....	21
3.2.3 Advantages of Reputation Systems.....	22
3.2.4 Reputation Systems in Business Models of Online Entities.....	23
3.3 Issues and Challenges.....	25
Chapter 4 Literature Review on the Portability of Online Reputation.....	28

4.1 Literature Review on the Portability of Online Reputation	28
4.2 A Study of Industry Solutions to the Problem of Portability.....	30
4.2.1 RapLeaf's Portable Rating System	30
4.2.2 iKarma's Portable Reputation Management System.....	33
4.2.3 Opinity's Portable Reputation Management System	35
4.2.4 Authorati's Portable Rating System	38
Chapter 5 Design of a Portable Online Reputation System	41
5.1 Methodology and Tools	41
5.1.1 Web Service Technologies	41
5.1.2 Development Environment of the Implementation.....	43
5.2 Design of a Portable Reputation System.....	45
5.2.1 Overview.....	45
5.2.2 Business Model for ORAS Plus.....	46
5.2.3 Design of the Portability Feature of ORAS Plus.....	47
5.2.4 Assumptions.....	47
5.2.5 Architecture of ORAS Plus.....	48
Chapter 6 Implementation and Execution Scenarios	53
6.1 Implementation of RepCard.....	53
6.2 Scenarios and Screenshots	55
6.2.1 RepCard	55
6.2.2 How the System Works.....	57
Chapter 7 Conclusion and Future Work.....	68
7.1 Conclusion	68
7.2 Limitations and Suggestions for Future Work	68
References	70

List of Figures

Figure 2.1. General Framework for a Centralized Reputation System [12].....	15
Figure 2.2. General Framework for a Distributed Reputation System [12]	16
Figure 4.1 A Member's RepLeaf Profile.....	31
Figure 4.2 Profile Badge of a RapLeaf Member.....	31
Figure 4.3 Reputation Profile of an iKarma Member	34
Figure 4.4 iKarma Seal of a Member.....	35
Figure 4.5 Reputation Profile of an Opinity Member	37
Figure 4.6 Home Page of Authorati	39
Figure 4.7 An Authorati Widget.....	40
Figure 5.1 Architecture of ORAS Plus.....	49
Figure 6.1 Profile Page of Member Jay	56
Figure 6.2 Member Jay's RepCard	56
Figure 6.3 JSP Page - index.jsp with Username Helen	57
Figure 6.4 JSP Page - res_member.jsp	58
Figure 6.5 JSP Page - Search for the Reputation Information of a User Bob	59
Figure 6.6 Text Files That Contain Reputation Information at Different Online Communities	59
Figure 6.7 Select Personalized Weights for Computing Bob's Reputation Values	60
Figure 6.8 JSP Page – res_user.jsp with Bob's Reputation Information	60
Figure 6.9 JSP Page – a List of Members in a Rank of Global Reputation Value	61
Figure 6.10 Login Page.....	62
Figure 6.11 A Member's Profile Page.....	62
Figure 6.12 Posted RepCard on a Blog.....	63
Figure 6.13 Reputation Information Page of Member Jay.....	63
Figure 6.14 JSP Page for Administrators	64
Figure 6.15 JSP Page for Administrators Adding More Reputation Sources.....	64
Figure 6.16 Reputation Sources in the Database before Adding a New One.....	65
Figure 6.17 Reputation Sources in the Database after Adding a New One.....	65
Figure 6.18 Rating Mechanisms in the Database before Adding a New One.....	66
Figure 6.19 Rating Mechanisms in the Database after Adding a New One.....	66
Figure 6.20 JSP Page for Administrators after Adding a New Reputation Source	67

Chapter 1

Introduction

The advent of the Internet has led businesses, information technology and online communities to a booming growth. The wide application of e-commerce reduces enterprises' operation and management cost, facilitates the flow of capital, technology, products and services and propels the globalization of the economy. Online shopping has become an increasingly prevalent trend because of its convenience, absence of space and time limitations, and limitless choice of goods and services. Online communities create an open, dynamic and convenient environment for individuals to share their personal thoughts, reactions and opinions with the global Web users. The Internet, one of the most unprecedented inventions in the 20th century, has permanently changed our lives.

The Internet creates vast opportunities to let people interact with total strangers. Online dating could lead to a fun experience. Reading advice or a comment from a so-called guru might be joyful and useful. Online shopping lets people have the opportunity to select incalculable goods and services without the limits of time and space. Nonetheless, those interactions involve risks. Is the nice person on an online dating website really who s/he is? Is the advice from a so-called guru on the Web reliable? Will an eBay¹ buyer receive the purchased item and will it be as described on the site? When doing online interactions, we often find ourselves in situations where we have to trust complete strangers. The concept of trust, studied in many fields including business, management, law, philosophy, psychology, etc., therefore has been brought to the online world in recent years.

Trust is a crucial ingredient in commerce, communication, collaboration and any mutual

¹ www.ebay.com

relationships. Prior to the Internet, trust-related questions were partly answered through personal and corporate reputation. Vendors provided references; Better Business Bureaus tallied complaints; past personal experiences and person-to-person gossip told you whom you could rely on and whom you could not; and participants' standing in their communities, including their roles in church and civic organizations, served as a valuable hostage [1].

As a solution to the ubiquitous trust-related problem, reputation systems [1], also known as online reputation mechanisms [2], have emerged for building trust and fostering collaborations online in recent years. These community tools collect, aggregate, and distribute feedback about participants' past behavior helping people decide whom to trust, encourage trustworthy behavior, and deter unskilled and dishonest participants [1].

1.1 Motivation of the Research

Although successfully used, today's reputation systems lack an important feature: portability [1, 3, 4]. Since every reputation system by far is bound to a specific website, a user's reputation is thereby built and locked in one community only. For instance, an eBay user is unable to take advantage of her/his good reputation history on Yahoo! Auctions², even though these two sites provide highly similar services. The time and effort that s/he has spent and made on building her/his reputation gets no value in return outside eBay's reputation system [4]. Portable reputation systems will solve such problems by making the user's reputations built in different online communities accessible to other users on the Web [3] so that s/he can enjoy those reputations anywhere s/he goes in the online environment.

Unfortunately, research on the portability of online reputation is insufficient. Only a small number of researchers and online businesses are trying to address the issue. Therefore, this

² <http://auctions.yahoo.com>

thesis aims to conduct a study on the portability of online reputation and design a prototype of a reputation system with the characteristic of portability.

1.2 Objectives of the Research

The objectives of the research are stated as follows:

- (1) To study online trust and reputation systems and analyze their relationships and importance in e-commerce and online interactions.
- (2) To conduct a literature review on the related work on the portability of online reputation and the impact of portability on online reputation.
- (3) To complete a study of available industry solutions that try to achieve the portability of online reputation.
- (4) To design a prototype of an online reputation system with the characteristic of portability.

1.3 Organization of the Thesis

The rest of this thesis is organized as follows. Chapter 2 introduces the concepts of trust, online trust, reputation and reputation systems. Chapter 3 explains the importance of trust and reputation systems in e-commerce and online interactions, outlines their strengths and weaknesses, and details the motivation of the research at the end. Chapter 4 conducts a study on the portability of online reputation, including a literature review on related works and an analysis of business applications. Chapter 5 elaborates the methodologies and the design of the model for a reputation system with the characteristic of portability. Chapter 6 describes the implementation and displays the results in some scenarios with screenshots. Chapter 7 draws the conclusion and elicits perspectives and suggestions for future work.

Chapter 2

Concepts of Trust, Reputation and Reputation Systems

This chapter provides the background information that is required to comprehend the thesis, including the concepts of trust, online trust and reputation, an analysis of the relationships between them, and an introduction to reputation systems.

2.1 Trust

The Oxford English Dictionary (1971) defines trust as “confidence in or reliance on some quality or attribute of a person or a thing, or the truth of a statement”. Trust exists as long as human history and almost in every aspect of a person’s life. Undoubtedly, trust is vital and positive to human beings because love, friendship and any meaningful relationship depend on some forms of trust [5]. However, trust is a complex, abstract, multi-faceted and context-dependent notion that is difficult to accurately define and identify the elements that construct it [5]. Across most current research, definitions of trust fall into various categories. Many researchers define and comprehend trust in diverse disciplines such as economics, computer science, management, sociology, psychology and so on.

According to [6], trust, which is characterized by the concept of trust relationship, is both context and time dependent. A trust relationship is determined by a particular time and a given context. Given an example of a merchant with a good performance history, his excellent record of past behavior in selling books doesn’t guaranty that he will be as much trusted as a car salesman. In addition, his good performance history doesn’t mean that this

year he will behave as well as he did in the past two years.

Chang et al. [6] stated the following advanced definitions of trust and other relevant terms in the service-oriented environment.

2.1.1 Trust

Trust is defined as the belief that the trustor has in the trustee's willingness and capability to deliver a mutually agreed service in a given context and a given time slot.

2.1.2 Trustor and Trustee

Trustor is an entity in a trust relationship who has belief or faith in another entity in a given context and a given time slot. *Trustee* is the entity in whom the trustor has belief or faith.

2.1.3 Context

Context can be defined as an object, an entity, a situation or a scenario, and each context has a name, type and functional specification, such as “rent a car”, “buy a book”, “repair a machine”, etc.

2.1.4 Time Slot

A *time spot* is a particular time at which one entity interacted with another and subsequently assigned a trust value to it. It refers to a specific time, such as June 6, 2006. And a *time slot* is a period of time between two time spots over which the trust value is

collected.

2.2 Online Trust

In recent years, lack of trust has become one of the main barriers to people for engaging in e-commerce activities. Traditional forms of communication such as face-to-face meetings provide people with a much wider range of cues relevant to trustworthiness than computer-mediated environments. Comfortable conversations, polite manners and appropriate body language often lead to a successful business interaction. Sometimes even a hearty smile or handshake could contribute to concluding a deal. However, in online relationships, whether they are personal or professional, these cues are missing, making it harder to trust any given individual [7]. Two parties are not able to meet, and there is little or nothing known about their characteristics, or their locations are beyond cities or even countries. Therefore, in order to build online trust models, engineers and designers need to perceive the concept of trust in both offline and online context and to distinguish between them [8].

Wang and Emurian [5], for instance, described the characteristics of online trust as follows:

(1) *Trustor and trustee*. These two essential parties in any offline trust-related relationship are still vital for establishing online trust. Unlike the offline world where trustor and trustee can be many different entities, in most online situations, the trustor is typically a consumer browsing an e-commerce website, and the trustee is the site or the merchant that the site represents.

(2) *Vulnerability*. Transaction partners can behave in an unpredictable manner on the Internet due to the high complexity and anonymity associated with e-commerce.

Consumers are often unconcerned about the risks current and subsequent when transacting online. They are vulnerable to specific trust violations such as loss of money and privacy [8]. In online interpersonal interactions, individuals can be harmed if given bad advice or misleading information [3].

(3) *Produced actions*. Two forms of action from the consumer are generated in consumer trust: a). making a purchase from the merchant with providing credit card and personal information in the transaction, and b). “window-shopping” at the merchant’s website. Trust leads to engaging more consumers in such activities.

(4) *Subjective matter*. As is known, offline trust is dependent on individual differences and situational factors. Likewise, online trust is inherently a subjective matter. Individuals’ different levels of trust determine different results in online interactions.

To understand the nature of online trust, Daignault et al. [9] outlined ten main principles that underpin the concept of trust and the online mechanisms that promote it.

(1) *Trust depends on identity*. Identity is the condition of being distinct from others. In the online environment, individuals and companies may have virtual identities mapping to their offline identities, but as long as these identities remain consistent they can be used to tie together individual interactions into a history of interactions.

(2) *Trust is based on information*. One must first get to know the detailed information about someone or some organization before trusting them.

(3) *Trust is a function of the perception of risk*. Trust and risk are interrelated. Risk is the core of trust because trust is the degree to which a trustor holds a positive attitude toward

the trustee's goodwill and reliability in a risky exchange situation.

(4) *Trust deepens over time and with increased reciprocity.* Usually when a trustee realizes that a trustor has taken significant risk in trusting her/him, s/he tends to be motivated to behave in a trustworthy manner.

(5) *Trust is a matter of degree.* Different people have different levels of tolerating risk and situational factors. For instance, if a buyer's purchase decision involves certain attributes such as high price, complexity, learning and rapid change, the requirement of information for building trust will be greater.

(6) *Culture affects trust.* The globalization of the economy via the Internet makes it necessary to establish trust in disparate foreign markets, jurisdictions and cultures, and it is very important to understand the impact of national culture on the trust building process. Different norms and values in each culture cause the processes of making trust-related decisions to heavily depend on a society's culture.

(7) *Third-party ratings are important in developing trust.* The incorporation of seals of approval, trustmarks, or third-party certificates (directories of trusted sites, trust infomediaries and label bureaus) into content design have been widely accepted as a strategy to assure consumers that the websites are trustworthy. These seals or certificates, in a form of logo or statement, have proven useful for building consumer trust online through trusted third parties (TTPs), such as BBBOnline³, TRUSTe⁴, and VeriSign⁵ [5]. However, these seals can easily lose credibility if they fail to enforce the principles they represent.

(8) *Second-party opinions are important in developing trust.* Second-party opinions are

³ www.bbbonline.org

⁴ www.truste.com

⁵ www.verisign.com

accumulated on the Web by using feedback mechanisms such as reputation systems that capture word-of-mouth feedback and a history of the previous performance of those parties. The summarization of the feedback is made publicly visible in an online community to help diminish others' perception of risk. The strength of second party opinions in building trust is its communication of others' experience in performing similar interactions, while the weakness is that such opinions are usually unstructured and potentially unreliable due to unknown or anonymous sources.

(9) *First-party information is important in developing trust.* First-party information is communicated online by businesses through many types of information including privacy and security statements, mission statements, guarantees and assurances, fulfillment schedules, past performance reports, customer support phone numbers and company information such as addresses, history, investor information, news release and biographies of the major executives. The advantage of first-party information in establishing trust is the directness of the communication between trading partners; the disadvantage is that such information is not unbiased or subject to independent validation or verification.

(10) *Formal and social controls are important in developing trust.* Formal controls employ codified rules, goals, procedures and regulations that specify desired patterns of behavior and penalties or sanctions to be applied in cases of nonconformance. Developing over time, social controls use organizational and cultural values and norms to encourage desirable behavior and deal with other people within the context of a community or organization. Formal controls have distinct information requirement, and typically more information than social controls, thus it is more important to the development of trust.

Building online trust involves many business elements, new computer and Web technologies. For example, some useful and popular technical solutions are introduced to

build online trust, including third-party trademarks or approval seals, second-party feedback mechanisms and highly enhanced security on electronic payment such as PayPal and Escrow services. These technologies have a significant impact on producing a perception of trust to the online consumers and increasing the profitability of the online businesses that deploy them.

On the other hand, many online businesses offer customers quality services for building consumer trust other than applying the technologies mentioned above. Bluenile.com, for instance, the largest online retailer of certified diamonds and fine jewelry, has million-dollar worthy transactions every day. Its success in earning customers' trust at first is believed to be its money back guarantee policy that allows buyers to get the refund if they are not fully satisfied with their purchases.

Lanford et al. [10] believe that online stores should try to make customers feel that they are more important to the stores than sales, and the Websites should be designed in a customer-oriented way. For instance, the layout of products can be arranged from consumers' perspectives rather than back-end perspectives such as a database style layout. In addition, a responsive contact and support can convey a clear message to the customer that the online business is not only about making money, but about making the customer happy and satisfied as well. Although the usability is a definite factor to the success of an e-commerce Website, trustworthiness is more important. In order to thrive, what an online business is required to do is minimize the customer risk, utilize third parties, build long relationships and strong reputation [10].

2.3 Reputation

Reputation has been studied widely in many different disciplines such as economics,

sociology and psychology [11]. In the field of computing, the concept of reputation has been mainly applied to multi-agent systems [6]. In this section, we review some definitions of reputation and its characteristics.

2.3.1 Definition of Reputation

Merriam-Webster Dictionary defines reputation as an “overall quality, characteristic, or ability as judged or recognized by other people in general”. This definition corresponds well with the view of social networks that reputation is a quantity derived from the underlying social network globally visible to all members of the network [12].

Chang et al. [6] define reputation as an aggregation of the recommendations from all of the third-party recommendation agents and their first-, second- and third-hand opinions as well as the trustworthiness of the recommendation agent in giving correct recommendations to the trustor about the quality of the trustee, service, or product.

2.3.2 Characteristics of Reputation

Reputation and trust are usually interrelated and dependent on different personal opinions. For instance, a person may trust someone because of his/her good reputation, whereas they may also do so despite his/her bad reputation [12]. The first half of the statement reflects the fact that the trustor is aware of the trustee’s reputation, and bases his/her trust on it. The second half of the statement makes sense in the situation where the trustor has some private knowledge about the trustee such as direct experience or intimate relationship. Individuals’ trust is a personal and subjective phenomenon that is based on various factors or evidence, and some of those carry more weight than others [12].

From the viewpoint of reliability, reputation can be considered as a collective measure of trustworthiness based on the referrals or ratings from the members in a community [12]. These referrals or ratings as second-hand information are often used as a basis for trust due to the absence of first-hand opinions such as personal direct experiences.

Reputation is also conceived as a multi-dimensional or contextual value [13]. An individual may enjoy a very high reputation for his or her expertise in one domain, while having a low reputation in another. For instance, a UNIX expert may not have a reputation regarding Microsoft's operating system as high as his reputation for the knowledge related to Linux.

2.4 Reputation Systems

During online interactions, which could be commercial or interpersonal, individuals sometimes find themselves in situations where they have to trust complete strangers [3]. Will a purchased item on eBay be as it was described? Is the review or advice from a so-called expert at Epinions⁶ reliable? In order to solve these ubiquitous problems of trust in short-term online relationships, reputation systems, also known as online feedback mechanisms, have emerged as a technology for building trust and fostering collaborations [2].

As mentioned in previous sections, reputation systems are information systems that accumulate and present second-party opinions. The fundamental idea is to use a mechanism for rating products, services, or individuals' past behavior and performances on various aspects and computing an overall value, such as a reputation score, based on the feedback ratings from many different peers in a community. Those values and ratings are made publicly visible so that other peers can use them as a prediction of a given party's future

⁶ www.epinions.com

performance. With such mechanisms, reputation systems help people make decisions on whom to trust, encourage trustworthy behavior, and deter dishonest and unskilled participants [1].

2.4.1 Applications of Reputation Systems

The most remarkable and prevalent instances of reputation systems are those used in online marketplaces. Nowadays the most famous and prevalingly studied reputation system is perhaps eBay's Feedback Forum. One of the marvelous attributes of the feedback forum is that the transactions are performed without any contractual guarantees [2]. In the forum, sellers and buyers have the opportunity to rate each other regarding how smoothly a transaction was executed after the completion. They rate each other with feedback as ("positive", "neutral", or "negative", also known as 1, 0, or -1) and leave comments on the transaction. The ratings and comments about a seller or buyer are made publicly visible to the entire eBay community. Other traders will use those feedback ratings and comments to decide whether to trust one another before making future transactions. Although using a computation engine as simple as a summation of the ratings, that feedback mechanism is considered as a major contribution to eBay's high rate of successful transactions (5 million transactions happening per day). Readers can refer to [14, 15] for more details about eBay's feedback mechanism.

Another pervasive application of reputation systems is the consumer reviewing platform. Amazon, for instance, provides a system for online book review to inform buyers and help them make purchasing decisions. Epinions, with a similar mechanism, allows members to write reviews and comments on any products or services. Those systems use an averaged rating mechanism on a certain scale, usually of 1 to 5 stars. An overall reputation (basically referring to the quality) of a product or service is the average of its total ratings.

Furthermore, reviewers at those sites gain reputations in various contexts through their participation in writing reviews and recommendations. Sometimes they even have the opportunity to earn financial rewards for their participation. Epinions, for instance, has a remarkable program, the Income Share, to reward the writers who contribute reviews helping people make purchasing decisions. These contributions could be recommendations on buying some good quality goods and services, or disparagements that prevent people from buying bad goods or service.

Other information sharing sites (e.g., online news, articles, blogs, etc.) such as Slashdot⁷, use reputation systems to benefit writers and bloggers by increasing the visibility of their publishings and blogs.

2.4.2 Classification of Reputation Systems

Jøsang et al. [12] classified reputation systems into two main types based on different network architectures: the centralized and the distributed. These are the two most popular and major types of reputation systems in current research.

Most existing commercial and live reputation systems are centralized. In such systems, information about the performance of a given participant is collected as ratings from other members in the community who have had direct experience with that participant. The central authority (i.e., reputation center) collects all the ratings, derives a reputation score for every participant, and makes all scores publicly available. Participants can use each other's scores when deciding whether or not to transact with one another. The idea is that transactions with reputable participants are likely to result in more favorable outcomes than those with disreputable participants.

⁷ <http://slashdot.org>

Figure 2.1 below illustrates the framework of a typical centralized reputation system, where A and B are denoted as two transaction partners with a history of transactions in the past and they are considering to transact with each other in the present.

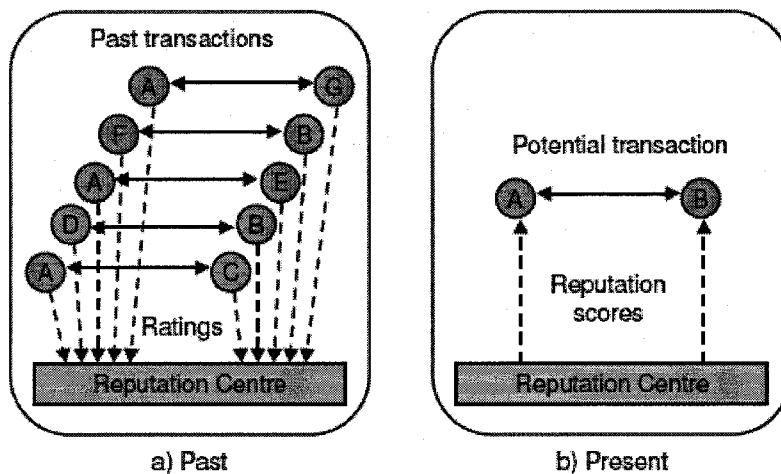


Figure 2.1. General Framework for a Centralized Reputation System [12]

After each transaction, the agents (i.e., C, D, E, F, and G) provide ratings about each other's performance in the transaction. The reputation center collects the ratings from all the agents and continuously updates each agent's reputation score as a function of the received ratings. Updated reputation scores are provided for all the agents and can be used by the agents who will decide whether or not to transact with a particular one [12]. eBay's Feedback Forum is a typical instance of the centralized reputation system.

The other main type of reputation system is distributed. A distributed reputation system is better suited than a centralized system in some environments such as peer-to-peer (P2P) networks [12]. In such a system, there is no central location for submitting ratings or obtaining reputation scores of others. Instead, there can be distributed storages where ratings can be submitted, or each participant simply records the opinion about each experience with

other parties and provides this information on request from relying parties [16]. A relying party, who considers transacting with a given target party, must find the distributed stores or try to obtain ratings from as many community members as possible who have had direct experience with that target party [17]. This is illustrated in Figure 2 below.

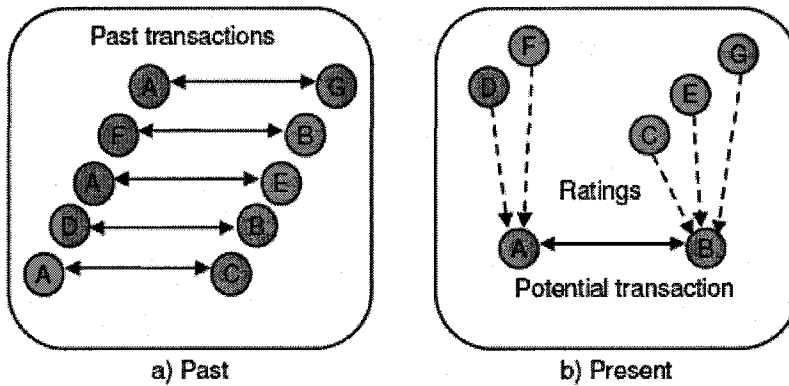


Figure 2.2. General Framework for a Distributed Reputation System [12]

Unfortunately, thus far there is no mature model or application of the distributed reputation system.

Chapter 3

Trust and Reputation Systems in Online Interactions

This chapter gives the business perspective of reputation systems by focusing on the importance of trust and the role reputation systems play in building trust in e-commerce and online interactions, outlines the issues, limitations and challenges that current reputation systems confront, and states the research motivation of the thesis.

3.1 Trust in E-Commerce and Online Interactions

The strength of e-commerce continues to outpace growth rates in many other industries. The year of 2006 witnessed the rapid development of e-commerce around the world. The U.S. Census Bureau of the Department of Commerce⁸ announced that the estimate of U.S. total e-commerce sales in 2006 was \$108.7 billion, an increase of 23.6% from 2005. According to a Forrester research⁹, in 2006 worldwide e-commerce reached US\$12.8 trillion, accounting for 18% of the global sales. The success of eBay and Amazon¹⁰ shows that e-commerce is leading the development of global service industry and affecting the development of commerce models in the future.

However, a critical impediment to the success of e-commerce is the lack of trust [18]. In the offline world, for many years, financial services and credit-rating firms have provided services to check credit, hold money in escrow or determine the long-term financial viability of businesses [19]. However, building trust is very different when trading and

⁸ <http://www.census.gov/mrts/www/data/html/06Q4.html>, last visit: May 23, 2007

⁹ www.forrester.com

¹⁰ www.amazon.com

purchasing are conducted over the Internet. How do we know we are dealing with a legitimate business that will pay its bills, especially given that online transactions are performed with little human intervention? How do we make sure that an online transaction is secure and the trading partners at the other end are who they claim they are?

Considerable evidence reveals the significance of trust in developing e-commerce. A Gartner¹¹ research reports that roughly 20% of consumers will not do online business at all due to the lack of trust in e-commerce websites. Consumers have become increasingly anxious about how the businesses use the information they disclose on the Web. Almost 95% of Internet users have declined to provide their personal information to websites at one time or another when asked, because many of them don't trust those sites on how the data will be used and fear losing the data [20]. Such fears and distrust keep many Web users away from participating in e-commerce activities.

Like in offline-world situations, trust plays a crucial role in online interactions as well. A participant's choice often depends on the level of trust in others or on their reputation in an online community [21]. In online commercial interactions such as business-to-business (B2B), business-to-consumer (B2C) and consumer-to-consumer (C2C) transactions, trust is vital to establish between businesses, business and consumers, and consumers respectively [3].

In B2B e-commerce, for instance, buyers worry that they will not get the products delivered from a licensed vendor in the right quality, at the right time and at the right price, while sellers' worries include not getting paid on time or at all, and extending credit to unworthy buyers. Therefore, trust is the glue binding two business partners in a long-term relationship in B2B e-commerce [22].

¹¹ www.gartner.com

In B2C e-commerce, it is believed that building a durable trust between customers and a brand is a prerequisite for the brand's profitability [23]. The rationale for this perspective is that a brand with strong trust or equity commands a higher price than a brand with low trust or equity [24].

In C2C commercial transactions, trust is significant between sellers and buyers, especially in online marketplaces. The research in [24] shows that trusted sellers may receive higher profit margins which could be the difference between success and failure in highly competitive online markets.

In interpersonal interactions, exchanges between individuals demand a certain level of trust that can be called individual-to-individual (i2i) trust [3]. A study highlighted the importance of trust in location-independent communications in i2i e-commerce in two main scenarios: global teams inside organizations and advisor/advisee interactions from one organization to another or from an agent to a customer [25]. In the global team scenario, employees from different locations and time zones need to trust each other's abilities to achieve the same corporate goals [3]. In advisor/advisee interactions, trust on the advice from an expert or professional is required to serve advisees' needs, while advisors also have to trust that their advisees will pay for their services [25]. Recently the interactions between bloggers and their readers also call for i2i trust [3].

Trust is based on experience over time, building initial trust can be very challenging to newcomers in e-commerce, especially to those who do not have well established offline brands [26]. Scholars and researchers have discussed and designed some technologies and strategies for building trust in e-commerce such as Web interface design, privacy and security strategy, third-party trustmark seals, payment intermediation, insurance providing, and so on [27-29]. For instance, third-party associations such as Trust-e and Better

Business Bureau play an increasing role of intermediary in B2B relationships. The third parties also include commercial institutions such as payment systems, payment guarantors, authentication services, certificate authorities, delivery services and insurance companies, which help decrease the opportunism of a trading partner [22].

Among those technologies, reputation systems have emerged recently and played an increasingly important role in fostering trust in e-commerce and other online environments.

3.2 Reputation Systems in Online Interactions

3.2.1 Overview

Introduced in the previous chapter, reputation systems are community tools that gather, aggregate and distribute the opinions and feedback on a given party's past behavior and performance. They help people make decisions on whether to trust a specific party and provide an incentive for honest behavior.

Fundamentally, reputation systems are a critical component of trust infrastructure supporting social controls [9]. The expectation of reciprocity or the desire to avoid retaliation in future interactions generates an incentive for good behavior [9]. Reputation systems establish the "shadow of future" [30], giving a measure of the trustworthiness of a remote partner [31]. They act as a predictor of the future performance of individuals and companies based on the past experience with them in order to create a culture in which good behavior is rewarded and bad behavior is punished [9].

3.2.2 Important Factors in Reputation Systems

The study in [24] indicates that a seller's reputation is the most important trust factor affecting consumer perceptions of seller trustworthiness in C2C e-commerce. The result in a controlled experiment shows that sellers with high reputation gain 8.1% more profit than those with no reputation for identical items [32]. In reputation systems, some factors are considered rather significant in the information preserved about past online interactions.

(1) Context factor. Context is very important when we talk about someone's reputation, because we rarely trust a person with everything but trust him/her in a specific context only [10]. In reputation systems, the roles that participants play in different interactions determine diverse levels of trust in different contexts. For instance, a Top100 book reviewer at Amazon is not as trusted as a computer seller.

(2) Time factor. Trust and reputation are both time-dependent and developed based on experiences over time. Therefore, the time when a transaction occurred is also an important factor when considering a given party's reputation in a reputation system [33], which reflects whether the party has a long-term trustworthy behavior.

(3) Value factor. It is believed that the volume of a financial transaction should be considered as an important factor in the evaluation of the reputation of a given party. Bhattacharjee et al. [34] think that not only transaction cost is necessary for a reputation system to function well, but the reputation of a seller should be related to the transaction cost. In this case, sellers that have made large volume transactions should be considered more trustworthy than those who have made low-value transactions.

(4) Rater's reputation. Some researchers even take into account the rater's reputation in a transaction feedback rating [33, 35-38]. The idea is that the ratings or feedback on a

transaction from reputable raters should be weighted more than those from disreputable ones.

3.2.3 Advantages of Reputation Systems

Online reputation systems offer many benefits to the online entities that deploy them. Daignault et al. [9] outline some strengths of online reputation systems as follows:

- (1) *Community building*. Reputation systems help responsible members share ethical values and a sense of building a better future of the online community.
- (2) *Reduction in perception of risk*. Viewing user feedback diminishes a potential customer's perception of risk in terms of helping them understand the past performance history of the trading partner from others' experiences.
- (3) *Positive reinforcement*. Reputation systems encourage the consistency of honest behavior. Once a participant has built a positive reputation, there is great incentive to maintain and improve on it.
- (4) *Mixed format*. Reputation systems often depend on unstructured free text comments and quantitative summary measures, which adds to the richness and the utility of the feedback.
- (5) *Dynamic*. Reputation systems are highly dynamic as their feedback components capture comments and ratings over a large number of participants and over time. This dynamic nature is particularly important in supporting the principle that trust is time dependent.

Another advantage of applying reputation systems is that, from an economic point of view,

they reduce the cost that organizations and businesses spend on building consumer trust online. For example, trusted third-party services such as trust-mark seals and Escrow services are popular and play a big role in establishing trust online, but those services are usually costly. The appeal of reputation systems is that, when functioning well, they establish trust and facilitate cooperation without the requirement for those expensive services. The success of eBay is believed, to some extent, due to its reputation system [3].

Furthermore, reputation systems have emerged as a viable alternative for building trust in the electronic environment where contractual guarantees cannot be efficient for organizations and individuals [39]. The potential application of reputation systems will go beyond the relatively narrow domain of trust building in online markets. They have the potential to provide economically efficient outcomes in a wide range of moral hazard settings [40] where societies currently rely on the threat of litigation in order to induce cooperation [39].

3.2.4 Reputation Systems in Business Models of Online Entities

In addition to building trust between strangers, reputation systems help online businesses generate profits as well. On the basis of the insights in [3], the business models of the online that deploys reputation systems can be classified into the following categories:

(1) Advertising. Most of consumer reviews websites fall within this category. For example, BizRate¹² ranks its vendors with an algorithm based on certain criteria, and the vendors who have paid are ranked higher than those who have not.

(2) Donations. This model is the most difficult way to generate revenue because usually the

¹² www.bizrate.com

company provides and maintains a free public service but requires donations to survive. BadBusinessBureau¹³ is a typical example in this category.

(3) Market research. Selling market research to other companies, some companies have this kind of mechanisms as their business models. An example is BizRate whose business model belongs to this category.

(4) Business certification. Some businesses, BBBOnline, for instance, offer the service of investigating and certifying participating companies' profiles as third parties and make the seals of approval for them. Those companies then pay for the service and the seals that can be displayed on their websites.

(5) Business Intelligence (BI) Software. Mining the web including internal and external databases, this kind of software searches for reputation related information about a company or its competitors. The Biz360¹⁴ market intelligence software is an example which, according to its vendors, aggregates, analyzes, and measures corporate reputation based on widespread print, online, and broadcast sources.

(6) Web service supply. Companies sell their web services to cash in. Amazon, for instance, allows other sites to integrate with its web services by charging some amount of money. Epinions provides XML feeds to its partners and licenses its technologies.

(7) Premium user services. Some reputation system websites charge their users for the services provided. In this case, different types of users have different access to the services. Usually premium users enjoy much better services than common users.

¹³ www.badbusinessbureau.com

¹⁴ www.biz360.com

3.3 Issues and Challenges

Every coin has two sides. Despite the widespread and successful use of today's reputation systems, they face many problems that need to be studied and solved. According to [1, 2], there are three main challenges that most existing reputation systems encounter.

(1) Eliciting feedback. There are three related problems with eliciting feedback. First, after completing interactions, people have little incentive to, or may not bother to leave feedback. Second, people don't provide negative feedback as they tend to avoid retaliatory negative feedback or unpleasant potential transactions. Third, assuring the honesty of feedback is very difficult.

(2) Distributing feedback. Username (or online identity) change is a major problem in distributing feedback. Usually people choose a pseudonym when registering at many websites. If they have dishonest performances and a bad reputation record, they can simply re-register with a new pseudonym to start over. Therefore, no one will know their bad reputation histories.

(3) Aggregating and displaying feedback. Different sites have different rating systems to aggregate and display feedback. eBay operates a mechanism displaying the net feedback (positive minus negative ratings), while other sites like Amazon display an average. These simple numeric ratings fail to reflect important subtle details of online transactions such as whether the feedback all comes from low-value transactions or whether it is provided by reputable raters.

Many researchers are dedicated to finding solutions to the issues mentioned above and designing novel and robust systems, yet there is an important characteristic of reputation systems missing, the portability [1, 3].

As a result of bounding to specific websites, today's reputation systems have a noticeable shortcoming: the lack of portability. The maintenance and management of a user's reputation is locked into one community only. The portability of an online reputation system is a feature that allows users to take their reputations that are built at different websites everywhere they go in the online environment. In other words, it is a build-once-use-everywhere characteristic of a reputation system.

As is believed, it takes a lot of time and effort to gain reputation within an online community. A user gets no value for that effort outside the system or the community and cannot maintain or preserve it in any way [4]. Consequently, for instance, a user with an excellent reputation history at eBay is unable to take the advantage of it at Amazon's auctions¹⁵, even though the two sites provide extremely similar services. A portable reputation system will solve this kind of problem by making a user's reputation information accessible to any online entities s/he wishes to interact with [3]. Not only can it save plenty of time and effort that people spend on building reputation in different online communities, it also increases the rate of successful interactions in terms of providing more information about their past behavior and performances. It therefore will be more effective than any other existing reputation system.

In addition to benefiting individuals, the portability of online reputation plays an important role in the business world. Most existing reputation systems are subject to such dominant websites as eBay, Amazon, Yahoo¹⁶, etc., therefore it's really difficult for other merchants and companies, especially small ones, to survive and compete with those sites. A portable reputation system, however, can help them build their brands, businesses, products, and services in terms of sharing and providing one's reputation information built at different

¹⁵ www.zshops.com

¹⁶ www.yahoo.com

sites. And it seems there is no reason why users will not accept them if they are able to reveal even more reputation information about a specific individual. Subsequently, portable reputation systems will have a positive impact on the outputs from the competition between the small businesses and those large websites.

Chapter 4

Literature Review on the Portability of Online Reputation

In this chapter, a study on the portability of online reputations is conducted, including a literature review on related works and an analysis of relevant business implications.

4.1 Literature Review on the Portability of Online Reputation

Many researchers have designed different types of reputation systems for different networks such as client-server, P2P, mobile and ad-hoc networks. Unfortunately, related works on the issue of portable reputation is insufficient, but the concept of portability and some interesting ideas have emerged in some researchers' works.

EgoSphere [4] is a reputation system aiming to integrate different reputation services into one global system by facilitating the transfer of reputation between services. It is composed of three modules: EgoSphere Webproxy, EgoSphere Reputation Database and EgoSphere Reputation Exchange. The EgoSphere webproxy, a web proxy running on users' computers, monitors all users' requests for those reputation-related activities. It first fetches the webpage that a user requested in the server of an EgoSphere-supported service, and analyzes the HTML searching for reputation evidence and EgoSphere annotatable content such as usernames. The webproxy requests annotations for the content from EgoSphere Exchange which computes the reputation evidence and inserts the annotations into the HTML at proper places before returning the webpage to the user's browser. EgoSphere

Reputation Database receives and manages the reputation evidence from many webproxy sources. EgoSphere Reputation Exchange will use such evidence to calculate how much reputation should be transferred from one service to another. The basic idea is that the more similarity two services have, the more reputation evidence can be transferred from one to the other.

Ismail et al. [41] proposed a centralized security architecture for reputation systems. In this architecture, a module called Collection Center/Certificate Authority (CC/CA) contributes to the portability of the reputations of a particular feedback target that is being evaluated. After the feedback target is registered, The CC/CA module collects valid reputation feedback about her/him based on past transactions, uses the feedback to compute a reputation value, and then issues a reputation certificate for her/him after the authentication of her/his identity. During a transaction, a participant can request the feedback target to show her/his reputation certificate. The system will validate the reputation certificate and return it to the participant. Based on the reputation information on the certificate, the participant can make a decision on whether or not to proceed to conduct the transaction with that feedback target. Although Ismail et al. did not unveil how they computed the reputation ratings and feedback, the idea of the CC/CA module represents the portability of the reputation system.

Li et al. [33] proposed a personalized online reputation aggregation system (ORAS) based on a discrete statistical model in which reputation feedback values from the reputation systems of different online communities are re-computed by its algorithm. The algorithm takes into account the credibility of the rater who gave the feedback in every single transaction and several other factors that qualify the transaction such as the time when the transaction occurred and the volume of the transaction, converts different types of feedback values into a universal set of values based on its mapping technique, and works out the

local reputation value of the ratee at each online community and a global reputation value for the ratee.

4.2 A Study of Industry Solutions to the Problem of Portability

In Chapter 2, a critical shortcoming of existing reputation systems is identified, which is the lack of portability due to the fact that they are generally bound to specific websites. Amazon actually realized the issue early and used to allow its users to import their reputation ratings from eBay. However, it did not take long for Amazon to stop this scheme because of eBay's protest claiming that its feedback mechanism was proprietary. A possible reason is that eBay got nothing in return for assisting its users in switching to Amazon [4].

In recent years, some small companies have already applied models of reputation systems with a portable feature in their businesses on the Web.

4.2.1 RapLeaf's Portable Rating System

Based in San Francisco, RapLeaf¹⁷ which was launched on May 7, 2006 is a portable rating system for commerce. RapLeaf allows members to leave feedback on anyone (could be a member or not) they have transacted with. Others can use such feedback to determine whether they are going to transact with this person. On the home page of RapLeaf, users can find or rate some member based on his/her unique email address or phone number. This can be a seller, buyer or swapper they have transacted with, or just a friend they want to endorse. Same as eBay's feedback system, a free-text area is included for comments in addition to a positive/neutral/negative rating. This is illustrated in Figure 4.1 below.

¹⁷ www.rapleaf.com

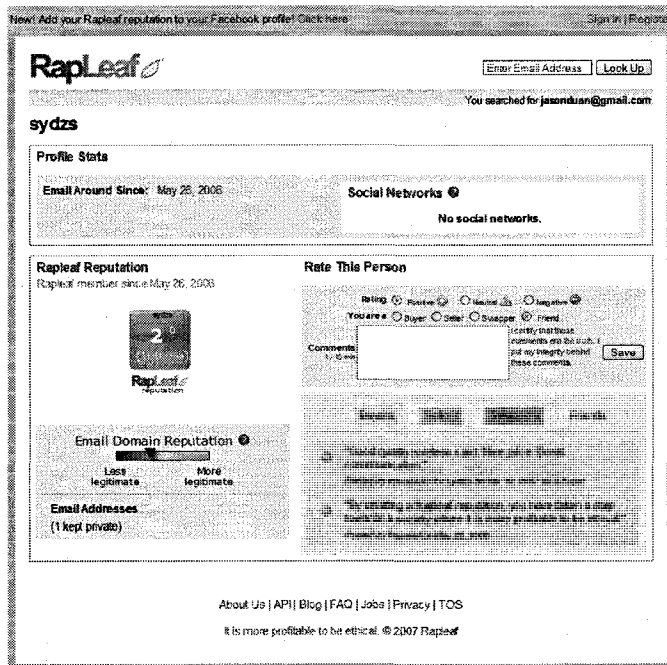


Figure 4.1 A Member's RepLeaf Profile

The gray image, called RepLeaf Profile Badge, in Figure 4.2 below contributes the portability of the rating system. RapLeaf allows its members to copy and paste the HTML code generating the image into their blogs, web pages or wherever they want the image to appear. The image will automatically be updated as a member gets more feedback, and if anyone clicks on it, it will take them directly to the member's profile on RapLeaf.



Figure 4.2 Profile Badge of a RapLeaf Member

The RapLeaf Reputation displayed in the profile badge contains three parts: RapLeaf Score,

Positive Feedback and RapLeaf Personal Score. The algorithm of the first two is the same as eBay's feedback algorithm. Concretely, RapLeaf Score, the white number in the green image (will be gray after printing, see Figure 4.2 above), is the main commerce score that is calculated by the number of seller/buyer positive ratings minus that of negative ratings. Multiple ratings from the same person are not counted. Positive Feedback, the number with percentage in Figure 4.2, is the percentage of positive commerce feedback given about someone compared to the total commerce feedback. It is calculated by the number of positive buyer and seller ratings divided by the total number of buyer and seller ratings. The Feedback Percentage and the RapLeaf Score are not affected by the RapLeaf Personal Score, and vice versa. The RapLeaf Personal Score is composed of personal endorsements from friends and designated by the superscript small number in the image.

Compared to common reputation systems, RapLeaf has two remarkable features. The first one is its open API. This rating system can be considered as the open version of eBay's feedback system. People can rate one another without the constraint of specific transactions. And RapLeaf deploys an API to make account creation, review creation and feedback scores accessible and free to the third parties who choose to integrate with it. For non-eBay online shopping sites, RapLeaf could be a competitive leveler. And if adequate sites start to integrate with RapLeaf over time, the data might become more informative than eBay's¹⁸.

The second noticeable feature of RapLeaf is its fraud detection system which is its most valuable property. On eBay, every feedback report is bound to a specific transaction, and subsequently that removes a great deal of fraud issues. RapLeaf doesn't have this property, but it uses a fraud prevention and detection system to make its feedback reliable and trustworthy. The system looks at the ratings over time and the RapLeaf's staff will determine confidence intervals around all the ratings through which they make decisions to

¹⁸ Michael Arrington, "*RapLeaf to Challenge eBay Feedback*", April 23, 2006, TechCrunch, available: <http://www.techcrunch.com/2006/04/23/rapleaf-to-challenge-ebay-feedback/>, Last visit: Aug.8, 2006

the validity of each rating. This scheme might not be robust or reliable because it seems like those suspicious ratings are handled manually. Since RapLeaf's CEO Auren Hoffman didn't disclose his trade secrets, there is no way to tell whether he is right or not.

As was mentioned previously, RapLeaf addresses the portability of its reputation system with an image called Profile Badge on which a member's unique email address (as his/her RapLeaf username) and RapLeaf Reputation Score are shown. RapLeaf creates a profile page for every member and offers a service to post his/her profile badge on web pages or blogs. People that see the badge can be linked to his/her reputation profile page when clicking on it.

4.2.2 iKarma's Portable Reputation Management System

In August 2005, iKarma¹⁹ that aims at providing reputation management services was founded in Jupiter, Florida, USA. Users can register for iKarma directly at the site or via an email notice from someone who would like to write about them. Upon the completion of registration, a user gets an initial full five-star review from the iKarma team and is ready to start writing reviews about others. If they are not members, the user can invite them.

An iKarma review consists of a star rating (1-5) and a free-text area, which is similar to Amazon's and other review systems. A member's overall star rating is averaged among all of the reviews. iKarma allows anyone with a valid email to write a review about any iKarma member. Meanwhile, Web users can review a member with different interests and qualities, such as real estate, home sale, broker, and so on. They can also add the member they just reviewed as an advisor, associate, client/customer, consultant, employee, employer, family, friend, vendor/supplier, or other categories. Although s/he is only able to leave a

¹⁹ www.ikarma.com

review for a given member once, a user can edit the review if s/he changes her/his mind later.

iKarma allows its members to import their other online reputation-related identities into their iKarma reputation profiles. For instance, a member can inform iKarma of his/her account(s) at eBay by typing his/her eBay username(s) in a search bar. iKarma will then create a link to the member's eBay feedback profile, which will be displayed on his/her iKarma reputation profile page. This is shown in the following Figure 4.3.

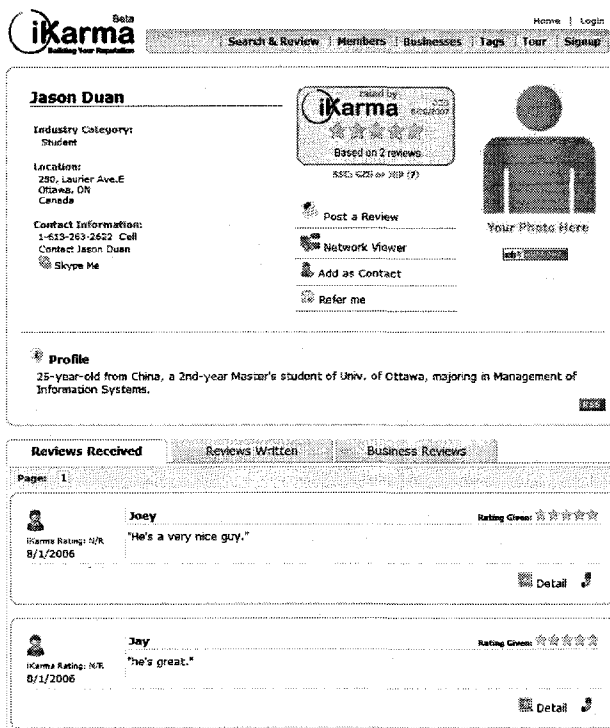


Figure 4.3 Reputation Profile of an iKarma Member

Similar to the RapLeaf badge, iKarma makes its reputation system portable by providing an icon called iKarma Seal. It can be personalized by an individual member to include in an email or on a Web site. People that see the seal can be linked to the member's iKarma reputation profile when clicking on it. This seal is shown in the following Figure 4.4.



Figure 4.4 iKarma Seal of a Member

According to an interview with the CEO Paul Williams²⁰, iKarma is currently free and basic membership will always be free, but later members will be divided into free, premium, and Enterprise level groups. iKarma will have advertisements in the Admin section for basic members. Premium members will pay \$10 per month to enjoy better services and won't have advertising on any of their profile pages. They also will have the ability to post their own comments at the bottom of each customer review. The enterprise level members will get a more advanced "key based" system that will provide a variety of identity verification features as well as a system for limiting posts to verified customers.

4.2.3 Opinity's Portable Reputation Management System

Founded in April 2002 and based in San Jones, California, USA, Opinity²¹ was the first company to develop reputation systems for individuals and small merchants engaging in e-commerce and social network communities on the Internet. It allows members to review and rate transactions with others as well as manage their own reputation profiles. It was the first one among many reputation management services to aggregate online reputations and verify reputation-related information across all areas, from both online and offline sources.

²⁰ "Interview with iKarma CEO Paul Williams", Available at: <http://www.searchengineguide.com/lavcock/005468.html>.
Last visit: Aug.7, 2006

²¹ www.opinity.com

Opinity offers Web users a consolidated view of their various online identities. In different contexts such as commerce, community, dating, and gaming, members can put together their multiple online and offline reputation sources with personal information, certifications, awards, education backgrounds, testimonies from friends, the existing reputations in other communities, and so on.

Different from iKarma's way of importing members' online identities, Opinity gets an imported online identity verified by using a patent-pending ID verification mechanism, the Veridem™ Technology. With such a technology, the authenticity of a person's own online ID can be securely verified by providing his/her specific User ID and Password along with the website name where he/she is registered. For example, a user has an account at eBay with good reputation history, and s/he wants to add this identity into her/his Opinity reputation profile to enhance her/his trustworthiness. S/he will be linked to the log-on page of eBay. After successfully logging on, s/he will be taken back to the previous Opinity page where s/he will find that the eBay ID has already been verified.

The rating system of Opinity is very similar as that of iKarma, but Opinity weights reviews for and by someone with a verified ID much more heavily than reviews done by those without ID verification. Another difference is that Opinity has four categories of classified reputation based on personal interests and qualities such as commerce, community, dating, and gaming. Each category's reputation score will be calculated and displayed separately in a member's reputation profile. Figure 4.5 below shows a sample of this property where Member Marcus Hernandez has an average reputation value of 3.8.

Opinity (Log In | Register)

Home | Profile Manager | Profile Exchange | Search | Tools | Help

Reputation Profile: marcusghernandez

Reputation Score: [Contact](#) [Establish as friend](#) [View this person](#)

Dating: [View all reviews](#) [Add review](#)

Personal Info:


Name: Marcus Hernandez **Gender:** Male
Location: Cupertino, CA, United States **Year Born:** 1982

Interests:
 Sports, cars, video games, and of course women!

Welcome message:
 Hello all, welcome to my reputation page. Feel free to send me a message and don't forget to add me as a friend! :)

My Online Identities:

ID: marcusghernandez	Site: Match.com
ID: marcusghernandez	Site: OkCupid
ID: *****	Site: eHarmony
ID: markus	Site: Dating.com
ID: *****	Site: www.true.com
ID: 5083837	Site: DatingDirect.com

Testimonials:

It was nice meeting you, hope we can hang out again.
 We're planning to go to the game again this weekend, I hope you can join us!
 I'll talk to you soon.
 Submitted by caromy, 11/03/2005

Figure 4.5 Reputation Profile of an Opinity Member

In addition, Opinity has a noticeable feature letting its members control and manage their reputation and personal information when they are interacting with others. It offers an opt-in service which allows users to decide what from their information to disclose to others and what to reserve. This service is called Opinity Reputation Exchange. A member can request a reputation profile from, send his/her reputation profile to, or exchange his/her reputation profile with the participant that he/she wants to interact with.

In April 2006, Opinity announced its partnership with RapLeaf in order to provide Internet users with better rating and reputation services. To achieve this goal, Opinity integrates with RapLeaf's commerce rating system, and meanwhile RapLeaf is allowed to use Opinity's online identity verification service. Therefore, people now have another option to rate an Opinity member by using the rating system of RapLeaf.

Opinity has a similar design of the portability for its portable reputation management system as RpLeaf and iKarma, which is the Opinity Seal that can be included in members' blogs and web pages. A member's Opinity reputation in certain context is displayed on the Opinity seal. When others click on it, the Opinity profile page of the member will show up.

4.2.4 Authorati's Portable Rating System

With a portable ratings and authority system for blogs and online articles, Authorati²² enables bloggers and authors to gain reputation and increase the visibility of their publishing. Users are allowed to list the URLs of their articles/blogs on their Authorati pages after registration. Readers then can rate the articles/blogs on Authorati.

The Authorati rating consists of two parts, the authority rating (scale of 1-5) and the authorship rating (scale of 1-10). And each averaged rating will be shown below a blog or an article. Authorati allows readers to specify tags on the contents of blogs/articles in different fields, such as arts, business, sports, technology, science, entertainment and so on. These are shown in Figure 4.6 below.

²² www.authorati.com



Figure 4.6 Home Page of Authorati

In order to provide a portable rating service for blogs and online articles, Authorati offers members a service of adding a web widget into their blogs template or web pages to display the Authorati ratings. Members could simply copy a segment of HTML code that generates the web widget and paste it on any web pages, blogs, or anywhere they want to show their Authorati ratings. This web widget is illustrated in the following Figure 4.7.

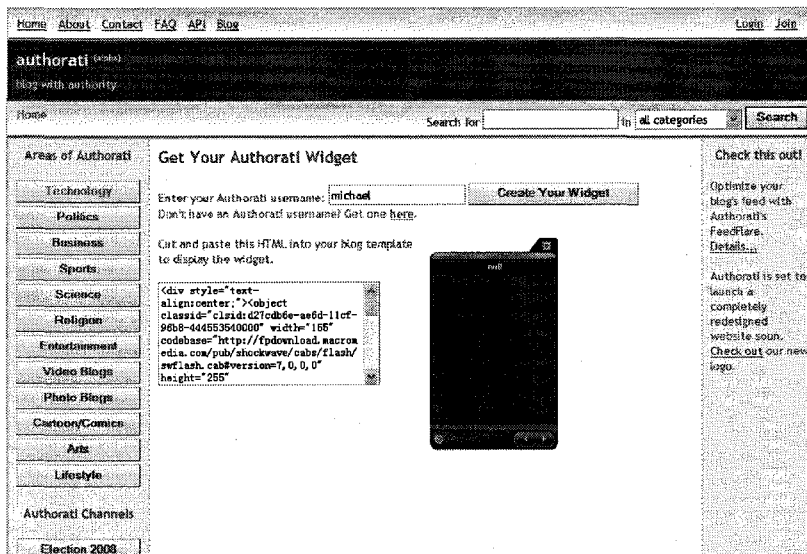


Figure 4.7 An Authorati Widget

Chapter 5

Design of a Portable Online Reputation System

This chapter presents the design of a portable online reputation system. We start with a description of the methodology and then we present and discuss the architecture of the proposed portable online reputation system.

5.1 Methodology and Tools

This subsection introduces some Web services and Web application technologies and tools we used to develop a portable reputation system. We use Java Web applications to implement our system because of the possibility to update and maintain Web applications without distributing and installing software on potentially thousands of client computers. We also use Java Web services to implement clones of the Web services that are assumed to be provided by partner online communities.

5.1.1 Web Service Technologies

The W3C²³ defines a Web service as a software system designed to support interoperable machine-to-machine interaction over a network. Web services are usually Web APIs that can be accessed over a network such as the Internet, and executed on a remote system hosting the requested services.

Web services have many advantages over other types of distributed computing technologies.

²³ www.w3.org

According to a Systinet's online tutorial²⁴, these benefits are:

(1) Interoperability. Web services are platform and language independent. Web services can run on any platforms and allow developers to use their preferred programming languages such as Java, C++, VBScript, JavaScript, and Perl that all have one or more Web service APIs maintained by many vendors.

(2) Reusability. One Web service might be used by several clients. Instead of creating a service for each client, portions of a service are simply re-used as necessary.

(3) Adaptability. Web services are deployed over standard Internet technologies such as XML and HTTP, which make it possible to deploy Web services to any servers running on the Internet.

Below are some core specifications about Web services, including four standards that form the basis of Web services: Extensible Markup Language (XML), Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description Discovery and Integration (UDDI).

(1) XML. The most fundamental element of Web Service technologies is XML. In broad terms XML is a text based human interpretable way to represent data and data structures using a subset of the Structured General Markup Language (SGML). Web Services use XML to describe application class interfaces and to encode messages [42].

(2) SOAP. SOAP is an XML-based, extensible message envelope format with bindings to underlying protocols which specifies the communication message format that defines a uniform way of passing XML-encoded data [42]. SOAP messages support publishing,

²⁴ <http://dev.systinet.com/doc/ssc-60/primer/html/using.web.services.html>

binding and finding operations for a service-oriented architecture [6]. It lets an agent or application invoke another agent or application using an XML message over the Internet.

(3) WSDL. WSDL is an XML format used for describing the services available in the broker or in the service registry for service publishing and finding [6]. It gives the location, functions and operations of a Web service and their data type information and is typically used to generate server and client code, and for configuration.

(4) UDDI. It is a protocol for publishing and discovering metadata about Web services. It collects all the services available in the network to the service broker or central registry, acts like yellow pages for the reason that it clusters similar services under similar headings for the clusters and lists them individually, and provides publish/find functions for service provider and service requester/customers [6].

In our design, the partner online communities use UDDI to publish the Web services that give access to raw reputation data kept in their databases. The description is in WSDL. With Web service clients, our system invokes the corresponding Web services using SOAP messages.

5.1.2 Development Environment of the Implementation

In the implementation process, we used MySQL 5.0 as the database support, the NetBeans IDE 5.5 as our integrated development environment, and Apache Tomcat 5.5 as the web server.

MySQL is a popular open-source, multithreaded, multi-user SQL database management

system, which has, according to MySQL AB²⁵, more than 11 million installations ranging from large corporations to specialized embedded applications in the world. MySQL runs on more than 20 platforms including Linux, Windows, OS/X, HP-UX, AIX, Netware, offering users a great deal of flexibility.

We use MySQL 5.0.26 to create and manage the databases in our portable reputation system.

Apache Tomcat²⁶ is an open source, cross-platform web container developed at the Apache Software Foundation (ASF) and able to run on any operation system that has a Java Runtime Environment (JRE). Tomcat implements the Java servlet and the JavaServer Pages (JSP) specifications from Sun Microsystems, providing an environment for Java code to run in cooperation with a Web server.

We use Tomcat 5.5.17 as the Web server which runs all the Java beans, Servlets, JSP pages, HTML pages and other Web components.

The NetBeans IDE²⁷ is a free, open-source integrated development environment written in Java using the NetBeans Platform, a reusable framework for simplifying the development of other desktop applications. NetBeans IDE supports development of all Java application types (J2SE, EJB, Web and mobile applications) out of the box, allowing developers to focus on the logic specific to their cross-platform applications.

We use NetBeans IDE 5.5 to bind together all of the Web services and Web applications.

²⁵ <http://www.mysql.com/>

²⁶ <http://tomcat.apache.org/>

²⁷ www.netbeans.org

5.2 Design of a Portable Reputation System

5.2.1 Overview

This work is part of a bigger project which studies various architectures for online reputation systems. In the project, we propose a portable reputation system providing a platform that allows users to search other's reputation and members to take their existing reputations built in different online communities anywhere they go in the online environment. To achieve this goal, our system should be able to collect reputation data from those online communities, aggregate the data, and compute overall reputation information from the data. For the aggregation and computation processes, we integrate our system with the aggregation module and the computation engine of the online reputation aggregation system (ORAS) [33].

As its name implies, ORAS aggregates a peer's reputation data from different online communities. With a discrete stochastic algorithm, ORAS computes the local reputation values (a peer's reputation values in different online communities which are computed based on a couple of parameters such as the feedback value of a transaction, the time when the transaction occurred, the volume of the transaction, and so on) and a global reputation value (the aggregated value from the local reputation values) for the peer [33]. Unlike EgoSphere's reputation transferring mechanism that transfers a peer's reputation from only one to another at a time, the global reputation value represents the peer's overall reputation summarized from different online communities and can be displayed with the RepCard on web pages, blogs, or anywhere s/he wants to show the value if the peer is a member of our system.

Based on the design of ORAS, we proposed an extended system with more modules and functionalities, ORAS Plus. It has a centralized architecture with a special module

providing the portability feature of the reputation system, which was designed by me. Other modules were designed by another student and detailed in his thesis.

5.2.2 Business Model for ORAS Plus

We start by explaining how our system can be sustained economically.

First and paramount, advertising is always a good way to make revenue. In our system, other than the advertisements on members' profile pages, the reputation searching service (explained later in this chapter) may allow members to promote their online reputations in a way similar to Google's way of ranking on a searching result page, that is, sponsors pay in order to be ranked higher.

Second, in the future, profits could be made from different types of members, such as common and premium members. Service for common members will stay free while premium members will pay some amount of money for more and better services.

Third, since the reputation searching service is deployed as a web service, other websites could integrate it into their systems by paying a fee.

Last but not the least, due to the possibility that the reputation searching functionality might become mature and widespread, being purchased by Google²⁸ in Google search would be another superior option to make revenue.

²⁸ www.google.com

5.2.3 Design of the Portability Feature of ORAS Plus

Based on the ideas inspired by the literature businesses analyzed in the previous section, we introduce the RepCard (meaning Reputation Card), an image showing a member's username and some reputation information, to realize the portability of our reputation system. The RepCard module in the architecture of ORAS Plus will create a RepCard for each member based on his/her gathered reputation information. A member's overall reputation value, which is calculated by the system, will be shown on the RepCard, and s/he can easily copy and post the HTML code that links to the RepCard into web pages or blogs. When clicking on the RepCard, other users will be linked to a detailed reputation profile of the member.

5.2.4 Assumptions

In order to simplify the process and keep the implementation practical, it is necessary to make some assumptions.

(1) Unique online identities. A user has a unique online identity when using ORAS Plus. As we all know, the online identity has become a critical issue in online commerce and interactions. User identities are hard to control and most likely distinguished from one community to another. By far many websites and companies are trying to offer solutions to this issue such as OpenID²⁹, ClaimID³⁰, Opinity, IBM's SAML³¹, Microsoft's CardSpace³², Identity 2.0³³, etc. Since we focus on the portability of reputation systems, we assume that a user has a unique online identity when using our system.

²⁹ www.openID.net

³⁰ www.claimID.com

³¹ <http://www.ibm.com/developerworks/xml/library/x-seclay4>

³² <http://cardspace.netfx3.com/content/introduction.aspx>

³³ <http://www.technologyreview.com/article/16531>

(2) Available Web services from other online communities. We assume that Web services providing reputation data from other online communities are available to us or the public so that we could obtain the information about one's reputation from those different reputation systems. We also assume that the privacy of users is protected.

(3) The RepCard is allowed to be posted on websites. The assumption here is that websites allow our members to post the RepCard. The RepCard, the key feature of our portable reputation system, is merely a chunk of HTML code to the users. Without the permissions from other websites such as eBay, Amazon zShops, and Yahoo! Auctions, members will not be able to post the code on those sites to make their reputation accessible to others.

5.2.5 Architecture of ORAS Plus

Based on the architecture of ORAS, we designed a centralized architecture for ORAS Plus with more modules. Those architectural components are illustrated in Figure 5.1.

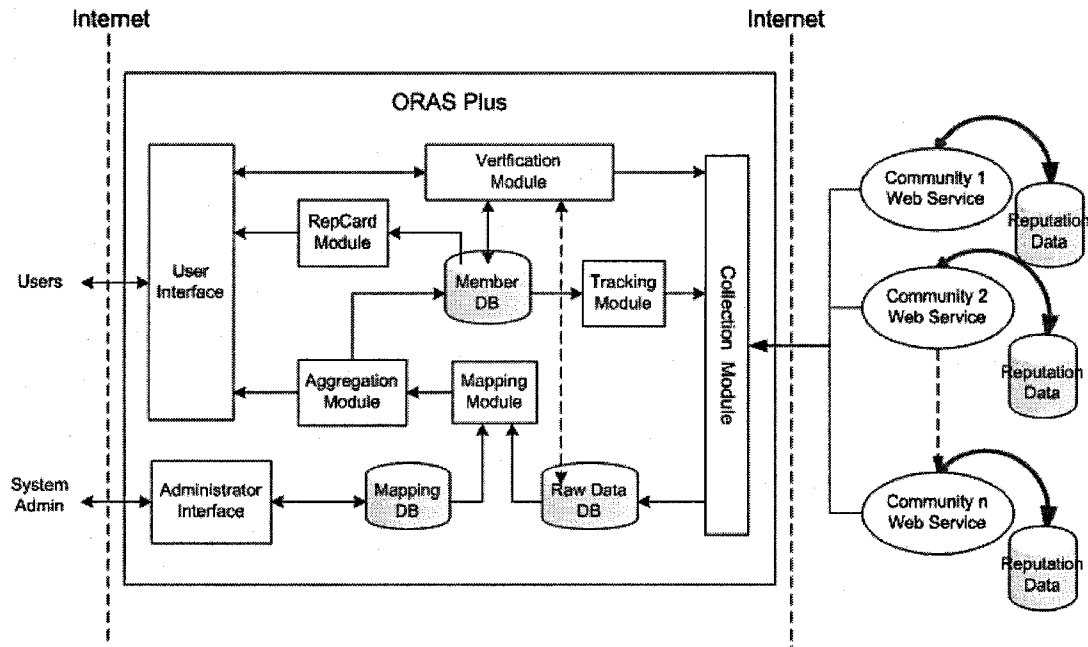


Figure 5.1 Architecture of ORAS Plus

User Interface

The user interface is a couple of web applications and pages that divides users into two types: regular users and members. Regular users are those who use our system to query for the reputation information about a specific ratee (a peer in an online community), and they also can search the reputation information of a group of members based on certain criteria (e.g. reputable members with high reputation values) in Member DB. Regular users can register to become members who have the privilege to manage their reputation profiles and RepCards.

Administrator Interface

System administrators have the privilege to decide what online communities with reputation systems should be included in ORAS Plus as partners, classify the corresponding rating mechanism that different communities use, and convert these mechanisms into a

universal format through the criteria defined in Mapping Module.

RepCard Module

The RepCard module creates a RepCard for each member displaying the number of transactions s/he has performed in total and her/his global reputation value.

Verification Module

The verification module will check whether the queried individual is a member of ORAS Plus or whether s/he has raw reputation data in Raw Data DB. If s/he is a member, the information will be obtained from the member database and then the result will return to her/him. If s/he is not a member but already has raw transaction data stored in Raw Data DB, the system will return the result after computing the data in Aggregation Module. In the case that s/he is not a member and doesn't have raw transaction data in the database, the query request will be forwarded to the collection module. This design derives from the consideration of reducing the workload of the collection module.

Collection Module

The collection module is a set of Web service clients consuming the Web services provided by different online communities. It is responsible for collecting the raw reputation data related to all of the interactions an individual has made, such as the time and volume of each interaction, the feedback value rated on it, and the rater's credibility [33]. The returned information is stored in Raw Data DB.

Mapping Module

This module converts the local reputation data gathered from different communities into a universal format. For example, some of the reputation systems use an average rating mechanism on a scale of 1-5, while others may use it on a scale of 1-10. Mapping Module

standardizes those scales into a scale of 0 to 1 [33].

Aggregation Module

Aggregation Module computes the reputation data received from Mapping Module with given algorithms, aggregates the data, and displays the result in a user understandable format such as a ratee's global reputation value, the total number of online interactions s/he has ever performed, and the amount totally involved [33].

Tracking Module

This module is used to track and receive the latest local reputation information of members. The tracking module re-collects members' local reputation information in different online communities automatically to keep the members' reputation information up-to-date, sends the gathered information to Mapping Module and Aggregation Module, and then updates the reputation values and other data in Member DB, as well as members' reputation profiles and their RepCards. Since some members do not have interactions very often, Tracking Module is set to re-collect their reputation information at regular intervals. Members also can choose how often their reputation information is updated when registering.

Member DB

The member database is responsible for storing members' reputation profiles, including local reputation values for different online communities, the global reputation values computed by Aggregation Module and so on. Therefore, it will reduce the workload in the mapping and aggregation modules, and have the RepCard refreshed quickly.

Raw Data DB

This database keeps all of the raw transaction data (i.e., the time, value, feedback and rater's reputation of each interaction) of a peer from different online communities in order

to reduce the workload of Collection Module because otherwise the module would connect to the web services of different communities every single time the given peer's reputation information is requested.

Mapping DB

This database stores the names and rating mechanisms of different reputation sources and the feedback mapping tables for converting different types of feedback into a universal format that is used in Mapping Module.

Community Web Services

The Web services are provided by partner online communities. When invoked, each Web service gathers the raw reputation data of a specific ratee that is kept in the database in each community, then writes the data into a text file and returns it to our system.

Chapter 6

Implementation and Execution Scenarios

In this chapter, the implementation of the RepCard within ORAS Plus is explained and illustrated with a couple of screenshots. I did the implementation of RepCard Module and the user interface for members. My project partner did the implementations of the rest of modules in ORAS Plus.

6.1 Implementation of RepCard

Using the NetBeans5.5 IDE, we created a java class, RepCardGenerator, to generate the RepCard. It is basically an instance of the ImageIO extended class in Java which draws a member's information based on her/his username, global reputation, total number of transactions, etc., generates the image file named after the member's username and stores the image in the server.

First, we created a class, *DBQuery*, to obtain the reputation information of a specific member through the *getMemberInfo* method in it. Another class, *MemberDetail*, is responsible for temporarily storing the returned data from the database, including a member's username, global reputation value, total transactions performed, total amount of money involved, and the local reputation values at different online communities.

```
// create a new instance of the DBQuery class
DBQuery dbq = new DBQuery();

// get the information of a member and store it in an instance of the MemberDetail class
```

```

MemberDetail md = dbq.getMemberInfo(memberid);

// get the member's global reputation value
String gr = md.getGlobalRep();

// get the transactions the member has performed in total
String tt = md.getTotalTransactions();

// get the total amount in the transactions
String ta = md.getTotalAmount();

```

Second, the RepCardGenerator class draws the information and makes an image to display it.

```

// create a 130x140 image
int width = 130, height = 140;
BufferedImage image = new BufferedImage(width, height, BufferedImage.TYPE_INT_BGR);

// get an image object
Graphics g = image.getGraphics();

// fill the background
g.setColor(Color.GRAY);
g.fillRect(0, 0, width, height);
g.setColor(Color.WHITE);
g.fillRect(3, 3, width - 6, height - 6);
g.setFont(new Font("Arial", Font.BOLD, 10));

// draw a username
g.setColor(Color.GREEN);
g.drawString(memberid, 45, 20);

// draw a global reputation value
g.setColor(Color.BLUE);
g.drawString("global reputation value:", 10, 40);
g.setColor(Color.RED);
g.drawString(gr, 10, 60);

// draw the total number of transactions
g.setColor(Color.BLACK);

```



```

g.drawString("number of transactions:", 10, 80);
g.setColor(Color.ORANGE);
g.drawString(tt, 10, 100);

// draw the last update date
g.setColor(Color.GRAY);
g.drawString("Last update:", 10, 115);
g.setColor(Color.GRAY);
g.drawString(formattedDate, 20, 125);

```

Third, the class creates a graphic file in a local hard drive in the server.

```

// create a PNG file for the image with the username of the member
File file = new File("D:/NetBeans Projects/ORASplus/web/images/" + memberid + ".png");
ImageIO.write(image, "png", file);

```

Last, an introduction on how to use the RepCard (copying and pasting a fragment of HTML code into web pages or blogs) is shown on the member's profile page.

```

// To promote your reputation with RepCard, copy this section of HTML codes below and paste it on any
Web page you want:

<a href="http://localhost:8084/ORASplus/res_member.jsp?memberid=jay"></a>

```

6.2 Scenarios and Screenshots

6.2.1 RepCard

The program runs under the Netbeans5.5 IDE and successfully creates the image of the RepCard in the server. Following Figure 6.1 presents the profile page of Member Jay, and Figure 6.2 shows what his RepCard looks like, where Jay has a global reputation value of 0.77 and 9 transactions totally performed.

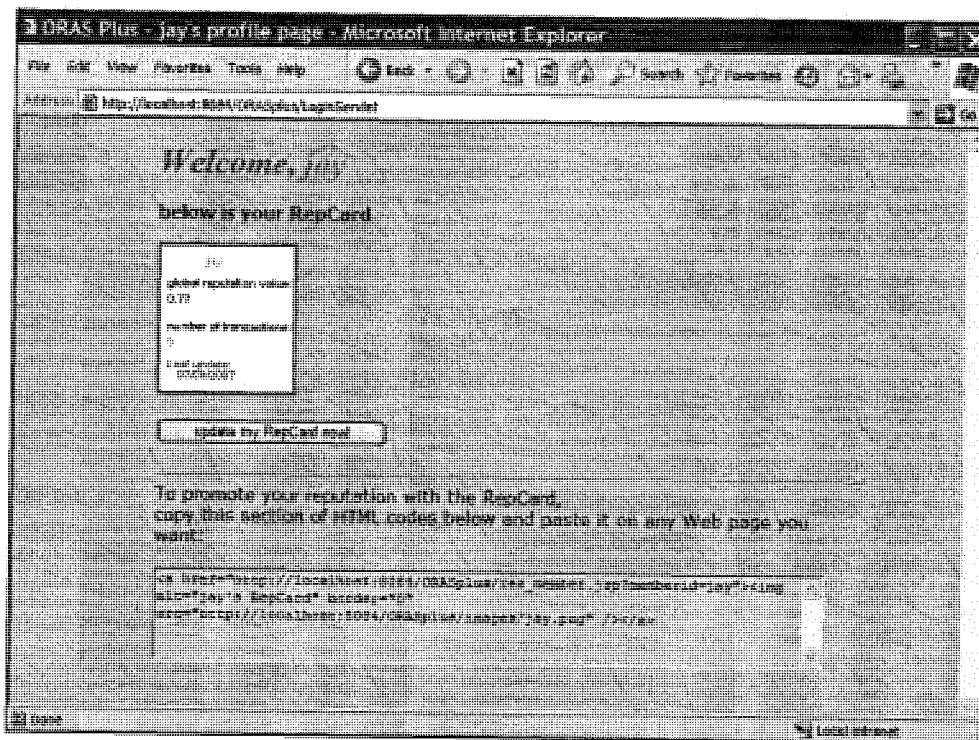


Figure 6.1 Profile Page of Member Jay

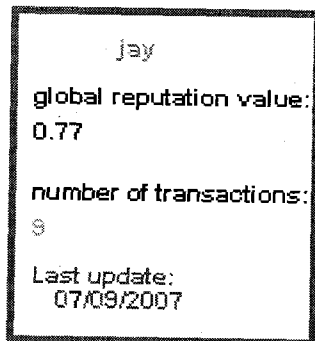


Figure 6.2 Member Jay's RepCard

6.2.2 How the System Works

Scenario 1: Regular Users

A user wants to check the reputation information of a specific individual, Helen, for example, on the index.jsp page. After the user clicks on the search button, the request will be sent to Verification Module, a Java Servlet called VerificationServlet, to check whether Helen is a member of ORAS Plus. If so, the response will display on a JSP page named res_member.jsp with Helen's global reputation value, local reputation values, total number of transactions performed, total amount of money involved, etc. These are shown in Figure 6.3 and Figure 6.4 below.

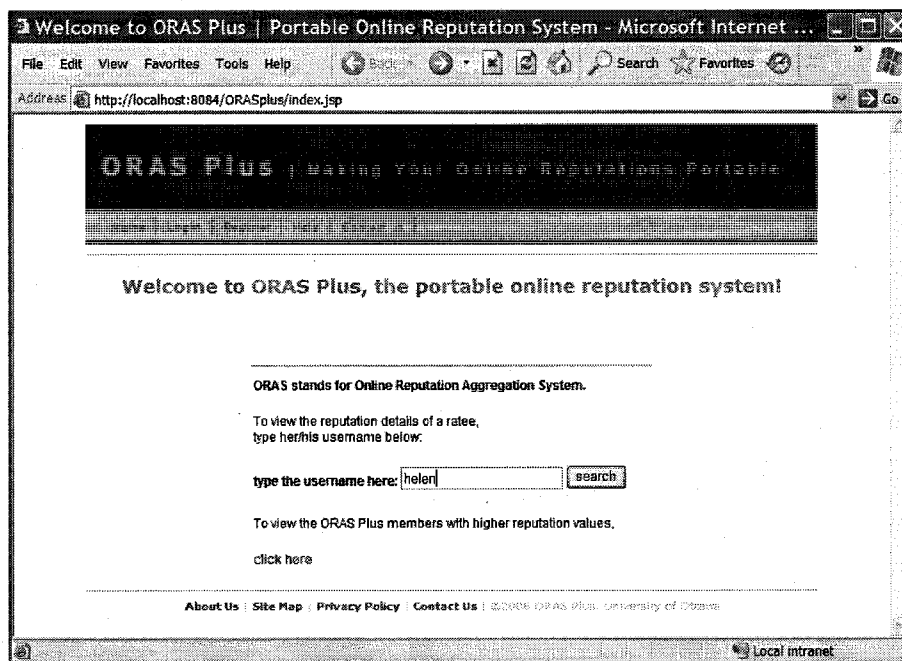


Figure 6.3 JSP Page - index.jsp with Username Helen

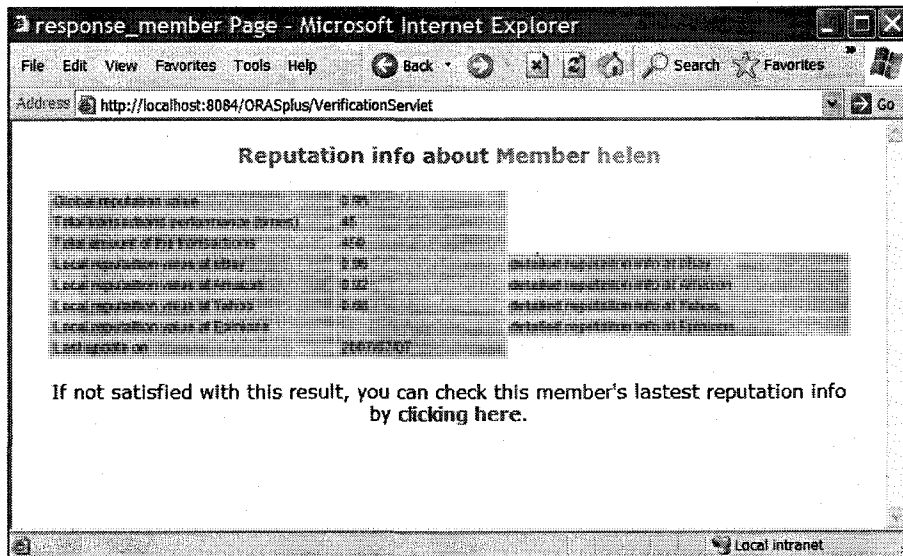


Figure 6.4 JSP Page - res_member.jsp

If the queried individual, say Bob for instance, is not a member, verification Module will forward the request to Collection Module which consists of the Web service clients for consuming the Web services provided by partner online communities such as Amazon, eBay and Yahoo. The Web services generate some text files under Bob's username if they have his reputation information. Each text file contains the information about the transactions Bob has performed within that community, including the time and size of each transaction, the feedback on each transaction and the credibility of the rater who left the feedback in each transaction.

Collection Module stores the above information in Raw Data DB and then forwards the request to Mapping Module and Aggregation Module respectively where the feedback values are converted into universal formats and local reputation values and a global reputation value for Bob are computed. The results will be shown on a JSP page, res_user.jsp. These processes are illustrated in the following Figure 6.5 - 6.8.

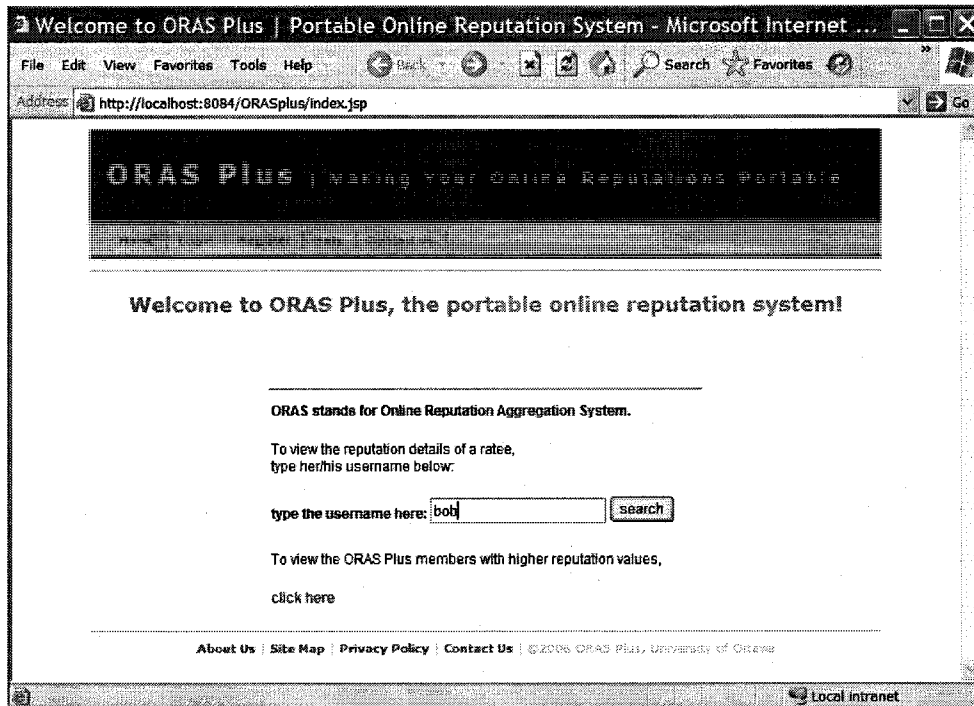


Figure 6.5 JSP Page - Search for the Reputation Information of a User Bob

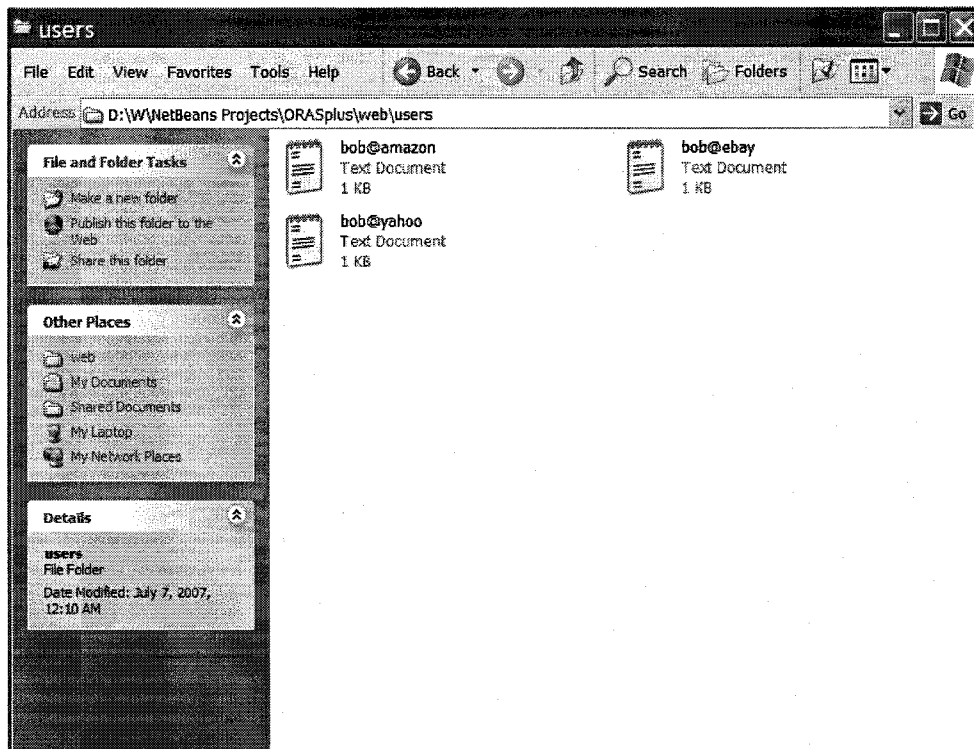


Figure 6.6 Text Files That Contain Reputation Information at Different Online Communities

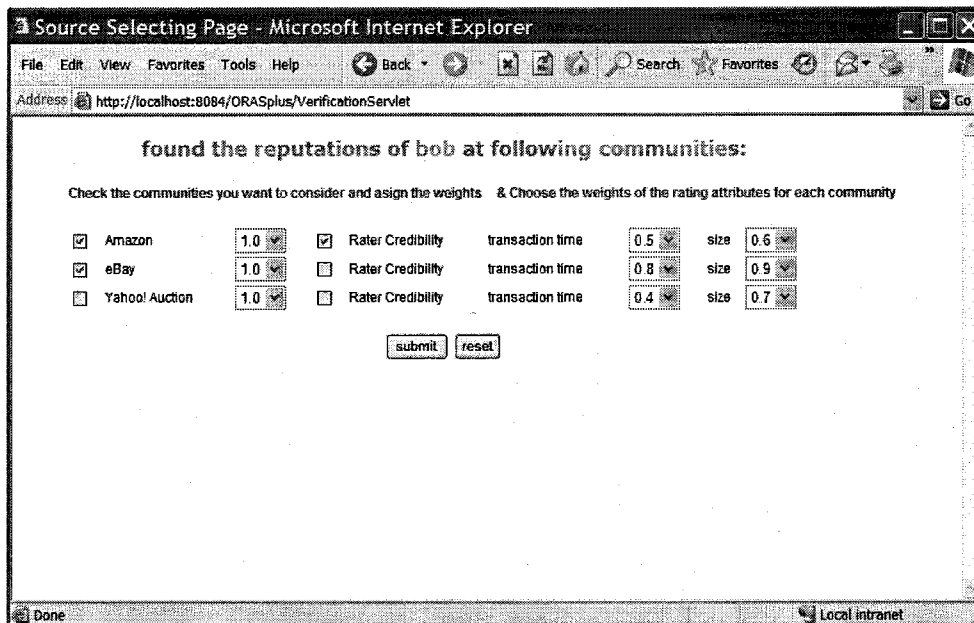


Figure 6.7 Select Personalized Weights for Computing Bob's Reputation Values

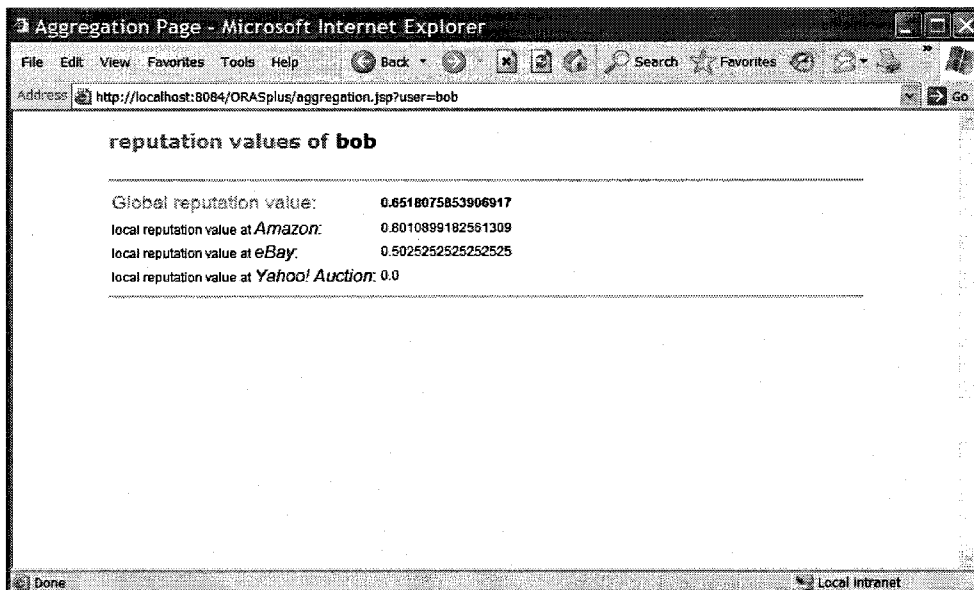
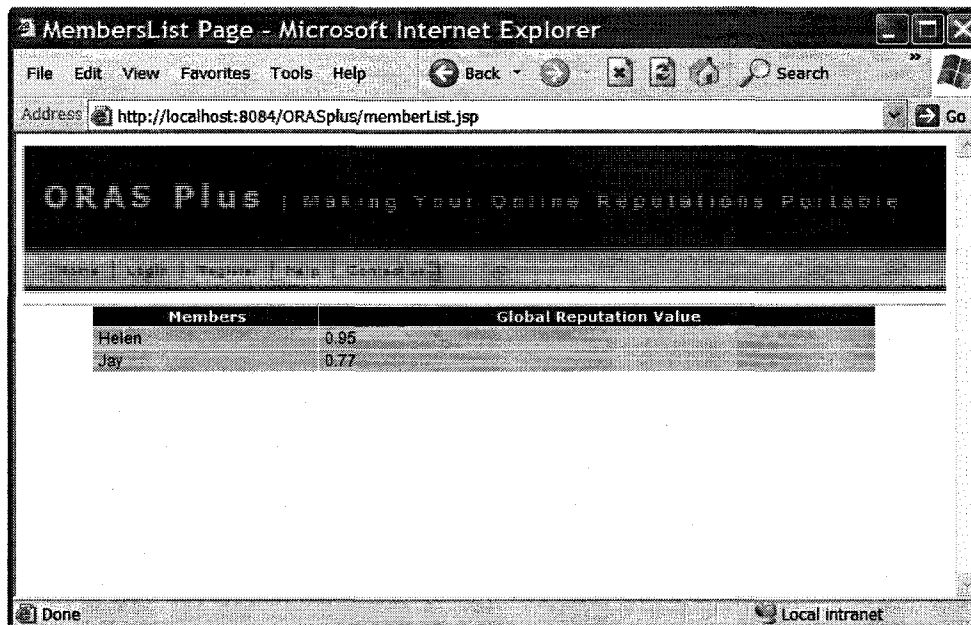


Figure 6.8 JSP Page – res_user.jsp with Bob's Reputation Information

A user can also search for the members with higher reputation values in ORAS Plus. The

result will be returned in a decreasing order of global reputation values. This is illustrated in Figure 6.9 below.



Members	Global Reputation Value
Helen	0.95
Jay	0.77

Figure 6.9 JSP Page – a List of Members in a Rank of Global Reputation Value

Scenario 2: Members

After a member signs in with ORAS Plus, s/he will see her/his profile page and RepCard displayed on it. S/he has the opportunity to promote her/his reputations by posting her/his RepCard on web pages or blogs. For instance, the member Jay can post his RepCard on his blog, <http://jayduan.blogspot.com>. When others click on the RepCard, they will be linked to the reputation information page of Jay. These processes are shown in Figure 6.10, 6.11, 6.12 and 6.13.



Figure 6.10 Login Page

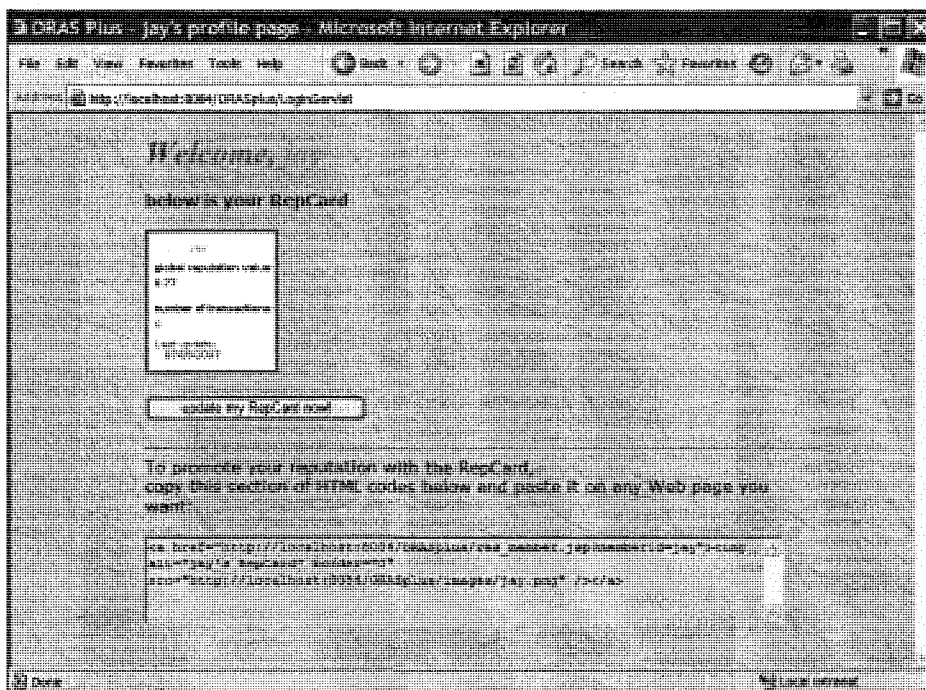


Figure 6.11 A Member's Profile Page

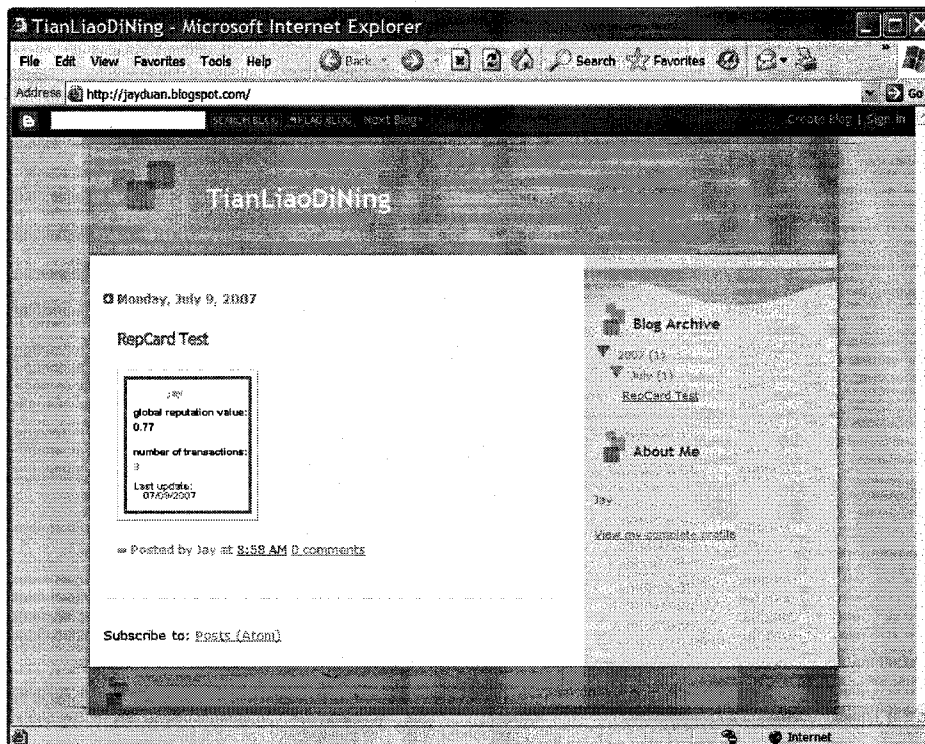


Figure 6.12 Posted RepCard on a Blog

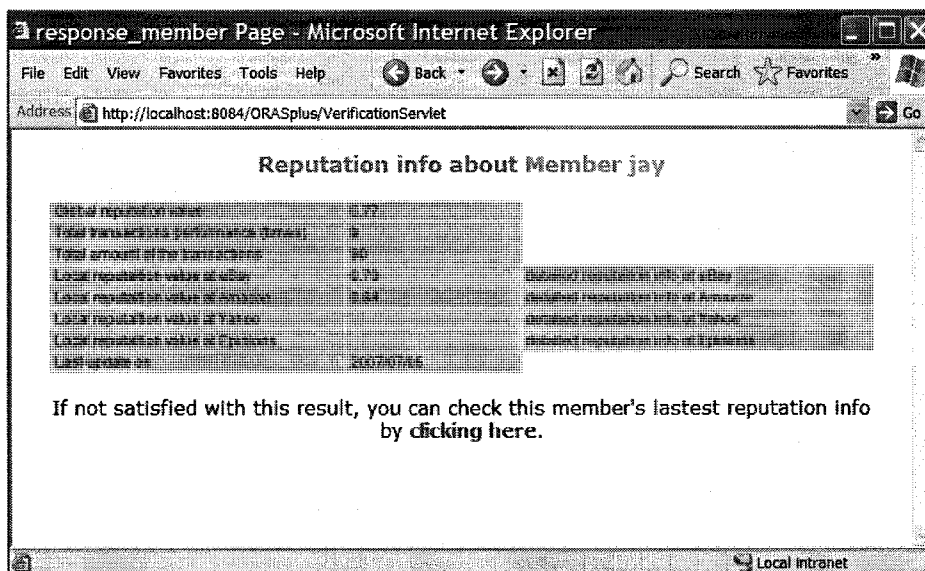


Figure 6.13 Reputation Information Page of Member Jay

Scenario 3: Administrators

ORAS Plus system administrators decide what reputation sources and rating mechanisms from different online communities will be included in the system, and convert the different feedback values into universal ones based on the criteria mentioned in the previous chapter. This scenario is shown in Figure 6.14 to Figure 6.20.

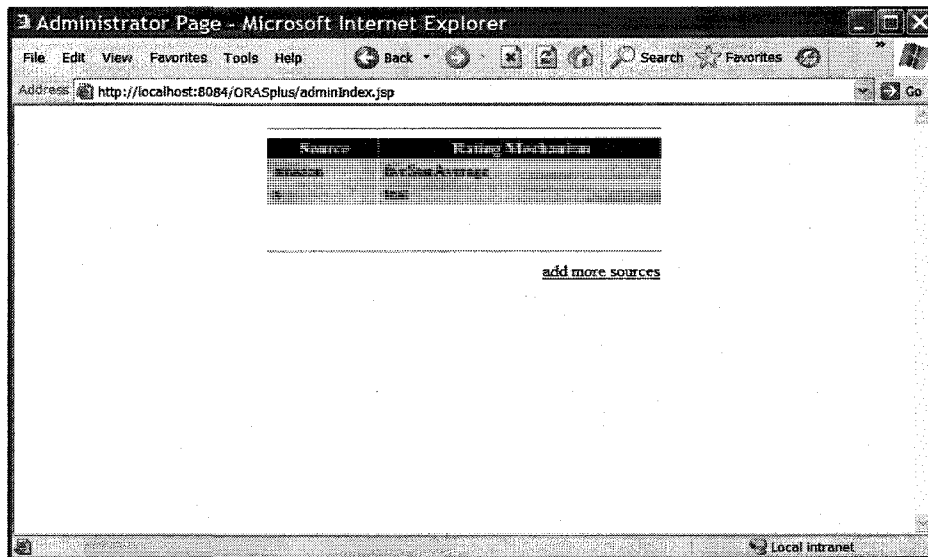


Figure 6.14 JSP Page for Administrators

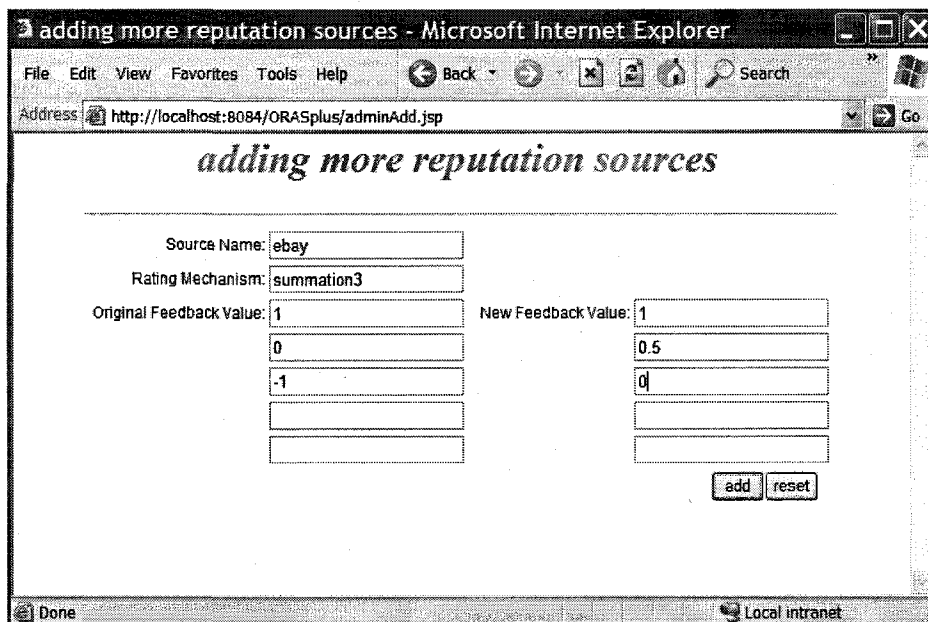


Figure 6.15 JSP Page for Administrators Adding More Reputation Sources

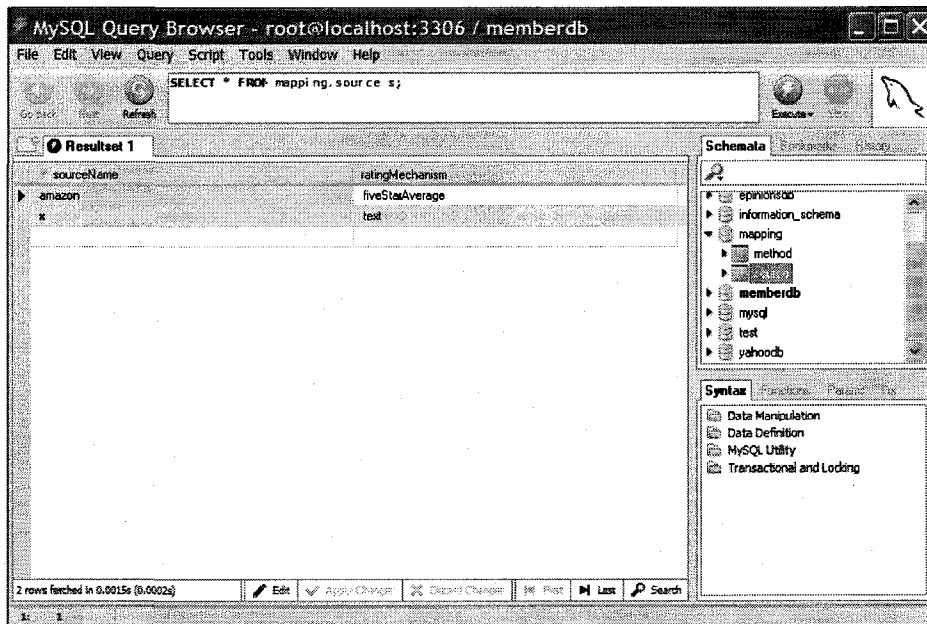


Figure 6.16 Reputation Sources in the Database before Adding a New One

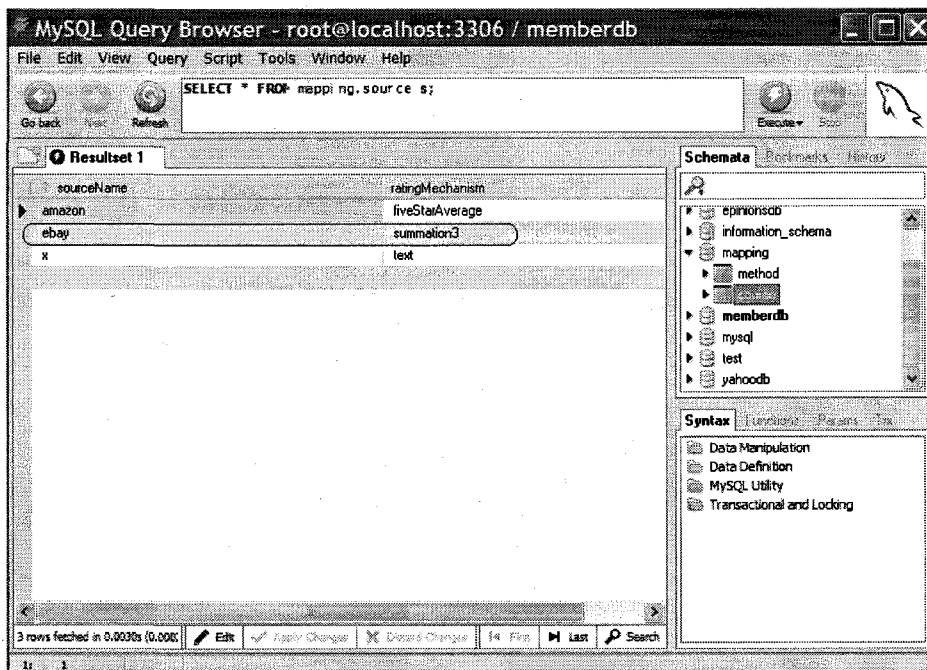


Figure 6.17 Reputation Sources in the Database after Adding a New One

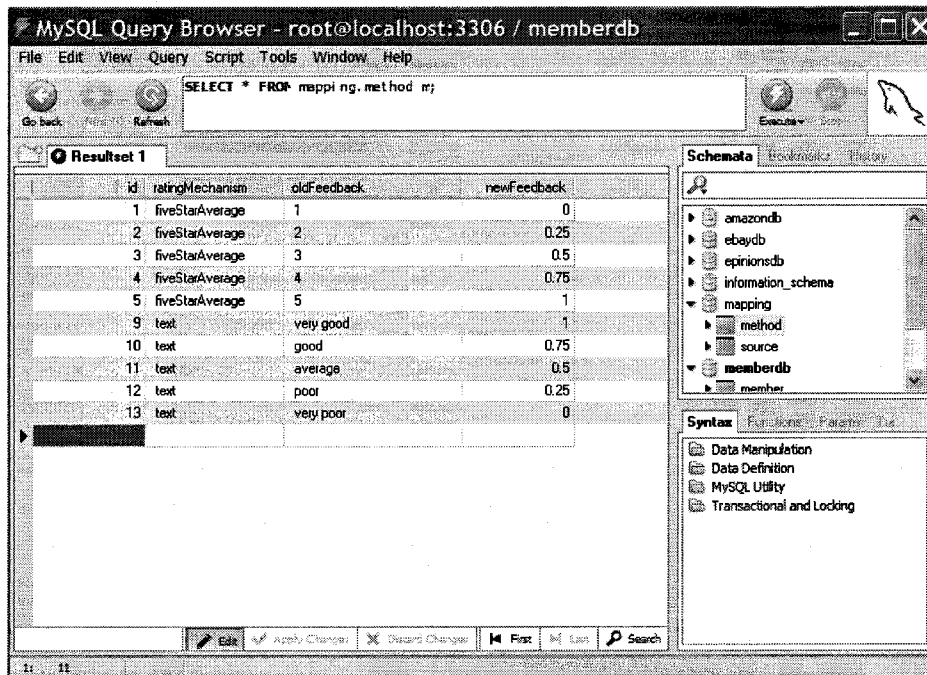


Figure 6.18 Rating Mechanisms in the Database before Adding a New One

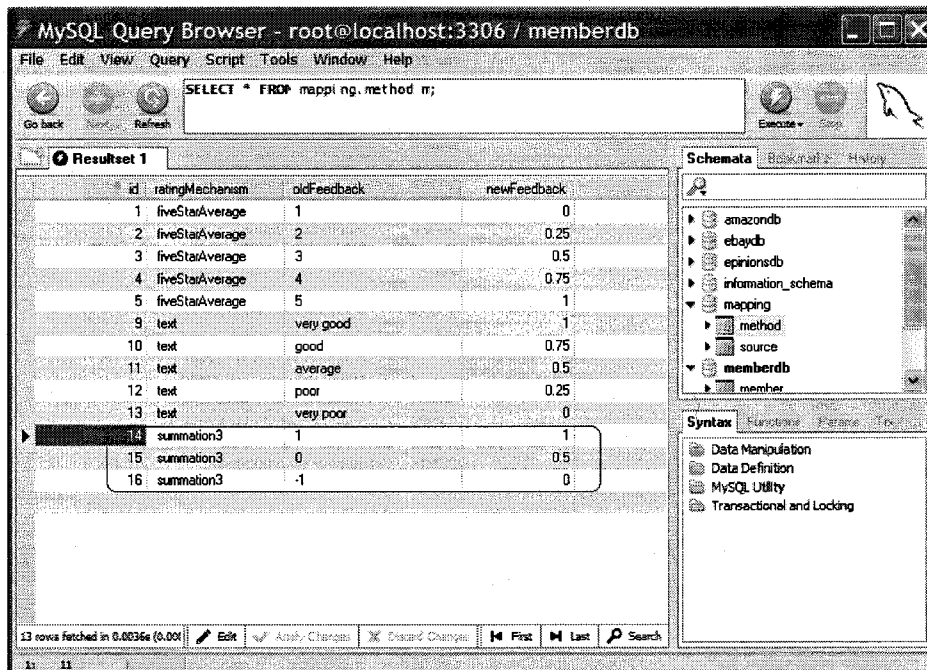


Figure 6.19 Rating Mechanisms in the Database after Adding a New One

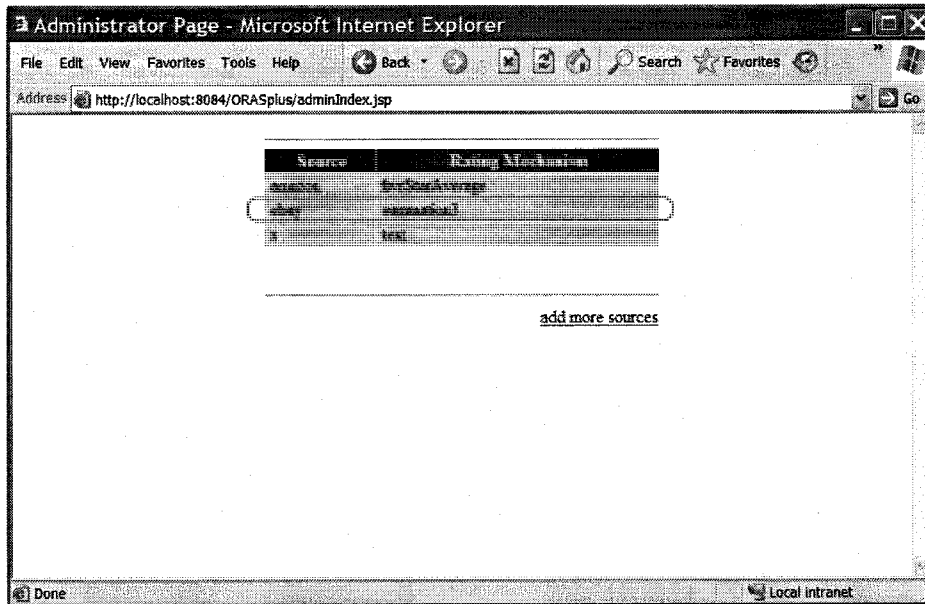


Figure 6.20 JSP Page for Administrators after Adding a New Reputation Source

Chapter 7

Conclusion and Future Work

7.1 Conclusion

In previous chapters, we conducted a study on online trust and reputation systems, analyzed their relationships and importance in e-commerce and online interactions, and accomplished a literature review on the portability of online reputation. In addition, we found some interesting industry solutions that try to address the issue. The online businesses, RapLeaf, iKarma, Opinity and Authorati, implement the portability of their reputation systems in a very similar way which is allowing their members to add an image or a web widget into blogs or Web pages. When a Web user clicks on those images or widgets, s/he will be linked to the member's profile page.

We also designed a prototype of a portable online reputation system, ORAS Plus, in which the reputation card called RepCard represents the portability of the system. The RepCard provides members the opportunity to promote their online reputations in a manifest way with summarized reputation information. Members can post it on blogs, web pages, or wherever they want people to see their online reputations.

7.2 Limitations and Suggestions for Future Work

ORAS Plus is only a prototype, therefore the issues such as security, scalability, reliability and reusability should be carefully considered in the future. For now, we outline the

following limitations and suggestions.

Firstly, mappings for different types of reputation data are incomplete. By far we only have done the mapping for the feedback values from different online communities. Other data such as the types of the time, volume of the transactions are different from one community to another and should be mapped before computation by the aggregation module.

Secondly, context should be considered as a very important factor when ORAS Plus is providing portable online reputation services. For instance, does a ratee have a good reputation as a seller, a writer, or an expert? Such questions reflect a substance of reputation that reputation makes sense in a given context only.

Thirdly, as the saying goes, “on the Internet, no one knows you are a dog”. Online identity is a huge problem for establishing trust and collaboration in online interactions. In the future, a novel and robust online identity management module could come into effect in the architecture in order to address the online identity issue.

Finally, with proper designs, the model of the portable reputation system could be applied on portable devices like cellular phones, PDAs, etc. And also, more services could be added into the system to serve members better. For instance, members would have the option to add particular individuals as favorite interaction partners.

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