



## Short Paper

Towards a trust, reputation and recommendation meta model<sup>☆</sup>

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## ABSTRACT

New trust, reputation and recommendation (TRR) models are continuously proposed. However, the existing models lack shared bases and goals. For this reason, in this work we define an innovative meta model to facilitate the definition and standardization of a generic TRR model. Following the meta model, researchers in the field will be able to define standard models, compare them with other models and reuse parts of them. A standardization is also needed to determine which properties should be present in a TRR model.

In accordance with the objectives we were seeking, following our meta model, we have defined a pre-standardized TRR model for e-commerce, identified the fundamental concepts and the main features that contribute to form trust and reputation in that domain, respected the dependence on the context/role of trust and reputation, aggregated only homogeneous trust information; listed and shown how to defend from the main malicious attacks.

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## 1. Introduction

Recently, it has become of paramount importance to obtain information about trust and reputation of online service providers as well as of other users. In practice, there is the need for a support to make relatively better *trust-based choices*. Of course, as we are in an area where subjectivity plays a predominant role, the optimal point actually does not exist and the best choice is not easy to spot. In recent years there have been numerous studies aimed at understanding how to manage online trust and reputation. Nevertheless, in our opinion, all of these studies have not gone in the same direction. In fact, according to [1–4], we recognize the lack of shared bases and goals. Authors in [5] also recognize the lack of a unified research direction and note that there are no

unified objectives for trust technologies and no unified performance metrics and benchmarks.

In fact, there are many models in the literature that treat trust and/or reputation contradictorily. For instance, some models use calculation methods based on the transitivity of trust while some authors demonstrate that trust is not transitive but propagative [6]. Other models calculate trust/reputation without taking into account properties deemed essential by some authors (e.g., context-specific, event-sensitive, etc.) [6,7].

Lastly, differently from other areas of computer science, there is not a well-defined set of testbeds for comparing models [2]. Validations are not performed through a comparison of the results with other models because often they are neither reproducible nor comparable [8]. Almost always the data are not shared and therefore validations use different data even in the same application domain [9]. It rises from the above reasons the urgency of reaching a standard trust and reputation model.

In this paper we lay the foundation for the formulation of a meta model to be shared with researchers in the field,

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defining properties, characteristics, methods and best practices to which trust, reputation and recommendation (TRR) models should be compliant. We draw inspiration from similar proposals in the literature [3–5,10]. Our meta model is also the result of a critical review in which we have recognized strengths and weaknesses of the most important existing TRR models [7,11,12].

However, differently from the above cited works, we define a meta model with real requirements for the definition of TRR models. The main purpose of the meta model is to facilitate the definition of a generic TRR model. In fact, the meta model explains how to create, step-by-step, a compliant model. Among others, a standardization is needed to determine the fundamental properties which must be present in a TRR model, thus avoiding that the models do not take them into account. Designing a TRR model in a standard manner will also facilitate the reuse of some of its parts.

Another goal is to introduce a pre-standardized TRR model for e-commerce. Obviously our model does not claim to be final, since the intention is to propose a basis on which researchers will be able to discuss and, “speaking the same language”, establish a common objective and select the best proposals [7].

The paper is organized as follows: we firstly describe related work in Section 2. Then, in Section 3, we present our meta model. In Section 4, following our meta model, we introduce a pre-standardized TRR model for e-commerce. Finally, in Section 5 we draw some conclusions and outline future work.

## 2. Related work

Several papers [6,7,13] review the most important TRR models. Conversely, to the best of our knowledge, only a few propose meta models to facilitate the definition of standard models. Many authors, among which [1–5,14], emphasize the lack of common understanding and shared description in trust models.

Authors in [3] describe an interesting pre-standardized approach for trust and/or reputation models for distributed and heterogeneous systems. They also survey several representative trust and reputation models, describing their main characteristics, with the objective of extracting some common features from them in order to obtain a set of recommendations for a pre-standardized process. In their view, a generic model should consist of the following five components: *gathering behavioral information*; *scoring and ranking entities*; *entity selection*; *transaction*; *rewarding and punishing entities*.

Authors in [14] deal with the *federated trust management*. Trust management in federated environments, as in service-oriented architecture (SOA), will introduce additional complexity. In these environments, it is necessary that different trust management systems can interoperate. Complexity increases because, as many authors complain, there is no consensus on what constitutes the trust. There is the need for a way of representing trust that may be understood by all parties involved. Authors also stress the need for a shared understanding and they identify important aspects of trust frameworks. In order to systematically

study the requirements rising from federated trust management, they classify these problems into five aspects: *trust representation*, *trust exchange*, *trust establishment*, *trust enforcement* and *trust storage*. Then they propose a conceptual architecture for federated trust management.

An approach for building a generic trust model, called *UniTEC*, is also described in [5]. Authors identify the following dimensions of the trust relationship: *trust measure*; *trust certainty*; *trust context*; *trust directness*; *trust dynamics*. Then, they map these concepts on the components of their generic trust model. With this approach, built on the observation, the outcome of each trust model can be mapped onto *UniTEC* and it is also possible to compare models with each other. However, during mapping to the generic trust model details of the trust model are lost [4].

Authors in [4] created a generally applicable meta model, called *TrustFraMM*, which aims at creating the common ground for future trust research in computer science. As authors declare, their meta model was born from the idea of identifying identical functionalities in different available trust frameworks. Using their meta model any trust framework can be described as a set of standard elements of the *TrustFraMM*. The authors expect to get several common implementations so that it will be possible to apply Model Driven Architecture to trust management. This way, it will be easier for researchers and developers to find new solutions also in domains that have not yet been explored. The proposed meta model is only at its first version. The authors plan to further detail the identified elements taking into account the proposals of the other researchers.

In [1] the *TrustFraMM* meta model is extended to be used in the design process. The authors describe a systematic approach for the design of trust frameworks. The basic idea is that in trust framework design there are typical aspects that restrict the possible solutions. For this reason, the authors believe that, by using tested and approved procedures, the design of a trust framework is an exploratory process. Therefore, a designer can select the elements of *TrustFraMM* suitable for his/her specific implementation.

An investigation of trust-based protocols in mobile ad-hoc networks is reported in [15]. The authors also provide a set of properties and essential concepts that should necessarily be considered by trust framework designers in these environments. In addition, methods for the management of trust evidences are categorized. Although some concepts are only briefly exposed and not explained in detail [4], the work provides some important insights on trust management.

As remarked in [16,17], the existing works do not well address how to request and obtain recommendations and how to manage attacks and protection mechanisms. Several authors including [18] showed that a significant number of trust and reputation systems could easily be “cheated”, revealing inconsistencies in their validation process. Our meta model, besides identifying some crucial aspects in the building of trust/reputation, addresses researchers on how to “think of” and define a standard TRR model. The meta model “forces” to deal with some fundamental aspects which are often neglected in many of the proposed TRR models.

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