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Trust-Based Access Control Model for Decision Making under Uncertainty using Fuzzy Logic

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ABSTRACT

Cloud Computing is an emerging and flexible computing field where autonomous decision-making plays a vital role in establishing trust between different systems and players involved. Trust plays different role in different context. In cloud computing, Trust is a measure that can't be derived only based on facts but also on belief to a greater extent. And hence the parameters for calculating trust are qualitative and uncertain. This paper proposes a fuzzy based trust access control model which helps to take decision in uncertainty and also an architecture for Trust/Risk based access control mechanism. Experience, previous interactions made by the user; knowledge about the users' action and systems involved are the parameters used to calculate the trust factor. MATLAB7.0 is used to validate and demonstrate the results.

Keywords: Cloud Computing, Trust, Uncertainty, Access Model, Fuzzy.

1. INTRODUCTION

Cloud computing is a pervasive paradigm where trust plays a major role. In typical scenarios, there is always a need for the user and the data owner to trust the CSP (Cloud Service Provider) and vice versa [1]. This makes storing sensitive data in the cloud a challenge. Since some of the parameters used to calculate trust are qualitative, it is imperative that such parameters are converted into quantifiable ones to determine the real trust factor. Trust mainly revolves around the concept Risk and Uncertainty.

Risk applies to situations when one is unsure of the outcome but the odds are known. Whereas Uncertainty is applied when one is unsure of the outcome and the odds are unknown [2]. Computational trust model of evidence and reputation is used to transform this uncertainty to risk, which is used in EU SECURE. In calculating trust taking parameters which are uncertain, the proposed model uses fuzzy trust by considering parameters such as Experience(E), Knowledge(K) and Recommendation (R), which are collectively called as Evidence(Ed) in a particular context.

Fuzzy is a tool for making decision during uncertain scenarios. In calculating Trust, credibility is important that is calculated using the proposed fuzzy logic. To quantify the trust, Fuzzy member function proposed by Lotif A.Zadeh is used,

Fuzzy membership function, μ_A: X $\rightarrow$ [0, 1]

This paper is organized as follows: Section 2 - Literature Survey, Section 3 - Decision Making under Uncertainty, Section 4 - The Work flow graph of the proposed work, Section 5 - Proposed Architecture for Trust/Risk Based Access control, section 6 - Mathematical Model for the Proposed System, Section 7 - Implementation and Result Section 8 - Conclusion.

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2. LITERATURE SURVEY

In paper [3], fuzzy TOPSIS method along with fuzzy multi-criteria method is used in calculating performance of a computer system. A matrix representation of fuzzy soft set is used in solving a decision problem is emphasized in paper [4]. Paper [5] deals with a decision making problem in selecting suitable supplier in supply chain management and proposed a solution by combining VIKOR algorithm (Vlse Kriterijumska Optimizacija Kompromisno Resenje) and Multi Attribute Decision Making (MADM) TOPSIS method. Paper [6] illustrates various QOS parameters, QOS requirements, services and fuzzy inference system using these parameters to ensure service selection. A trust evaluation model based on reputation and experience is proposed to select unknown peers in peer-to-peer network [7]. Paper [8] presents an easier method for ranking of generalized trapezoidal fuzzy numbers. Fuzzy Analytic Hierarchy Process is used in getting customer requirements and incorporating it in designing vehicle is done in [11].

3. DECISION MAKING UNDER UNCERTAINTY

Trust models have been touted to facilitate cooperation among unknown entities. Existing behavior-based trust models typically include a fixed evaluation scheme to derive the trustworthiness of an entity from knowledge about its behavior in previous interactions. But this is not enough to calculate the trust value. In the proposed model trust is calculated with parameters like Experience (E), Knowledge (K) and Recommendation (R). These parameters are qualitative in nature and not quantitative. To quantify the above parameters, Fuzzy member function is used and to defuzzify, centroid method is used. The evidence is being calculated for making decision. The following is the conceptual framework for fuzzification and defuzzification of parameters:

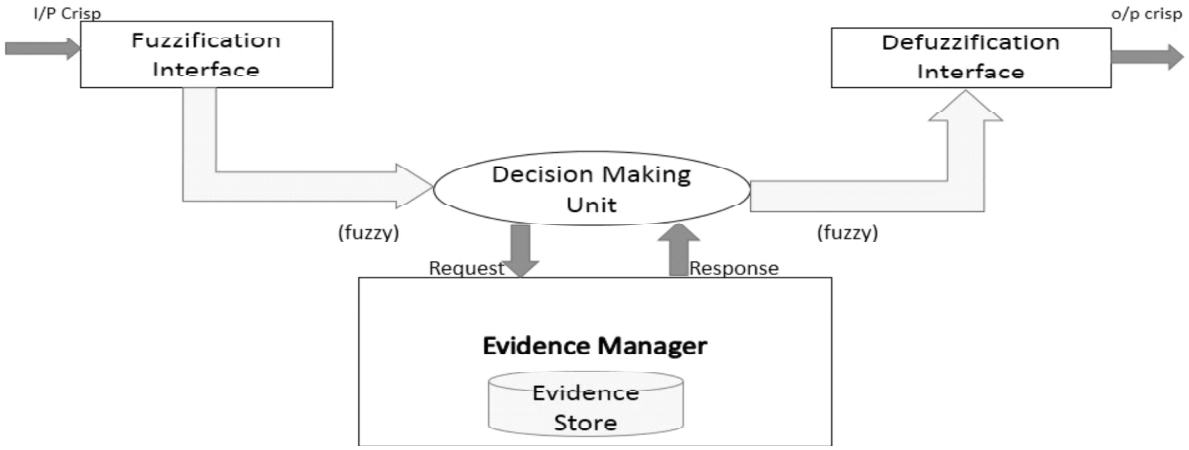

Figure 1: Proposed Fuzzy Model

4. THE WORK FLOW GRAPH OF THE PROPOSED WORK

The work flow and Pseudo code of the proposed work is given Figure 2.

A. Pseudo code for the work flow graph

Step 1: Request is made by the User to cloud service provider (CSP).

Step 2: Trust is calculated by the Trust Manager using Fuzzy Logic.

Step 3: Trust is calculated by the parameters Experience, Knowledge and Recommendation.

Step 4: Defuzzification is done by centroid method.

Step 5: The calculated trust value is checked against the threshold value.

Step 6: If the calculated trust value is greater than the acceptable threshold value, grants will be given else rejected.

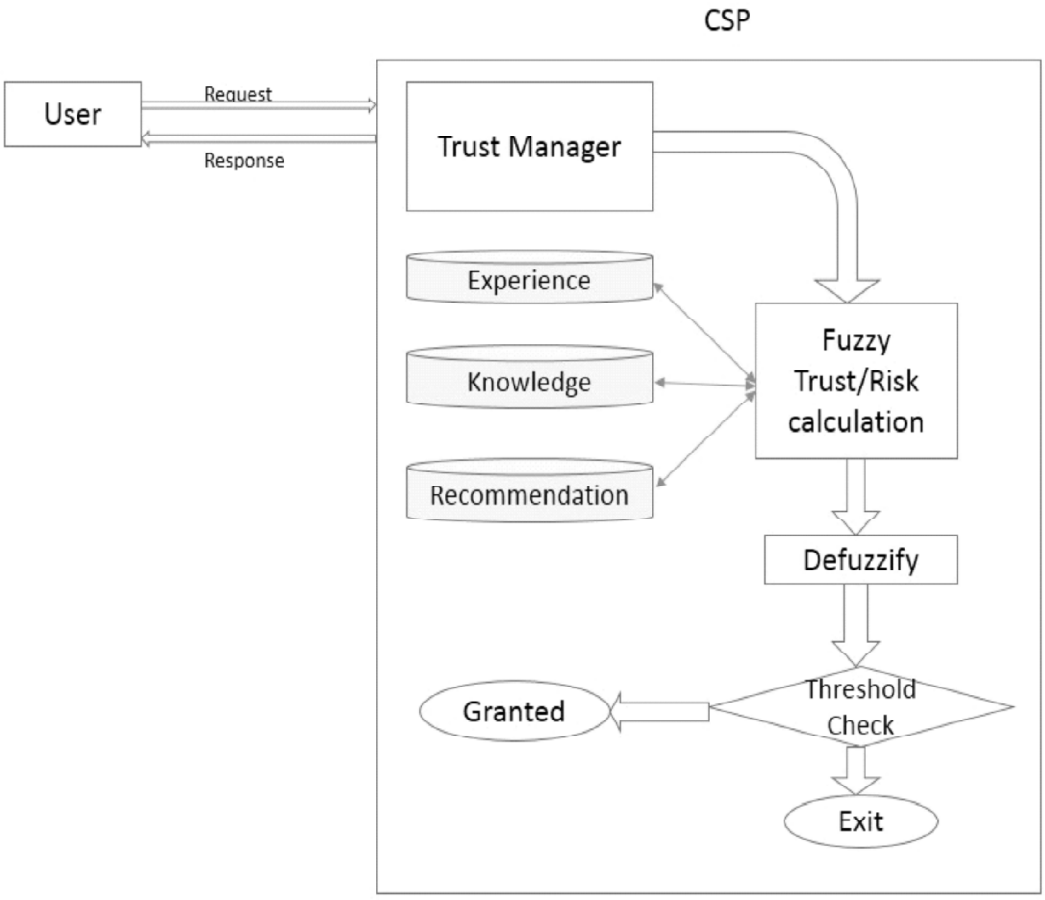

Figure 2: Proposed Work Flow Graph

5. PROPOSED ARCHITECTURE FOR TRUST/RISK BASED ACCESS CONTROL

In the proposed framework Figure 3, there are six layers namely Data Layer, Service Layer, Integration Layer, Process Layer, Channel Layer and Device/Presentation Layer. In Data Layer, Security Policy of the consumer, Identity & Entitlements and Credentials of the user are stored. In the Service Layer, Security Policy enforcement components like Identity Information Service, Policy Information Service, and Security Session Service along with Risk-Based Authorization Decision are maintained.

These services provide information to support decision making at the enforcement points. Authorization may occur at any layer, either in the form of a Trust Interceptor on entry to the layer or as Security Controls within the layer. Automated Response, Threat Trigger, Fraud Management are done in the Process Layer. Threat assessment is done in the Integration Layer. In the proposed architecture, Trust/Risk-Based Authorization decision point plays a vital role in guiding authorization decision.

6. MATHEMATICAL MODEL FOR THE PROPOSED SYSTEM

The Evidence Based Trust/Risk model is calculated using the parameters Experience (EX), Knowledge (KN) and Recommendation (RC)[1].

$$\text{Experience, } (EX)_c = \frac{\Sigma_{k=1}^{n} V_k}{\Sigma_{k=1}^{n} |vk|}, \ (EX)_c \in [-1,+1] \quad (1)$$

Where C – context; V_k-Record of previous interactions

$$\text{Knowledge, } (KN)_c = W_d.d + W_r.r \quad (2)$$

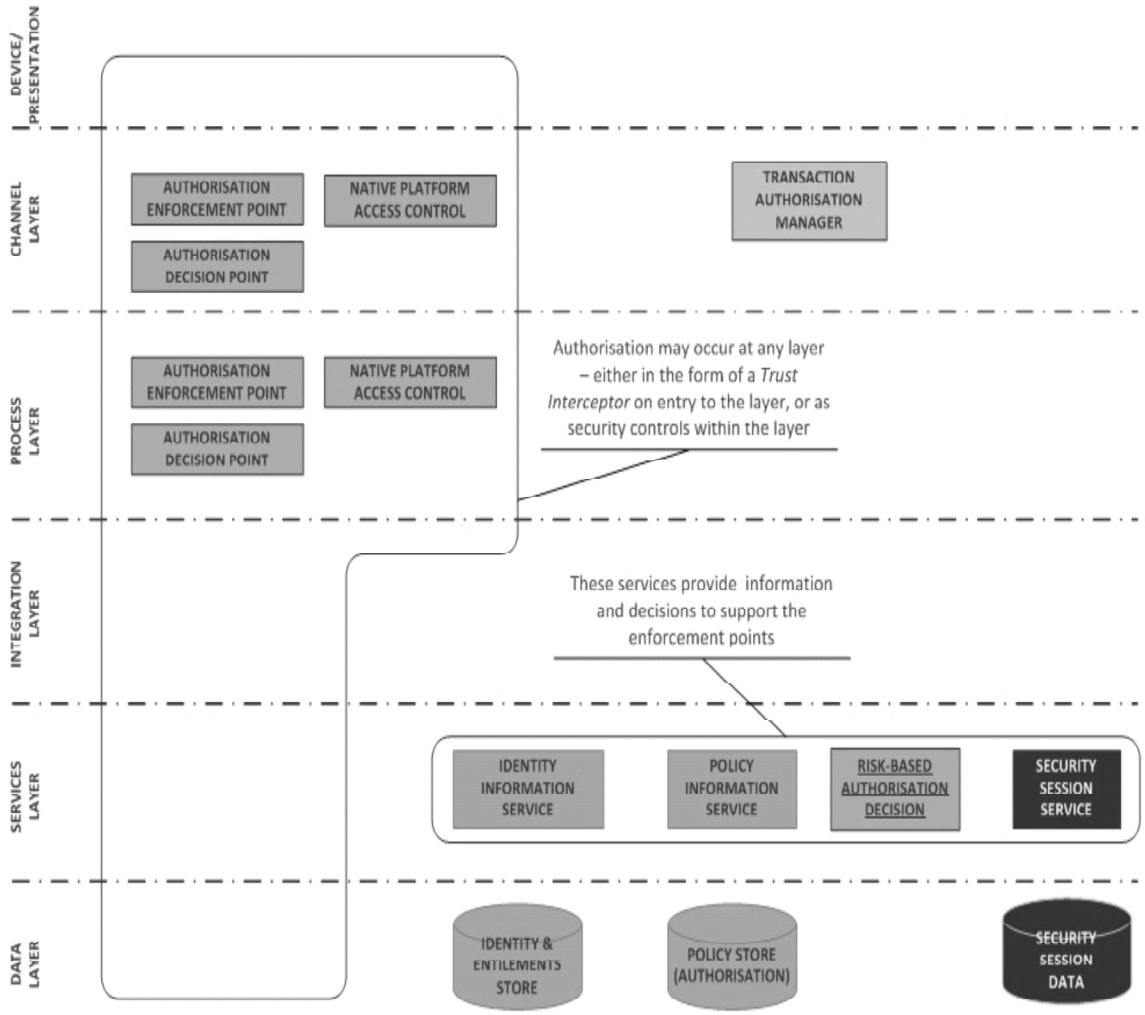

Figure 3: Architecture for Trust/Risk Based Access Control

Where d, r $\in$[0,1] & W_d+W_r=1,W_d & W_r are the corresponding weight.

$$\text{Recommendation, } (RC)_c = \frac{\Sigma_1^n w_i \, r_{c_i}}{\Sigma_1^n (r_{c_i})} \tag{3}$$

Where $r_c \in [-1,1]$, $w_i \in [0,1]$, w_i – weight assigned and $(r_c)_i$ is the recommendation of the ith element.

The Knowledge is calculated in either one of the two ways (i) Performance based (perf_T) or (ii) Belief based (Belief_T). And Recommendation is calculated using Recom_T. These procedures are discussed in the previous work [1].

7. IMPLEMENTATION AND RESULT

MATLAB 7.0 is used for the implementation of the proposed solution. The result is obtained by using Mamdani method. The input and output sets of the proposed model are Input={Low,Medium,High} and the Output={VeryLow(VL), Low(L), Moderate(M), High(H), Very High(VH)}. Using IF – AND linguistic fuzzy method the result is calculated.

Thus the result using Mamdani method is based on the Linguistic Descriptor Table 1 where input1 is EX, input2 is KN and input3 is RC respectively.

Table 1
Linguistic Descriptor

Trust (T)	*Lower Value*	*Higher Value*
VH	0.8	1.0
H	0.6	0.7
M	0.4	0.5
L	0.2	0.3
VL	0.0	0.1

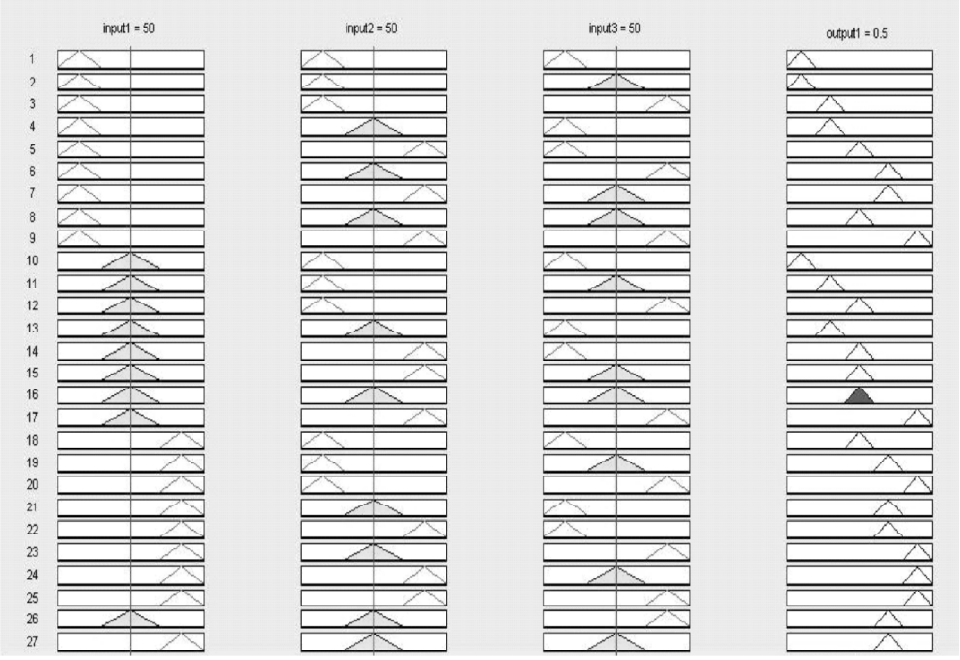

Figure 4: Sequential Process of all the outputs

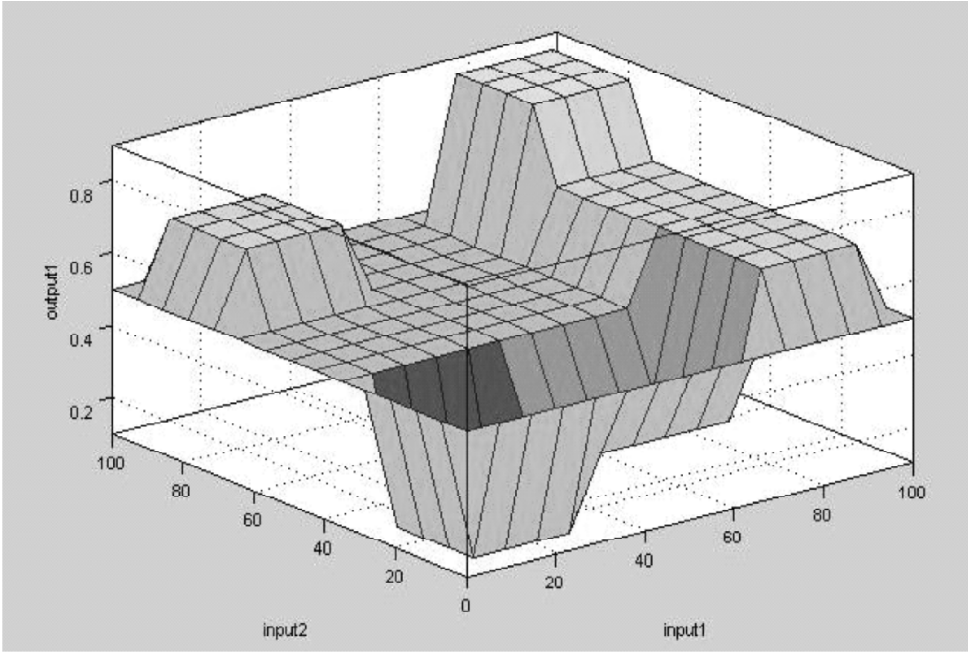

Figure 5: Aggregated Result of the outputs

8. CONCLUSION

Many methods have been developed for calculating trust in cloud environment. Trust management is a complex system having parameters comprising of uncertainties and ambiguities. In ensuring the trust, identifying the factors affecting trust is very important. Since many parameters are uncertain, fuzzy based decision is used. In this paper, a new model for calculating Trust is proposed and the result of the model is also obtained using Mamdani method. The parameters used in this work shows how much a cloud service provider can trust the cloud user. In future, more parameters will be added to ensure the trust of the user.

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