A Practical Framework for Policy Composition and Conflict Resolution

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ABSTRACT

In collaborative environments where resources must be shared across multiple sites, the access control policies of the participants must be combined in order to define a coherent policy. The relevant challenge in composing access policies is to deal with inconsistencies or modality conflicts. This difficulty exacerbates when the policies to compose are specified independently by different entities with no global power to decide in case of conflicts which entity must take precedence. This paper presents a semi-automated framework called Policy Composition and Conflict Resolution framework (P2CR) to address this issue. They focus on access control policies expressed as XACML statements. The authors propose a three-level conflicts resolution strategy: i) by using metadata added to the policies, ii) by using a defeasible logic theory, and iii) by providing recommendations to the entities owners of the resources. First, they provide a mechanism to add metadata to XACML. Second, they combine the access policies without prioritizing any of the entities involved in the composition. Given the context of the authors' work, they consider this approach to be more suitable than the current approaches that are mainly negotiation-oriented or assign priorities to the policies. Finally, the resulting composite policy appears flexible and easily adjustable to runtime conflicts.

Keywords: Annotations, Conflict Detection, Conflict Resolution, Defeasible Logic, OWL, Policy Composition, XACML

1. INTRODUCTION

Recent years have witnessed a growing number of special-purpose communities in which different organizations (or tenants) with common interests and needs interact and share pools of configurable resources governed by a cloud service provider. Community clouds have many advantages. They enable organizations that are technologically different and geographically separated to collaborate in a seamless manner. However, they can be difficult to manage especially when the tenants have differing access policies. The diversity of the policies of the entities may lead to serious obstacles in establishing a safe collaboration within the cloud. An important requirement for precisely achieving this goal is that each entity, tenant
as well as cloud service provider, abides by the security, compliance and risk management requirements of the others. Thus, to allow the entities to interact safely, their access policies must necessarily be compared and composed.

In this paper, leveraging the community clouds as an illustrative example, we address the policy composition problem in a broader scenario in which different entities are interested in composing their independently stated policies while retaining their autonomy i.e., maintaining the control over their resources. A non-trivial challenge generally faced in this context is the occurrence of conflicts. Two access policies may apply to same objects and yield upon request of the objects contradictory evaluation results. Access control systems governed by such policies cannot deterministically decide whether to grant access to the requested objects or to deny the access. Consequently, they may even allow certain users to access resources they are not authorized for or deny the access to the legitimate ones. Thus, to enable access policies in individual systems to unambiguously evaluate users requests, many conflict resolution strategies have been proposed.

However, in situations where several autonomous entities want to integrate their independent access policies, these strategies are limited. Conflicts that occur in this scenario are difficult to eliminate because of the diversity of the policies of the entities, and more importantly because of the conflict resolution strategies that they use. Currently, no effective technique exists for resolving these conflicts while the policies are being integrated. An intuitive approach could however be to pick the conflict resolution strategy of a random entity and adopt it as the conflict resolution technique of all the policies. Unfortunately, because each entity enforces the strategy it finds more suitable to its needs, such an approach would result in many cases inconclusive. A typical example is two entities, $A$ that applies the Deny-overrides (XACML, 2005) scheme to restrict access to its resources, and $B$ that uses the Permit-overrides (XACML, 2005) method to ensure the availability of its data. In this case, if the strategy that $B$ uses is applied, then resources of $A$ may be accessed by unauthorized users. Conversely, if we opt for the strategy of $A$, then access to resources of $B$ may be severely restricted.

Over the past years, considerable work in composing independently stated access policies has been done (Bertolissi & Fernandez, 2008; Bonatti, Vimercati, & Samarati, 2000; Bruns, Dantas, & Huth, 2007; Lin, Rao, Bertino, & Lobo, 2010; Lupu & Sloman, 1999; Mazzoleni, Bertino, & Crispo, 2008; Ni, Bertino, & Lobo, 2009; Rao, Lin, Bertino, Lui, & Lobo, 2009). The approach common to many of the proposed studies is to combine these policies based on the priorities they are assigned with. Assigning priorities to policies is however difficult, and understanding them even more because the priorities are generally represented as numbers and no semantic is attached to them to reflect their meaning (Agrawal, Giles, Lee, & Lobo, 2007; Lee, Boyer, Olson, & Gunter, 2006). In addition, in many studies, the composite policy resulting from the integration of the policies is enforced in only one point. What this entails is either the party that administers the single point of enforcement is heading all the entities, or it is mandated by them to combine their individual access policies and to manage the resulting policy. However, entities that are interested in combining their policies may be under the authority of different parties or reluctant to part with the administration of their resources. Lastly, in many proposals, conflicts are detected manually (e.g., Agrawal et al., 2007) and their causes usually overlooked (e.g., Mazzoleni et al., 2008), and in order to eliminate the conflicts, access to resources to which conflicting policies apply are denied. However, such an approach is limited. First, without a precise knowledge of what causes a conflict it is difficult to guarantee the effectiveness of the solution that one would adopt to resolve the conflict. Moreover, in a
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